TECHNISCHE UNIVERSITÄT MÜNCHEN

Lehrstuhl für Volkswirtschaftslehre – Umweltökonomie und Agrarpolitik

Spatial competition of food processors in pure and mixed markets under uniform delivered pricing

Christoph Tribl

Vollständiger Abdruck der von der Fakultät für Wirtschaftswissenschaften der Technischen Universität München zur Erlangung des akademischen Grades eines

Doktors der Wirtschaftswissenschaften (Dr. rer. pol.)

genehmigten Dissertation.

Vorsitzende:	Univ.-Prof. Jutta Roosen, Ph.D.
Prüfer der Dissertation:	1. Univ.-Prof. Dr. Klaus Salhofer
	2. Univ.-Prof. Dr. Alfons Balmann, Martin-Luther-Universität Halle-Wittenberg

Die Dissertation wurde am 07. 05. 2012 bei der Technischen Universität München eingereicht und durch die Fakultät für Wirtschaftswissenschaften am 15. 07. 2012 angenommen.

DANKSAGUNG

Mit dem Abschluss meiner Dissertation möchte ich allen herzlich danken, die das Gelingen dieser Arbeit möglich gemacht haben:

Herrn Prof. Dr. Klaus Salhofer für spannende und lehrreiche Vorlesungen während meiner Studienzeit, für die Motivation, am Lehrstuhl mitzuarbeiten und eine Dissertation zu verfassen, für die Unterstützung bei fachlichen Fragen, für viele Anregungen und hilfreiche Diskussionen.

Herrn Prof. Dr. Alfons Balmann für wichtige Hinweise und fachliche Diskussionen bei verschiedensten Treffen im Rahmen der Arbeiten an der Dissertation.

Frau Prof. Dr. Jutta Roosen für die Übernahme des Vorsitzes der Prüfungskommission.

Danken möchte ich auch allen Kolleginnen und Kollegen am Lehrstuhl für Volkswirtschaftslehre und am Lehrstuhl für Wirtschaftslehre des Landbaues für eine spannende und schöne Zeit in Freising-Weihenstephan, sowie allen Kolleginnen und Kollegen an der Bundesanstalt für Agrarwirtschaft in Wien und am IAMO in Halle für viele Anregungen. Herrn Prof. Richard Sexton von der University of California, Davis, danke ich für zahlreiche wertvolle Kommentare zu Erstfassungen von bestimmten Teilen dieser Arbeit. Herrn Direktor Dr. Hubert Pfingstner von der Bundesanstalt für Agrarwirtschaft danke ich für die Möglichkeit und Unterstützung, die Arbeit neben anderen Projektarbeiten an der Bundesanstalt abschließen zu können.

Nicht zuletzt gilt mein Dank meiner Familie, meinen Freunden und vor allem meiner Frau Christine für die unermüdliche Unterstützung, Motivation und Geduld.

TABLE OF CONTENTS

DANKSAGUNG 2
TABLE OF CONTENTS 3
LIST OF FIGURES 5
LIST OF TABLES 6
LIST OF ABBREVIATIONS 8
ABSTRACT 9
1 INTRODUCTION 10
2 THE DAIRY SECTOR AS AN EXAMPLE OF SPATIAL COMPETITION IN THE FOOD PROCESSING INDUSTRY 13
2.1 Market structure of the milk processing industry 14
2.2 Cooperatives in the food processing industry 17
2.3 Definition of COOPs and COOP principles 19
2.4 Prices paid to farmers for raw milk 25
2.5 Supply contracts between milk producers and processors 29
2.6 The spatial dimension of raw milk collection by milk processors 32
2.7 Concluding remarks 35
3 A REVIEW OF THE SPATIAL ECONOMICS LITERATURE 37
3.1 General assumptions and market forms in spatial models 38
3.2 Pricing policy 42
3.2.1 Pricing policy in the spatial monopoly/monopsony 46
3.2.2 Empirical relevance of pricing policies 51
3.2.3 The pricing policy under spatial competition: market areas 53
3.3 Spatial competition: conjectures 54
3.3.1 Löschian conjecture 56
3.3.2 Hotelling-Smithies conjecture 59
3.3.3 Other conjectures in the spatial competition literature 63
3.3.4 Pricing policies: relative prices under different conjectures 64
3.4 Concluding remarks 66
4 A REVIEW OF THE THEORY OF (PROCESSING) COOPERATIVES 69
4.1 Objective functions of COOPs 70
4.1.1 Maximization of total member welfare 74
4.1.2 NARP pricing 76
4.1.3 Concluding remarks 77
4.2 Different views on COOPs 79
4.2.1 Monopoly/oligopoly power of COOPs 80
4.2.2 Procompetitive effect of COOPs 83
4.2.3 Efficiency of COOPs 84
4.3 The COOP in a mixed market 86
4.3.1 Non-spatial mixed-market models 88
4.3.2 Spatial mixed-market models 93
4.3.3 Concluding remarks 96
5 SPATIAL COMPETITION OF INVESTOR-OWNED FIRMS (IOFS) 97
5.1 A review of ALVAREZ ET AL. (2000) 98
5.2 Modification of the market form 107
5.2.1 Monopsony 110
5.2.2 Competition en route 110

5.2.3 Competition in the backyard 115
5.3 Löschian competition 125
5.4 Summary 127
6 SPATIAL COMPETITION OF COOPERATIVES (COOPS) 130
6.1 Introduction to the COOP models 131
6.2 Restricted membership 133
6.2.1 The total member welfare-maximizing COOP 134
6.2.2 The NARP-pricing COOP 146
6.3 Open Membership 153
6.3.1 The no-rationing assumption 154
6.3.2 Existence of an outside option 162
6.4 Summary 168
7 SPATIAL COMPETITION IN A MIXED MARKET 172
7.1 Mixed market under the efficient tie-breaking rule 173
7.1.1 Sequential moves game 180
7.1.2 Simultaneous moves game 1 184
7.1.3 Simultaneous moves game 2 188
7.1.4 Competitive yardstick effect 193
7.2 Mixed market under the random tie-breaking rule 195
7.3 Mixed market given an outside option 201
7.3.1 Pure IOF market given an outside option 201
7.3.2 Mixed market given an outside option 206
7.3.3 Competitive yardstick effect given an outside option 211
7.4 Summary 214
8 SUMMARY AND DISCUSSION 217
8.1 Spatial competition and pure IOF markets 218
8.2 Processing COOPs 223
8.3 Mixed markets 228
REFERENCES 233
COOPERATIVE SOCIETIES ACTS 245
APPENDIX 246
A1 PURE IOF MARKET 246
A1.1 The model of ALVAREZ ET AL. (2000) 246
A1.2 Circular market: competition en route 247
A1.3 Circular market: competition in the backyard - lower extreme case 247
A1.4 Competition in the backyard in a circular market 248
A1.5 Solutions for the upper extreme case of competition in the backyard 253
A2 PURE COOP MARKET 259
A2.1 The total member welfare-maximizing COOP under restricted membership 259
A2.1.1 The TMW-maximizing COOP: Monopsony and Duopsony situation 259
A2.1.2 Price-matching conjecture: adjusted UD prices 260
A2.2 The total member welfare-maximizing COOP using the market form of *AFSZ* ... 261
A2.3 The NARP-pricing COOP under restricted membership 267
A2.3.1 The NARP-pricing COOP with positive fixed costs 267
A2.3.2 The NARP-pricing COOP: price-matching conjecture 269
A2.4 The open-membership COOP 270
A2.4.1 The no-rationing assumption 270
A2.4.2 A simulation of overlapping market areas in a pure COOP market 270
A3 MIXED MARKET 275

A3.1 The no-rationing assumption of the COOP in a mixed market 275
A3.2 The mixed market under the efficient TBR 278
A3.3 The mixed market under the random TBR: simultaneous moves games 279
A3.4 Behavior of the IOF in a pure IOF market given an outside Option 282

LIST OF FIGURES

FIGURE 3-1. The spatial monopoly/monopsony 40
FIGURE 3-2. Market forms of spatial markets 41
FIGURE 3-3. Mill and delivered/net prices of the spatial monopolist/monopsonist 48
FIGURE 4-1. Price-quantity equilibria under different COOP objective functions 72
FIGURE 5-1. Monopsony model of the IOF 99
FIGURE 5-2. Competition en route (*AFSZ* model) 101
FIGURE 5-3. Competition in the backyard (*AFSZ* model) 102
FIGURE 5-4. UD price (*AFSZ* model) 104
FIGURE 5-5a. Market area (*AFSZ* model) depending on *t* 105
FIGURE 5-5b. Market area (*AFSZ* model) depending on *d* 105
FIGURE 5-6. Competition en route (processors located at the endpoints) 107
FIGURE 5-7. Competition en route (competition in both directions) 108
FIGURE 5-8. Monopsony in a circular market 109
FIGURE 5-9. Competition en route in a circular market 109
FIGURE 5-10. Competition in the backyard in a circular market 110
FIGURE 5-11a. UD price (competition en route) depending on *t* 113
FIGURE 5-11b. Market area (competition en route) depending on *t* 113
FIGURE 5-12. UD price and market area (competition en route) depending on *N* 114
FIGURE 5-13. LEC of competition in the backyard in a circular market 116
FIGURE 5-14a. UD prices (competition in the backyard) depending on *t* 119
FIGURE 5-14b. Market areas (competition in the backyard) depending on *t* 119
FIGURE 5-15a. UD price and market area (LEC of comp. in the backyard) depending on *N* 120
FIGURE 5-15b. UD price and market area (LEC of comp. in the backyard) depending on *N* (including *AFSZ*) 120
FIGURE 5-16a. UD price (UEC of competition in the backyard) depending in *N* 122
FIGURE 5-16b. Market area (UEC of competition in the backyard) depending in *N* 122
FIGURE 5-17. Price transmission 123
FIGURE 5-18. UD price depending on the profit level 124
FIGURE 5-19. Löschian competition 125
FIGURE 5-20. UD price (Löschian competition) 127
FIGURE 6-1. Spatial competition models (pure COOP market) 130
FIGURE 6-2. Monopsony model of the restricted-membership COOP compared to the IOF. 138
FIGURE 6-3. COOP duopsony under price matching (TMW maximization) 139
FIGURE 6-4. UD price and components of TMW of the TMW-maximizing COOP (restricted membership) 141
FIGURE 6-5. UD price of the TMW-maximizing COOP (restricted membership) 144
FIGURE 6-6. COOP duopsony under Löschian competition 145
FIGURE 6-7. UD prices of the TMW-maximizing COOP (restricted membership) 146
FIGURE 6-8. Monopsony model of the NARP-pricing COOP 149
FIGURE 6-9. COOP duopsony under price matching (NARP-pricing COOPs) 151
FIGURE 6-10. UD price of the NARP-pricing COOP (restricted membership) 152
FIGURE 6-11. Comparison of TMW (restricted membership) 153
FIGURE 6-12. Random and efficient TBR 156
FIGURE 6-13. Efficient/random TBR in a pure COOP market 158

FIGURE 6-14. UD prices in a pure COOP market (efficient/random TBR) 160
FIGURE 6-15. Comparison of TMW (restricted and open membership) 161
FIGURE 6-16. Open-membership COOP monopsony given an outside option 163
FIGURE 6-17. Open-membership COOP duopsony given an outside option 165
FIGURE 6-18. UD price in a pure COOP market given an outside option 167
FIGURE 7-1. Mixed market under the no-rationing assumption (efficient TBR) 174
FIGURE 7-2. Mixed market – the IOF as a monopsonist ($s / \rho > 2$) 177
FIGURE 7-3. Mixed market – sequential moves game 181
FIGURE 7-4a. UD price in the mixed market (sequential moves game) 183
FIGURE 7-4b. Market areas in the mixed market (sequential moves game) 183
FIGURE 7-5. Mixed market – simultaneous moves game 1 185
FIGURE 7-6a. UD price in the mixed market (simultaneous moves game 1) 187
FIGURE 7-6b. Market areas in the mixed market (simultaneous moves game 1) 187
FIGURE 7-7. Mixed market – simultaneous moves game 2 190
FIGURE 7-8a. UD price in the mixed market (simultaneous moves game 2) 191
FIGURE 7-8b. Market areas in the mixed market (simultaneous moves game 2) 191
FIGURE 7-9. Profits of the IOF in the mixed market 192
FIGURE 7-10a. CYE – UD prices 194
FIGURE 7-10b. CYE – differences in UD prices 194
FIGURE 7-11. Mixed market under the no-rationing assumption (random/efficient TBR) 196
FIGURE 7-12a. UD price in the mixed market (random TBR) 198
FIGURE 7-12b. Market areas in the mixed market (random TBR) 198
FIGURE 7-13. CYE (random TBR) 200
FIGURE 7-14. IOF monopsony given an outside option 202
FIGURE 7-15. UD prices in the pure IOF market given an outside option 204
FIGURE 7-16. Mixed market – the IOF as a monopsonist ($s / \rho > 2$) given an outside option 207
FIGURE 7-17. UD prices in the mixed market given an outside option 208
FIGURE 7-18. Mixed market given an outside option 210
FIGURE 7-19a. CYE – low outside option 212
FIGURE 7-19b. CYE – high outside option 212
FIGURE A1-1. UEC of competition in the backyard 249
FIGURE A2-1. Components of TMW in the pure COOP market (market form of *AFSZ*) 263
FIGURE A2-2. UD price and TMW in the pure COOP market (market form of *AFSZ*) 264
FIGURE A2-3. Simulation of the NARP function with positive fixed costs *F* 268
FIGURE A2-4. Overlapping market areas in a pure COOP market 271
FIGURE A2-5. Simulation of UD prices in a pure COOP market 273
FIGURE A3-1. Pricing schedule of the COOP (efficient/random TBR) 276
FIGURE A3-2. UD prices in the mixed market (random TBR) 281
FIGURE A3-3. Pure IOF market given an outside option 282

LIST OF TABLES

TABLE 2-1. Leading German and Austrian milk processors 15
TABLE 5-1. Comparative statics: *AFSZ* model 103
TABLE 5-2. Comparative statics: competition en route (*AFSZ* and circular market model) 112
TABLE 5-3. Comparative statics: competition in the backyard (*AFSZ* and circular market model) 117
TABLE 6-1. Summary: spatial competition among COOPs 168
TABLE A1-1. Comparative statics: *AFSZ* model 246

TABLE A1-2. Comparative statics: competition en route ... 247
TABLE A1-3. Comparative statics: LEC of competition in the backyard ... 247
TABLE A1-4. Ranges of the relative importance of space: UEC of competition in the backyard ... 257
TABLE A1-5. Comparative statics: UEC of competition in the backyard ... 258
TABLE A2-1. Comparative statics: the TMW-maximizing COOP I ... 259
TABLE A2-2. Comparative statics: the TMW-maximizing COOP II ... 260
TABLE A2-3. Comparative statics: the TMW-maximizing COOP I (market form of *AFSZ*) 265
TABLE A2-4a. Comparative statics: the TMW-maximizing COOP IIa (market form of *AFSZ*) ... 265
TABLE A2-4b. Comparative statics: the TMW-maximizing COOP IIb (market form of *AFSZ*) ... 266
TABLE A2-5. Comparative statics: the NARP-pricing COOP under price matching ... 269
TABLE A2-6. Comparative statics: the pure COOP market under the no-rationing assumption ... 270
TABLE A2-7. Comparative statics: simulation under the no-rationing assumption ... 274
TABLE A3-1. Comparative statics: sequential moves game ... 278
TABLE A3-2. Comparative statics: simultaneous moves game 1 ... 278
TABLE A3-3. Comparative statics: simultaneous moves game 2 ... 279
TABLE A3-4. Comparative statics: simultaneous moves games 1 and 2 (random TBR) ... 281

LIST OF ABBREVIATIONS

AFSZ	ALVAREZ, FIDALGO, SEXTON AND ZHANG (2000)
BKA	Bundeskartellamt (German Federal Cartel Office)
CAP	Common Agricultural Policy
COOP	cooperative
CYE	competitive yardstick effect
DBV	Deutscher Bauernverband (German Farmers' Union)
DRV	Deutscher Raiffeisenverband (German Raiffeisen Association)
EOP	Erzeugerorientierungspreis (Producer Orientation Price)
EU	European Union
FOB pricing	free-on-board pricing
GENG	Genossenschaftsgesetz (Cooperative Societies Act)
GENG-A	Genossenschaftsgesetz Österreich (Austrian Cooperative Societies Act)
GENG-D	Genossenschaftsgesetz Deutschland (German Cooperative Societies Act)
ICA	International Cooperative Alliance
IOF	investor-owned firm
LEC	lower extreme case (of "competition in the backyard")
NARP	net average revenue product
NEIO	New Empirical Industrial Organization
NMRP	net marginal revenue product
OD pricing	optimal discriminatory pricing
TBR	tie-breaking rule
TMW	total member welfare
UD pricing	uniform delivered pricing
UEC	upper extreme case (of "competition in the backyard")
USDA	U.S. Department of Agriculture

ABSTRACT

Spatial competition of food processors in pure and mixed markets under uniform delivered pricing

The spatial dimension of most agricultural raw product markets (e.g., milk) and the high concentration of food processors facilitate the exercise of market power towards farmers. In the milk sector, processors that are investor-owned firms (IOFs) compete alongside processing cooperatives (COOPs) in a “mixed market”. According to the “yardstick of competition” hypothesis COOPs are regarded as a means to mitigate the market power of IOFs. This thesis theoretically analyzes spatial competition of processors in a pure IOF market, a pure COOP market and a mixed market under uniform delivered pricing. The analytical results confirm a competitive yardstick effect, but the strength of this effect crucially depends on the behavior of the IOF in the mixed market.

Räumlicher Wettbewerb von Lebensmittelverarbeitern in reinen und gemischten Märkten unter einheitlichen Ortspreisen

Die räumliche Dimension der meisten landwirtschaftlichen Rohproduktemärkte (z.B. Milch) und die hohe Konzentration der Lebensmittelverarbeiter können zur Ausübung von Marktmacht gegenüber den landwirtschaftlichen Produzenten führen. Im Milchsektor stehen in einem „gemischten Markt“ private Firmen und genossenschaftliche Verarbeiter in direktem Wettbewerb. Entsprechend der „yardstick of competition“-Hypothese können Genossenschaften die Marktmacht von privaten Firmen abschwächen. Mithilfe analytischer Modelle untersucht diese Arbeit räumlichen Wettbewerb zwischen Verarbeitern derselben Rechtsform und in einem gemischten Markt für den Fall einheitlicher Ortspreise. Die analytischen Ergebnisse bestätigen einen prokompetitiven Effekt der Genossenschaft, wobei die Stärke dieses Effektes vom Verhalten der privaten Firma im gemischten Markt abhängt.

1 INTRODUCTION

In most agricultural markets, farmers are suppliers of raw products that serve as inputs for the food processing industry. Often, a multitude of atomistic and spatially dispersed sellers (i.e., farmers) face a few buyers in a highly and increasingly concentrated food processing industry (see, e.g, SEXTON, 1990; MURRAY, 1995; COTTERILL, 1999; and SEXTON AND LAVOIE, 2001). Most markets of agricultural inputs to the food processing industry exhibit the characteristic that raw agricultural products are often bulky and/or perishable, resulting in significant transportation costs and limited access of farmers to alternative buyers (SEXTON, 1990; ROGERS AND SEXTON, 1994). The high costs of transporting bulky and/or perishable raw agricultural products imply that input markets are often regional or local, whereas markets for the processed product may be national or international (ZHANG AND SEXTON, 2001). Thus, most markets of raw agricultural products are spatial markets, and the number of buyers of these inputs is rather limited due to the high concentration of the food processing industry and the fact that transportation costs limit the spatial distance over which agricultural inputs can be hauled or delivered.

The spatial dimension of agricultural markets and the high concentration of food processors facilitate food processors' exercise of market power over farmers. Exercise of market power results in lower prices for farmers and potential deadweight losses for society. A high concentration of the food processing industry might also imply market power of food processors over retailers. However, the food retailing industry is also characterized by a high concentration. Therefore, a highly concentrated food processing industry might be more disadvantageous for farmers than it is for retailers.

One option for farmers to mitigate the market power of food processors is to form a processing cooperative (COOP). The main difference between investor-owned firms (IOFs) and COOPs is the assumed objective functions of the processors. Whereas it is generally assumed that IOFs maximize their own profit only, COOPs have different objective functions, such as maximizing total member welfare or prices paid to members (see, e.g., LEVAY, 1983). The co-existence of IOFs and COOPs in the same market with direct competition leads to a mixed market (as opposed to a pure market with competition between IOFs only or between COOPs only) in which the objective functions of competitors are different (DEFRAJA AND DELBONO, 1990). According to the "yardstick of competition" hypothesis, COOPs constitute a competition-improving legal form that can mitigate the oligopsonistic power of IOFs (see, e.g., COTTERILL, 1987; and SEXTON, 1990). Therefore, COOPs (or, rather, the promotion of

COOPs via public policies) are sometimes regarded as one suitable instrument for indirectly regulating imperfect competition in oligopsonistic markets (see, e.g., TENNBAKK, 1995).

The milk sector in general (and in Germany and Austria in particular) seems to be a good example of an agricultural market as characterized above. The concentration of milk processors is rather high, as is the share of milk processors, which are organized as COOPs. Thus, milk processors compete in a mixed market of processors with different legal forms. Space plays a predominant role in milk processing due to the perishable nature of the raw product and the (spatial) distribution of milk farmers and processors within a region. In competing for raw milk across space, milk processors generally employ a pricing policy in which they bear the costs of transporting the raw product from the location of the farmer to the processing facility (see, e.g., BKA, 2009, p. 30 and 56). This pricing policy, where each farmer receives the same price irrespective of his location, is commonly referred to as uniform delivered (UD) pricing. Under UD pricing, however, (at least IOF) processors need to determine an economically reasonable market area. As a result, processors either operate within an exclusive area for collecting the raw product or compete with neighboring processors for input supply of the same farmers. Overlapping market areas of competing processors are characteristic of the raw milk market (see, e.g., HUBER, 2007a and 2009, for some regions in Germany). Therefore, the spatial aspect partly establishes farmers' options to choose their processor for themselves (or, to put it differently, to switch to another processor).

In the literature, analytical contributions regarding spatial competition in oligopsonistic markets are rather limited. Analytical contributions regarding spatial mixed markets (with competition between COOPs and IOFs) under UD pricing are especially rare. Thus, the aim of this thesis is to theoretially analyze the pricing of food processors in a spatial oligopsonistic market. More specifically, the analytical models assume UD pricing and consider different legal forms of processors. First, differences in the outcome of spatial competition in a pure COOP market relative to a pure IOF market will be investigated. Second, the outcome of spatial competition in a mixed market will be analyzed. These results will contribute to the understanding of the impact of COOPs on oligopsony power in a mixed market under UD pricing by examining any competitive yardstick effect. Previous models of mixed markets are predominantly non-spatial in nature (see, e.g, TENNBAKK, 1995; and ALBAEK AND SCHULTZ, 1998). One exception that definitely accounts for the spatial dimension of agricultural markets is SEXTON (1990). In his model, he assumes that farmers account for the costs of transporting the raw product to the processor. Such a spatial pricing policy is referred to as free-on-board (FOB) pricing. A recent example in the analytical literature considering both UD pricing and

FOB pricing in a mixed market is FOUSEKIS (2010). His model refers to the conference contributions by HUCK, SALHOFER AND TRIBL (2006) and TRIBL (2009a), among others.[1]

This thesis is organized as follows. The first part (CHAPTERS 2 to 4) is a sequence of literature reviews. This part describes the underlying theory and literature, which form the basis for the subsequent analytical models. The second part (CHAPTERS 5 to 7) is a sequence of different analytical models under the assumption of UD pricing.

More specifically, CHAPTER 2 summarizes findings from the literature related to the food processing industry by focusing on some of the characteristics of agricultural markets and food processors that were highlighted above, in particular regarding milk processors in Germany and Austria. A review of the theoretical spatial economics literature is provided in CHAPTER 3. This chapter discusses general assumptions in spatial competition models, the economics of different spatial pricing policies, and the outcomes given different firms' conjectures regarding the reaction of competitors. CHAPTER 4 reviews the theoretical literature on COOPs, with a focus on processing COOPs. First, different possible objective functions of COOPs are described. Second, whether COOPs are a reasonable means of improving market conditions is discussed. Finally, this chapter reviews various contributions of the analytical mixed-market literature.

Based on the seminal work of ALVAREZ ET AL. (2000), a spatial pure IOF market is analyzed in CHAPTER 5. This chapter reviews their analytical model and analyzes the impact on the market outcome if a different market form is assumed. The main characteristics of these models are the assumption of UD pricing and the feature of overlapping market areas. CHAPTER 6 analyzes spatial competition in a pure COOP market. The models in this chapter assume different possible objective functions and different membership policies (restricted and open membership). A spatial mixed market is analyzed in CHAPTER 7. The aim of this chapter is to examine whether the existence of a competitive yardstick effect of COOPs can be confirmed under the assumption of UD pricing. Generally, relative to a pure IOF market, oligopsony power over farmers should be lower in a mixed market. Finally, CHAPTER 8 summarizes and discusses the main findings of this thesis. Appendices to the analytical models in CHAPTERS 5 to 7 can be found at the end of the thesis.

[1] The conference contribution TRIBL (2009a) and the working paper TRIBL (2009b) are first attempts to model different aspects of spatial competition under UD pricing. In this thesis, some models included in these papers have been improved in many dimensions.

2 THE DAIRY SECTOR AS AN EXAMPLE OF SPATIAL COMPETITION IN THE FOOD PROCESSING INDUSTRY

The present chapter aims to examine the empirical relevance of the characteristics of agricultural markets and food processors from the existing literature as summarized in CHAPTER 1. More specifically, this chapter focuses on the milk processing industry. However, the aim of this chapter is not to provide an exhaustive description of the milk processing industry or a review of the literature on the milk processing industry *per se*. Rather, the milk processing industry is used as an example of a market with several specific characteristics. First, the degree of concentration of milk processors is rather high and increasing. Second, the share of COOPs in milk processing is rather high. Due to the presence of processors with different legal forms in the same market, processors need to consider the pricing decisions of processors with the other legal form when setting their own prices. Third, mainly due to the perishability of the raw product and the concentration of processors, the spatial dimension (and, thus, transportation costs) is of importance.

This chapter highlights the empirical relevance of these features and provides examples of the business practices in the milk processing sector. Milk processors compete for raw milk in space, i.e., for farmers located within a certain region. Interdependent factors influencing competition include the number of processors, the legal form of processors, the membership policy of COOPs (open or restricted membership), the determination of raw milk prices and differences between COOPs and IOFs, supply contracts (in particular, contract and termination periods), and spatial aspects like transportation costs, the density of raw milk production within a region, and processors' collection areas for raw milk. Using analytical models, competition in a market characterized by some of these features will be formally analyzed in CHAPTERS 5 to 7.

The reminder of this chapter is organized as follows. CHAPTER 2.1 describes the market structure and concentration of the food processing industry and the dairy industry, respectively. Similarly, CHAPTER 2.2 describes the importance of COOPs in food processing. CHAPTER 2.3 summarizes definitions of COOPs and discusses COOP principles, which can be found in several national acts of legislation.[2] This discussion is complemented by examples of business practices in COOPs. CHAPTER 2.4 describes the current pricing practices of German and Austrian milk processors and differences between COOPs and IOFs. Additionally, CHAPTER 2.5 discusses supply contracts between farmers and milk processors, which partly

[2] A review of the theory of COOPs, the analytical literature regarding COOPs, and the literature on analytical mixed market models is provided in CHAPTER 4.

determine farmers' ability to switch to alternative processors. Finally, CHAPTER 2.6 considers the spatial dimension of raw milk collection by milk processors. Some concluding remarks are provided in CHAPTER 2.7.

2.1 MARKET STRUCTURE OF THE MILK PROCESSING INDUSTRY

In general, the food processing industry is characterized by a high and increasing concentration. For example, according to COTTERILL (1999), the four-firm concentration ratio (CR4) of the 53 census-defined food and tobacco manufacturing industries in the U.S. in 1992 was 53.3% (SIC 4-digit data); among the most concentrated industries are vegetable oil mill products (89%) and refined cane sugar (85%).[3] Compared to the U.S., the concentration of food manufacturing industries in Europe, when considered as a single market, is lower, but it is higher in individual European countries. In 1997, the three-firm concentration ratio (CR3), an average of 20 different food products across 10 European countries ranged from 55% in Germany to 89% in Ireland. For specific products, the CR3 in Europe ranged from 47% for canned vegetables to 91% for baby foods. Such high concentrations are observed mostly because of the exits of processors and rapid growth, mergers and consolidations of larger processors (see, e.g., SEXTON AND LAVOIE, 2001, p. 867 and 911).

The concentration of the dairy industry in the U.S. seems to be moderate. In 1992, the CR4 values were 49% for butter, 42% for cheese, 43% for condensed and evaporated milk, but only 22% for fluid milk (COTTERILL, 1999). Except for butter, these concentration ratios remained rather stable compared to 1967. In Europe in 1997, however, the average CR3 values of 10 different European countries were 70% for yogurt and 65% for butter.[4] The concentration of dairies in Europe is further increasing (see, e.g., JANZ, 2002, pp. 18; and FAHLBUSCH ET AL., 2009). For example, according to FAHLBUSCH ET AL. (2009, p. 40; see references therein), the dairies *Friesland Foods* and *Campina* collected 76% of raw milk in the Netherlands in 2007, making them approximately ten times larger than the next largest dairy; these two COOPs merged in 2008/09. In Denmark, the dairy *Arla* has a market share of approximately 90%.

In Germany, the highest share of revenues of the food processing industry comes from the dairy industry (BOYSEN AND SCHRÖDER, 2006; see references therein). However, the number of processors and the number of processing locations have been decreasing over time: from 1979 to 2000, the number of firms in Germany producing drinking milk decreased from 589

3 ROGERS AND SEXTON (1994, p. 1144) note that a CR4 $\geq$50 is generally a "[…] benchmark for separating markets into workable competition and noncompetitive groups."

4 In 1997, Germany had CR3 values of 76% for yogurt and less than 30% for butter (COTTERILL, 1999).

to 198; for butter, from 516 to 135; and for hard cheese, from 72 to 51 (JANZ, 2002, p. 19). This increasing concentration can be explained as a reaction to factors like constant sales volumes, the liberalization of the Common Agricultural Policy (CAP), the eastern enlargement of the European Union (EU), and an increased market power of retailers (BOYSEN AND SCHRÖDER, 2006; see references therein). In 2006, the milk processing industry in Germany consisted of 198 milk processors and 281 milk processing facilities (BMLEV, 2008, chapter F); approximately 25.4% of the raw milk was processed by the three largest processors (see TABLE 2-1). The index of value added ("*Wertschöpfungsindex*", FAHLBUSCH ET AL., 2009, p. 41; i.e., revenues divided by quantity processed) of the nine largest milk processors is 1.15 on average.[5] Due to its exclusive production of cheese, the processor *Bayernland* has the highest index value (FAHLBUSCH ET AL., 2009).

TABLE 2-1. Leading German and Austrian milk processors

Country	**Processor**[+)]	**Revenues in million €**	**Milk processed in million kg**	**Index of value added**
Germany (2007)	Nordmilch	2,300	4,100	0.56
	Müller	2,200	2,300	0.96
	Humana	2,200	2,500	0.88
	Hochwald	1,100	1,800	0.61
	Hochland	1,000	530	1.89
	Bayernland	950	360	2.64
	Campina	869	860	1.01
	Zott	700	780	0.90
	Ehrmann	650	-	-
	Meggle	650	725	0.90
	Germany (2006)		*35,083*	
Austria (2006)	Berglandmilch	526	866	0.61
	NÖM AG	309	297	1.04
	Gmundner Milch	153	303	0.51
	Tirol Milch	138	224	0.61
	*Austria (2006)**[*)]		*2,673*	

Sources: BMLFUW (2007, p. 18), BMLFUW (2008, p. 17), FAHLBUSCH ET AL. (2009, p. 41), BMLEV (2008, chapter F), own calculations

[+)] The cooperatives *Nordmilch* and *Humana* merged in 2011 and now trade under the name *Deutsches Milchkontor* (DMK); see, e.g., HANDELSBLATT (2011). In 2010/2011, *Tirol Milch* was taken over by *Berglandmilch* (both are organized as cooperatives); the takeover was approved by the cartel office (see, e.g., WIRTSCHAFTSBLATT, 2011).

*[)] raw milk delivered to milk processors (BMLFUW, 2008, p. 17)

In Austria, milk has the highest share of the production value in agriculture (17%), followed by cattle (15%) and pigs (12%); see BMLFUW (2008, p. 6). In 2006, 85% of the total raw

[5] The index of value added (revenues divided by milk quantity processed) is an average price per kg of processed milk (i.e., unit values) and thus reflects utilization of raw milk.

milk was delivered to milk processors; the remaining 15% was used in direct marketing and animal feeding (BMLFUW, 2008, pp. 17). In the same year, the Austrian milk processing industry consisted of 87 milk processors and cheese dairies and 101 processing facilities; it is characterized by relatively small production and processing facilities. However, according to TABLE 2-1, more than 50% of the raw milk was processed by the three largest processors. *Berglandmilch* was the largest processor in 2006, with 866,000 tons of milk processed, followed by *Gmundner Milch* and *NÖM AG*; see TABLE 2-1. According to this table, *NÖM AG* has the highest index of value added. SCHMID ET AL. (2011, p. 6) argue that milk processors are currently trying to improve their market position via mergers due to the future abolishment of milk quotas (e.g., *Berglandmilch* and *Tirol Milch* in 2010).

An increasing concentration in the dairy sector (and, thus, larger processing facilities) offers the possibility of economies of scale and consequently the possibility to realize cost savings. According to WEINDLMAIER (2007, p. 60), the current size of processing facilities in Germany does not allow for these cost savings. Based on model results, BUSCHENDORF (2007, pp. 38) shows that an even higher concentration of German milk processors would reduce the processing costs due to the economies of scale of larger processing facilities. However, below an optimal number of milk processors (91 processing facilities compared to 223 facilities in 2003), these decreasing costs are negated by higher acquisition expenses for raw milk and higher transportation costs for the processed product. Similarly, BOYSEN AND SCHRÖDER (2006) argue that larger milk processors benefit from economies of scale, but larger milk collection regions imply higher average transportation costs relative to smaller processors.[6] Based on model results they conclude that increases in transportation costs may slow down the structural change towards fewer milk processors with larger processing facilities; more specifically, the number of small processors is positively correlated with the level of transportation costs. In CHAPTER 2.6, the relevance of transportation costs is discussed in more detail.

It is sometimes argued that the high concentration of retailers and their ability to "dictate" purchase prices of processed products is one reason for decreasing raw milk prices (see, for example, the discussion in a report of the German Federal Cartel Office, *Bundeskartellamt*; BKA, 2009, p. 92).[7] To counterbalance a possible exercise of market power by retailers

[6] BOYSEN AND SCHRÖDER (2006) hypothesize that a higher degree of processing may decrease the relevance of transportation costs; usually, the degree of processing is higher in smaller milk processors thus creating a cost advantage for smaller processors relative to larger processors.

[7] Due to some indications that competition in the German dairy industry might be rather limited at various stages of the supply chain, the German Federal Cartel Office began a sector analysis in 2008. The resulting interim report, BKA (2009), is based on discussions with several market participants, interviews with milk processors,

towards food processors, the German Farmers' Union (*Deutscher Bauernverband*, DBV) demanded that milk processors either cooperate more often or consolidate in order to be able to pay higher prices for raw milk (BKA, 2009, p. 104). To the contrary, the BKA (2009, p. 105) argues that a dominant position of the processing industry as a result of consolidation should be avoided and that the regional markets for collecting raw milk should be kept "open": farmers should have the choice between different milk processors as buyers of their raw milk (see also CHAPTER 2.5 and 2.6). However, the BKA (2009, p. 79) also argues that a dominant market position of a processor in a certain region (or high market shares in the collection of raw milk) can be regarded as harmless (from the viewpoint of merger control) as long as there are competitors within the market area of the respective processor (for the case of overlapping market areas between processors, see CHAPTER 2.6).

2.2 COOPERATIVES IN THE FOOD PROCESSING INDUSTRY

A higher concentration in the food processing industry might imply higher bargaining power of processors towards the retail sector and, consequently, higher prices for the processed product (see, e.g., WEINDLMAIER, 2007, p. 60). However, it should be noted that milk prices for farmers will not necessarily increase as well: farmers only gain in terms of higher prices for raw milk if these benefits due to economies of scale and bargaining power are actually transmitted to farmers. Generally, a high concentration of food processors facilitates the exercise of market power towards farmers by food processors, which are organized as IOFs. One option for farmers to mitigate the market power of IOFs is forward integration and the formation of a processing COOP. "The idea is that cooperatives have no incentive to exercise market power over their own members" (SEXTON AND LAVOIE, 2001, p. 876). The resulting market is either a "mixed market" with competition between processors of different legal forms (i.e., COOPs and IOFs), or a "pure" COOP market.

Examples of mixed markets including both IOFs and COOPs in various food processing industries that are mentioned or analyzed in the economics literature are ROGERS AND SEXTON (1994) and COTTERILL (1999) for the U.S., BERGMAN (1997) for the U.S. and Europe, and HENDRIKSE (1998) for Europe. Specific examples for Europe are the egg market in Norway (TENNBAKK, 2004), the Swedish beef-slaughter industry (AZZAM AND ANDERSSON, 2008), the meat industry in Europe (VAN BEKKUM ET AL., 2001, taken from AZZAM AND ANDERSON,

---

and assessments of mergers of milk processors. Therefore, BKA (2009) represents a valuable and extensive source of information. However, it must be emphasized that BKA (2009) is an interim report, and the German Federal Cartel Office requested feedback on this report (one example is DRV, 2010). The final report, BKA (2012), was published in January 2012 and focuses on an assessment in terms of competition law.

2008); specific examples for the U.S. are pear processors (WANN AND SEXTON, 1992), the dairy sector (ZEULI AND BENTANCOR, 2005), and ethanol plants (GALLAGHER ET AL., 2005). Another prominent type of mixed market in the economics literature involves competition between IOFs and public firms. Examples of this type of market are air travel in France, Holland and India; banking in Portugal; oil in Norway; and mail delivery and railways in the U.S. (AZZAM AND ANDERSSON, 2008).

According to COTTERILL (1999), agricultural COOPs do not play a major role in most food and tobacco processing industries in the U.S.: in 1987, the average share of COOPs in the U.S. was 6.9%.[8] However, the share of COOPs among 53 food processing industries was highest for butter (62.8%; in particular *Land O'Lakes* is a major COOP); the shares for cheese, condensed milk, and fluid milk were 23.7%, 27.1%, and 17.2%, respectively. Using the same source of data, ROGERS AND SEXTON (1994) show the relevance of COOPs in the U.S. in 1987 on a product class basis: for the top 100 COOPs, the largest combined market shares of COOPs can be found in the product classes "canned olives, including stuffed" (56.5%), "canned fruits, except baby foods" (38.6%), and "noncarbonated soft drinks, including fruit drinks" (32.8%).[9] Likewise, BERGMAN (1997) argues that COOPs in the U.S. are relatively weak and fragmented compared to Europe. Exceptions are dairy COOPs (for example, the combined share of dairy COOPs in the U.S. was 80% in the early 1990s) and COOPs in the fruit industry.

In Europe, COOPs are especially important in agricultural markets. According to COGECA (2010), COOPs in the EU have a share of more than 50% in the supply of agricultural inputs and a share of more than 60% in the collection, processing and marketing of agricultural products. HENDRIKSE (1998) provides market shares of COOPs for the EU in 1991. For example, COOP market shares in the selling of milk ranged from 4.1% in the U.K. to 98% in Ireland (Germany: 56%). In the case of pork, COOP market shares ranged from 3% in Greece to 97% in Denmark. COOPs are especially dominant in Northern European countries (BERGMAN, 1997). For example, "[…] virtually all of the Swedish cooperatives are part of the same federated structure, with no geographical overlap between rival cooperatives, and their presence in the downstream food industry is rather strong" (BERGMAN, 1997, p. 74). In the early 1990s in Sweden, COOPs had market shares of 75% and 99% in the purchase of

[8] This is the 1987 estimated percentage of value-of-shipments accounted for by the 100 largest agricultural marketing COOPs (COTTERILL, 1999). This share is based on SIC 4-digit data, which are industry data; data with five or more digits are product class data (ROGERS AND SEXTON, 1994).

[9] ROGERS AND SEXTON (1994, p. 1146) indicate that "The [COOP] share is positively related to the importance of the agricultural input in the production process and negatively related to the industry's ratio of the value added to shipments."

cereals and raw milk, respectively; the corresponding share in Denmark was 95% in the case of raw milk (BERGMAN, 1997). In Norway, large national COOPs, among them dairy COOPs, have market shares between 60% and almost 100% “in the first level handling of domestic production” (TENNBAKK, 2004, p. 1).

In 2008, eight COOPs among the top 25 COOPs in terms of turnover in the EU were dairy COOPs (see COGECA, 2010). *Friesland-Campina* (NL) is ranked first, with a turnover of 9,481 billion Euros and 15,837 farmer members. Numbers 16 and 19, respectively, in this ranking are the German dairy COOPs *Nordmilch* and *Humana Milchunion* (which merged in 2011).[10] In 2007, approximately one quarter of the raw milk delivered in Germany was delivered to these two COOPs (STEFFEN ET AL., 2009, p. 2). In Germany in 2010, 2,604 COOPs were organized within the German Raiffeisen Association DRV (*Deutscher Raiffeisenverband*); 24.4% of the total annual revenues of 41.0 billion Euros were achieved by dairy COOPs (AGRA-EUROPE, 2011). Approximately 29% of the 198 German dairy companies (281 milk processing facilities) in the market in 2006 were processing COOPs and processed 45.6% of the total milk supply (BMLEV, 2008, chapter F; see also FAHLBUSCH ET AL., 2009, p. 41). Whereas the average dairy corporation (i.e., IOF) processed 155,000 tons of milk in 2006, the average German dairy COOP was almost twice as large (281,000 tons); see BMLEV (2008, chapter F). There are regional differences in the legal form of processors: the northern part of Germany is dominated by a few large dairy COOPs, but the market in southern Germany consists of many small IOFs (HUCK ET AL., 2006; see also WOCKEN AND SPILLER, 2009, p. 114, taken from HELLBERG-BAHR ET AL., 2010). For Austria, COGECA (2010) reports 1,049 agricultural COOPs in 2008. In the same year, 46.6% of the milk processors in Austria were COOPs (see also BMLFUW, 2009, p. 27).[11] The Austrian milk processors listed in TABLE 2-1 are COOPs or partly organized as a COOP (see also COGECA, 2010).

2.3 DEFINITION OF COOPS AND COOP PRINCIPLES

Due to the relevance of COOPs in the food processing industry, as demonstrated before, and to the aim of this thesis to analyze spatial competition in pure and mixed markets, a definition of COOPs is essential. In general, an (agricultural) COOP is privately owned by farmers who

[10] The remaining dairy COOPs in this ranking are *Arla Foods* (DK-SE), Kerry (IE), *Sodiaal* (FR), *GLANBIA* (IE) and *Irish Board* (IE); see COGECA (2010). Number 2 in this ranking is the German supplies COOP *BayWa*. Number 24 is the only Austrian COOP in this ranking: the supplies COOP *RWA*.

[11] According to BRAZDA AND WERNER (2004), 90% of the Austrian dairy sector is cooperatively organized (see also SCHMID ET AL., 2011, p. 8). In 2001, 95% of Austrian milk was collected by COOPs with the following market shares: 99% of drinking milk and 95% of butter; the share for cheese was lower (BRAZDA AND WERNER, 2004).

are members of this organization (see, e.g., TENNBAKK, 1995). Thus, one distinctive feature of COOPs is that their owners (i.e., members) are simultaneously users of the services offered (see, e.g., HIGL, 2003; and DRIVAS AND GIANNAKAS, 2007). In Germany, COOP members must purchase shares, and COOPs are 100% owned by members; these shares constitute the equity capital of the COOP (BKA, 2009, p. 31). According to TOP AGRAR ÖSTERREICH (2011), there are significant differences between dairy COOPs: the shares to be purchased by members range from 109 Euros to 23,991 Euros for an average dairy farm with a milk quota of 150 tons (survey of ten COOPs in Austria and Bavaria).

A substantial literature attempts to define a "cooperative" (for reviews, see, e.g., BATEMAN ET AL., 1979a; and LEVAY, 1983). The term "cooperative dilemma" denotes the lack of agreement on how to define a COOP (COTTERILL, 1987, p. 172, referring to BRISCOE, 1971). A rather consolidated definition of the setup of a COOP may be the following: "A cooperative is a special type of business firm owned and operated for the mutual benefit by the users (member-patrons). Actual management is by salaried professionals. The interests of the members are represented by an elected board of directors" (RHODES, 1983, p. 1090). For example, according to the German Cooperative Societies Act (*Genossenschaftsgesetz,* GENG), the decision-making bodies of COOPs are the board of directors, the supervisory board and the general assembly (or assembly of representatives for COOPs with more than 1,500 members; the general assembly is an assembly of all members) (BKA, 2009, p. 86; DRV, 2010, p. 1). According to the cooperative concept of autonomy, all relevant decisions are made by the general assembly; farmers are represented on executive committees by voluntary representatives (BKA, 2009, p. 86). Institutional differences between COOPs and IOFs are discussed, for example, by HENDRIKSE (1998).

The Rochdale principles of cooperation help to clarify the definition of a cooperative, although not all "cooperatives" subscribe to all Rochdale principles (LEVAY, 1983).[12] The original principles have repeatedly been revised by the International Cooperative Alliance (ICA), who currently recognizes the following seven cooperative principles (ICA, 2011):[13]

1) Voluntary and open membership
2) Democratic member control
3) Member economic participation
4) Autonomy and independence

[12] According to COTTERILL (1987, p. 174), these principles originated from the Society of Equitable Pioneers purchasing COOP in Rochdale, England, in 1844.
[13] The current version of these principles was adopted in 1995 (ICA, 2011). For the original principles or later versions, see, e.g., BATEMAN ET AL. (1979a), COTTERILL (1987, pp. 174) and ICA (2011).

5) Education, training and information
6) Cooperation among cooperatives
7) Concern for community

Most of these principles will be discussed in more detail in the following. The principle of open membership implies that the COOP admits all producers applying for membership (COTTERILL, 1987, p. 175).[14] Membership is voluntary and not subject to any type of restriction or discrimination. Likewise, open membership means that the COOP must accept all deliveries offered (see, e.g., TENNBAKK, 2004). In many countries (such as Germany and Austria), the principle of open membership is implemented in Cooperative Societies Acts.[15] For example, both the German and the Austrian Cooperative Societies Acts describe COOPs as "associations with a non-closed number of members" ("*Gesellschaften von nicht geschlossener Mitgliederzahl*") in their respective first paragraphs (§1(1) GENG-D, GENG-A; see also BKA, 2009, p. 81). However, restrictions on membership are obviously possible. SEXTON (1984), for example, notes (for the U.S.) that membership may be restricted if existing members would be harmed in case of open membership. COTTERILL (1987, p. 175) indicates that a COOP may, at least temporarily, restrict membership by refusing a prospective member (closed-membership COOP), which is useful in avoiding the short-run free-rider problem: new suppliers to a COOP might benefit from a higher raw product price (relative to the non-COOP option) without contributing product and investment capital. A restriction on membership would help existing members to benefit from long-run investment strategies (such as branding). Thus, open membership (i.e., no exclusion of new members from the allocation of benefits of a certain investment) gives rise to opportunistic behavior and free riding that limits a COOP's ability to raise investment capital; this property rights problem is often addressed by financing investments via retained earnings (DRIVAS AND GIANNAKAS, 2007 and 2010; see also references therein). According to HIGL (2003), some COOPs try to restrict the number of members via restrictions on shares or via other means.

However, the principle of open membership obviously does not oblige COOPs to accept every farmer as a COOP member (BKA, 2009, p. 81; see relevant jurisdiction mentioned therein): according to past jurisdiction in Germany, open membership does not necessarily

[14] For an early empirical analysis of membership policies of agricultural COOPs in the U.S., see YOUDE AND HELMBERGER (1966).

[15] In the U.S., however, restricted membership is possible (COOK AND ILIOPOULOS, 1999; taken from HIGL, 2003): so-called "New Generation Cooperatives" restrict entry by restricting the number of members (see also KARANTININIS AND ZAGO, 2001).

imply the right or duty of acceptance.[16] German milk producers may be able to supply raw milk even without being members; likewise, COOPs are allowed to buy raw milk from other processors (p. 32). HIGL (2003) notes that trade with non-members has been allowed since the amendment of 1974. According to TENNBAKK (2004), COOPs in Denmark must accept deliveries from non-members as well.[17] Generally, statutes indicate that COOP members in Germany have the duty to deliver all of their raw milk to the COOP; the COOP, in turn, has the duty to accept all milk delivered by COOP members - similar duties apply to IOFs in regard to their suppliers (see, e.g., BKA, 2009, p. 32, 89 and 104; SCHMID ET AL., 2011, p. 8).[18] These duties are permitted for a maximum of five years and are established in the supply contracts of COOP members (BKA, 2009, p. 74 and 90). Nevertheless, it is generally possible for a milk producer to be member of more than one COOP at a time (see also DRV, 2010, who note that membership in and, thus, the duty to deliver all milk to a COOP automatically exclude the possibility of simultaneous membership in more than one COOP). Since the milk producer is in charge of his quota, this possibility is not constrained by the milk quota; however, a processor must be assigned to administer the quota (BKA, 2009, p. 91).[19]

The principle of democratic member control establishes the internal control of a COOP by giving one vote per member (this applies to “primary” COOPs, i.e., COOPs that are not owned by one or more other COOP(s); see COTTERILL, 1987, pp. 174, or ICA, 2011). LEVAY (1983, p. 4) argues that a COOP is, in essence, a voluntary association of people (and not of capital): as capital subscription has no influence on voting power, this internal political structure affects capital accumulation relative to an IOF and is often claimed to be “democratic, in the sense of egalitarian”. According to the DRV (2010), the principle of democracy implies that the board of directors and the supervisory board derive their management and control authority from the majority decisions of members in the general assembly or the assembly of representatives. As these assemblies act according to the

[16] According to the BKA (2009, p. 81), past jurisdiction approves the farmers’ right to deliver the raw product rather than their „acceptance in a cooperative dairy” as a member (“*Anspruch [...] auf Aufnahme in eine genossenschaftliche Molkerei*”). Thus, open membership implies the right to apply for membership for every farmer; acceptance as a new member, however, is decided by the COOP itself (information by phone - Chamber of Agriculture/Upper Austria, Mr. Wöckinger, July 14, 2011). Likewise, the discussion of the “closed shop” model of possible future quantity management in COOPs (see, e.g., SCHMID ET AL., 2011, p. 11) suggests that restriction of membership is possible (for example, if the sales volume of COOPs is limited).

[17] LEVAY (1983) notes that trade with non-members (who do not provide capital and do not receive any bonus on patronage) is limited in some countries by law up to 50% of turnover.

[18] See also FAHLBUSCH ET AL. (2009) regarding COOPs. The DRV (2010) notes that the duty to deliver and accept the total amount of raw milk produced by members can be altered via statutes, but the majority of German COOPs have retained these duties in the past.

[19] This gives processors knowledge about the past or future processor of a farmer who switched or is willing to switch processors (BKA, 2009, p. 81).

principle of “one member - one vote”, members have the right of co-determination (either directly or via representatives in larger COOPs).

However, some dairy COOPs in Germany complain about the influence of COOP members on business policy and their sole interest in high milk prices (and, thus, lack of interest in investments in, e.g., brand development); see BKA (2009, p. 85). These COOPs argue that this focus impedes competitiveness. The report of the German Federal Cartel Office, BKA (2009, pp. 84), discusses the possible influence of members on the COOP’s business strategy: pricing practices (e.g., down payments) are defined in statutes of the COOP, which are subject to acceptance by a majority of COOP members. Prices for raw milk are determined by the board of directors (which also includes voluntary representatives of milk producers) and the management on a monthly basis. Thus, in principle, milk producers, as COOP members, participate in all relevant decisions by the COOP. However, because the shareholding is relatively small on an individual basis, a single member’s ability to influence the business strategy of the COOP may be limited (p. 48). In addition, large COOPs have outsourced parts of their business (e.g., marketing, sales, milk trade) to private associations (i.e., IOFs), which similarly limits the impact of COOP members on strategic decisions and their ability to influence prices for raw milk (p. 87). In this situation, management and operational business are subject to the board of directors of the private association, and COOP members must be informed only about their decisions. In a response to BKA (2009), the DRV (2010) argues that outsourcing of certain business operations must be approved by COOP members by a three-quarter majority at least.[20] According to results from a survey of Austrian dairy farmers, SCHMID ET AL. (2011, p. 34) show that, in practice, only approximately 26% of COOP farmers report that they have some influence over the COOP’s decisions, and 6% report that they have no influence.

The principle of member economic participation is defined by the ICA (2011) as follows:

“Members contribute equitably to, and democratically control, the capital of their co-operative. At least part of that capital is usually the common property of the co-operative. Members usually receive limited compensation, if any, on capital subscribed as a condition of membership. Members allocate surpluses for any or all of the following purposes: developing their co-operative, possibly by setting up reserves, part of which at least would be indivisible;

[20] The COOP principle of autonomy and independence states: “Co-operatives are autonomous, self-help organisations controlled by their members. If they enter to agreements with other organisations, including governments, or raise capital from external sources, they do so on terms that ensure democratic control by their members and maintain their co-operative autonomy” (ICA, 2011, s.p.).

benefiting members in proportion to their transactions with the co-operative; and supporting other activities approved by the membership" (ICA, 2011, s.p.).

It can be argued that the first part of this quote describes the principle of "limiting the rate of return on share (equity) capital", as discussed in COTTERILL (1987, p. 175) or LEVAY (1983). LEVAY (1983) notes that interest on share capital of COOPs is limited in many countries by law. This principle serves as an incentive to distribute the benefits of a COOP to its members as users rather than as investors (COTTERILL, 1987, p. 175). The second part of the quote obviously encompasses an adoption of the principle of "operation at cost", which covers the distribution of net margins (i.e., surpluses) earned by a COOP. The "operation at cost" principle suggests that net margins are allocated by providing common services to members[21], that these margins are retained as capital to expand business, or that they are refunded to members according to patronage (COTTERILL, 1987, pp. 175). The residual claimant is not capital, but the user; "[t]he reward to this residual claimant is […] the [dividend] or patronage rebate […]" (LEVAY, 1983, p. 4).

As COOPs are set up by the members themselves, members expect a promotion ("*Mitgliederförderung*") of their activities in return (HIGL, 2003, p. 4). Member promotion is named as the fundamental aim of COOPs in several national Cooperative Societies Acts. For example, both the German and Austrian Cooperative Societies Acts state in their respective first paragraphs that the aim of a COOP is to promote the purchasing or economic activities of its members (§ 1(1) GENG-D and GENG-A; see also BKA, 2009, p. 85). According to the DRV (2010), this aim constitutes a personal promotion of members' individual business and not primarily a promotion of the return on capital.

The aim of member promotion is one reason for COOPs to distribute significant portions of their profits via prices paid to members (see, e.g., BKA, 2009, p. 69, 78 and 86). Generally, the objective of an IOF is assumed to be maximization of profits (see CHAPTER 5). On the contrary, and as discussed by the BKA (2009, pp. 85), it can be assumed that the objective of a COOP is to achieve the highest possible raw product price for the benefit of COOP members:[22] German dairy COOPs state that they aim not to achieve high margins (or returns), but to achieve high raw milk prices. However, COOPs are not legally obligated to pay the highest possible milk price: the German Cooperative Societies Act stipulates the possibility to distribute profits or losses among members after determination of year-end accounts (§ 19(1)

[21] See also the COOP principle of education, training and information.

[22] This statement suggests that a suitable objective function of a dairy COOP might be maximization of raw milk prices subject to covering costs (net average revenue product (NARP) pricing; see the discussion of possible COOP objective functions in CHAPTER 4.1).

GENG-D) but, via statutes, profits can also be retained as reserves (§ 20 GENG-D); see also BKA, 2009, p. 86. Due to the distribution of profits, the BKA (2009, p. 86) concludes that the possibility for larger long-run investments and reserves is rather limited in COOPs. SCHRAMM ET AL. (2005) argue that investments in branding, for example, may be sacrificed in favor of higher raw milk prices. They note that this argument partly explains the low brand share of COOPs relative to other legal forms and, thus, deficits in value added. In addition, SCHRAMM ET AL. (2005) note that members do not receive voting rights based on patronage. Whereas farmers with larger deliveries may be interested in long-run decisions and investments of the COOP, smaller farmers may be more interested in a guarantee of a certain price level.

According to the DRV (2010), the promotional duties of a COOP imply the following: the focus of a COOP's internal relationship is the promotion of members, whereas the focus of the external relationship (towards wholesalers or retailers) is the achievement of the "highest possible surplus" ("*höchstmöglicher Überschuss*", p. 2), either to build up reserves or to distribute to the members. Due to the liberalization of agricultural markets in the EU, milk processors, including COOPs, need to remain competitive by acquiring milk at lower prices (BKA, 2009, p. 48). Contrary to the members' objective of high raw milk prices, COOPs increasingly act like vertically integrated firms with the objective of "maximizing total profits" ("*Gesamtgewinnmaximierung*", p. 48), where raw milk prices might be considered merely as an "internal clearing item" ("*interner Verrechnungsposten*", p. 48).[23]

The principle of cooperation among COOPs hypothesizes that different COOPs are not assumed to compete with each other (ZEULI AND BENTANCOR, 2005). However, due to the success of COOPs in many agricultural markets, ZEULI AND BENTANCOR (2005) argue that competition between COOPs is rather common in the U.S. As an example, they mention milk processors in California, Wisconsin and Minnesota, where more than 50 dairy COOPs compete for raw milk. Anecdotal evidence of fierce competition between agricultural supply COOPs in Germany is provided by DLZ AGRARMAGAZIN (2010). HUCK ET AL. (2006) provide empirical evidence of spatial competition among diary COOPs in Northern Germany.

2.4 PRICES PAID TO FARMERS FOR RAW MILK

For milk processors, raw product costs account for 50-90% of total costs (WEINDLMAIER AND HUBER, 2001, p. 1087; taken from HELLBERG-BAHR ET AL., 2010). Consequently, the prices

[23] Contrary to footnote 22, this might suggest that another suitable objective function of dairy COOPs is total member welfare-maximization (see the discussion of possible COOP objective functions in CHAPTER 4.1).

paid to farmers for raw milk are an important determinant of competitiveness in the milk processing sector.

In general, the prices for raw milk are mainly determined by factors such as quality aspects[24] (e.g., fat and protein content, bacteriological compositions), the availability of the raw product, the product portfolio of processors (basic or niche products, brands), and the density of milk processors (BKA, 2009, p. 40 and p. 56).[25] For example, in Bavaria, the density of (relatively small) farms and of milk processors is rather high. Due to a multitude of "successful" IOFs, the BKA (2009, p. 64) argues that raw milk prices in this region are rather high (and likewise in Rheinland-Pfalz; p. 39). According to the BKA (2009, p. 40), the legal form of processors (COOPs or IOFs) does not seem to be a factor influencing the "level" of raw milk prices ("*Höhe des Auszahlungspreises*"). However, most COOPs produce basic products (e.g., drinking milk, butter, milk powder; as a storable product, the latter is more dependent on world market prices) and have less established brands compared to IOFs (see also the discussion in SCHRAMM ET AL., 2005). Similarly, the size of milk processors does not seem to influence the level of raw milk prices since cooperations between or consolidations of (IOF) processors do not necessarily imply higher raw milk prices (BKA, 2009, p. 107). Likewise, BOYSEN AND SCHRÖDER (2006, see references therein) note that empirical results from the literature show no systematic influence of the size of processors on raw milk prices.

The BKA (2009) and HELLBERG-BAHR ET AL. (2010) describe differences in the determination (or derivation) of raw milk prices between COOPs and IOFs. In general, raw milk prices in COOPs are unilaterally determined ex post on a monthly basis by the board of directors and the management (BKA, 2009, p. 57 and 84): COOP members either receive monthly installment payments according to the market situation (e.g., as determined by statistical data and forecasts) in combination with supplementary payments[26] after annual statements (as determined by the general assembly), or they receive monthly payments with adjustments according to results during the accounting year. In general, much or all of the annual surplus is distributed among members.

Raw milk prices in COOPs are generally determined according to the "utilization system" ("*Verwertungssystem*"; HELLBERG-BAHR ET AL., 2010, p. 13), which implies an "upside down" approach (BKA, 2009, p. 56). As COOPs must pay their members "by legal

[24] The German regulation on milk quality, *„Verordnung über die Güteprüfung und Bezahlung der Anlieferungsmilch"*, stipulates premiums for certain qualities as well; see BKA (2009, p. 56).

[25] In a response to BKA (2009), the DRV (2010, p. 7) argues that the „remoteness from the market" ("*Marktferne"*) rather than the density of processors influences the prices for raw milk prices. Other important contributors include the cost factors of processors.

[26] Although the BKA (2009, p. 57) mentions the possibility of reclaims as well, the DRV (2010) argues that reclaims are not established by any processor.

appointment" ("*aufgrund ihres gesetzlichen Auftrages*"; BKA, 2009, p. 78) according to the performance (i.e., utilization) generated in the processed goods market (see also STEFFEN ET AL., 2009, p. 3 and references therein), final raw milk prices are not determined until revenues from the processed product are known (BKA, 2009, p. 59). To put it differently, farmers get what is left after selling the processed product (BKA, 2009, p. 56). Raw milk prices are determined according to gross utilization via selling of the processed product net of the costs of collection, processing and marketing; however, as any change in prices can only be future-oriented, prices paid in the first half of the year are below net utilization, and farmers receive supplementary payments in the second half of the year (WEINDLMAIER AND HUBER, 2001, p. 1088; taken from HELLBERG-BAHR ET AL., 2010).

The BKA (2009, p. 56) argues that such a system of price determination allows retailers to have an immediate impact on the raw milk prices paid by COOPs.[27] Because this system reduces the economic risk for the COOP, the BKA (2009, p. 58) argues that there may be a limited interest to achieve high selling prices (relative to a situation in which raw milk prices were determined in the first place). The DRV (2010) responds that COOPs must achieve the highest possible prices due to the duty of member promotion (and, thus, members' interest in high prices), statutes, the promotion of members' production, and the duty of a "proper management" ("*ordnungsgemäße Geschäftsführung*", p. 10).[28] Ex ante bargaining over selling prices would increase a COOP's risk in times of supply surpluses (i.e., the COOP would have to use its reserves to pay raw milk prices). In Austria, representatives of milk processors (both COOPs and IOFs) argue that raw milk prices must be generated in the selling market so that the future focus will be on the marketing of processed products (SCHMID ET AL., 2011, p. 50).

FAHLBUSCH ET AL. (2009, see also references therein) note that raw milk prices in a COOP are unilaterally determined by the COOP itself; members can influence raw milk prices via representatives. The results from a survey of dairy farmers (mostly suppliers of COOPs) in northwest Germany show that even those farmers with high preferences for COOPs do not favor the current pricing practices of COOPs (STEFFEN ET AL., 2009, p. 9). Farmers would most prefer a model of price determination that involves negotiations between milk producer groups ("*Milcherzeugergemeinschaften*", p. 9) and processors. Similar results for Austria were found by SCHMID ET AL. (2011, p. 51), who show that a high percentage of farmers opt to negotiate raw milk prices with their processor (as is the rule in IOFs).

---

[27] Interestingly, a high share (65%) of Austrian farmers (IOF suppliers and COOP members) surveyed in 2010 argued that the retailers decide on the "existence" of dairy farmers (SCHMID ET AL., 2011, p. 42).

[28] According to the DRV (2010, p. 4), price determination in COOPs is tightly regulated by jurisdictions of the Federal Court of Justice.

In general, differences in raw milk prices paid to farmers within the same COOP are possible. There may be differences between the prices paid to members and non-members (BKA, 2009, p. 63), although any discrimination would be rather infeasible.[29] In addition, farmers (COOP members and IOF suppliers) with larger deliveries may receive higher raw milk prices than farmers with smaller deliveries due to a system of "graduated prices" ("*Staffelpreise*"; see, e.g., HUBER, 2007a, p. 45; and HUBER, 2007b, p. 45; see also SCHRAMM ET AL., 2005). In addition, there might be differences in prices paid to COOP members according to membership duration (see, e.g., HELLBERG-BAHR ET AL., 2010, p. 13, in contrast to SCHRAMM ET AL., 2005, p. 143; see references therein).

As a high share of milk is processed by COOPs, milk processors that are IOFs must consider the benefits that COOPs provide to their members when making their own pricing decisions (BKA, 2009, p. 57). Similarly, SCHMID ET AL. (2011, p. 8; see also references therein) argue that IOFs need to consider raw product prices of COOPs if the share of COOPs in the market is sufficiently high.[30] In such a situation, IOFs also offer delivery acceptance guarantees and long-term supply contracts.

The BKA (2009, p. 57) identifies two models of raw milk price determination in IOFs. First, most IOFs in Germany guarantee a milk price based on the average milk price of other milk processors or regions (using the "reference price system" – "*Referenzpreissystem*"; WEINDLMAIER, 2000; taken from HELLBERG-BAHR ET AL., 2010, p. 14). An example of this is the *Erzeugerorientierungspreis* (EOP, Producer Orientation Price) in Bavaria until 2006 (BKA, 2009, p. 57; HELLBERG-BAHR ET AL., 2010): IOFs paid supplementary payments if the average annual milk price was lower than the EOP.[31] In 2006, the EOP was replaced by an average of monthly prices of Bavarian milk processors and is published by the Bavarian Regional Office for Agriculture (*Bayerische Landesanstalt für Landwirtschaft - LfL*). This price constitutes the minimum raw milk price; supplementary payments, premiums, and bonuses are then added (BKA, 2009, p. 58).

Second, contrary to a COOP's price determination, price determination in some IOFs can be regarded as a "bottom up" approach (BKA, 2009, p. 56 and 58) from the viewpoint of

[29] The DRV (2010) argues that there is no discrimination between members and non-members of COOPs in terms of milk prices. This discrimination would not be possible for fiscal reasons since higher prices for COOP members than for non-members would lead to hidden distribution of profits.
[30] In this context, for example, SCHMID ET AL. (2011, p. 8; see references therein) mention the case of three Bavarian dairy IOFs who signed contracts with Austrian producers' associations ("*Liefergemeinschaften*") and contract periods of up to 10 years.
[31] The EOP was determined on a monthly basis by agreements of interest groups of IOFs and COOPs and by the Bavarian Regional Office for Agriculture (*Bayerische Landesanstalt für Landwirtschaft - LfL*). The EOP was not an actual average milk price *per se*, but the possible milk price given the utilization of certain standard products and taking into account the market situation (BKA, 2009, p. 58).

farmers. A fixed raw milk price is determined by the IOF for the first months of the contractual relationship. After that, prices are subject to negotiations between farmers (or milk producer groups, "*Milcherzeugergemeinschaften*") and the IOF ("bargaining system" – "*Verhandlungssystem*"; HELLBERG-BAHR ET AL., 2010, p. 15). In case no agreement is reached, either the contract is terminated or the price is set according to the previously mentioned reference price system (BKA, 2009, p. 58). Due to this "heteronomous" determination of raw milk prices, the BKA (2009, p. 59) concludes that both the processors' incentives to offer high prices and the competition between processors may be rather low.

In a response to BKA (2009), the DRV (2010) notes that COOPs and IOFs do not determine prices differently: milk prices in general are determined by business performance, both COOPs and IOFs react to market conditions, and even IOFs determine and pay raw milk prices ex post (including supplementary payments, e.g., in Bavaria). However, the DRV (2010) emphasizes that the raw milk supply of COOP members is an important determinant of milk prices because COOPs must accept all milk delivered.

2.5 SUPPLY CONTRACTS BETWEEN MILK PRODUCERS AND PROCESSORS

The differences between current regulations regarding milk supply (or delivery) contracts of COOPs and IOFs appear to be insignificant (see, e.g., BKA, 2009, p. 74, for Germany or SCHMID ET AL., 2011, p. 8). Central elements of supply contracts include quantity and quality regulations (e.g., seasonal differentiation), price determination rules and modes of settlement, and regulations regarding contract and termination periods (SCHMID ET AL., 2011, p. 9; see references therein). In Germany, the average contract period is three years; average termination periods are shorter in IOFs (nine months) than in COOPs (fourteen months) (BKA, 2009, p. 75).[32] Generally, COOPs cannot unilaterally terminate supply contracts, but COOP members can (BKA, 2009, p. 32; STEFFEN ET AL., 2009, p. 4).

If the farmer does not terminate the contract, it is usually extended automatically (BKA, 2009, p. 75). Thus, in the case of COOPs, supply contracts (and, likewise, membership) are generally open-ended but include annual termination rights (SCHMID ET AL., 2011, p. 18 and 64). For Austria, SCHMID ET AL. (2011, p. 53) mention additionally that some supply contracts

[32] According to the BKA (2009, p. 75), there are differences between processors' contract periods in Germany. In COOPs, they vary between one and five years, and in IOFs, between one and ten years. The same applies to termination periods (which range between three months and three years). STEFFEN ET AL. (2009, p. 4) mention that the average termination period for membership is approximately two years. In addition, termination is only possible at the end of the business year. In practice, however, it is possible to bypass these termination periods (STEFFEN ET AL., 2009, p. 4; see references therein): for example, in recent years, many COOP members have left their COOP earlier by changing their legal form.

may end automatically (with a defined contract period between six months and ten years). In this case, however, only mutual preterm termination is possible.[33]

A member's commitment to the COOP is possible for a maximum of five years (BKA, 2009, p. 90). To put it differently, the termination period for membership (i.e., possibly, but not necessarily, the termination period for the supply contract) can be extended to five years (or even ten years for certain COOPs according to the German Cooperatives Societies Act, § 65(2) GENG-D; see also BKA, 2009, p. 90). According to processor representatives, shares held by COOP members only qualify as equity capital if they are tied in the long run (BKA, 2009, p. 76). Therefore, loosening the termination period would reduce equity capital and, thus, liquidity. The BKA (2009, p. 90) notes that the process of switching processors is rather complex for a COOP member in Germany: whereas an IOF supplier only needs to terminate the supply contract, a COOP member may also need to resign from membership, followed by a refund of shares.[34]

The future abolishment of milk quotas in the EU as of 2014/15 makes it necessary to consider the possible design of supply contracts and quantity management systems (see, e.g., the studies by STEFFEN ET AL., 2009, for Germany and SCHMID ET AL., 2011, for Austria). Due to the high share of COOPs, STEFFEN ET AL. (2009, p. 1; see also references therein) note that future supply contracts will become particularly important for COOPs, which will need to unify their own objectives with the objectives of their members. Currently, the quantities of milk processed by COOPs are determined by the quota system and by requirements that COOP members deliver and COOPs accept all raw milk, respectively. Likewise, SCHMID ET AL. (2011, p. 10) argue that contract design will be challenged, particularly in COOPs, because of the duty to accept all milk delivered and because of uniform milk prices within the COOP. Therefore, alternative supply management systems are currently under discussion.[35]

A survey of farmers in Germany conducted by STEFFEN ET AL. (2009, pp. 11) in 2008/09 shows that most dairy farmers opt for a contract period of about one to three years. Likewise, many farmers (in particular, IOF suppliers) prefer rather short termination periods and opt for extraordinary termination rights (which are regarded as a means of pressurizing processors).

[33] Generally, farmers' contracts with COOPs are automatically extended when these contracts are not terminated. IOFs offer contracts with a predefined duration (information by phone - Chamber of Agriculture/Upper Austria, Mr. Wöckinger, July 14, 2011).

[34] In Austria, termination of the supply contract on the part of a COOP member may not imply a termination of membership. The farmer may remain registered as a member even though he has stopped deliveries to the COOP (information by phone - Chamber of Agriculture/Upper Austria, Mr. Wöckinger, July 14, 2011). In this case, the shares of the farmer obviously have not been paid out yet. See also BKA (2009, p. 90) for the case of the Netherlands.

[35] Examples include the Fonterra model, the A/B model and the closed-shop model (see reviews in SCHMID ET AL., 2011, pp. 10).

A comparable survey for Austria conducted by SCHMID ET AL. (2011, pp. 64) in 2010 shows that Austrian farmers opt for longer contract periods than German farmers do. As in Germany, however, IOF suppliers in particular favor significantly shorter termination periods than COOP members do and opt for special termination rights. On the part of processors, farmers prefer longer termination periods. This preference may imply a higher planning reliability for farmers and, at the same time, the option to switch between processors rather quickly. Contrary to STEFFEN ET AL. (2009) for Germany, SCHMID ET AL. (2011, pp. 64) conclude that Austrian farmers are rather critical of higher flexibility in delivered quantities (i.e., variable deliveries that are not determined by contracts). Both farmer groups, however, opt for long-term negotiated raw milk prices. If delivery acceptance is guaranteed, then German farmers are more willing to accept lower prices. A long-run commitment between farmers and processors seems to be more important for Austrian than for German farmers.

In Germany, the option to switch to another processor quickly is important for approximately 47% of farmers, whereas one third do not feel the need to switch (STEFFEN ET AL., 2009, pp. 11). IOF suppliers are more likely to switch between processors than COOP members are. For Austria, SCHMID ET AL. (2011, p. 37) show that only a minority of farmers would switch more if they were not bound by a long contract periods; in particular, COOP members favor a long-run commitment to processors more strongly than IOF suppliers do. Similarly, ZEULI AND BENTANCOR (2005) argue that membership commitment to a certain COOP is especially an issue in the case of direct competition between COOPs if the termination period is rather short. This is the case in many dairy COOPs in the U.S., where a farmer can terminate his annual supply contract within a few days. ZEULI AND BENTANCOR (2005) estimate a logit model to analyze the determinants of switching to other milk processors among farmers in the U.S. They empirically show that COOP members are less likely to switch to another processor than IOF suppliers are. In addition, farmers who consider price as an incentive to switch are more likely to switch. However, milk producers in Germany complain that it is sometimes not possible to switch from one COOP to another due to some “territory protection” reasoning (“*Gebietsschutzdenken*”, BKA, 2009, p. 81) by COOPs so that other farmers are not accepted.[36] According to observations of the BKA (2009, p. 81), milk producers do not seem to switch between COOPs in significant numbers in certain regions, even when processing facilities are close to each other; this may be partly driven by the milk quota, which is administered by milk processors.

[36] The BKA (2009, pp. 80) notes that principles that impede farmers from switching to alternative (COOP or IOF) milk processors may be questionable according to antitrust legislation.

The Germany Federal Cartel Office, BKA (2009, pp. 73), argues that a high share of milk is committed in the long term via supply contracts[37] (i.e., it is not freely available on the spot market). Such contracts may constitute an entry barrier for new processors and may also limit the selling options of farmers. In particular, some IOFs that are willing to expand claim that long contract periods wall off the market. However, some IOFs themselves opt for longer contract periods (i.e., five to six years) for two main reasons: either to secure raw milk deliveries when there is no milk quota regime (p. 75) or due to long-run agreements between COOP members and their COOP (which make these farmers unavailable in the medium term, p. 47).

The German Federal Cartel Office will observe in the future whether long-run contract periods generate "market foreclosure effects" ("*Marktabschottungseffekte*"; BKA, 2009, p. 82). Likewise, some dominant positions of processors may limit the options of farmers to switch to another processor, depending on regional market conditions (see also CHAPTER 2.6) and on the effect of contract periods on competition. The interim report of the BKA (2009, p. 82 and p. 92) preliminarily concludes that long contract periods and high transparency regarding raw milk prices may be rather disadvantageous for farmers. Shorter contract periods and price determination, which is neither ex post nor based on prices of competing processors, may be desirable. Since incentives for competition increase (in particular, for processors willing to expand) raw milk prices may be higher. However, the BKA (2009, p. 76) notes the view of the industry's representatives that short-run supply contracts may limit the planning reliability of both processors and farmers. In addition to contract and termination periods, another factor influencing the possibility for farmers to switch to another processor is the spatial dimension of the raw milk market (see the following subchapter, CHAPTER 2.6).

2.6 THE SPATIAL DIMENSION OF RAW MILK COLLECTION BY MILK PROCESSORS

Due to the spatial dimension of most agricultural raw product markets, transportation costs are a significant cost component in the agricultural sector (see also BOYSEN AND SCHRÖDER, 2006). Milk processors (not farmers) are responsible for the costs of transporting raw milk from the location of the farmer to the processing facility and all farmers of a certain processor receive a uniform price (see, e.g., HUCK ET AL., 2006; BKA, 2009, p. 56; and GRAUBNER ET

[37] The DRV (2010), however, notes that a two-year contract cannot be considered a "long-term" contract. A two-year contract can be considered short-term, a contract of five years can be considered medium-term, and a contract of up to ten years as long-term. A supply contract of a longer duration is especially important for COOPs in fulfilling the promotional relationship with their members. Even milk producers benefit from longer contracts because such contracts allow a more reliable planning for farm investments. SCHMID ET AL. (2011, p. 54) find that the understanding of the term "long-term contract" among milk processors in Austria differs between three and ten years.

AL., 2011a, for the case of Germany; or ALVAREZ ET AL., 2000, for the case of Asturias in Spain).[38] According to SCHMID ET AL. (2011, p. 35 and p. 50), many milk farmers and processors in Austria disapprove of raw milk prices that would partly be determined by spatial aspects like milk density or distance within a collection area; thus, spatial aspects should not be a means of assigning different raw milk prices to different farmers.

BOYSEN AND SCHRÖDER (2006) argue that the importance of transportation costs relative to other cost factors will increase in the future, for example, because of increasing fuel costs, road charges or future environmental policy regulations. The total costs of a milk truck in Germany are approximately 0.54 Euros per kilometer of milk transported, independent of the degree of capacity utilization; transportation costs per ton of raw milk are also influenced by the number of trucks employed, the capacity of the trucks (9 tons), the maximum daily kilometers traveled (480 km), and the length of the collection cycle (BOYSEN AND SCHRÖDER, 2006, p. 153, based on JANZ, 2002). Based on data for 2007, WEINDLMAIER AND BETZ (2009, pp. 43) argue that the costs of raw milk collection are mainly influenced by the structure of milk producers and collection points ("*Haltestelle*", p. 43). Compared to Germany, the average milk supply per collection point is rather low in Austria: 455 kg per collection versus 1,155 kg in Germany (or 732 kg in Bavaria) in 2007. In addition, a processor in Austria served, on average, 2.31 milk producers per collection point in 2007; the corresponding figure for Germany is 1.28 (and 1.32 for Bavaria). This difference reflects the higher average milk production per farmer in Germany.[39] Whether raw milk is collected on a daily basis or less frequently depends on the milk quantity, the location, and farmers' storage capacities (BKA, 2009, p. 64). The frequency of milk collection is another factor influencing the costs of raw milk acquisition (WEINDLMAIER AND BETZ, 2009, pp. 45): 22.4% of German milk processors collect milk on a daily basis and 23.7% every second day. The remaining 47% of processors collect milk by combining these two collection schedules. In Austria, one third of processors collect milk every second day, and two thirds collect milk by combining daily collection and

[38] "Milk processors are responsible for the collection of raw milk from producers. […] Milk processors bear the costs of collection" (BKA, 2009, p. 30, quote translated from German). According to the BKA (2009, p. 56) in reference to pricing in German COOPs, dairy farmers receive a uniform raw milk price that is "[…] independent from transportation costs, which accrue in individual cases due to the distance from the dairy farm to the milk processor […]" (quote translated from German). Stopping costs are taken into account ("*Stoppgeld*", p. 56), but these costs are set equal for any milk producer and thus are independent of individual distances. However, the BKA (2009, p. 57) adds that "at least" the largest COOPs pay farmers the same price irrespective of the processing location. Such a pricing policy, in which processors bear transportation costs and in which raw milk prices for farmers are not differentiated according to space, is commonly referred to as uniform delivered (UD) pricing; see CHAPTER 3.2. The opposite case would be that farmers account for transportation costs by themselves, which is referred to as free-on-board (FOB) pricing.

[39] According to BOYSEN AND SCHRÖDER (2006, p. 154) and based on data for 2000/2001, the median milk density for administrative districts ("*Landkreise*", p. 153) in Germany is 58.46 t/km^2. In general, collection areas for raw milk are more fragmented for smaller milk processors than for larger processors.

collection on every second day. The share of processors cooperating with neighboring processors is higher in Austria (43% of the processors versus 16% in Germany). Average acquisition costs are higher in Austria (1.81 cents/kg milk in 2007) than in Germany (1.15 cents/kg) because of a less advantageous structure of milk producers and collection points.

Due to transportation costs, the collection of raw milk is only feasible within a certain distance from a processor's location, which is also influenced by factors like the capacities of processing facilities within a region, the size and density of dairy farms, and the regional infrastructure (BKA, 2009, p. 43). The market area of milk processors is limited by the distance that is technically possible and economically reasonable to collect raw milk. The collection area ("*Erfassungsgebiet*", p. 42) is the region where the processor transports raw milk from farmers to the processing location. According to a survey by the German Federal Cartel Office, BKA (2009, p. 43), milk processors collect raw milk from a distance of 170 km on average (maximum: 425 km; minimum: 60 km).[40] The catchment area ("*Einzugsgebiet*", p. 42), however, is the area that allows an economically reasonable acquisition of raw milk. Thus far, the BKA (2009, pp. 42) has assumed a catchment area with a radius of at least 150 km, which is not a cross-border market radius.[41] According to its survey, the catchment area seems to be economically reasonable up to a distance of 220 km on average (maximum: 500 km; minimum: 100 km). However, when accounting for smaller milk processors, a catchment radius of 150 km around the processing location seems to be reasonable. Many milk processors cooperate to optimize their respective market areas for raw milk collection ("*Milchtauschverträge*", p. 105). In addition, processors cooperate on sales, packaging material purchases, deliveries of semi-processed products, and other aspects of their business.

Analyzing raw milk collection in Germany, HUBER (2007a, pp. 43) concludes that the raw milk collection areas of processors overlap. This observation particularly applies for regions with a high milk density (in terms of t/km^2) and processor density, such as Allgäu in Bavaria. In almost half of the area of Germany, more than one processor operates in certain regions. Most regions that are exclusively served by one processor have a low milk density (e.g., regions like Baden, the Southern Pfalz region, the Ruhr region or Hannover; HUBER, 2009, p. 36), although some specific milk producers in these regions are separately served by other processors. HUBER (2007a) argues that one reason for this fragmentation ("*Zersplitterung*", p.

[40] The DRV (2010) argues that milk collection also depends on the density of milk processors. Although the average distance is 170 km, a market radius of 250 to 300 km is commonly observed. In addition, transportation of raw milk and concentrate must be distinguished, and processors can exchange raw milk due to transportation routes. In accordance to legislation, the DRV (2010) suggests to consider the total federal territory as the market area for collecting milk.

[41] Contrary to the BKA (2009), the DRV (2010) argues that milk is collected across borders (e.g., in Belgium or the Netherlands).

45, i.e., overlap of market areas) may be the differentiation of raw milk prices according to the quantity supplied (i.e., graduated prices/"*Staffelpreise*", p. 45), especially in western and northern Germany. In addition, processors in eastern Germany enter into individual supply contracts with specific large raw milk suppliers.[42] HUBER (2007a, p. 45) concludes that some processors with a high demand for raw milk are better off accepting higher transportation costs and paying differentiated prices that are dependent on the quantities supplied. To account for costs associated with specific (e.g., large) milk suppliers, some processors increased the standard price for raw milk and introduced deductions such as basic cost allowances and/or deductions accounting for stopping costs (HUBER, 2007b, pp. 45). To consider small suppliers or to attract specific large suppliers, more processors have begun to introduce graduated prices in recent years.

HUBER (2009, p. 36) concludes that, first, the additional costs associated with a larger market area may play a minor part for processors that want to gain raw milk supplies. Second, the advantages of high milk density in southern Germany are lost due to higher competition: market overlap implies that the actual milk density of farmers is reduced from the viewpoint of competing processors because farmers are shared by different processors within the area of overlap. As a result, milk collection routes become longer. In northern Germany in particular (Schleswig-Holstein, Niedersachsen, Mecklenburg-Vorpommern), there are only a few milk processors with relatively small collection areas (BKA, 2009, p. 47) and less competition between processors compared to southern Germany (see also HUBER, 2009, p. 36). Therefore, in addition to issues related to supply contracts (see CHAPTER 2.5) and possibly membership policies of COOPs (see CHAPTER 2.3), the option for milk producers to switch to alternative milk processors also depends on the number of milk processors within a region and their corresponding market areas (see also BKA, 2009, p. 47).

2.7 CONCLUDING REMARKS

The findings from the literature described here will help in deriving and justifying some assumptions made in the analytical models in CHAPTERS 5 to 7. Based on these findings, important assumptions include a high concentration of processors, a spatial pricing policy where processors account for transportation costs, spatial competition between processors via

[42] For an annual comparison of milk prices paid by Austrian milk processors and graduated milk prices paid to farmers in Austria, see, e.g., TOP AGRAR ÖSTERREICH (2011). In this comparison, milk prices are differentiated according to annual farm supplies of 50 tons, 150 tons and 300 tons of raw milk. As an example, in 2010, the dairy *NÖM AG* paid milk prices (including supplementary payments) of 30.30 cents/kg (50 tons), 31.64 cents/kg (150 tons) and 31.96 cents/kg (300 tons). The basis for these calculated milk prices (exclusive of VAT) is a fat content of 4.2% and a protein content of 3.4%.

raw product prices, different legal forms of processors (COOPs and IOFs), and a behavior of processors that allows overlapping market areas. Supply contracts will not be considered explicitly in the models as they constitute a dynamic problem. One might also argue that the possibilities for farmers to switch between processors easily seem to be influenced more by the spatial dimension of raw milk collection (see also CHAPTER 3) and by the membership policy of COOPs than by contract design.

The membership policy and the derivation of a suitable objective function of dairy COOPs are elusive. Open membership is a COOP principle, but some restriction of membership seems to be possible (and even practiced) in German and Austrian dairy COOPs. Therefore, both open and restricted membership will be considered in the analytical models in CHAPTER 6. Because a COOP consists of different interest groups, objectives within the COOP may differ. Thus, the assignment of one specific objective function to German or Austrian dairy COOPs is rather difficult. The “upside down” approach of price determination in COOPs may suggest that COOPs pursue the objective of paying the highest possible price to members subject to covering costs (net average revenue product (NARP) pricing). However, according to the BKA (2009, p. 48), an increasing number of COOPs now aim to maximize total profits as vertically integrated firms. This finding, in turn, suggests the objective of total member welfare maximization (see the discussion of possible COOP objective functions in CHAPTER 4.1). Thus, the analytical models in CHAPTER 6 will consider different objective functions of COOPs.

3 A REVIEW OF THE SPATIAL ECONOMICS LITERATURE

CHAPTERS 1 and 2.6 highlighted the importance of the spatial dimension of agricultural markets, particularly the raw milk market, and the high concentration of food processors. These characteristics facilitate the exercise of market power towards farmers. The costs of transporting the raw product to the processing location have to be borne either by farmers or by processing firms. According to CAPOZZA AND VAN ORDER (1978), transportation costs can provide some type of protection from spatially separated competitors. Similarly, PHLIPS (1983, p. 23) argues that transportation costs can create local oligopolies (or oligopsonies) so that there are only few competitors. The "segmentation of consumers [or input suppliers] into separate markets" is an essential feature of imperfect competition (GREENHUT ET AL., 1987, p. 101). Spatially separated markets always imply imperfect competition and, consequently, (at least local) market power (see GREENHUT ET AL., 1987, p. 2). Thus, "[…] freight is a significant factor in price formation […]" (PHLIPS, 1983, p. 23).

Contrary to analytical contributions on the oligopolistic power of the food processing industry, the literature on oligopsonistic power towards agricultural producers is rather limited (see also the discussion in ROGERS AND SEXTON, 1994). In addition, only a few papers address the spatial dimension of oligopsonistic power. Generally, one can distinguish two cases in the spatial economics literature: the spatial monopoly/monopsony and spatial competition. In the case of the spatial monopoly/monopsony, either only one firm operates in the space or multiple firms operate in the space without direct competition. Thus, the spatial monopolist/monopsonist operates within an exclusive market area. In the case of spatial competition, the potential market areas of neighboring firms may overlap or share a common market boundary.

Analytical models of the spatial monopoly are well established. Prominent works on the spatial monopoly are GREENHUT AND OHTA (1972 and 1975), BECKMANN (1976), HSU (1983) and OHTA (1984). In addition to the spatial monopoly, GREENHUT AND OHTA (1975), CAPOZZA AND VAN ORDER (1977) and NORMAN (1981), for example, also consider the situation of the spatial oligopoly. Only a few authors consider the case of a spatial monopsony, such as LÖFGREN (1986) and ALVAREZ ET AL. (2000). Examples of spatial oligopsony models include SEXTON (1990), ROGERS AND SEXTON (1994), ALVAREZ ET AL. (2000), ZHANG AND SEXTON (2001), and GRAUBNER ET AL. (2011a and 2011b).

This chapter attempts to provide a review of the spatial economics theory by highlighting some important works from the analytical literature and summarizing relevant conclusions. It is obvious that any conclusion depends on the underlying model assumptions, in particular, in the spatial economics literature, where slightly different assumptions may yield qualitatively different results. A large body of literature focuses on the impact of different assumptions as the primary objective of the analysis. Therefore, this review cannot claim to be complete and aims to review the literature in a non-analytical way.[43]

Generally, the outcome of an analytical spatial economics model depends on two important features. First, it depends on the pricing policy (or pricing scheme), which generally establishes who (farmers, processors) is responsible for transportation costs. Second, in the situation of spatial competition, the outcome depends on the firm's expected reaction of competitors (i.e., the conjecture). This review primarily focuses on the impact of these two issues. Other issues, like location theory (which, inter alia, analyzes the location choice of firms), are not the primary focus of this review.[44]

After introducing the most general model assumptions in the spatial economics literature and commonly used market forms (see CHAPTER 3.1), this review proceeds by discussing assumptions on the spatial pricing policy of firms (CHAPTER 3.2). These pricing policies are examined for the spatial monopoly/monopsony. After highlighting the empirical relevance of these pricing policies, their impact in the situation of spatial competition will be discussed. CHAPTER 3.3 reviews the impacts of the most commonly assumed conjectures in spatial competition models. These conjectures will be discussed given a certain spatial pricing policy employed by firms. Some concluding remarks are given in CHAPTER 3.4.

3.1 GENERAL ASSUMPTIONS AND MARKET FORMS IN SPATIAL MODELS

Generally, the spatial firm can either sell goods to spatially distributed consumers (the spatial monopoly or oligopoly) or buy goods from spatially distributed input suppliers (the spatial monopsony or oligopsony). As noted before, most literature considers the monopoly/oligopoly case. In the analytical models in CHAPTER 5 to 7, the spatial firm is assumed to be a food processor that buys the raw product from spatially distributed farmers

---

[43] Examples of analytical reviews of the spatial economics theory are BECKMANN AND THISSE (1986) and GREENHUT ET AL. (1987).

[44] Typically, location games follow the tradition of HOTELLING's (1929) seminal work; see also TIROLE (1988, chapter 7.1). According to the "principle of minimum differentiation", "[…] in equilibrium the duopolists are located at the centre of the market rather than being in the locations that would maximize transportation costs" (EATON AND LIPSEY, 1975, p. 27, referring to HOTELLING, 1929). An example of this strand of literature is DE PALMA ET AL. (1987). Examples of the choices of firms regarding their location in a spatial market (i.e., location games, which are followed by a price game) are LEDERER AND HURTER (1986), DE FRAJA AND NORMAN (1993), KATS AND THISSE (1993) and ANDERSON AND ENGERS (1994). For example, DE FRAJA AND NORMAN (1993) adopt the concept of a subgame perfect equilibrium, where firms choose a location in the first stage and the price to charge in the second stage. "This approach reflects the idea that prices can be changed at relatively short notice, whereas the location tends to be fixed in the short run. In the traditional interpretation of this model, as the choice of position of the product in a characteristics space, the two stage assumption implies that the characteristics of the commodity supplied cannot be easily changed in the short run" (p. 345).

(the spatial monopsony/oligopsony). Thus, in this review, both types of firms will be considered; in general, one is the mirror image of the other.

Most analytical models in the spatial economics literature apply a set of similar assumptions, which can be found in numerous analytical contributions. For the case of the spatial monopsony, the most common simplifying assumptions in spatial economics models are summarized in LÖFGREN (1986, p. 708) and presented in a slightly modified way as follows:[45]

1) In a spatial market of some form (e.g., a linear market), a single buyer of the raw product (i.e., the food processor) processes the raw product and resells the processed product at a constant price ρ. For reasons of simplicity, it is assumed that ρ is the selling price P net of constant per-unit processing costs c (see, e.g., ALVAREZ ET AL., 2000).[46]
2) All sellers of the input (i.e., farmers) have identical supply curves $q = q(u)$, which are twice continuously differentiable. q is the supply of the raw product of a single farmer, and u is the net price received by the farmer, which is the price after accounting for transportation costs. It is assumed that $q'(\cdot) > 0$ and $q(0) = 0$.
3) Transportation costs t are the constant costs of transporting one unit of the input one unit of the distance (i.e., the freight rate).
4) Farmers are continuously distributed over space according to some density function $D(\cdot)$, which is defined over space r, where $D(r) \geq 0$ for all r and $D(r) > 0$ for at least one r.
5) The market area R served by the single processor is limited only by the price he pays to his suppliers.

According to assumption 1, the selling market (i.e., the processed goods market) is characterized by perfect competition. As, by assumption, the product is produced with input q only, ρ is constant and equal to marginal revenue of processors. The assumption of perfect competition in the selling market is justified because, once the product is processed, it can travel longer distances and processors face competition from other processors in the processed goods market nationally or internationally (see, e.g., KARANTININIS AND ZAGO, 2001; and

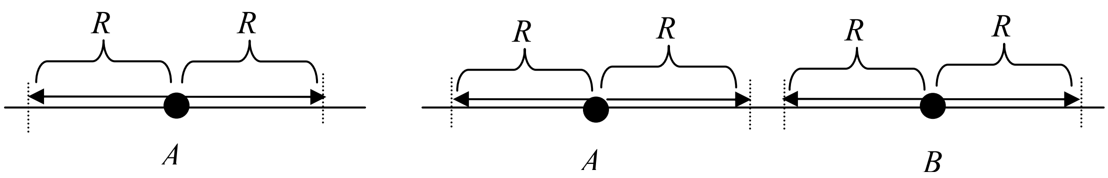
[45] For the case of the spatial firm selling to consumers (i.e., the spatial monopoly/oligopoly), see, e.g., CAPOZZA AND VAN ORDER (1978).

[46] For a more detailed specification of processing costs, see, e.g., SEXTON (1990). ZHANG AND SEXTON (2001) also assume constant marginal processing costs in their spatial duopsony model. In addition, they ignore fixed costs as they have no effect on their model. They note: “Fixed costs, however, provide a heuristic justification for the duopsony market structure, given the constant returns processing technology” (p. 203, footnote 11).

ZHANG AND SEXTON, 2001). Therefore, any decision on the extent of the market area of the processor or on the prices paid to farmers (and, thus, the quantity processed) has no effect on the selling prices of food processors. For the specification of the supply function, as in assumption 2, more structure is usually added. For example, ALVAREZ ET AL. (2000) assume that $q(u)$ is linear; LÖFGREN (1986) analyzes the spatial monopsony for linear and non-linear supply curves.[47] In general, it is assumed that farmers are price takers. The freight rate t is specified in assumption 3. However, so far, it is not specified whether farmers or processors are in charge of transportation costs. This is determined by the pricing policy of processors and will be discussed in CHAPTER 3.2.

Assumptions 1 to 4 are not necessarily limited to the case of the spatial monopsony and also apply to the case of the spatial oligopsony. In the spatial context, a monopsony can imply two different cases. First, the firm *A* can be the only buyer in the market, i.e., there is only one firm located in space (see, e.g., FIGURE 3-1 on the left-hand side). Second, at least two firms *A* and *B* may be located in the market, but each of them serves an exclusive region (spatial monopsony); see FIGURE 3-1 on the right-hand side. As assumption 5 indicates, the extent of the market area *R* is partly determined by the pricing policy (i.e., who is in charge of transportation costs; see CHAPTER 3.2).

FIGURE 3-1. The spatial monopoly/monopsony



In the spatial economics literature, different market forms are assumed.[48] Assumptions 1 and 5 address the possible shape of the market: the market form of the spatial market can be linear and theoretically unbounded. The consideration of space is one example of (horizontal) product differentiation.[49] An early model in this context is HOTELLING (1929; taken from

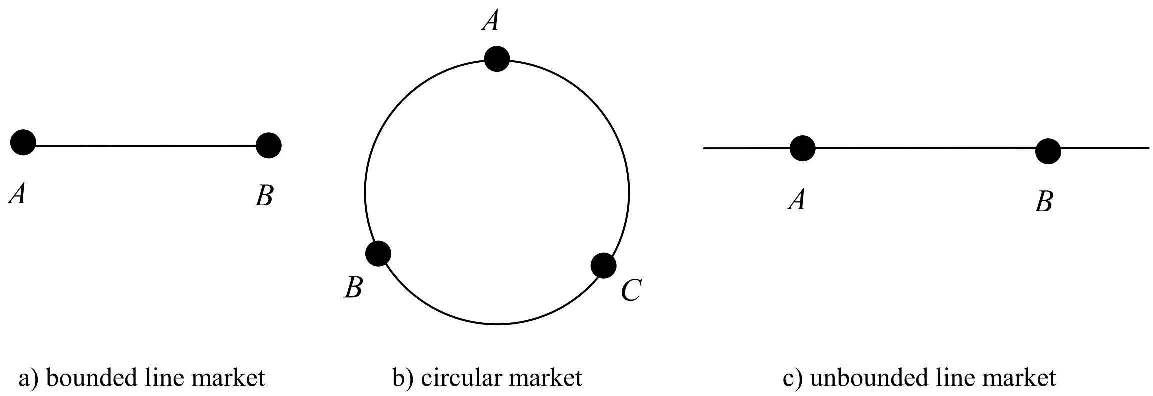
[47] LÖFGREN (1986, p. 708) notes that assumptions 1 and 2 are "restrictive, but their relaxation would considerably complicate the […] analysis."

[48] For a discussion of some different market forms, like bounded or unbounded space, see EATON AND LIPSEY (1975).

[49] Goods are mostly differentiated according to some characteristics, and, given equal prices, the optimal choice depends on the particular consumer (see, e.g., TIROLE, 1988, p. 97). The products can be differentiated, for example, due to transportation of the product over different places, storage over time periods, and variations in packing or design (see, e.g., GREENHUT ET AL., 1987, pp. 3; and PHLIPS, 1983, p. 6). One example is product differentiation by location: consumers may prefer goods that are available nearby over physically identical goods that are available far away (TIROLE, 1988, p. 97). Thus, in the context at hand, it is assumed that products are differentiated by transportation costs.

TIROLE, 1988, pp. 97), which assumes a “linear city” where two “shops”, *A* and *B,* are located at both ends of the city and consumers are uniformly distributed along the line (see FIGURE 3-2a). In a non-spatial context, the (in this case, bounded) linear market allows the analysis of price competition with differentiated products and product choice in a duopoly framework (see, e.g., TIROLE, 1988, chapter 2). Examples of an explicitly spatial context with a bounded line market are SCHULER AND HOBBS (1982), DURHAM ET AL. (1996) and MÉREL ET AL. (2009).

FIGURE 3-2. Market forms of spatial markets



Alternatively, it can be assumed that two or more firms are located along the line equidistant from one another (see, e.g., GRONBERG AND MEYER, 1981). Then, such a market is similar to a circular market (see FIGURE 3-2b). These two market forms imply a ”symmetry of location between firms” (ALVAREZ ET AL., 2000, p. 351).[50] In such a market, the long-run (free entry) equilibrium with entry and exit of firms can be analyzed (see, e.g., GRONBERG AND MEYER, 1981; CAPOZZA AND VAN ORDER, 1977 and 1978). In addition, issues like location choice can be analyzed in such a “circular city” in the tradition of SALOP (1979, taken from TIROLE, 1988, pp. 282). Examples of circular markets in the spatial economics literature are KATS AND THISSE (1989 and 1993), PAL (1998), and MATSUSHIMA AND MATSUMURA (2003) .

In contrast to these market forms, ALVAREZ ET AL. (2000) assume a special case of a line market: an unbounded line market with two firms (see FIGURE 3-2c). In such a situation, a processor will face a competitor only on one side of the market. This feature also applies to the bounded line market with two firms located at the endpoints (see FIGURE 3-2a). However, in a duopsonistic unbounded line market, as in Figure 3-2c, areas of *competition* between

[50] Assuming a bounded linear market with two firms located at its endpoints, MÉREL ET AL. (2009, p. 464) note: “Results from the linear market generalize immediately to some alternative spatial settings, such as Salop’s circular market (Salop 1979).”

firms are not necessarily symmetrical in both directions (see CHAPTER 5.1).[51] In such a market, not all farmers along the line are necessarily served by processors in the situation of spatial competition. Since the model cannot easily be adopted for a situation with more than two firms, a consideration of the long-run (or free-entry) equilibrium does not appear to be applicable for this market form. The analysis of this equilibrium requires symmetry of location between firms as in FIGURES 3-2a and 3-2b. Another possible market form is similar to FIGURE 3-2c, but with the assumption that the line market is bounded (see, e.g., BECKMANN AND THISSE, 1986, p. 37). Different model results associated with alternative market forms will be discussed in more detail in the analytical models in CHAPTER 5.

In the spatial economics literature, mostly one-dimensional spatial markets are assumed. Regarding the distribution of farmers across the line space (assumption 4), a simplifying assumption such as $D(r)=1$ implies a uniform distribution of farmers across space (see, e.g., ALVAREZ ET AL., 2000). By adding dimensional parameters in the density function, the analysis can be extended to the case of farmers that are distributed over a plane (see also LÖFGREN, 1986). Examples of spatial models assuming two-dimensional markets are EATON AND LIPSEY (1975) and SCHÖLER (2001).[52]

3.2 PRICING POLICY

The assumptions in the previous chapter do not specify which market participant (processor or farmer) is responsible for the costs of transporting the raw product. This responsibility is determined by the pricing policy. Let the actual price paid by the processor be the "mill price" u_m and the actual price received by the farmer located at point r after accounting for transportation costs the "net price" $u^{pol}(r)$, where index *pol* denotes the pricing policy.[53] The term "net price" indicates that this is the price net of any possible transport costs to be borne by the farmer (see LÖFGREN, 1986, for the monopsony case or ZHANG AND SEXTON, 2001, for the duopsony case). In this sense, the mill price u_m can be regarded as the price at the location of the processor (i.e., at the mill) and the net price $u^{pol}(r)$ as the price at the location of the farmer (i.e., at the farm gate).

[51] Depending on the pricing policy (see CHAPTER 3.2) and on the conjecture (see CHAPTER 3.3), competing firms can either have a common market boundary or overlapping market areas.

[52] EATON AND LIPSEY (1975) also consider one-dimensional markets and discuss the differences from two-dimensional markets. SCHÖLER (2001) argues that additional modeling expenses due to the consideration of two-dimensional markets are only justified if there are qualitative differences in the results between one-dimensional and two-dimensional markets.

[53] In the mirror image, the spatial monopoly/duopoly, the price paid by a consumer located at r, $u(r)$, is mostly termed the "delivered price"; see, e.g., CAPOZZA AND VAN ORDER (1978), NORMAN (1981), and HOBBS (1986).

Most literature distinguishes between two extreme positions of pricing policies (for reviews, see, e.g., BECKMANN AND THISSE, 1986; and GREENHUT ET AL., 1987): free-on-board (FOB) pricing, where farmers/consumers are responsible for transportation costs, and uniform delivered (UD) pricing, where the processor (as a buyer) or the selling firm is responsible for transportation costs. The intermediate case where processors and farmers share transportation costs is termed "optimal discriminatory (OD) pricing". In the following, these pricing policies will be defined in more detail.

Under FOB pricing (or "mill pricing"; see, e.g., LÖFGREN, 1986), all farmers receive an identical ex-factory price (i.e., the mill price u_m) at the plant gate of the processor, but they pay transportation costs themselves. The usual interpretation is that farmers deliver the raw product on their own to the processor (see also BECKMANN AND THISSE, 1986, p. 30, for the case of monopoly under FOB pricing in which consumers ship the product on their own). Thus, in a FOB-pricing monopsony, the optimal market area of the processor is determined by the most distant farmer who is willing to supply the processor (see also BECKMANN AND THISSE, 1986, p. 33, for the FOB-pricing monopoly). Analytically, a farmer located distance *r* from the processor receives the following net price:

(3-1) $u^{FOB}(r) = u_m^{FOB} - tr$

Hence, transportation costs are deducted in proportion to distance so that local prices (at the locations of different farmers) differ by the transportation costs between two different locations (see also BECKMANN AND THISSE, 1986, pp. 30). FOB pricing is the only non-discriminatory pricing policy because no farmer pays more or less than the corresponding transportation costs from his farm to the location of the processor (DURHAM ET AL., 1996). In the monopoly/oligopoly framework, a pricing policy is non-discriminatory when

"[…] two varieties of a product are sold by the same seller [i.e., the firm] to two different buyers [i.e., the consumer] at the same *net price*, the net price being the price paid by the buyer corrected for the cost associated with product differentiation. […] It follows, for example, that the only non-discriminatory spatial *pricing* policy is the [FOB] pricing policy under which all consumers pay exactly the same (mill) price at the factory gate and then pay full transportation costs to their own consuming locations" (GREENHUT ET AL., 1987, p. 4, referring to PHLIPS, 1983, p. 6, who defined the opposite case, i.e., "price discrimination").[54]

[54] Note the difference between the monopsony/oligopsony case and the monopoly/oligopoly case. In a monopoly/oligopoly context, like in GREENHUT ET AL. (1987, e.g., p. 116), the "net price" is the mill price u_m. In such a context, a consumer located at point *r* pays the FOB price $u(r)=u_m+tr$. Consequently, the net price is $u_m=u(r)-tr$. However, in a monopsony/oligopsony context, as, for example, in LÖFGREN (1986), the "net price"

Most analytical spatial economics literature assumes FOB pricing because the analytics are simpler than for other pricing policies (ALVAREZ ET AL., 2000).

Any pricing policy other than FOB pricing, i.e., any (spatial) pricing policy where at least part of the transportation costs is absorbed by the processor, is discriminatory (see also ALVAREZ ET AL., 2000). The case of total freight absorption is UD pricing (or "c.i.f. pricing"; see LÖFGREN, 1986).[55] Under UD pricing, farmers receive an identical farm-gate price irrespective of their distance to the processor. Because the processor is responsible for transportation costs, it is usually the processor who collects the raw product (and not the farmer who delivers the raw product; see also IOZZI, 2004, for the oligopoly case). Consequently, the processor may refuse to collect raw products from certain locations, i.e., there is rationing (see BECKMANN AND THISSE, 1986, p. 30, for the case of UD pricing in the spatial monopoly). For the monopoly/oligopoly case, DE PALMA ET AL. (1987) argue:

"As the product is homogeneous, consumers want to order from the firm charging the lower delivered price. In the case of a price tie, we make the convention that consumers have an equal probability of buying from either firm. However – and this constitutes a distinctive feature of [UD pricing] – a firm may refuse to satisfy some orders. […] Under [UD pricing], for certain pairs of prices, some consumers may therefore be rationed" (DE PALMA ET AL., 1987, pp. 443).

Thus, contrary to FOB pricing, under UD pricing it is the spatial firm that determines the market area (see also BECKMANN AND THISSE, 1986, p. 33). In general, the market area of the spatial firm is determined by refusing (local) negative profits (see, e.g., ALVAREZ ET AL., 2000). As transportation costs are borne by the processor, net prices received by farmers are equal for any location of input suppliers:

(3-2) $u^{UD}\left(r\right)=u_m^{UD}$

Because processors bear total transportation costs, UD pricing is an extreme case of price discrimination across space in favor of more distant input suppliers and against suppliers located closer to the processor (ALVAREZ ET AL., 2000). In effect, farmers located closer to the processor cross-subsidize more distant farmers (DURHAM ET AL., 1996). UD pricing is discriminatory because differences in local prices (at the location of farmers) do not reflect

under FOB pricing is $u(r)=u_m-tr$; see equation (3-1). In CAPOZZA AND VAN ORDER (1978), NORMAN (1981) and HOBBS (1986), for example, the actual price paid by the consumer (after accounting for transportation costs) is termed the "delivered price".

[55] Examples of the spatial competition literature on UD pricing are GRONBERG AND MEYER (1981), SCHULER AND HOBBS (1982), and ALVAREZ ET AL. (2000).

these transportation costs (GRAUBNER ET AL., 2011a; see also PHLIPS, 1983, p. 6, or GREENHUT ET AL., 1987, p. 102).

Another discriminatory pricing policy considered in the literature is termed "optimal discriminatory (OD) pricing".[56] Spatial price discrimination can be interpreted as follows (see also GREENHUT ET AL., 1987, p. 10 and p. 102, or LÖFGREN, 1986): either as (partial) freight absorption by the processor of the raw product, or as the processor paying different FOB mill prices to suppliers at different locations. Mill prices are determined for each specific location to maximize profits (BECKMANN AND THISSE, 1986, p. 30). Thus, the mill price $u_m^{OD}(r)$ is variable, and net prices received by farmers under OD pricing are

(3-3) $u^{OD}(r) = u_m^{OD}(r) - tr$

(see also GREENHUT ET AL., 1987, p. 105). Hence, differences between net prices $u^{OD}(r)$ paid to different farmers are not necessarily related to differences in transportation costs (see HOBBS, 1986, for the case of firms selling to consumers).

Following NORMAN (1981)[57], a general price equation that includes all three cases (FOB, UD, and OD pricing) for the net price $u(r)$ received by farmers under either pricing policy is

(3-4) $u(r) = u_m - \alpha tr$,

where u_m is the mill price under either pricing policy, *tr* are the costs of transporting one unit of the raw product *r* miles, and α is some proportion of the transportation costs (see also GRAUBNER ET AL., 2011b). Similar to NORMAN (1981), equation (3-4) can be interpreted in two different ways:

i) The processor pays a *constant* "base price" $[u_m]$ (i.e., mill price) minus some proportion α of transportation costs *tr*; or

ii) The processor pays a *variable* "base price" $[u_m + (1-\alpha)tr]$ minus full transportation costs tr (see also equation (3-3)). Thus, for $0 < \alpha < 1$, the processor pays a higher base price to more distant farmers than to farmers located closer to the processor.

The degree of price discrimination is given by $(1-\alpha)$. For $\alpha = 0$, the processor employs UD pricing, and input suppliers do not take transportation costs into account. For $\alpha = 1$, the processor employs FOB pricing, and transportation costs are borne by input suppliers themselves. For the intermediate case of $0 < \alpha < 1$, the processor employs OD pricing and

[56] In the literature, OD pricing is often referred to as "spatial price discrimination" or "(spatial) discriminatory pricing"; see, e.g., NORMAN (1981), HOBBS (1986), LÖFGREN (1986), and BECKMANN AND THISSE (1986, p. 30).
[57] NORMAN (1981) assumes the mirror image of a monopoly/duopoly.

compensates only for a fraction of transportation costs. Given OD pricing, the optimal (profit-maximizing) solution is to absorb half of the transportation costs, i.e., $\alpha = 1/2$ (for the monopoly case, see, e.g., BECKMANN, 1976; NORMAN, 1981; and GREENHUT ET AL., 1987, p. 12 and p. 107).[58]

A spatial firm (e.g., a monopsonistic processor) determines an optimal price that it pays to its input suppliers. The optimal market area of the firm determines its input suppliers. In the following, important results from the literature will be summarized for the case of the spatial monopoly/monopsony (see CHAPTER 3.2.1). After highlighting the empirical relevance of these pricing policies (see CHAPTER 3.2.2), some general features of spatial pricing for the case of spatial competition (i.e., firms in direct competition with each other) will be explained (see CHAPTER 3.2.3).

3.2.1 PRICING POLICY IN THE SPATIAL MONOPOLY/MONOPSONY

Any spatial firm operates within a certain market area. In the monopoly/monopsony case, the market area predominantly depends on the pricing policy. For example, BECKMANN AND THISSE (1986, p. 33) summarize the results for the case of the spatial monopoly as follows. Under FOB pricing, it is the consumer who determines the market area. Thus, the optimal market area is determined by the most distant point in space at which consumers are willing to buy. Under UD pricing, however, the firm will not ship beyond the point in space where price equals marginal costs and transportation costs. Under OD pricing, the firm will ship up to the point in space where the discriminatory price reduces local demand to zero. GREENHUT AND OHTA (1975), BECKMANN (1976), HSU (1983), OHTA (1984) and BECKMANN AND THISSE (1986, pp. 30), among others, analyze the differences between discriminatory and non-discriminatory pricing for the spatial monopoly. Each of them, however, analyzes the spatial monopoly under different assumptions regarding market areas (fixed or endogenous), demand functions (linear or non-linear) and the distribution of consumers across space (uniform or non-uniform distribution).

Assuming an arbitrary distribution of consumers across space and linear demand functions, both BECKMANN (1976) and HSU (1983) conclude that profits of the spatial monopolist are equal under UD pricing and FOB pricing.[59] This result is independent of the assumption on

[58] Although BECKMANN (1976) derives this result analytically, he mentions that SINGER (1937) had already derived it (see also BECKMANN AND THISSE, 1986, p. 32).

[59] Regarding the linearity of supply functions (in the monopsony framework) or demand functions (in the monopoly framework), BECKMANN (1976, p. 619) argues that "[…] linearity is not much of a restriction as long as the range of prices considered is small. This will be true, in turn, when transportation costs per unit distance are small relative to mill prices […]."

market areas because BECKMANN (1976) assumes a fixed market area and HSU (1983) an endogenous market area.[60] Consequently, if the spatial monopolist is free to choose between these two pricing policies, he will be indifferent between employing UD pricing and FOB pricing. Likewise, BECKMAN (1976) and HSU (1983) show that total output and market areas, respectively, are equal under FOB and UD pricing. In addition, both works show that consumer surplus is higher under FOB pricing than under UD pricing. Thus, total surplus (as the sum of the monopolist’s profit and consumer surplus) is higher under FOB pricing than under UD pricing.

In addition to UD and FOB pricing, BECKMANN (1976) considers OD pricing. He shows that the monopolist’s profits are higher under OD pricing than they are under the other pricing policies. Therefore, in the absence of institutional constraints, the spatial monopolist will choose OD pricing. Given the assumption of a fixed market area, the consumer surplus is still highest under FOB pricing, but it is higher under OD pricing than under UD pricing. The same ranking applies for total welfare. Hence, in the case of a fixed market area, FOB pricing is socially superior. BECKMANN AND THISSE (1986, pp. 33) complete the analysis by assuming an endogenous market area. Again, OD pricing implies not only the highest profits but also the largest market areas and the highest total output; market areas, total output and profits under UD and FOB pricing are equal. However, because market areas are endogenous (and different), total welfare can be compared only under the assumption of a uniform distribution of consumers. In this case, total welfare is higher under OD pricing than under FOB pricing; the opposite is true regarding the consumer surplus.

The result that OD pricing is more profitable than FOB pricing is also derived by GREENHUT AND OHTA (1975) under the assumption of evenly distributed consumers.[61] They show that this result is independent of the assumed elasticity of demand (convex, linear, or concave demand). However, under non-linear demand, the indifference of the monopolist between UD pricing and FOB pricing does not hold (see, e.g., BECKMANN AND THISSE, 1986, p. 36; see references therein): if demand functions are convex (concave), FOB pricing is more

---

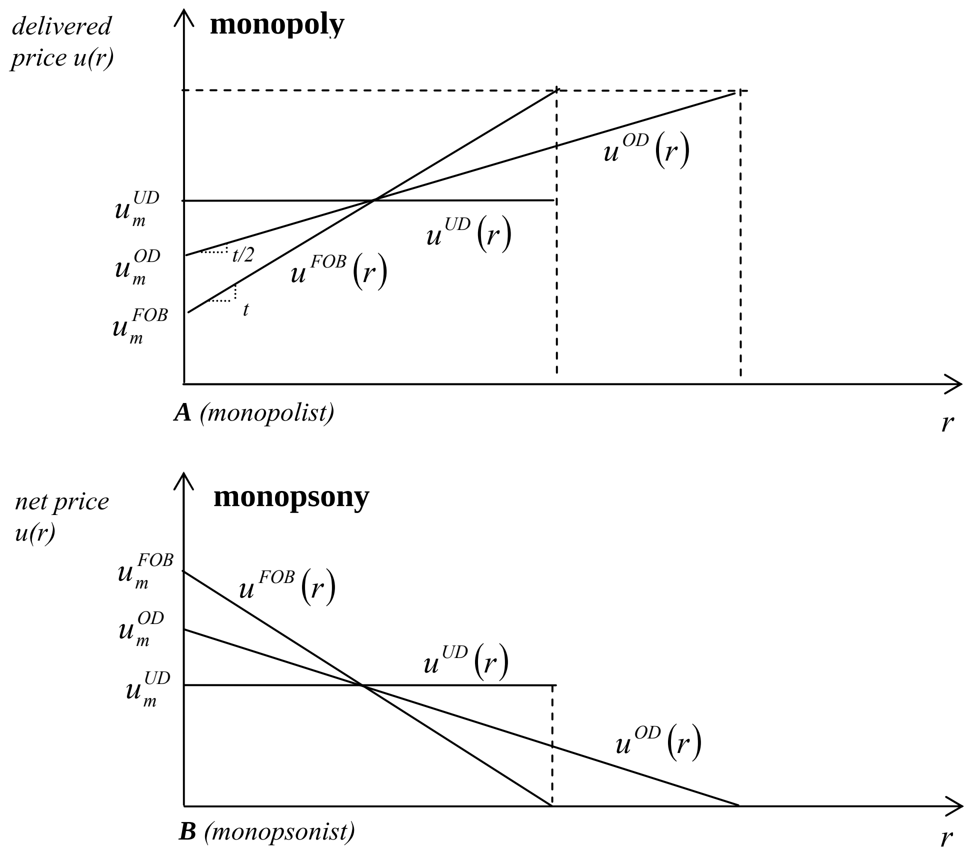
[60] BECKMANN (1976, p. 619) argues that the assumption of a given market area is valid when firms collusively divide the region into “mutually exclusive market areas” or follow a “customer retention” policy (see also references therein). For the case of the spatial monopsonist, LÖFGREN (1986, p. 728) argues that exogenously given market areas are a realistic assumption “[…] as the area in which the monopsonist acts has often been determined through a bargaining process or some other kind of deal long before price setting takes place.” An example of this is the wood market in Sweden (see LÖFGREN, 1985).

[61] Because there are different mill prices for either location in the model involving “price discrimination” in GREENHUT AND OHTA (1975, pp. 312), this model can be considered an example of OD pricing. In addition, they show that in a zero-profit competitive equilibrium, the decision of the spatial monopolist to employ price discrimination or not depends on the level of fixed costs.

(less) profitable than UD pricing for a given market area.[62] The profitability of OD pricing also depends on the specification of the demand function (e.g., exponential).

The upper graph in FIGURE 3-3 illustrates the results regarding mill prices and delivered prices in the spatial monopoly (see also ANDERSON ET AL., 1992, p. 323; for analytical results, see, e.g., GREENHUT AND OHTA, 1975; BECKMANN, 1976; and HSU, 1983). Monopolist *A* is located at the endpoint of a line market; consumers are distributed along the line *r*. Generally, and on an individual basis, more distant consumers are better off under UD pricing, because delivered prices $u(r)$ are lower under UD pricing than under FOB pricing. For consumers located closer to the spatial monopolist, the opposite applies.

FIGURE 3-3. Mill and delivered/net prices of the spatial monopolist/monopsonist



Source: in accordance with ANDERSON ET AL. (1992), p. 323. ANDERSON ET AL. (1992) consider only the spatial monopoly.

Given a fixed market area, BECKMANN AND THISSE (1986, p. 32) show that the difference between UD prices u_m^{UD} and FOB mill prices u_m^{FOB} is equal to the average transportation

[62] Likewise, under the assumptions of a fixed market area and strictly convex (concave) demand, CHEUNG AND WANG (1996) show that UD pricing implies both lower (higher) profits and total welfare than would occur under FOB pricing.

costs. Thus, consumers within (beyond) the average distance of the market area are better (worse) off under FOB pricing than under UD pricing. The price paid by consumers under OD pricing $u^{OD}(r)$ is the average of the prices paid under UD pricing $u^{UD}(r)$ and FOB pricing $u^{FOB}(r)$. Therefore, BECKMANN AND THISSE (1986, p. 32) conclude that the average full price paid by consumers $u(r)$ is the same under any pricing policy. Given an endogenous market area and, thus, larger market areas under OD pricing, the average price paid by consumers under OD pricing is higher than it is under FOB pricing or UD pricing (see BECKMANN AND THISSE, 1986, p. 34).

In the literature, the impact of changes in the freight rate *t* has received special attention. The comparative statics of the model results regarding changes in the freight rate strongly depend on the underlying assumption about the distribution of consumers across space. HSU (1983 p. 174), for example, concludes: "Whether a change in freight costs adversely affects the commodity price as well as economic benefits depends not only upon who pays for transportation costs, but also upon the type of spatial consumer distribution." Under the assumption of a uniform distribution of consumers across space, monopolistic UD prices and mill prices under FOB pricing are independent of the freight rate (see, e.g., HEFFLEY, 1980; and OHTA, 1984; see also LÖFGREN, 1986, for monopsonistic prices).[63] The OD-pricing schedule does depend on the freight rate, but it is independent of consumer density (BECKMANN AND THISSE, 1986, p. 35). For the case in which consumer density is a negative exponential function of distance from the firm, HEFFLEY (1980) shows that a decreasing freight rate increases monopolistic FOB mill prices but decreases monopolistic UD prices. Referring to this result, BECKMANN AND THISSE (1986, p. 35) note: "This means that, contrary to wide-spread opinion, *cost-reducing technical progress in transport may generate perverse effects on market price*. Notice, however, that at least in the linear demand case the rise in the mill price is more than offset by the fall in the freight paid by the average consumer so that the average full price still decreases."

LÖFGREN (1986) analyzes FOB, UD and OD pricing for the mirror image, the spatial monopsony. According to LÖFGREN (1986) UD pricing is a special case of spatial price discrimination. If the spatial firm is allowed to pay different *mill* prices to different farmers (i.e., OD pricing), it can freely choose between UD pricing and FOB pricing, whereas the latter implies a constant mill price (there is no price differentiation). Thus, "[…] as uniform delivered pricing and mill pricing are both options open to a single buyer practicing spatial

[63] OHTA (1984) analyzes this "neutrality of freight" in the spatial monopoly for various consumer distributions in detail.

price discrimination, the profit under discrimination can never be lower than under uniform delivered pricing or mill pricing" (LÖFGREN, 1986, p. 709).

LÖFGREN (1986) assumes a non-uniform distribution of input suppliers across space. Assuming linear supply functions and an endogenous market area, he derives conclusions that are comparable to the results of, for example, BECKMANN AND THISSE (1986, pp. 30) for the spatial monopoly: the profits of the monopsonist are highest under OD pricing and equal under FOB and UD pricing. Again, these results indicate that the rational choice for a spatial monopsonist is OD pricing. The total inputs and the market area are highest under OD pricing and equal under FOB and UD pricing. LÖFGREN (1986) notes that the economic reason for the market area being higher under OD pricing than under UD or FOB pricing is that freight costs are absorbed to some extent under spatial price discrimination. Total welfare (as the sum of monopsony profits and producer surplus of input suppliers) is higher under FOB pricing than under UD pricing, "[…] the intuitive economic reason being that the seller [i.e., farmer] under [FOB] pricing faces the true social transportation costs" (p. 721). Thus, the total producer surplus of input suppliers is higher under FOB pricing than under UD pricing. LÖFGREN (1986) notes that unambiguous comparisons of welfare between OD pricing and FOB pricing are not possible. However, the producer surplus of input suppliers and total welfare are higher under OD than UD pricing.

Given nonlinear supply functions of input suppliers, LÖFGREN (1986) shows that when the supply curve changes from linear to strictly convex (concave), the UD price will increase (decrease) and the market area will be smaller (larger). For the case of FOB pricing, the change in the mill price due to such changes is ambiguous, and nothing can be said about the relative sizes of profits and market areas under FOB and UD pricing. A result, however, can be derived under the assumption of a fixed market area: if the market area is exogenously given, FOB pricing is more (less) profitable than UD pricing if supply is strictly convex (concave).[64] Again, the monopsonist's profits are equal under linear supply. Thus, under these assumptions, the monopsonist will be indifferent between employing FOB pricing and UD pricing.

LÖFGREN (1986) also considers the change in prices due to an increase in the freight rate. If input suppliers are uniformly distributed across space, the UD price and the FOB mill price are independent of the freight rate (irrespective of the supply function); see also OHTA (1984)

[64] According to ZHANG AND SEXTON (2001), ZHANG (1997) shows that these results also hold under the assumption of an endogenous market area. In addition, total welfare is always higher under FOB pricing than under UD pricing.

for the spatial monopolist. However, given an exogenous (i.e., fixed) market area, an increasing freight rate decreases the UD price but increases the FOB mill price.

To summarize the results of the spatial monopoly/monopsony, in the absence of institutional constraints, the spatial monopolist/monopsonist will choose OD pricing because profits are highest. Only for the case of linear demand/supply functions of consumers/input suppliers, the monopolist/monopsonist is indifferent between employing FOB pricing and UD pricing. Given a fixed market area and linear demand/supply, total welfare (in terms of the monopolist's/monopsonist's profits plus the total consumer/input supplier surplus) is highest under FOB pricing. However, given a uniform distribution of consumers/input suppliers and endogenous market areas, OD pricing is socially superior to FOB pricing. The UD price and the FOB mill price are independent of the freight rate in the case of a uniform distribution of consumers/input suppliers. Generally, more distant consumers/input suppliers are individually better off under UD pricing (for the monopsony case, see the lower graph in FIGURE 3-3). To the contrary, consumers/input suppliers located closer to the firm are better off under FOB pricing.

3.2.2 EMPIRICAL RELEVANCE OF PRICING POLICIES

The theoretical results suggest that OD pricing should be the rational choice of the spatial monopoly/monopsony as profits are highest. However, besides some possible institutional constraints,[65] BECKMANN (1976) argues that freight rebates, as in the case of OD pricing, are costly to administer. In contrast, mill prices under FOB pricing may be easy to administer because the consumer or a third firm undertakes all transportation responsibilities. According to GREENHUT ET AL. (1987, p. 19), FOB pricing is the option preferred by policy makers (see also NORMAN, 1981); in addition, if it is difficult for processors/selling firms to assign suppliers/consumers to separate markets, FOB pricing is the only feasible pricing policy.

BECKMANN (1976) argues that UD pricing is the simplest pricing policy for industries in which the spatial firm as a seller delivers to the consumer. "Difficulties arise when customers must be refused in cases where the delivered price does not cover transportation costs. In cases like these, the firm is liable to complaints of discrimination. They may also subject the firm to the attention of antitrust authorities" (p. 629).[66] In addition, he argues that market areas in the spatial oligopoly are more sensitive to price and – under certain conditions - less

[65] BECKMANN (1976) argues that spatial price discrimination (i.e., OD pricing) is not the most common pricing policy as it is illegal in some countries.

[66] ZHANG AND SEXTON (2001, footnote 1) mention that UD pricing may have anticompetitive implications, and it has been criticized, for example, by the U.S. Federal Trade Commission and the Price Commission in the U.K.

stable under UD pricing than under FOB pricing (see also CHAPTER 3.2.3). FOB pricing, in turn, implies higher (delivered) prices for more distant consumers, yielding a competitive disadvantage of firms using FOB pricing against firms using UD pricing. BECKMANN (1976) argues that any advantage from UD pricing is lost if all firms in the market employ UD pricing. He concludes that "[…] there are several distinct advantages to [FOB] pricing, and these may account for the fact that it appears to be the system most often found in spatial markets in practice" (p. 629).

Contrary to the presumptions of BECKMANN (1976), the empirical relevance of UD-pricing policies is demonstrated, for example, in GREENHUT (1981). His analysis of spatial pricing policies in the United States, (at the time West) Germany and Japan reveals that FOB pricing is the exception rather than the rule. According to his study, approximately two thirds of the firms followed a discriminatory pricing policy (such as OD or UD pricing) rather than a non-discriminatory pricing policy; about one quarter adopted UD pricing (regarding the obvious high importance of UD pricing as empirically investigated, see also GREENHUT ET AL., 1980, and GREENHUT ET AL., 1987, pp. 239).

Unlike BECKMANN (1976) and GREENHUT ET AL., (1987, p. 19), SCHULER AND HOBBS (1982) argue that UD pricing may be preferred due to administrative and marketing convenience:

"Many governmental regulatory agencies in the United States encourage [UD pricing], even if transportation costs are significant, possibly because of simplicity and equity considerations or out of the mistaken belief that the uniform pricing paradigm of a spaceless, perfectly competitive world is applicable. One example is the electric utility industry, a regulated monopoly, where uniform prices are charged to all customers of similar commercial characteristics throughout the utility's widespread service territory" (SCHULER AND HOBBS, 1982, p. 175).

According to IOZZI (2004, p. 514), examples of firms adopting UD pricing are utilities, mail-order firms, furniture appliance stores, or, in a non-spatial context, insurance companies. Other examples of UD pricing are the labor market if workers are compensated for their commuting expenses (LÖFGREN, 1986, footnote 2), the cement market in Belgium and the market for plasterboards in the U.K. (PHLIPS, 1983, p. 24). The British brick industry is an example of non-uniform zone pricing, where UD prices are charged within certain circular zones (PHLIPS, 1983, pp. 25).[67]

[67] PHLIPS (1983, chapter 1) highlights business practices for several different pricing policies.

Referring to agricultural markets, DURHAM ET AL. (1996) note that no systematic assessment of spatial pricing policies in agriculture has been conducted (as may continue to be true today), but they argue that UD pricing is rather common in food processing industries (e.g., almonds, canned fruits, rice, sugar beets, processing tomatoes and wine grapes in the U.S.). In Europe, an important example of UD pricing is the milk processing sector (see, e.g., ALVAREZ ET AL., 2000; HUCK ET AL., 2006; and GRAUBNER ET AL., 2011a), as the (local) price any farmer receives generally is not differentiated according to space (see CHAPTER 2.6). ALVAREZ ET AL. (2000) argue that reasons for the implementation of UD pricing are its administrative simplicity (e.g., in the milk market in Spain) and, referring to GREENHUT ET AL. (1987), the possibility to compete over larger geographical areas relative to FOB pricing.

3.2.3 THE PRICING POLICY UNDER SPATIAL COMPETITION: MARKET AREAS

A spatial firm is in a monopolistic or monopsonistic position if it operates in exclusive market areas without direct competition from neighboring spatial firms (see FIGURE 3-1). The extension of the (endogenous) market area is predominantly determined by the pricing policy. If the market area extends further, for example, due to a decrease in the freight rate, then the firm enters the situation of spatial competition (see, e.g., ALVAREZ ET AL., 2000, for the case of UD pricing). In the situation of spatial competition, the market areas of competitors will either overlap or have a common market boundary.

In the spatial oligopoly/oligopsony, the determination of equilibrium prices depends on several factors, including the elasticity of the supply curves of farmers, the nature of the spatial surface, the density of farmers across space, and firms' conjectures, i.e., the type of competition among processors (DURHAM ET AL., 1996). Before turning to the impacts of different conjectures on the outcome of spatial competition (see CHAPTER 3.3), the features of overlapping market areas of competing firms will be briefly discussed in the context of the spatial pricing policy only.

Generally, UD pricing can facilitate the overlap of the market areas of neighboring competitors (see, e.g., GRONBERG AND MEYER, 1981; GREENHUT ET AL., 1987, chapter 7; DURHAM ET AL., 1996; and ALVAREZ ET AL., 2000).[68] Under UD pricing, the price paid to input suppliers is equal for any location across space. Consequently, provided that the UD prices between processors are equal and that input suppliers do not have a preference for the nearest processor, market overlap is possible. However, market overlap is generally not

[68] ALVAREZ ET AL. (2000), for example, argue that the degree of overlap depends on the importance of space (in terms of the freight rate times the distance between processors, $t{\cdot}d$) relative to the net selling price received by processors in the processed goods market, ρ.

possible under FOB pricing, in which input suppliers are responsible for transportation costs. Under FOB pricing, the net prices of two neighboring processors must be equal at the common market boundary in equilibrium (SEXTON, 1990). Therefore, the common market boundary is determined by the location of the farmer who is indifferent about which processor to supply and spatial competitors have exclusive, non-overlapping market areas (see also DURHAM ET AL., 1995 and 1996; or ALVAREZ ET AL., 2000).

These considerations allow the conclusion that the market area is generally larger under UD pricing than under FOB pricing (see, e.g., ALVAREZ ET AL., 2000, referring to GREENHUT ET AL., 1987, and ANDERSON ET AL., 1989). As UD pricing implies discrimination in favor of distant farmers, there is competition over larger market areas relative to FOB pricing (DURHAM ET AL., 1996; ALVAREZ ET AL., 2000). DURHAM ET AL. (1996) argue that UD pricing may cause excess transportation costs because it facilitates the feature of overlapping market areas of competing processors. “Uniform prices tend to cause firms’ market areas to overlap, leading *ceteris paribus* to higher transportation costs to allocate a given amount of raw product than would be incurred under FOB prices” (DURHAM ET AL., 1996, p. 116). However, they also note that competition between processors is increased due to market overlap: relative to FOB pricing, raw product prices can be competitive over a longer distance.[69] “A uniform price […] enables a processor to compete effectively in distant regions, while exploiting its locational monopsony power over proximate growers” (DURHAM ET AL., 1995, p. 12). A pricing policy like UD pricing, however, does not necessarily imply market overlap; the feature of overlapping market areas also depends on the firms’ conjecture and will be discussed in the following (see CHAPTER 3.3).

3.3 SPATIAL COMPETITION: CONJECTURES

Firms move from the situation of a spatial monopoly/monopsony into the situation of spatial competition with neighboring firms for several reasons. For example, a change in the freight rate has an impact on a firm’s market area (see, e.g., ALVAREZ ET AL., 2000, for the case of UD pricing). Another reason may be the entry of another competitor, which reduces the inter-firm distance. As soon as processors leave the monopoly/monopsony situation and enter the situation of spatial competition (oligopoly/oligopsony), processors need to consider the reaction of competitors in their objective functions.

[69] DURHAM ET AL. (1996) argue for the spatial oligopsony that even though total welfare in the market may be lower under UD pricing relative to FOB pricing due to transportation inefficiencies, the total surplus of farmers may be higher. Reasons for such results are the possibility of increased overlap and the high degree of competition due to UD pricing.

In addition to the pricing policy, another important assumption in the spatial competition literature are the firms' conjectures (or "conjectural variation"; TIROLE, 1988, p. 244), i.e., "the reaction of a firm to a change in a competitor's price" (CAPOZZA AND VAN ORDER, 1978, p. 898). Thus, any price effect in the situation of spatial competition crucially depends on the firm's anticipation of a competitor's reaction to its own changes in price (GREENHUT ET AL., 1987, p. 20). The most common conjectures assumed in the spatial competition literature are the Löschian and the Hotelling-Smithies conjectures. Under the Löschian conjecture, firms assume that competitors react "identically to any proposed price change" (GREENHUT ET AL., 1987, p. 20). In contrast, under the Hotelling-Smithies conjecture, firms assume that competitors will not react to any change in their own prices (see, e.g., BECKMANN, 1973; and EATON AND LIPSEY, 1975). Further conjectures assumed in the spatial competition literature are the Greenhut-Ohta conjecture and, if the decision variable is quantity, the Cournot conjecture.[70]

The outcome of any given conjecture in a spatial market depends on the pricing policy that firms employ. In contrast to spatial competition models assuming FOB pricing, UD-pricing models have been analyzed to a lesser extent in the spatial oligopoly theory because of issues related to the existence of an equilibrium in certain cases (see, e.g., IOZZI, 2004, and later in this chapter). Likewise, Hotelling-Smithies competition seems to be more prominent in the literature than any other conjecture, most likely because HOTELLING's (1929) influential work was based on the assumptions of FOB pricing and Bertrand-Nash behavior (see, e.g., TIROLE, 1988, pp. 279). Examples of spatial competition model assuming FOB pricing are CAPOZZA AND VAN ORDER (1977 and 1978). The alternative UD-pricing policy in the situation of spatial competition is analyzed, for example, by GRONBERG AND MEYER (1981).

In the literature on spatial competition, some contributions contrast their results with results of the non-spatial price theory (see, e.g., CAPOZZA AND VAN ORDER, 1978; BENSON, 1980; and GRONBERG AND MEYER, 1981). "Theoretical examination of the pricing behavior of firms competing in a spatial setting indicates that many of the conclusions of classical price theory are altered as the cost of distance becomes significant" (BENSON, 1980, p. 1098). CAPPOZZA AND VAN ORDER (1978) argue that non-spatial perfect competition can be regarded as a special case of imperfect spatial competition if either of the following two features is not relevant: first, there are transportation costs, and, second, the average cost curve of firms is

[70] Generally, the underlying conjectures in spatial competition models are exogenously given. In a non-spatial context, BRESNAHAN (1981) derives endogenous conjectures in the form of "consistent conjectures"; conjectures and reactions are the same. Given "consistent conjectures", (ex ante) expected and (ex post) actual conjectures coincide. In a spatial context, consistent conjectural variations are analyzed by SCHÖLER AND SCHLEMPERER (1991).

downward sloping in the relevant area due to fixed costs or economies of scale. CAPOZZA AND VAN ORDER (1978) specify several criteria that should be satisfied in any spatial (duopoly) model (i.e., in the case of spatial firms selling goods to spatially distributed consumers):

"[…] we should expect a reasonable spatial model to behave like the perfect competition model in the limit. In particular, we should expect the following characteristics:

1) As transportation costs approach zero, perfect competition should be approached and price should approach marginal cost.

2) As fixed costs approach zero, concentrated production is less essential; spatial monopoly power is diminished; and again, price should approach marginal cost.

[…]

3) As costs (fixed, marginal, or transportation) rise, price should rise.

4) As demand density rises, firms should be able to take advantage of economies of scale. Price should fall in the long run.

5) As more firms enter the industry, there should be increased competition and price should fall" (CAPOZZA AND VAN ORDER, 1978, p. 897).

GRONBERG AND MEYER (1981) note that characteristics 1 and 2 concern the case where space becomes less important (since transportation costs and fixed costs justify a spatial model): if the importance of space decreases, then the price should approach the (non-spatial) competitive equilibrium price (i.e., marginal cost). In addition, they note that characteristic 3 argues that the comparative static impact of any cost variable should be equivalent to that in a non-spatial model. The following sub-chapters discuss the outcome of spatial competition for an exogenously given conjecture under different pricing policies.

3.3.1 LÖSCHIAN CONJECTURE

Under Löschian competition, firms assume that rivals match any proposed price change (see, e.g., GREENHUT ET AL., 1987, p. 20; and ALVAREZ ET AL., 2000). According to CAPOZZA AND VAN ORDER (1978), Löschian competition can be regarded as the spatial analogue to the non-competitive oligopoly/oligopsony: "Firms raise and lower price in unison either because of collusion or price leadership" (p. 899); see also ALVAREZ ET AL. (2000). In this sense, Löschian competition implies cooperative behavior between firms (GRAUBNER ET AL., 2011a). However, this conjecture also implies the property that firms' market areas are fixed (see, e.g., BENSON, 1980; CAPOZZA AND VAN ORDER, 1987; and SEXTON, 1990). The Löschian model "[…] supposes that *firms in choosing their profit-maximizing price treat their market area as* *given*. In other words, firms always adjust their price by whatever amount required to prevent encroachment on their tributary area" (BECKMANN AND THISSE, 1986, p. 46). To put it differently (for the case of FOB pricing), "Competitors exactly match any change in mill price so that the firm takes its market radius as an exogenous variable […]" (p. 75). SCHÖLER (1988, p. 163) notes for the case of Löschian competition (and assuming FOB pricing) that a firm that increases its mill price assumes that a competitor will increase its mill price in such a way that the market area remains constant. Thus, firms can be regarded as spatial monopolists/monopsonists within their respective market areas (see also CAPOZZA AND VAN ORDER, 1977; BENSON, 1980; or ALVAREZ ET AL., 2000).[71] More specifically, the fixed market area property of Löschian competition applies *per se* only under FOB pricing (ALVAREZ ET AL., 2000): the market areas of competing processor under FOB pricing are constant for any mill price paid to input suppliers (provided that the mill prices of competing processors are equal).

For the case of Löschian competition between duopolistic firms under FOB pricing, CAPOZZA AND VAN ORDER (1978) observe the following "perverse" (p. 905) comparative statics (see also GREENHUT ET AL., 1987, p. 21; BENSON, 1980; or GRONBERG AND MEYER, 1981, for discussions):[72] i) as transportation costs and fixed costs approach zero, the (consumer) price approaches the non-spatial monopoly price; ii) as fixed costs and transportation costs increase, price decreases (there are ambiguous results for the effect of an increase in marginal costs on price); iii) as consumer density increases, price increases; and iv) as firms enter the market, price increases. Thus, Löschian competition under FOB pricing violates all of the expected characteristics of a spatial model as cited above in CHAPTER 3.3. BENSON (1980), however, concludes that these unexpected effects are crucially driven by the shape of the individual demand curve (i.e., by the degree of convexity).

Under the alternative UD-pricing policy, the Löschian assumption of a fixed market area does not apply *per se* because the market area of a processor varies inversely with the price (see, e.g., ALVAREZ ET AL., 2000). However, an *a priori* assumption of a fixed market area in the case of UD pricing implies that competitors collude regarding market areas and split the distance between them exactly (GRONBERG AND MEYER, 1981).[73] GRAUBNER ET AL. (2011a)

---

[71] CAPOZZA AND VAN ORDER (1977, p. 1335) note that "[…] unlike the monopolist the L[ö]schian firm cannot control market radius."

[72] CAPOZZA AND VAN ORDER (1987) assume a uniform density of consumers and a linear demand function of consumers. Problems regarding the interpretation of the Löschian model by focusing on the case of FOB pricing are also discussed in BECKMANN AND THISSE (1986, pp. 78).

[73] According to IOZZI (2004), the result of exclusive market areas can alternatively be regarded as the result of the "efficient tie-breaking rule", where consumers buy from the nearest firm (or farmers deliver the nearest processor) in case of equal prices between firms. In this sense, the market area is determined by

note that Löschian competition requires a high degree of coordination and is similar to the traditional cartel. As mentioned before, the underlying conjecture is that processors react identically to price changes. The more general term for this behavior is the so-called "price-matching conjecture" (see the discussion in GRONBERG AND MEYER, 1981; see also SCHÖLER, 1988, pp. 163; and ALVAREZ ET AL., 2000, p. 352). "This price-matching property implies that prices in equilibrium must be equal among firms engaged in direct competition […]" (ALVAREZ ET AL., 2000, p. 352). In this sense, Löschian competition with a fixed market area can be regarded as a special case of the price-matching conjecture under UD pricing. Under Löschian competition and UD pricing, GRONBERG AND MEYER (1981) confirm unexpected comparative statics as well (by referring only to characteristics 1 to 3 from CHAPTER 3.3): the UD (consumer) price approaches the (non-spatial) monopoly price as transportation costs or fixed costs approach zero. Thus, this model is non-competitive as space becomes unimportant. However, the property of increasing UD (consumer) prices as costs increase is fulfilled.

If, however, market areas are not assumed to be fixed (since they can vary with the price under UD pricing; see, e.g., ALVAREZ ET AL., 2000), the price-matching conjecture under UD pricing implies that market areas of competitors can overlap, and suppliers within the area of overlap randomly choose their processor (GRONBERG AND MEYER, 1981; ALVAREZ ET AL., 2000).[74] To put it differently, as processors are assumed to be identical, farmers have an equal probability of supplying either firm within the area of overlap (see also IOZZI, 2004).[75] By re-interpreting GRONBERG AND MEYER (1981), IOZZI (2004) argues that market overlap might be the outcome if firms are not able (or allowed) to collude to determine exclusive serving locations. Thus, each *local* market point is equally split (at least in expected terms). GRAUBNER ET AL. (2011a, p. 104) note, "[price-matching] competition requires less coordination [regarding market areas and relative to Löschian competition] because only prices need to be negotiated."

For the price-matching conjecture under UD pricing (i.e., overlapping market areas), GRONBERG AND MEYER (1981) cannot find unexpected comparative statics (characteristics 1 to 3). Thus, this combination can be regarded as a competitive model. However, in the case of

consumers/farmers and not by the firms themselves. See also LEDERER AND HURTER (1986) or KATS AND THISSE (1989), which is an earlier and more extensive version of KATS AND THISSE (1993).

74 "[…] the Löschian analogue in a model of UD pricing is the price-matching conjecture that the fixed market radius assumption implies in FOB pricing models" (ALVAREZ ET AL., 2000, p. 352). ALVAREZ ET AL. (2000) term the conjecture used in their model "Löschian competition" (which, generally, implies fixed market areas; see GRONBERG AND MEYER, 1981). However, their model makes clear that they consider the "price-matching conjecture" with variable (i.e., overlapping) market areas.

75 Alternatively, market overlap can be interpreted as the result of the "random tie-breaking rule", in which demand/supply at each location is equally split between the firms charging/paying the same price (IOZZI, 2004). This may be the outcome if consumers (farmers) randomly choose their firm (processor).

a strict duopsony in an unbounded line market, as in ALVAREZ ET AL. (2000), the UD price paid to farmers decreases towards the (spatial) monopsony level as the freight rate decreases towards zero. This is the case if processors extend their market area beyond the location of their competitor (or “competition in the backyard” as in HUCK ET AL., 2006). These unexpected comparative statics are obviously driven by the assumed market form. The impact of the assumed market form is analyzed in more detail in CHAPTER 5. Following GRONBERG AND MEYER (1981), in this thesis, the term “price-matching conjecture” will be used for the case of variable market areas and the term “Löschian conjecture” for the case of fixed market areas in the analytical models in CHAPTERS 5 and 6.

3.3.2 HOTELLING-SMITHIES CONJECTURE

Under the Hotelling-Smithies conjecture, a firm ignores any changes in the prices of its competitors (see, e.g., BECKMANN, 1973; EATON AND LIPSEY, 1975; SCHULER AND HOBBS, 1982; and GREENHUT ET AL., 1987, p. 20).[76] Thus, each firm believes that his actions will have no impact on the prices of competitors (SEXTON, 1990), i.e., each firm assumes that the prices of its competitors are fixed (CAPOZZA AND VAN ORDER, 1978). In this sense, Hotelling-Smithies competition implies non-cooperative behavior (GRAUBNER ET AL., 2011a). Hotelling-Smithies competition is analogous to non-spatial Bertrand (competitive) pricing as the (price) reaction of the competitor due to the firm’s own changes in price is equal to zero (see, e.g., ALVAREZ ET AL., 2000; GREENHUT ET AL., 1987, p. 20; and SEXTON, 1990).[77] Within the context of a spatial competition model under FOB pricing, EATON AND LIPSEY (1975, p. 28, footnote 2) argue that the Hotelling-Smithies conjecture “[…] is a reasonable assumption, either where the equilibrium is approached very rapidly so that firms do not have time to learn their opponents’ reaction, or where relocation occurs with a long time lag (because, e.g., relocation is very costly) as with many locational problems.”

[76] In the literature, there are several different expressions for “Hotelling-Smithies competition” (as this conjecture is termed in GREENHUT ET AL., 1987, p. 20). It is termed “zero conjectural variation”, for example, in EATON AND LIPSEY (1975), CAPOZZA AND VAN ORDER, (1978), and SCHULER AND HOBBS (1982). Alternatively, it is termed “noncooperative game (model)” (see, e.g., BECKMANN AND THISSE, 1986, p. 37; and ZHANG AND SEXTON, 2001). In ALVAREZ ET AL. (2000) and many other articles, Hotelling-Smithies competition is termed “Bertrand-Hotelling behavior“.

[77] CAPOZZA AND VAN ORDER (1978, footnote 3) argue that Hotelling-Smithies competition is comparable to non-spatial monopolistic/monopsonistic competition or to a non-spatial competitive oligopoly/oligopsony. However, they note that the term “spatial monopolistic competition” is sometimes used in the context of the Löschian conjecture.

Under FOB pricing and Hotelling-Smithies competition,[78] market areas are variable (see, e.g., CAPOZZA AND VAN ORDER, 1978). In most cases, the combination of the Hotelling-Smithies conjecture and FOB pricing leads to the intuitive comparative static results as characterized in CHAPTER 3.3 (see CAPOZZA AND VAN ORDER, 1978, for the oligopoly case; see also GREENHUT ET AL., 1987, pp. 20). However, CAPOZZA AND VAN ORDER (1978) can find "perverse" comparative statics under Hotelling-Smithies competition under certain conditions as well. For their oligopoly model under FOB pricing and Hotelling-Smithies competition ("competitive spatial pricing", p. 43), BECKMANN AND THISSE (1986, p. 45) conclude: "[…] *when the impact of distance becomes negligible, the […] model of spatial competition behaves like the perfect competition model*. However, *perverse effects may occur when the impact of distance is significant*."

In certain cases, Hotelling-Smithies competition implies problems in terms of the existence of an equilibrium. These problems are obviously less severe under FOB pricing than under UD pricing. Examples of non-existent equilibria under FOB pricing are given by EATON AND LIPSEY (1975) and ANDERSON ET AL. (1989). In their FOB-pricing duopoly model, BECKMANN AND THISSE (1986, pp. 37; see also references therein) show that duopolistic firms must be located either far apart or at the same point in space for a price equilibrium to exist. "In contrast, *when firms are close but separated, mill price competition results in indefinitely fluctuating prices*. […] This invalidates Hotelling's (1929) belief that spatial differentiation yields stability" (BECKMANN AND THISSE, 1986, p. 39).

As noted earlier, market overlap is not possible under FOB pricing.[79] It is also not possible under UD pricing given the Hotelling-Smithies conjecture: under UD pricing, one firm will always have an incentive to outbid its competitor by a small amount and capture the total area in dispute (GRONBERG AND MEYER, 1981; ALVAREZ ET AL., 2000). An equilibrium in pure strategies does not exist under UD pricing and Hotelling-Smithies competition (see, e.g., SCHULER AND HOBBS, 1982; BECKMANN AND THISSE, 1986, pp. 39; and ALVAREZ ET AL., 2000). Thus, under UD pricing, Hotelling-Smithies competition results in instability that can be presented analytically by a well-defined price cycle (see, e.g., SCHULER AND HOBBS, 1982, given linear demand, or the Edgeworth cycle in the non-spatial oligopoly theory; see TIROLE, 1988, p. 234; or ANDERSON ET AL., 1992, p. 339). "Spatial competition under [UD pricing], however, suggests the indeterminate oscillation of price, initially proposed by Edgeworth for

[78] As mentioned before, this combination of FOB pricing and Bertrand-Nash behavior is the original setup of HOTELLING (1929); see, e.g., TIROLE (1988, pp. 279).

[79] BECKMANN (1973, p. 263) argues that models assuming FOB pricing study equilibrium in spatial markets "as a problem of monopolistic competition".

a spaceless world, in which duopolists alternatively engage in price wars and then concede and resort to monopolistic practices" (SCHULER AND HOBBS, 1982, p. 176). According to IOZZI (2004), this instability is most likely the reason why UD pricing has been studied to a lesser extent. ALVAREZ ET AL. (2000) note that the non-existence of Nash equilibrium under Hotelling-Smithies conjecture may cause UD-pricing firms to seek more stable, i.e., collusive, outcomes as they do under Löschian competition.

Obviously, the non-existence problem seems to be driven partly by the specification of demand functions. BECKMANN AND THISSE (1986, p. 40) note for the duopoly case: "[…] when consumers have price-sensitive demands, a price equilibrium exists when firms are sufficiently distant for their market areas at the monopoly prices not to overlap. If not, we necessarily have instability." Consequently, if the importance of space is relatively high (e.g., due to a long distance between firms or a high freight rate) so that each firm can operate as a spatial monopolist/monopsonist, an equilibrium in pure strategies exists (ALVAREZ ET AL., 2000, pp. 351).

Several approaches have been used to obtain an equilibrium under UD pricing and Hotelling-Smithies competition. BECKMANN (1973) analyzes a mixed strategy equilibrium.[80] The properties of the equilibrium in mixed strategies are discussed in KATS AND THISSE (1989 and 1993) for the duopoly case and, according to ALVAREZ ET AL. (2000), in ZHANG (1997) for the duopsony case. SCHULER AND HOBBS (1982) discuss the non-existence of a Nash equilibrium and analyze different optimal strategies under Hotelling-Smithies competition: the undercutting strategy and the concession strategy. In addition, they consider "collusion" (p. 181), i.e., Löschian competition. Several authors assume product heterogeneity (or product differentiation) to obtain equilibrium. Examples include DE PALMA ET AL. (1987), ANDERSON ET AL. (1989), ANDERSON ET AL. (1992, pp. 375) and DE FRAJA AND NORMAN (1993). For example, ANDERSON ET AL. (1989) argue that products of different firms within the same industry are not perfectly homogeneous. Therefore, they "[…] allow different consumers to value different products differently" (p. 4) and take a discrete choice theory approach by modeling individual choices using the principle of stochastic utility maximization. GRAUBNER ET AL. (2011a) derive a price equilibrium in pure strategies under the assumption that farmers distributed over space are members of a marketing COOP; given the random tie-breaking rule, farmers choose each processor with equal probability (see also IOZZI, 2004).

GRONBERG AND MEYER (1981) analyze the long-run (i.e., zero-profit) equilibrium under UD pricing and Hotelling-Smithies competition. As is generally the case under FOB pricing,

[80] See also DASGUPTA AND MASKIN (1986a and 1986b) for the non-existence of a Nash equilibrium and the existence of an equilibrium in mixed strategies.

they cannot find unusual comparative statics: the UD price (paid by consumers) approaches the marginal cost as fixed costs or the freight rate moves towards zero, and cost increases (i.e., fixed and marginal costs, freight rate) yield an increasing UD price.

Assuming different pricing policies under Hotelling-Smithies competition, ANDERSON ET AL. (1989) show that consumer welfare may be higher under UD pricing than under FOB pricing in a duopoly framework, assuming product heterogeneity.[81] The reason for this result is that UD pricing implies a higher degree of price competition among firms. Profits of firms and total surplus, however, are highest under FOB pricing and lowest under UD pricing. Similarly, ZHANG AND SEXTON (2001) analyze a duopsony framework and argue that even though UD pricing causes inefficient transportation (in the case of elastic farm supply), it also encourages competition between processors and yields a higher welfare (relative to FOB pricing) in most cases.

The relevance of UD pricing is demonstrated theoretically in KATS AND THISSE (1989 and 1993; see also IOZZI, 2004): given the Hotelling-Smithies conjecture, the choice of UD pricing is a Nash equilibrium, when firms first choose a location, then a pricing policy and finally compete in prices. GREENHUT ET AL. (1987, p. 123) note that "[…] a uniform-delivered-price equilibrium cannot be ruled out when extreme price competition exists […]." In a duopsony framework, given the Hotelling-Smithies conjecture ("non-cooperative game model"), ZHANG AND SEXTON (2001) analyze the choice of duopsonistic processors for either UD pricing or FOB pricing.[82] They show that FOB pricing emerges as a dominant strategy equilibrium if the market structure is relatively competitive (which is the case when the freight rate is low compared to the value of the processed product). This is a collusive pricing outcome because competition is restricted to the market boundaries of firms under mutual FOB pricing. If the freight rate is relatively high, both processors will employ UD pricing in equilibrium. In such a situation, processors are nearly in a monopsonistic situation. For the intermediate case with a moderate competitive market structure, ZHANG AND SEXTON (2001) find an equilibrium where one firm employs FOB pricing and the other UD pricing (see also DE FRAJA AND NORMAN, 1993, for such an asymmetry in pricing policy).

---

[81] Therefore, and as discussed in ANDERSON ET AL. (1989), the ranking of pricing policies with respect to the consumer surplus is the opposite of the ranking of BECKMANN (1973) for the spatial monopoly.

[82] For the choice of the pricing policy in the oligopoly case, see THISSE AND VIVES (1998). They conclude that "[…] *there is a robust tendency for a firm to choose the discriminatory policy* since it is more flexible and does better against any generic strategy of the rival […]" (p. 169). Likewise, the choice of the pricing policy (and other issues) is analyzed by NORMAN (1981) who considers a multi-plant monopoly, Löschian competition and Greenhut-Ohta competition.

Finally, the case of OD pricing should be mentioned.[83] BECKMANN AND THISSE (1986, p. 41; see also references therein) argue that the stability of Hotelling-Smithies competition "appears less problematic" under OD pricing because competition is "less constrained": under OD pricing, firms compete separately at each point in space and thus control more independent strategic variables than they would under FOB or UD pricing. For their duopoly model, the authors conclude that there is a unique price equilibrium at each point in space regardless of the locations of firms. This result is valid for any price-sensitive demand function. "Thus, contrary to general beliefs, *spatial price discrimination is not a priori evidence of a lack of competition*" (BECKMANN AND THISSE , 1986, p. 41).

3.3.3 OTHER CONJECTURES IN THE SPATIAL COMPETITION LITERATURE

To complete the review of conjectures in the literature on spatial competition, this section deals with the Greenhut-Ohta conjecture and Cournot competition. Under Greenhut-Ohta competition, firms anticipate the "price on the market boundary to be constrained to a known, fixed value" (GREENHUT ET AL., 1987, p. 20; see also NORMAN, 1981).[84] If the (mill) price at the boundary is fixed at a certain level, the market area of the firm under FOB pricing will extend up to the point in space where the delivered price equals this fixed price (see CAPOZZA AND VAN ORDER, 1977, for the duopoly case). CAPOZZA AND VAN ORDER (1977) argue that the fixed price at the market boundary can be exogenously determined, for example, based on governmental price controls. In the absence of such controls, free entry will yield a boundary price so that profits of firms are zero. Under Greenhut-Ohta competition, only the price at the market boundary is constant. Firms know that they will lose market area, if the competitor increases its (consumer) price (see, e.g. SCHÖLER, 1988, p. 164). Consequently, the price reaction of the firm is opposite to the competitor's pricing decisions. GREENHUT ET AL. (1987, p. 20) note that the combination of FOB pricing and Greenhut-Ohta competition always implies the intuitive comparative static results mentioned in CHAPTER 3.3 (see also CAPOZZA AND VAN ORDER, 1978).

According to ANDERSON (1989), Cournot competition and, thus, competition in quantities instead of prices, was first set into a spatial context by GREENHUT AND GREENHUT (1975). EATON AND LIPSEY (1989, p. 755) note that most literature on "address models" of product

[83] For the case of Hotelling-Smithies competition under OD pricing, see also ANDERSON ET AL. (1992, chapter 8.4.1) under inelastic and elastic demand. The existence of an equilibrium under OD pricing in the homogeneous product case is also analyzed by DE FRAJA AND NORMAN (1993).

[84] CAPOZZA AND VAN ORDER (1978) note that Greenhut-Ohta competition may not have a non-spatial analogue. In addition, they note that this conjecture was developed in the context of zonal pricing by competitors (rather than FOB pricing).

differentiation assumes competition in prices rather than quantities due to the complexity and limited solvability of the latter models. Under the Cournot-Nash conjecture, a firm's quantity does not react to changes in a competitor's quantity (see, e.g., SEXTON, 1990). In assuming Cournot competition, GREENHUT AND GREENHUT (1975) analyze discriminatory pricing, whereas HOBBS (1986) assumes non-discriminatory (FOB) pricing. Even Cournot competition allows overlapping market areas (see, e.g., GREENHUT AND GREENHUT, 1975; BECKMANN AND THISSE, 1986, pp. 47; OHTA, 1988, pp. 127; and ANDERSON AND NEVEN, 1991). BECKMANN AND THISSE (1986, pp. 47) analyze Cournot competition in a duopoly market by assuming that firms "[…] supply the transportation and compete in *quantity* on each local market […]" (p. 47). In their model, firms are located at the endpoints of a line market. They show that three different equilibria can emerge depending on the position of the local market. In two of them, the local market is supplied by the corresponding firm that is closest. In these situations, the firms act as monopolists. In the remaining equilibrium (i.e., for locations in the middle area of the line market), both firms serve each location such that their market areas overlap. In the spatial monopoly situation, the outcomes of OD pricing and quantity competition are equivalent. This result, however, does not hold for the situation with market overlap. In this situation, the resulting price paid by any consumer is constant (i.e., equal) for any location. "In other words, spatial quantity competition implies freight absorption […]" (BECKMANN AND THISSE, 1986, p. 48).[85] In addition, and like in a non-spatial Cournot model, the spatial quantity competition model moves towards the perfect competition model as the number of firms increases (see references in BECKMANN AND THISSE, 1986, p. 49).

3.3.4 PRICING POLICIES: RELATIVE PRICES UNDER DIFFERENT CONJECTURES

In CHAPTERS 3.3.1 to 3.3.3, each possible conjecture was discussed separately. The discussion emphasized differences in the outcome of a given conjecture for different pricing policies. In the literature, two important contributions take a different route: CAPOZZA AND VAN ORDER (1977) consider FOB pricing only but analyze the outcomes under Löschian, Hotelling-Smithies and Greenhut-Ohta competition. Likewise, GRONBERG AND MEYER (1981) consider UD pricing only and consider Hotelling-Smithies and Löschian competition and the price-matching conjecture. Both contributions consider the free-entry competitive equilibrium and, therefore, the long-run equilibrium where locations of firms are endogenous. By considering

[85] See references in BECKMANN AND THISSE (1986, p. 48). For a similar result, see also ANDERSON ET AL. (1992, p. 334). For a comparison of Betrand and Cournot competition under spatial price discrimination, see ANDERSON ET AL. (1992, pp. 336).

one pricing policy only, these articles make it possible to rank the resulting prices for various forms of competition.

For the case of FOB pricing, CAPOZZA AND VAN ORDER (1977, p. 1330) argue that "[…] in general nothing can be said about relative market prices under various forms of competition unless the conditions of industry equilibrium are specified." With this comment they refer to GREENHUT ET AL. (1975), who analyze different conjectures under FOB pricing. In GREENHUT ET AL. (1975), mill prices are lowest under Greenhut-Ohta competition, followed by monopoly and Hotelling-Smithies, and highest under Löschian competition. Thus, in GREENHUT ET AL. (1975), (consumer) mill prices are higher under spatial competition than in the spatial monopoly, except for the case of Greenhut-Ohta competition. CAPOZZA AND VAN ORDER (1977) argue that this ranking is only correct in the case of elasticities of demand for a given market area (i.e., if market areas are set equal under each market organization), but it is not necessarily correct in terms of an equilibrium price. They note: "[…] if market size is parameterized, both spatial monopoly and [Hotelling-Smithies] competition lose their economic significance. A monopoly with a constrained market is just a Löschian firm. The same is true of a [Hotelling-Smithies] firm with a constrained market" (CAPOZZA AND VAN ORDER, 1977, p. 1330, footnote 2).

In CAPOZZA AND VAN ORDER (1977), the condition for market equilibrium is zero profits of firms. Thus, firms enter the market as long as positive profits are obtained and thereby reduce the distance between firms. The equilibrium is established when firms earn zero profits. Given a unitary density of consumers, CAPOZZA AND VAN ORDER (1977) assume both perfectly inelastic and elastic demand of consumers. Under perfectly inelastic demand, mill prices under all forms of competition are no greater than the mill price in a monopoly: the monopoly mill price is highest, followed by the mill prices under Löschian competition and Hotelling-Smithies competition; the mill price is lowest under Greenhut-Ohta competition. Under elastic demand, however, the mill price under Löschian competition is greater than or equal to that in a monopoly; under Hotelling-Smithies competition, the mill price can be higher than the monopoly price (if fixed costs are high); under Greenhut-Ohta competition (and if the border price is set competitively), the mill price will be no greater than those mill prices under the Löschian or Hotelling-Smithies conjectures. Thus, as in GREENHUT ET AL. (1975), the Greenhut-Ohta conjecture yields the lowest mill prices. However, only Löschian competition is a candidate for a necessarily higher mill price relative to a monopoly.

For the case of UD pricing, market areas can overlap. According to GRONBERG AND MEYER (1981, p. 760), "[…] a conflict arises between the two firms as to who will sell to the customers in the disputed region." Resolving this conflict between competing firms leads to (at least) three types of equilibria: the Hotelling-Smithies conjecture and the price-matching conjecture with, first, Löschian competition and, second, market overlap. As noted, GRONBERG AND MEYER (1981) analyze these conjectures for the free entry equilibrium as well. The outcome of their analysis is summarized as follows. The Hotelling-Smithies conjecture is a form of extreme price competition because a small cut in the (consumer) price enables a firm to capture the disputed area. Consequently, in equilibrium, (consumer) prices of firms will decrease until market areas no longer overlap. In such an equilibrium, (consumer) prices are relatively low and market areas are relatively large. As this is the free-entry equilibrium with zero profits, no firm will undercut its competitor any further. Under Löschian competition (which implies price matching), firms collude regarding market areas and split the distance between themselves in exclusive market areas. Due to this collusion with regard to market areas, this is not a competitive model. The solution to this equilibrium involves high (consumer) prices and small market areas. Under the price-matching conjecture *per se*, market overlap is a stable equilibrium. In this model, market overlap reduces the density of consumers and thereby drives profits towards zero. (Consumer) prices and market areas lie in between the two previously mentioned equilibria.

To conclude, given UD-pricing, individual consumers are worst off under Löschian competition as UD prices are highest. This result is due to collusion of firms in regard to their market areas. They are best off under the Hotelling-Smithies conjecture due to the high degree of competition. The price-matching conjecture with overlapping market areas constitutes an intermediate case.

3.4 CONCLUDING REMARKS

CHAPTERS 5 to 7 will examine spatial competition between processors under UD pricing using analytical models. The usefulness of analytical spatial competition models is discussed in GRONBERG AND MEYER (1981) by referring to UD pricing:

"Our results are useful for several different reasons: First, uniform delivered pricing seems to be a dominant feature in the marketing of certain products.[...] Hence, a formal characterization of the equilibria that can arise with uniform delivered pricing may be useful in describing the markets of those products. Second, uniform delivered pricing is often the only legal alternative to mill pricing. Thus, in certain instances, firms might have the option of setting either uniform delivered or mill prices, and must decide which is most beneficial. The basic properties of the equilibria that can arise under each of the pricing modes is relevant information in making that decision. […] Finally, regulators examining the pricing structure in a market may wish to know what the result of imposing a particular pricing mode will be in a competitive equilibrium" (GRONBERG AND MEYER, 1981, p. 758).

The empirical relevance of UD pricing has been demonstrated in the literature. In addition, most analytical results indicate that UD pricing is a dominant pricing strategy in spatial competition. In the analytical models in CHAPTERS 5 to 7, only the case of UD pricing will be considered. The feature of overlapping market areas will receive some attention in these models because market overlap has not been extensively considered in the literature so far. ANDERSON AND NEVEN (1991, p. 794) argue that "[…] casual observation and the empirical findings put forward by Phlips (1983) suggest that firms' spatial markets do often overlap." Models accounting for overlapping market areas are analyzed by GRONBERG AND MEYER (1981), GREENHUT ET AL. (1987, e.g., chapters 7 and 8), OHTA (1988, pp. 127), ALVAREZ ET AL. (2000), HUCK ET AL. (2006) and GRAUBNER ET AL. (2011a). One example of a context in which overlapping market areas can be observed is milk procurement, as milk processors employ UD pricing (see, e.g., ALVAREZ ET AL., 2000; HUCK ET AL., 2006; and HUBER, 2007a and 2009; see also CHAPTER 2.6). ALVAREZ ET AL. (2000) consider a duopsony of IOFs under UD pricing and the price-matching conjecture. They analyze overlapping market areas within the locations of processors and also the extension of market areas beyond the location of the competitor. Their analytical model is supported by an empirical analysis of spatial competition among milk processors in Asturias, Spain. Based on ALVAREZ ET AL. (2000), HUCK ET AL. (2006) analyze a pure COOP market and account for market overlap. They provide empirical evidence of spatial competition by estimating a reduced-form regression model for milk-processing COOPs in Northern Germany.

Due to the feature of overlapping market areas in milk procurement, the price-matching conjecture is a reasonable assumption. In a recent paper, empirical support for the assumption of the price-matching conjecture in the German raw milk market is given by GRAUBNER ET AL. (2011a). However, for the European milk market, also the assumption of Cournot competition may be applicable. First, Cournot competition allows market overlap, and, second, due to the quota regime and decisions on the locations of firms (i.e., high sunk costs), milk processors may use pricing to keep the quantity of processed milk constant. ANDERSON AND NEVEN (1991) argue that the appropriate decision variable (price or quantity) is the one that is less flexible: if quantity (or capacity) decisions are inflexible, Cournot competition will be relevant; if, however, quantity (or capacity) decisions are more flexible than price decisions, Bertrand competition will be relevant. The flexibility, e.g., with respect to the allocation of output over space depends on the transportation technology (which is costly if there are high fixed costs in transportation or significant indivisibilities) or on capacity constraints (ANDERSON AND NEVEN, 1991). PAL (1998) notes that there may be competition in quantities if altering production levels is costly. However, as already mentioned, the Cournot conjecture in a spatial competition model might imply problems for complexity and solvability reasons.[86]

There are many possible reasons for market overlap in the procurement market of food processors. In analyzing the market for processed tomatoes in California, DURHAM ET AL. (1995 and 1996) developed an optimization model for the case of UD-pricing firms with overlapping market areas. For this market, they argue that agricultural production of the raw product is not evenly distributed across regions. Reasons for this uneven distribution include urban expansion and poor yields and damaged crops in certain regions, which may affect processing. Consequently, processors must collect the raw product from longer distances, i.e., from alternative production areas and thereby spread the risk of crop failure. In addition, longer distances also result if some processors wish to extend their processing period by starting it before the commencement of the local production period or by continuing processing after local production ceases. Alternatively, processors may wish to purchase raw products with special characteristics and therefore extend their market areas. Thus, firms generally do not have exclusive control over local production. However, to succeed in collecting raw products from distant regions that are close to the locations of their competitors, processors must set prices competitively. These competitive factors lead to the emergence of UD pricing rather than FOB pricing and to the existence of overlapping market areas in this industry.

[86] For discussions on price versus quantity competition, see, e.g., EATON AND LIPSEY (1989, chapter 7) in their article on product differentiation and SHAPIRO (1989, chapter 2.3) in their article on oligopoly theory.

4 A REVIEW OF THE THEORY OF (PROCESSING) COOPERATIVES

One way for farmers to mitigate the market power of IOFs is to form a processing COOP. CHAPTER 2 highlighted the importance of COOPs in agricultural markets and reviewed COOP principles and business practices, in particular of milk processors in Germany and Austria. Due to the relevance of COOPs as food processors, many markets are mixed markets with direct competition between COOPs and IOFs, i.e., competition between two different legal forms. This chapter aims to provide a general review of the economic literature on COOPs and on mixed markets. In addition, related research from the spatial economics literature is included. The findings presented in this chapter will be used to develop the analytical models presented in CHAPTERS 6 and 7. In some sense, this review is selective as it considers only the more fundamental economic COOP theory and more general analytical COOP and mixed-market models. Special issues of the COOP literature, like quality choice, vertical product differentiation, investments and financing, and property rights issues, are mentioned only if otherwise relevant. The same constraints apply to the mixed-market literature, in particular in regard to the literature considering competition between IOFs and public firms.

Because of the focus of the analytical models in CHAPTERS 5 to 7, this chapter concentrates on marketing COOPs as, for example, analyzed by HELMBERGER (1964). More specifically, the case of processing COOPs will be primarily considered (COTTERILL, 1987, p. 177 and p. 202):[87] processing COOPs procure the raw product from their members, process it and sell it on the processed goods market either to wholesalers or to retailers directly. Any net margins may be returned to members as patronage refunds. According to BATEMAN ET AL. (1979b, p. 64), the interest of a marketing (or processing) COOP "[…] is linked to the provision of an identifiable input from individual farms to a jointly owned batching or processing unit (milk to creamery, fatstock or storestock to a livestock marketing association, fruit to a cannery, eggs to a packing station etc.)." Thus, processing COOPs are an example of forward (or downstream) integration (DRIVAS AND GIANNAKAS, 2007). "The distinguishing feature of cooperative integration is its jointness; agents horizontally coordinate (form a club) to attain vertical integration. The most obvious reason for joint integration is to exploit scale

[87] Another type of a marketing COOP is a bargaining COOP (see, e.g., COTTERILL, 1987, pp. 201). Bargaining COOPs do not process the raw product by themselves, but they can be regarded as a selling agent for their members. These COOPs negotiate contract terms with processors and are thus able to exert some countervailing power to offset the buyer power of (IOF) processors (see also LEVAY, 1983, pp. 14, for a discussion). The other type of COOP not considered here is a supply (or requisite) COOP (see, e.g., COTTERILL, 1987, pp. 185). These COOP provides inputs for its members, i.e., farmers are consumers of the COOP. "[…] farmers purchase through requisite societies without supplying non-capital inputs to them […]" (BATEMAN ET AL., 1979b, p. 64). (Input) supply COOPs involve backward integration of members (DRIVAS AND GIANNAKAS, 2007).

economies at the vertical stage(s), but risk pooling and institutional considerations may also favor joint integration in some cases" (SEXTON AND SEXTON, 1987, p. 581).

This chapter is organized as follows. CHAPTER 4.1 discusses the most commonly assumed COOP objective functions in the theoretical literature. CHAPTER 4.2 summarizes public policies towards COOPs and reviews various conflicting views on COOPs in the literature. Finally, CHAPTER 4.3 reviews analytical models of the mixed-market literature.

4.1 OBJECTIVE FUNCTIONS OF COOPS

In the economics literature, the most commonly assumed objective of an IOF is profit maximization. Thus, net margins are distributed as profits to equity holders (COTTERILL, 1987, p. 184). However, within a COOP, each interest group (members, management, and board of directors) has a different objective, and adoption of a distinct COOP objective is determined by the relative strength of these groups (LEVAY, 1983).[88] LOPEZ AND SPREEN (1984, p. 99) note: "A processing cooperative […] faces the problem of best coordinating the deliveries of the members who may have conflicting interests in the operation of the cooperative plant. This is different than the case of a vertically integrated investor-owned firm where the raw product is an input in the production process and not a vehicle on returns in itself."

The COOP literature expresses different views and assumptions regarding the behavior or objective of COOPs. LEVAY (1983), SEXTON (1984) and STAATZ (1987) review the literature on the development of the COOP theory. According to LEVAY (1983), contributions in the earlier literature, like EMILIANOFF (1942) or PHILLIPS (1953), did not assign a certain objective to the (agricultural) COOP. Instead, the COOP was regarded as the sum of individual members (farmers) who maximize their own profit by means of the COOP, and the COOP is an extension of the farm business. STAATZ (1987, p. 75) notes that "Emilianoff, in 1942, was the first to analyze formally the cooperative as a form of vertical integration." On the contrary, HELMBERGER AND HOOS (1962) assign the (marketing) COOP a decision-making role (see also LEVAY, 1983).[89] HELMBERGER AND HOOS (1962, pp. 278) assume "[…]

[88] For example, the board of directors consists of trading and non-trading members, which leads to conflict between keeping the COOP small and allowing it to grow. The management may favor an identifiable target like profit maximization, but this goal will not be the first choice of the members (see LEVAY, 1983, pp. 12, for a discussion)

[89] HELMBERGER AND HOOS (1962) provide a review of the earlier literature, which does not consider the COOP as a 'firm' and suggest that "[…] Emelianoff's morphology, which has lead several writers astray, should be abandoned in favour of recognizing a cooperative enterprise as a decision-making entity" (p. 290). According to STAATZ (1987), an early contribution to the discussion of different objectives of a consumer COOP is ENKE (1945): "Enke, writing about consumer cooperatives in 1945, was the first to analyze the cooperative as a

the existence of a 'peak coordinator' consisting of a person or group of persons that, for one reason or another, wields effective authority over all organizational participants in the firm." In addition, they assume that the COOP pursues a certain tractable objective, which is maximization of the price paid to members subject to covering costs. Thus, such a COOP has one distinct objective function as an organization.

The theoretical literature has assigned several different objective functions to COOPs. Reviews of different objective functions are provided by BATEMAN ET AL. (1979b), LEVAY (1983), COTTERILL (1987), and STAATZ (1987). The following review of objectives of a (non-spatial) processing COOP and the corresponding results are taken from this literature. The following set of assumptions is helpful to discuss these objective functions (see, e.g., COTTERILL, 1987, pp. 202). The COOP is considered as a monopsony that processes the raw product supply of a given set of farmers (i.e., members). One unit of input corresponds to one unit of output in the selling market of the COOP, which is characterized by perfect competition. Timing of payments and pooling arrangements are not considered. Thus, farmers consider only the raw product price (i.e., the "transaction price" or "market price") they receive at the time of delivery. Any patronage refunds at the end of the year (i.e., net margins to be distributed to COOP members according to their patronage) are regarded as windfall gains.[90]

In the upper part of FIGURE 4-1, the horizontal line P is the perfectly elastic demand curve for the processed product facing the COOP as a function of quantity Q. Assuming perfect competition in the processed goods market, marginal revenue MR of the COOP is equal to the selling price P. Given positive fixed costs, the average cost curve AC has a U-shaped form, and the marginal cost curve MC intersects AC at the minimum of AC. AC and MC include all costs of the COOP except the costs of buying the raw product supplied by members (i.e., these costs are net of the raw product price that members receive).

The total sum available to the COOP for payment of the raw product is given by the net revenue product (NRP); see also FOUSEKIS (2010 and 2011):

(4-1) $$NRP = PQ - C(Q)$$

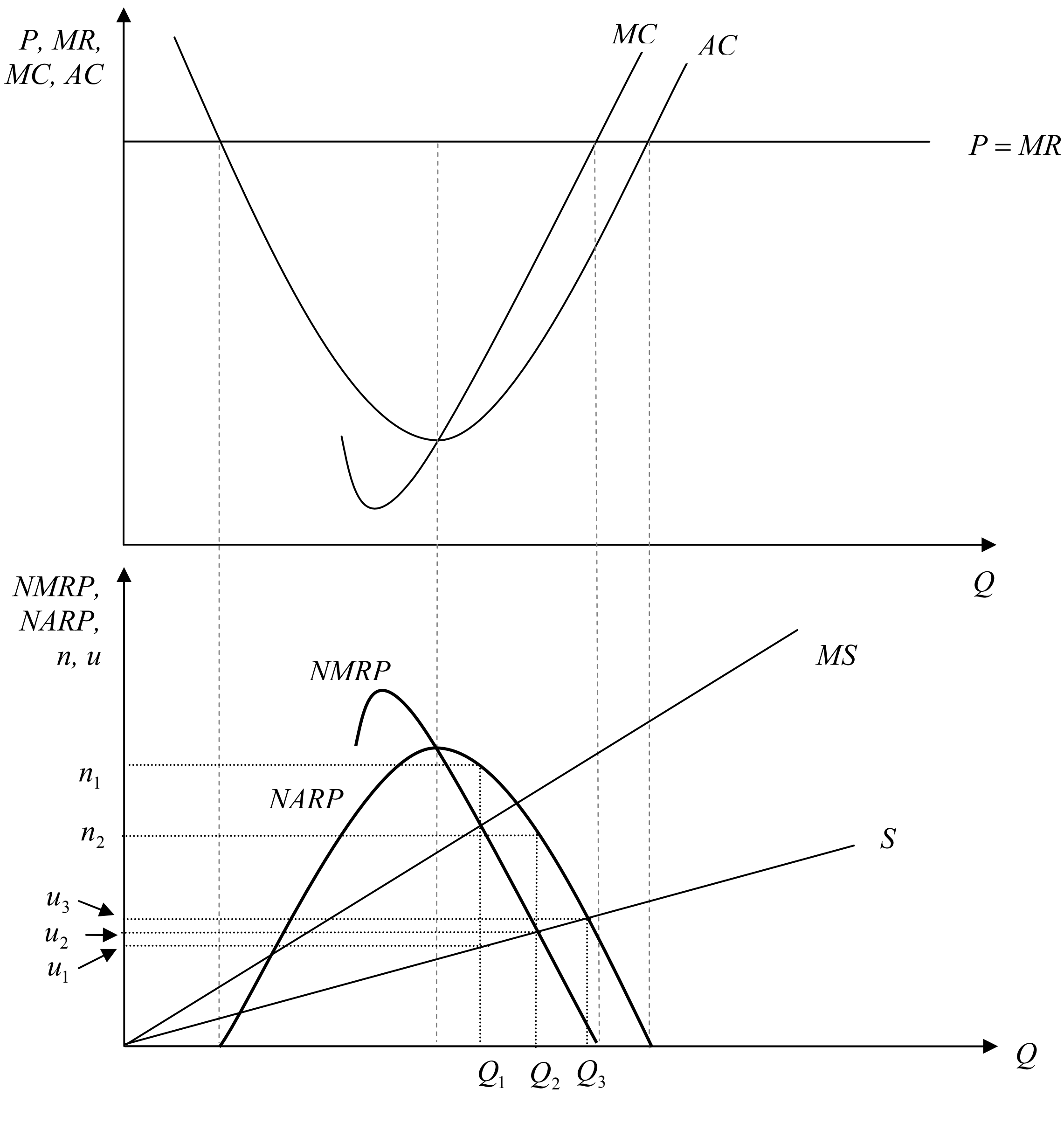
separate type of business firm. […] Enke's work initially was not drawn upon by theorists working in the area of agricultural cooperatives" (STAATZ, 1987, p. 76).

[90] COTTERILL (1987, p. 202) notes that, in reality, the pooling of products and the timing of sales requires special payment arrangements. For example, farmers receive several installment payments during the marketing process.

where PQ are total revenues of the COOP from selling the processed product and $C(Q)$ are total processing costs net of costs for buying the raw product. An important concept in the COOP literature is the net average revenue product (NARP); see also SEXTON (1990):

$$NARP = \frac{NRP}{Q} = \frac{PQ - C(Q)}{Q} = P - AC \tag{4-2}$$

FIGURE 4-1. Price-quantity equilibria under different COOP objective functions



Sources: see, e.g., BATEMAN ET AL. (1979b), LEVAY (1983), and COTTERILL (1987, p. 207).

The NARP function in the lower part of FIGURE 4-1 results from subtracting AC from P in the upper part of FIGURE 4-1.[91] NARP indicates the net revenue per unit of the processed product,

[91] According to SEXTON ET AL. (1989), the NARP function was introduced by HELMBERGER (1964).

which is the maximum price that the COOP can pay its members for the raw product covering fixed and variable costs (see, e.g., YOUDE AND HELMBERGER, 1966; and LEVAY, 1983). Thus, the NARP function determines the maximum break-even price a COOP can pay for a given quantity of the raw product (SEXTON ET AL., 1989). If AC is increasing, as is often expected in the short run, NARP will have a downward-sloping portion and, thus, there are diseconomies of scale (see, e.g., YOUDE AND HELMBERGER, 1966; and BATEMAN ET AL., 1979b).[92]

Subtracting MC from MR in FIGURE 4-1 yields the net marginal revenue product (NMRP) of the input to the COOP, which is the marginal change in NRP from processing an additional unit of the raw product (see, e.g., BATEMAN ET AL., 1979b; and SEXTON, 1990):

$$(4\text{-}3) \qquad NMRP = \frac{\partial NRP}{\partial Q} = \frac{\partial PQ}{\partial Q} - \frac{\partial C(Q)}{\partial Q} = P - MC$$

Hence, NMRP is the marginal curve associated with NARP (LEVAY, 1983). The section of the NMRP curve below the NARP curve is an IOF's short-run demand curve for the raw product (LEVAY, 1983; see also SEXTON, 1990). If $AC \geq P$, NARP is negative. NARP intersects the NMRP function at the maximum of the former. For any $MC \geq MR$, NMRP is negative.

In FIGURE 4-1, S is the market supply curve (i.e., total supply of a given set of farmers); this is the relevant offer curve for a marketing COOP (COTTERILL, 1987, p. 204).[93] MS are the (perceived) marginal costs of buying an additional unit of the raw product (see, e.g., BATEMAN ET AL., 1979b; and SEXTON, 1990), i.e., MS are marginal factor costs for the COOP. If the COOP maximizes profits like an IOF, it equates MS and NMRP and, thus, maximizes net earnings (i.e., total surplus, but not per-unit surplus; BATEMAN ET AL., 1979b). The resulting quantity processed is Q_1, and raw product price paid to farmers is u_1. The difference between NARP (n_1) and u_1 is either retained or distributed to members as patronage refunds (BATEMAN ET AL., 1979b). Maximizing profits may be a reasonable objective for the management or the board of directors if their performance is evaluated by means of accounting profits (BATEMAN ET AL., 1979b; see also LEVAY, 1983) or for inactive members who no longer trade with the COOP (LEVAY, 1983). However, as members' profits from raw product production are not considered, this is not the preferred objective of (active) COOP

[92] The same is true if the processed goods market is imperfectly competitive with a downward-sloping demand function (COTTERILL, 1987, p. 204; BATEMAN ET AL., 1979b).

[93] Under closed membership, there is one supply curve for a given set of members. Open membership implies new members if the price increases. Thus, there is another supply curve that is less steep than the closed-membership supply curve (i.e., the open-membership supply curve is more elastic). The market supply curve is a combination of these supply curves and thus consolidates changes in supply due to output changes of given members and changes in the number of members; see COTTERILL, 1987, p. 204-206.

members (BATEMAN ET AL., 1979b). The following sections discuss in more detail two prominent COOP objectives that have been assumed in the recent literature: maximization of total member welfare and NARP pricing.[94]

4.1.1 MAXIMIZATION OF TOTAL MEMBER WELFARE

As argued in the literature, one possible and appropriate objective of a COOP is to maximize the (total) welfare of its members.[95] In obtaining this goal, the COOP maximizes the profit on both inputs and outputs (i.e., the joint profit consisting of members' profits from producing the raw product and the profits of the COOP); see, e.g., LEVAY (1983) and BATEMAN ET AL. (1979b). According to BERGMAN (1997), the suggestion of joint profit maximization as a COOP objective dates from ENKE (1945), where the COOP sets revenues equal to marginal costs (see also BATEMAN ET AL., 1979b, or STAATZ, 1987). Thus, the COOP considers the production of its members as internal production and maximizes total net returns (TENNBAKK, 1992 and 1995).

The total member welfare-maximizing COOP equates S and NMRP (see FIGURE 4-1):[96] The raw product price paid to members (at the time of delivery) is u_2. Per-unit profits (or surplus) are given by the vertical difference between NARP (n_2) and NMRP (u_2). The total quantity processed Q_2 is larger than the quantity processed by a profit-maximizing IOF (Q_1). SEXTON (1984, p. 425) notes: "This solution has been described as mediating a member's conflicting role as an owner and a patron as it balances the profit motive with the desire to conduct business on the most favorable terms possible." Total member welfare is maximized at this point because the net marginal revenue (net of marketing costs) equals the raw product

94 Other possible COOP objectives include maximization of producer returns (i.e., net prices) per unit of the raw product and maximization of the dividend (i.e., patronage refunds) per unit of the input (see, e.g, BATEMAN ET AL., 1979; and LEVAY, 1983). Other objectives a COOP may pursue but that cannot be illustrated in the standard microeconomic (diagrammatic) framework include long-run security via stable prices and regional employment opportunities (LEVAY, 1983).

95 For example, COTTERILL (1987, p. 206) terms this objective "member welfare" maximization (see also SEXTON ET AL., 1989). In considering an input-supplying COOP, GIANNAKAS AND FULTON (2005, p. 416) term this objective "total member welfare" maximization. Likewise, HOFFMAN AND ROYER (1997, p. 3) assume a processing COOP that "maximizes the total welfare or profit of its members". This objective is also termed „producer surplus plus profit" maximization (BATEMAN ET AL., 1979b, p. 70), "joint profit maximization" (e.g., BATEMAN ET AL., 1979b; SORENSEN, 2005; HOFFMANN, 2005; AZZAM AND ANDERSSON, 2008); such a COOP is also termed a "NMRP-pricing co-op" (SEXTON, 1990, p. 717; see also SEXTON ET AL., 1989). Likewise, the COOP can be regarded as an agency whose objective is to maximize the quantity of inputs that yield the highest total returns to members (BATEMAN ET AL., 1979b). BATEMAN ET AL. (1979b, p. 70) note that maximizing "producer surplus plus profit" is also the maximand in the earlier COOP literature, as in ENKE (1945) and TAYLOR (1971).

96 "Treating the raw product supply curve of its members as given, it is well known that a cooperative maximizes its members' profit from jointly producing and marketing their product by setting raw product price […] and purchasing quantity […] where NMRP intersects member supply" (SEXTON, 1990, pp. 713)

price (see, e.g., COTTERILL, 1987, p. 206; and TENNBAKK, 2004). The marginal producer surplus (i.e., marginal profits of farmers) is given by the vertical distance between *MS* and *S* and the marginal profit of the COOP by the vertical distance between NMRP and *MS*. "As output expands, marginal profit falls as marginal producer surplus increases, the one being sacrificed to the other until S=[NMRP]" (BATEMAN ET AL., 1979b, p. 71).

Although the COOP's (total) net margin is lower compared to an IOF's objective of profit maximization, total member profits (including net margins) are higher than for any other objective (see, e.g., COTTERILL, 1987, p. 206). Total member welfare maximization is the only COOP objective that yields a Pareto optimal result (see, e.g. LEVAY, 1983; and SORENSEN, 2005). Referring to this "NMRP-pricing co-op" (e.g., SEXTON, 1990, p. 717), SEXTON ET AL. (1989, p. 57) note that "This solution is the 'first-best' optimum in that it maximizes member welfare for a given [supply…]." However, they argue that because NARP does not equal NMRP (except at the maximum of the NARP function, see FIGURE 4-1), the COOP will not break even in case of a simple linear price; to break even, a COOP needs to pay a price that is equal to NARP. Since the intersection of *S* and NMRP "is not ordinarily an equilibrium" (SEXTON ET AL., 1989, p. 57) (if members regard any deficit or surplus allocations as part of their net price and thus will adjust their supply), this optimum can only be established via a multi-part pricing scheme (e.g., fixed charges or rebates that are independent from patronage) or supply quotas (SEXTON ET AL., 1989; SEXTON, 1990). Therefore, the NMRP-pricing COOP is able to restrict (or control) members' supply if any profits of the COOP are distributed among members independent from patronage (TENNBAKK, 2000, p. 190). Similarly, SORENSEN (2005) argues that the joint profit maximization COOP is able to coordinate each member's supply. TENNBAKK (1992) notes that this objective may be infeasible if a COOP cannot restrict either membership or an individual member's supply.

BATEMAN ET AL. (1979b) discuss the interests of different groups within a COOP. They argue that any allocation of profits would be the result of bargaining between input suppliers and the management if the organization were an IOF. In the case of a COOP, however, the input suppliers are also the owners of the COOP so that the interests of the management, the members and the board of directors need to be harmonized: the management may prefer the objective of profit maximization, but members may prefer the objective of (total) member welfare maximization. The board of directors will favor profit distribution from the perspective as members, but from the perspective as directors it will favor profit retention. SEXTON (1986) analyzes the choice of different COOP objective functions and the choice between open or closed membership using a game-theoretic approach. One result of his article is a favorable position of COOPs towards NMRP pricing.

4.1.2 NARP PRICING

Another COOP objective commonly found in the literature is termed "NARP pricing" (see, e.g., SEXTON, 1990; SORENSEN, 2005; and FOUSEKIS, 2010 and 2011). This objective comprises several objectives a COOP might pursue, each of which yields the same result: i) the COOP maximizes either output or membership, subject to a no-loss constraint (see, e.g., BATEMAN ET AL., 1979b; and LEVAY, 1983); ii) the COOP maximizes the raw product price for members, subject to covering processing costs (see, e.g., YOUDE AND HELMBERGER, 1966; and COTTERILL, 1987, p. 206); and iii) the COOP "maximizes its members' profit from jointly producing and marketing their product [i.e., total member welfare] […] subject to the breakeven constraint" (SEXTON, 1990, p. 714). Given this objective, the COOP equates *S* and NARP, yielding output Q_3 and raw product price u_3 (see FIGURE 4-1). Thus, net margins of the COOP (i.e., profits from processing and thus patronage refunds) are zero (see also COTTERILL, 1987, p. 206). As mentioned, for example, by SEXTON (1984) in referring to this "zero-surplus solution" (p. 425), HELMBERGER AND HOOS (1962) is an example of the earlier COOP literature assuming NARP pricing. If the COOP treats members' supply as a parameter, it uses the NARP function to determine the raw product price; this solution is a (single-product) Ramsey second-best optimum (SEXTON ET AL., 1989; SEXTON, 1990).

BATEMAN ET AL. (1979b) indicate that any output lower than Q_3 will yield a surplus, which creates an incentive for members to increase production. Consequently, output will increase up to the point where *S* is equal to NARP (if the supply curve is the one for a given set of members). Therefore, this solution is the only sustainable (i.e., long-run) equilibrium if members of the (open-membership) COOP consider the "expected" raw product price (i.e., the raw product price plus any patronage refunds) in their production decisions (COTTERILL, 1987, p. 206; see also FOUSEKIS, 2010). SEXTON (1984, p. 425) notes: "The zero-surplus solution is the most descriptive of the alternative equilibria because, given the standard co-operative practices of simple breakeven pricing and no limits on member patronage, members will expand patronage to the zero-surplus level." TENNBAKK (2004) indicates the NARP-pricing COOP distributes profits ("revenue", p. 3) among members via the raw product price, which is equal to the COOP's average profit.

Unlike the total member welfare-maximizing COOP, several authors note that the NARP-pricing COOP is not assumed to be able to control members' supplies: either the NARP-pricing COOP is assumed to be powerless to control supplies in the short run to generate earnings (RHODES, 1983, referring to HELMBERGER, 1964), or the NARP-pricing COOP cannot control supplies since it must accept all members' inputs and does not have the coordinating abilities as the joint profit-maximizing COOP (SORENSEN, 2005, referring to HELMBERGER AND HOOS, 1962; see also TENNBAKK, 2004). Similarly, TENNBAKK (1992) argues that the objective of NARP pricing may be a likely outcome if a COOP is not able to restrict either membership or individual members' supply. "Growth of membership would be a possible objective if there were a belief amongst leadership in cooperative principles, particularly that of open membership, which could be construed in terms of admitting as many providers of the raw product as possible" (BATEMAN ET AL., 1979b, p. 69). BATEMAN ET AL. (1979b) note that beyond the point of total member welfare maximization (Q_2), existing members lose relative to new members, and control of the COOP decreases. In a static model with a perfectly competitive processed goods market, "[…] the [NARP-pricing COOP] has no direct influence on the *NARP*, but acts as a mere *price clearing central* for the members" (SORENSEN, 2005, p. 6).

BATEMAN ET AL. (1979b) discuss the reasons for establishing an objective like NARP pricing. One reason may be growth considerations (e.g., if the salaries of procurement officers are related to turnover). Another reason is that NARP pricing helps to establish a regional monopoly, which may create an entry barrier and increases the bargaining position of the COOP. Likewise, members may prefer a high raw product price to any potential patronage refund. Finally, COOPs may wish to maintain capacity reserves.

4.1.3 CONCLUDING REMARKS

The equilibria resulting from the objective of total member welfare maximization and NARP pricing lie within the decreasing portion of the NARP function (see FIGURE 4-1).[97] These solutions, however, depend on assumptions like (dis-)economies of scale and (im-)perfect competition in the market for the processed good (BATEMAN ET AL., 1979b). If NARP is decreasing, the output level is lower under the objective of total member welfare maximization than it is under the objective of NARP pricing. BATEMAN ET AL. (1979b) indicate that if NARP is horizontal, NMRP and NARP are equal, and the maximization of total member welfare and NARP pricing yield the same output level. If NARP is increasing,

[97] This outcome applies also to other COOP objectives but not to one particular objective: maximization of per-unit patronage refunds (see, e.g., BATEMAN ET AL., 1979b).

NMRP is greater than NARP. Then, output is higher under the objective of total member welfare maximization than it is under the objective of NARP pricing.

LEVAY (1983) discusses the possibilities for COOPs to increase the raw product supply in the short run, which, however, affects the NARP function. First, if COOP members do not sell their raw product exclusively via the COOP, obtaining a larger supply from existing members is possible if the COOP can induce members to use the COOP exclusively. The latter is only possible if the COOP is operating along the increasing portion of the NARP function. However, if members, in turn, request better services from the COOP and thereby increase the COOP's costs, NARP will be affected. Second, supplies can be increased by expanding membership; this approach will increase the capital requirements of the COOP and will also affect NARP. SEXTON (1990) argues that open membership is an optimal policy if the COOP operates on the increasing portion of the NARP function (i.e., if NARP is increasing over the relevant range of members' supply): increasing the number of members makes existing members better off. If the COOP operates on the decreasing portion of the NARP function, the optimal policy of the COOP is to restrict membership. However, the point in FIGURE 4-1 at which the COOP restricts membership is subject to alternative arguments in the literature (SEXTON, 1990).[98] Finally, a COOP may accept trade with non-members to increase the raw product supply (LEVAY, 1983).

The difficulty of attributing a particular COOP objective function to a specific market is demonstrated by TENNBAKK (2004) in the context of Norwegian COOPs in the egg market. She argues that these COOPs employ a "variety" (p. 4) of NARP pricing:

"[…] the Norwegian cooperatives implement a form of two-part tariff, in which deliveries within a preset 'quota' for each farmer are paid according to the NARP distribution rule, whereas excessive deliveries are paid at a much lower price, typically the export price. As argued, a major reason for choosing the cooperatives as regulatory agents, is their ability to restrict supply. Hence, it can be argued that although the Norwegian cooperatives are NARP cooperatives in the sense that they distribute profit through price, they are NMRP cooperatives in the sense that they restrict their members' supplies" (TENNBAKK, 2004, p. 4).

[98] According to SEXTON (1990), some authors argue that the restricted-membership COOP sets output at the intersection of NARP and NMRP and, thus, pays the maximum raw product price possible (see FIGURE 4-1; see also the discussion in LEVAY, 1983, for the long-run equilibrium and SEXTON ET AL., 1989). Others argue that the COOP will extend production into the decreasing portion of the NARP function.

4.2 DIFFERENT VIEWS ON COOPS

In general, COOPs benefit from rather favorable public policies (see, e.g., LEVAY, 1983; and BERGMAN, 1997). In many countries, governments promote, protect or even subsidize COOPs (TENNBAKK, 1995). Examples of such favorable policies in the U.S. are certain exemptions from tax law, exemptions from antitrust statutes, below-market interest rates, and free technical assistance through the U.S. Department of Agriculture, USDA (PORTER AND SCULLY, 1987; SEXTON, 1990). According to the literature review by BERGMAN (1997), agricultural marketing COOPs in some European countries (in particular Germany) are explicitly exempt from some regulatory constraints. In some countries (e.g., the U.K., Ireland, Mediterranean EU countries), COOPs are granted reduced tax rates. In Germany, dairy COOPs, for example, are exempted from corporate tax as long as mainly members' own raw milk is processed and the final products do not reach a certain level of processing, e.g., fruit yogurts (BKA, 2009, p. 31). In Sweden, COOPs are exempted from the Swedish Competition Act (VAN BEKKUM ET AL., 2001; taken from AZZAM AND ANDERSSON, 2008). Regarding Norway, TENNBAKK (1992) mentions protection of COOP's against competition from imports, special subsidies, and exclusive purchasing and processing rights (e.g., in the case of the national dairy marketing COOP). Relatedly, large COOPs in Norway are used by the government as a means to implement agricultural policies (see TENNBAKK, 2004, for details). This constitutes the dual role of Norwegian COOPs as both market players and regulators. According to TENNBAKK (2004), Norwegian COOPs are used as agents for the government for two reasons: first, the COOP coordinates farmers' production (i.e., it controls market supply), and second, the COOP distributes any surplus to members via raw product prices.

Reasons for such favorable positions towards COOPs include the presumption that COOPs may have higher costs than IOFs (e.g., due to the high costs of negotiating distribution rules within the COOP if farms are highly heterogeneous) and that COOPs may have difficulties to raise capital (TENNBAKK, 1995). LEVAY (1983) claims that governments are generally in favor of COOPs, even though the reason for this is seldom specified. She raises the question: "Can it be that agricultural co-operation is considered to be so self-evidently a good thing that its benefits do not have to be demonstrated?" (p. 31). Reasons why governments form a favorable view of COOPs seem to be that COOPs are perceived as non-profit oriented democratic organizations that serve their members and support farm maintenance; at the same time, COOPs can also attain economies of scale (LEVAY, 1983).

"The impression is that the effect of co-operation upon society will be salutary, but the mechanisms by which this beneficent influence is attained are not specified. […] Only on the most stringent assumptions is Pareto Optimality actually attained. Co-operatives tend either to produce too little or too much, depending on whether they follow a restrictive or open membership policy" (LEVAY, 1983, p. 32).[99]

Similarly, TENNBAKK (1995, pp. 33) notes: "Governments seldom specify the reasons why they are sympathetic to the formation of agricultural cooperatives, but seem to share the belief that cooperatives ensure better terms and greater security. In addition, cooperatives are believed to improve the overall market performance."

The literature presents different views on and arguments about COOPs. BERGMAN (1997) summarizes five prevailing hypotheses regarding marketing COOPs in this literature:

"1. Cooperatives can acquire and maintain high market shares more easily than other firms.
2. Cooperatives can efficiently exploit higher market shares, to the benefit of members firms (or individuals) and to the detriment of consumers.
3. Cooperatives represent an inefficient organizational form and tend to increase costs, thereby raising prices and hurting consumers.
4. Cooperatives reduce the transaction costs of the member firms, thereby benefitting consumers.
5. Cooperatives have a beneficial effect on distribution, in balancing market power of large (downstream) firms buying from other member firms or upstream firms providing farm inputs" (BERGMAN, 1997, p. 76).

Thus, as BERGMAN (1997) indicates, COOPs are either viewed as cartels (hypothesis 1 to 3) or as welfare-enhancing means (hypothesis 4 to 5). They are either viewed as inefficient (hypothesis 3) or as efficient (hypothesis 4). Similarly, SEXTON AND LAVOIE (2001, pp. 876) indicate the possible effects of COOPs on market behavior: either COOPs may exercise monopoly/oligopoly power or they have a procompetitive effect on the market outcome.

4.2.1 MONOPOLY/OLIGOPOLY POWER OF COOPS

Referring to the view on COOPs as cartels, BERGMAN (1997) notes that a COOP enables farmers to coordinate, for example, pricing strategies and to take advantage of returns to scale. "The basic difference – from an antitrust point of view – between the cooperative and the large firm is that, in the cooperative structure the small units [i.e., farmers] own and control

[99] Referring to the work of YOUDE AND HELMBERGER (1966), LEVAY (1983) concludes that restricted membership is always socially undesirable but that this may even be true in the case of open membership. TENNBAKK (1992, p. 18) notes that the open-membership NARP-pricing COOP "tends to produce too much output".

the large unit; whereas in the normal corporate structure, the large unit owns and controls the small units [i.e., daughter firms]" (BERGMAN, 1997, p. 73). Similarly, TENNBAKK (2000, p. 189) argues, "Although cooperatives enable members to coordinate supplies, they are different from cartels because they are not believed to be able to control the individual members' production." For the U.S., SEXTON AND SEXTON (1987) and ROGERS AND SEXTON (1994) note that without protection of COOPs by the Capper-Volstead Act of 1922, coalitions of sellers would be a violation of the Sherman (Antitrust) Act of 1890. According to BERGMAN (1997), COOPs in the U.S. are allowed to cooperate on pricing, and a COOP's market share may even be 100% provided that this share is the result of an open-membership policy ("members voluntar[il]y joining the cooperative", p. 75). For Germany, BERGMAN (1997) notes that COOPs are organized in several regional associations, some federated COOPs (which specialize in one specific commodity) and one national association. He argues, „Although explicit price cartels between cooperatives are prohibited in Germany, this has little effect, as cooperatives are allowed to sell through joint ventures with other cooperatives […]" (p. 75, see references therein).[100]

SEXTON AND LAVOIE (2001, p. 877) point out that "[…] cooperatives themselves may become instruments for the exercise of monopoly or oligopoly power through the cartel selling authority the law generally grants them." However, SEXTON AND LAVOIE (2001, pp. 877) indicate that marketing COOPs may not be in the position to exercise monopoly/duopoly power because COOPs are not assumed to be able to restrict output. They argue that a COOP's output level is determined by the chosen level of members' supplies and by the membership policy (open or restricted membership). Referring to the NARP-pricing COOP as in HELMBERGER AND HOOS (1962), BERGMAN (1997) argues:

"[…] this line of thought, which has become the standard model of cooperative marketing, holds that even if the cooperative gains a monopoly position, it will not exploit that position in any way that reduces welfare. It suggests that [the hypothesis 2, i.e., that COOPs can exploit higher market shares to the detriment of consumers (see CHAPTER 4.2)] does not hold and justifies the more liberal treatment of cooperatives in many countries' antitrust legislation" (BERGMAN, 1997, p. 77).

SEXTON AND LAVOIE (2001, pp. 877) indicate that conditions like a dominant market position of COOPs and a COOP's engagement in price discrimination are issues that give rise to the concern of anticompetitive behavior (see their review of the empirical literature). Referring to the analytical literature, TENNBAKK (1995) notes that the market structures

[100] See BERGMAN (1997) for a discussion of (antitrust) legislation regarding agricultural COOPs in the EU.

usually considered are oligopolies for supply COOPs and oligopsonies for marketing COOPs. Thus, a common assumption regarding processing COOPs is that of perfect competition in the selling market for the processed product, and it is argued that COOPs correct market imperfections to the benefit of farmers. "Therefore, the presence of the cooperative does not affect the magnitude of the consumers' surplus. There is, however, little reason to believe that cooperatives would not exercise market power towards consumers if given the possibility" (TENNBAKK, 1995, p. 35). One example that TENNBAKK (1995) mentions is the national Norwegian dairy COOP, which exploits its monopoly power in the national market. TENNBAKK (2004) notes that marketing COOPs in Norway have a dominant position and exert market power in their respective selling markets because they are able to restrict their members' supply.

In Sweden, there is a concern that COOPs may exercise market power over consumers due to the increasing concentration of COOPs and to their exemption from the Swedish Competition Act (AZZAM AND ANDERSSON, 2008; see references therein). This concern is addressed by AZZAM AND ANDERSSON (2008) with an empirical analysis of the Swedish beef-slaughter industry (1965 to 2004). COOPs compete with IOFs in selling beef to consumers and in procuring cattle from farmers. AZZAM AND ANDERSSON (2008) draw upon the works of TENNBAKK (1995) and HOFFMANN (2005), amongst others. In their New Empirical Industrial Organization (NEIO) model, they decompose the effect of COOP and IOF concentration on price into market-power effects and cost-efficiency effects. AZZAM AND ANDERSSON (2008) find that industry concentration (in particular COOP concentration) resulted in lower beef prices for consumers because the cost-efficiency effect offset the market-power effect. In addition, they conclude that IOFs are price takers in the procurement of cattle and in the sale of beef.

BERGMAN (1997) theoretically shows that if a (monopolistic) COOP does not price discriminate in the consumer market (e.g., via exports or between domestic markets), then the COOP will likely be socially beneficial (i.e., for farmers and consumers). However, the welfare effect is ambiguous in the case of price discrimination. Assuming Cournot competition between a COOP and an IOF and given the possibility of price discrimination, consumers are not necessarily better off in the presence of the COOP. Because the COOP is a fiercer competitor than the IOF, it can obtain a higher market share more easily than can an IOF. BERGMAN (1997) empirically supports his analytical results by estimating an econometric model using international cross-sectional data. His results indicate that a higher market share of the COOP tends to decrease consumer prices, whereas higher net exports tend to increase prices and thereby suggest price discrimination between domestic and foreign consumers. He concludes that COOPs in the U.S. (with the exception of dairy COOPs) may not exhibit anticompetitive effects because both exports and the degree of vertical integration are relatively low. In contrast, Swedish COOPs have high market shares and are characterized by a high degree of vertical integration; thus, the presence of a COOP in the market may have a negative effect on welfare.

4.2.2 PROCOMPETITIVE EFFECT OF COOPS

In contrast to the view that COOPs may exercise monopoly/oligopoly power, COOPs are regarded as procompetitive legal forms. Reviewing several theoretical contributions from the literature, STAATZ (1987) concludes that public policy that support COOPs are justified due to beneficial effects of COOPs on competition and potentially improved economic coordination. The following reason to form a favorable public policy towards COOPs may be most prominent: "Cooperatives are directly relevant to market conduct in agriculture because they enable their members to integrate around oligopsony processors. They may also influence oligopsonists' behavior by acting as a 'yardstick of competition' […]" (ROGERS AND SEXTON, 1994, p. 1146). The formation of a COOP is often justified by arguing that a COOP protects its members from the exercise of IOFs' monopsony or oligopsony power (TENNBAKK, 1995). In this sense, the possible benefit of a COOP for farmers seems to be viewed relative to the alternative, i.e., an IOF. However, considering a processing COOP in direct competition with IOFs (i.e., in a mixed market), government support of COOPs can be regarded as one way of indirectly regulating oligopsonistic or oligopolistic markets (TENNBAKK, 1995). Generally, the perspective of COOPs as "market-perfecting instruments" is envisioned in U.S. law (COTTERILL, 1987, p. 179).[101]

This line of reasoning, which considers COOPs as a means to correct market imperfections by competing with IOFs in a mixed-market structure, is known as the "competitive yardstick school" (COTTERILL, 1987, p. 179), dating from NOURSE (1922) and described, for example,

[101] Likewise, in many countries, oligopolistic markets are regulated via competition of IOFs with public firms (TENNBAKK, 1995). A maybe more apparent public intervention to correct market imperfections is the establishment of mixed markets via public firms that are used by governments to correct market imperfections and improve social welfare (for a review, see, e.g., DE FRAJA AND DELBONO, 1990). The establishment of a mixed market is done, for example, either by nationalization of private firms or by the explicit creation of a public firm (DE FRAJA AND DELBONO, 1990). By focusing on endogenous quality choice of firms, HOFFMANN (2005) discusses the impact of promotion of ownership (e.g., the promotion of COOPs via tax policies) on the ownership structure in the market.

in COTTERILL (1987, p. 179 and pp. 182) and SEXTON AND LAVOIE (2001, p. 876).[102] SEXTON AND LAVOIE (2001, p. 876) explain: "[…] payments received by members of a marketing cooperative may be used as a yardstick or barometer for farmers who patronize rival, for-profit handlers to gauge and improve their treatment at the hands of these firms." This school of cooperative thought "[…] reasons that cooperatives should seek to make the marketing system more efficient, thereby benefiting the consuming public as well as farmers" (COTTERILL, 1987, p. 179). Since an IOF must match the COOP's performance, the efficiency of an economy is improved to the benefit of all farmers; as a result, prices paid to farmers (and farmers' output) increase without necessarily increasing prices to consumers (p. 182).

In this sense, COOPs are regarded as a possible means to ease the oligopsony power of (IOF) food processors. Thus, the COOP is considered a competition-enhancing legal form that "disciplines" IOFs and limits the market power of IOFs (over farmers) in the same market (FOUSEKIS, 2010, p. 2; see also LEVAY, 1983; COTTERILL, 1987; or SEXTON, 1990). This possible "competitive yardstick effect" of COOPs (as it is termed in the literature; see, e.g., SEXTON, 1990, p. 718) is one justification of an economic policy that supports COOPs. For example, based on their theoretical results regarding a (consumer) COOP as a potential market entrant, SEXTON AND SEXTON (1987, p. 594) conclude: "Because potential cooperatives have a procompetitive effect on market conduct and enter markets only in response to market failure, public policies favorable to cooperatives and customer coalitions appear to be justified."

However, COTTERILL (1987, p. 182) also mentions some criticism of the competitive yardstick theory. First, some critics argue that the competitive yardstick theory (based on suggestions of the competitive price model) is simplistic (since members often benefit from product differentiation, education, etc., so that COOP activities can be regarded as public goods). Second, a COOP must be in a leading market position to be able to change the behavior of a competing IOF. According to this argument, "The competitive yardstick objective at best is a long run goal" (COTTERILL, 1987, p. 183).

4.2.3 EFFICIENCY OF COOPS

PIGOU (1950, taken from LEVAY, 1983) argues that although farmers may benefit from COOPs' pricing policies, nothing can be concluded about any possible advantage of COOPs

[102] COTTERILL (1987, p. 208) indicates that the concept of the competitive yardstick also refers to monopolistic/monopsonistic COOPs (relative to monopolistic/monopsonistic IOFs) because they improve welfare. For example, referring to the result of the NARP-pricing COOP in CHAPTER 4.1.2, he argues that this result constitutes a generalization of the competitive yardstick theorem of NOURSE (1922).

if they operate inefficiently. It may be difficult to harmonize conflicting objectives of different interest groups within a COOP (see LEVAY, 1983, and CHAPTER 4.1).[103] In addition, "Not only may objectives vary, but cooperatives may have particular problems of participation, management and control not paralleled in conventional firms. They may, as a result, be more or less efficient in terms of market entry, growth, survival and competitiveness" (LEVAY, 1983, p. 2). SORENSEN (2005, p. 12) argues: "[…] we may experience diseconomies of scale when a cooperative grows into a 'large' organization with a 'loose' management."[104] PORTER AND SCULLY (1987, p. 511) indicate that the organization of a COOP incurs "transaction, decision, information, and contract monitoring and enforcement costs", which reduce efficiency if these costs create a control problem.

Whether COOPs are more or less efficient relative to IOFs is a prominent issue in the literature with conflicting results (see, e.g., discussions in BERGMAN, 1997; PORTER AND SCULLY 1987; SEXTON ET AL, 1989, with an empirical application to cotton ginning COOPs in the U.S.; and SEXTON AND ISKOW, 1993). SEXTON AND ISKOW (1993) review the literature and provide examples for both views on the efficiency of COOPs. Accordingly, relative to IOFs, COOPs are regarded as technically inefficient due to the principal-agent problem (e.g., individual members are rather uninterested in performance monitoring since performance parameters like a COOP's stock value do not exist), COOPs exhibit allocative inefficiency due to the horizon problem (a COOP may underinvest and members are more interested in short-run payoffs for their time as patrons), or COOPs exhibit scale inefficiency due to a COOP's lack of patronage that is necessary for a cost-minimizing scale. In contrast, COOPs are regarded as more (technically) efficient than IOFs due to (transaction) cost savings resulting from vertical integration or due to improved information flows. The empirical analysis by PORTER AND SCULLY (1987) of milk processing COOPs in the U.S. in 1972 indicates that COOPs are less efficient than IOFs; this result is not due to allocative efficiencies because COOPs pursue alternative objective functions; instead, it is due to the structure of a COOP's property rights. To the contrary, SEXTON AND ISKOW (1993) critically review PORTER AND SCULLY (1987) and related work and conclude that empirical evidence that COOPs are more or less efficient than IOFs is rather limited.

[103] Tensions between the objectives of different interest groups are also discussed in BRISCOE (1971) in regard to a consumer COOP.

[104] However, SORENSEN (2005) notes that diseconomies of scale are rather unusual in the food processing industry (see also YOUDE AND HELMBERGER, 1966; or TENNBAKK, 2000, referring to HELMBERGER, 1964, and RHODES, 1983).

4.3 THE COOP IN A MIXED MARKET

The considerations and discussions in CHAPTER 4.2 regarding the effect of COOPs on market behavior justify analytical contributions regarding COOPs that assume different COOP objective functions (see also, for example, the motivation of COTTERILL, 1987, pp. 182) and analytical contributions regarding COOPs in direct competition with IOFs in a mixed market. SEXTON (1990), for example, notes that COOPs were usually analyzed in an isolated position (i.e., as a monopsony; see CHAPTER 4.1) rather than in direct competition with IOFs.

A mixed market in which COOPs directly compete with IOFs is a market that consists of two different organizational forms. In their review of the mixed-market literature regarding competition between private and public firms, DE FRAJA AND DELBONO (1990, p. 1) define mixed markets as follows by referring to oligopolistic markets: “A mixed oligopoly is a market where a homogeneous or differentiated good is supplied by a ‘small’ number of firms and the objective function of at least one of them differs from that of the other firms.” Due to the different objective functions of the COOP and the IOF, the reaction functions of processors are asymmetrical (see, e.g., TENNBAKK, 1995). In general, the literature on competition between COOPs and IOFs shows that mixed markets are more competitive than (pure) IOF markets, i.e., positive welfare effects can be expected; see, e.g., HIGL (2003), DRIVAS AND GIANNAKAS (2007), AZZAM AND ANDERSSON (2008), SORENSEN (2005), and FOUSEKIS (2010) for short reviews of certain mixed-market models and corresponding references from the mixed-market literature, respectively. AZZAM AND ANDERSSON (2008) note that the existing literature on competition between COOPs and IOFs in a mixed market remains largely theoretical, and empirical contributions are rather limited. The same is true of analytical and empirical contributions regarding spatial competition in a mixed market (see also FOUSEKIS, 2010).

TENNBAKK (2000, pp. 189) indicates: “[…] farmers are certainly better off as members of a cooperative, than dealing individually with wholesalers exercising market power.” However, if being a COOP member is obviously more profitable than being an IOF supplier (in a pure market), the question arises of why not all farmers in the market form a COOP (TENNBAKK, 2000, pp. 189). Although some theoretical results in the literature suggest that a mixed market is not a stable equilibrium (see discussions in TENNBAKK, 2000 and 2004; and SORENSEN, 2005), mixed markets exist in the food processing industry. In considering a NARP-pricing COOP and some IOFs in the same market, HELMBERGER (1964, p. 615), for example, argues: “If the profit seeking firms fail to match the cooperative’s price, their suppliers will seek, presumably with success, cooperative membership."[105] Referring to this presumption, TENNBAKK (2000, p. 190, and 2004) notes that if the IOF is able to match the COOP's conditions, farmers will be indifferent between the COOP and the IOF and the market structure may consist of IOFs only in the long run. However, farmers will favor the COOP if net returns (including patronage refunds) are higher relative to the IOF, and a likely market outcome will be a market consisting of COOPs only in the long run (RHODES, 1983, p. 1091; see also TENNBAKK, 2000, pp. 190, and 2004 for discussions). Thus, competition between a COOP and an IOF (i.e., a mixed market) is often viewed as an off-equilibrium situation (TENNBAKK, 2000, p. 190, and 2004). Similarly, SORENSEN (2005) notes that some theoretical contributions suggest that COOPs might crowd out IOFs, while other theoretical contributions suggest a stable mixed-market equilibrium (see also discussions in HENDRIKSE, 1998, and HIGL, 2003).[106]

Whether a (processing) COOP in a mixed market exhibits a procompetitive effect and, consequently, affects welfare in the market strongly depends on the model assumptions (see also SORENSEN, 2005, p. 1, who refers to "highly specific assumptions" in the mixed-market literature). The review of the theoretical literature in this chapter shows that the set of assumptions in mixed-market models with (processing) COOPs considers (at least) the following: the objective function of the COOP (total member welfare maximization or NARP pricing), the membership policy of the COOP (open or closed membership), the decision variable of processors in the mixed market (quantity or price), and assumptions regarding competition in the selling market of processors (perfect competition or imperfect competition).

Most mixed-market models assume quantity as the decision variable of firms.[107] Whether farmers in a market can choose their processor by themselves depends on the membership policy of the COOP. Closed membership is mostly established by assuming that the set of farmers patronizing the COOP is given. The assumption of open membership is often modeled as a sequential game. In addition, an assumed possibility of processors to exercise

[105] HELMBERGER (1964) refers to the case of perfectly competitive processors. For the case of imperfectly competitive processors, he assumes that the COOP and the IOFs may collude (e.g., "market sharing", p. 615), but to the disadvantage of consumers (see also TENNBAKK, 2000).

[106] SORENSEN (2005) notes that the theoretical contributions of RHODES (1983) and ALBAEK AND SCHULTZ (1998) suggest that COOPs might crowd out IOFs. Contrary to that, she notes that the theoretical contributions of TENNBAKK (1995), SEXTON (1990), KARANTININIS AND ZAGO (2001) and HENDRIKSE (1998) suggest a stable mixed market equilibrium.

[107] Exceptions to the assumption of competition in quantities in mixed markets include DRIVAS AND GIANNAKAS (2007) and FOUSEKIS (2010), who assume that the decision variable of food processors is the input price paid to farmers (see CHAPTER 4.3.2). In his mixed market model assuming endogenous quality choice, HOFFMANN (2005) assumes a two-stage game where processors first decide on the level of quality and then compete in (consumer) prices.

duopoly power over consumers affects total welfare in the market. Thus, the assumptions on the setup of models are important to interpret the effect of COOPs in a mixed market. In the following, various analytical mixed-market models will be reviewed and discussed.

4.3.1 NON-SPATIAL MIXED-MARKET MODELS

Examples of mixed market models assuming a given set of farmers patronizing a COOP, i.e., closed membership, are TENNBAKK (1995) and ALBAEK AND SCHULTZ (1998). However, these two studies assume different organizational forms of the COOP. TENNBAKK (1995) is an example of a mixed-market model, where firms (a marketing COOP and an IOF; both "wholesalers" market the production of farmers) compete in quantities in the final market á la Cournot.[108] She assumes a closed-membership COOP that is organized as a centralized decision-making entity; the COOP maximizes joint profits, i.e., the sum of farmers' profits from producing the raw product and the profits it earns in the selling market. Thus, the COOP is modeled as a horizontally and vertically integrated firm: "[…] the cooperative chooses its output taking into account that the price in the final market decreases when the quantity marketed increases, but also taking into account the positive effect on individual farm surplus" (TENNBAKK, 1995, p. 37). Therefore, the COOP regards members' supplies as internal production. Rather than paying a per-unit price for the raw product, the COOP's profits are shared among members. Since the COOP controls members' supplies, it has a coordinating function and determines the optimal quantity to the benefit of its members (see also the corresponding discussion in HIGL, 2003). The IOF in TENNBAKK (1995) maximizes its own profit only. It is a monopolist towards the residual demand curve (i.e., it competes á la Cournot by taking the quantity of the COOP as given) and has monopsonistic power in the input market (i.e., towards IOF suppliers, who receive a price according to their aggregate marginal costs).

TENNBAKK (1995) shows that the COOP produces more in equilibrium than the IOF does; likewise, total quantities are higher in the mixed market than in a pure IOF market. Farmers' profits are higher in the mixed market, and the increase in profits outweighs the marginal losses of processors in wholesale profits. In addition and relative to the pure IOF market, consumers will benefit from a mixed-market setting because higher quantities in the mixed

[108] TENNBAKK (1995) also considers a mixed market with competition between IOFs and public firms. The difference between the COOP and a public firm is the following: "While the public firm is concerned about the magnitude of both consumers' and producers' surpluses, the cooperative will take advantage of its duopolist position in the final market, thereby increasing its members' surplus" (TENNBAKK, 1995, p. 39). For the case of competition between private profit-maximizing firms and public total welfare-maximizing firms, see also, e.g., DE FRAJA AND DELBONO (1990).

market will lower selling prices according to the final (inverse) demand function. Hence, consumer welfare is higher in the mixed market. As a result, total welfare (as the sum of the surpluses of consumers and producers) is higher in the mixed market than it is in the pure IOF market.[109] The mixed market in TENNBAKK (1995) constitutes a stable equilibrium (see also SORENSEN, 2005) as it is assumed that the farmer groups (COOP members and IOF suppliers) are given. TENNBAKK (1995) argues that when both farmer groups are enabled to form a COOP, the resulting equilibrium market structure will be a pure COOP market, and farmers are better off than in a pure IOF duopsony. If IOF suppliers can be compensated in return for not setting up a COOP (which is only possible if the market is a pure IOF market with unintegrated firms), "[…] the mere threat by farmers to form cooperatives is sufficient to keep them as well off in private duopoly as in cooperative duopoly" (p. 43).

In a comparable model setup but under different assumptions regarding the COOP, ALBAEK AND SCHULTZ (1998) consider a given set of farmers that patronizes each processor. Thus, their COOP is also characterized by closed membership (see also KARANTININIS AND ZAGO, 2001, p. 1269). The COOP and the IOF in ALBAEK AND SCHULTZ (1998) compete á la Cournot, i.e., each takes output of the other as given. The COOP is described by individual objective functions of COOP members. In this mixed-market model, individual COOP members make output decisions by maximizing their individual profits. Thus, members individually decide for themselves how much they want to deliver to the COOP.[110] Each COOP member internalizes only the impact of its own supply decisions on the price that it receives but not the profit loss inflicted on the other members. This COOP does not have a coordinating function since members act individually (HIGL, 2003). The price received by COOP members is the price that the COOP earns in the selling market. Thus, the COOP retains no profit and can be regarded as a NARP-pricing COOP (SORENSEN, 2005). In the model, IOF suppliers receive a market price (see also KARANTININIS AND ZAGO, 2001). ALBAEK AND SCHULTZ (1998) assume a vertically integrated IOF, which chooses a production level that maximizes the joint profit of the IOF and of IOF suppliers.[111] Hence, unlike the COOP, the IOF is in control of their input supply (HIGL, 2003).

[109] TENNBAKK (1995) shows that if the mixed market consists of a welfare-maximizing public firm competing with an IOF, total welfare in the mixed market will even be higher.

[110] HIGL (2003, footnote 17) notes that this behavior of COOP members in the ALBAEK AND SCHULTZ (1998) model reflects the idea that COOP members expect an assured marketing of their production.

[111] This is rather unusual in the mixed market literature as the IOF is similar to a COOP. KARANTININIS AND ZAGO (2001), however, indicate the difference between such an IOF and a COOP. Decision-making in the vertically integrated IOF is centralized. This corresponds to a closed-membership COOP with centrally allocated delivery rights and is a form of a "New Generation COOP" (p. 1268). The COOP in ALBAEK AND SCHULTZ (1998), however, is characterized by decentralized decision making.

ALBAEK AND SCHULTZ (1998) show that COOP members produce more than IOF suppliers do in equilibrium. Total output is higher in the mixed market than in a pure IOF market and the presence of the COOP increases total welfare in the market (see also the review by HIGL, 2003). In addition, ALBAEK AND SCHULTZ (1998) argue that there is an incentive to join the COOP. As long as more than one farmer supplies the IOF, it is always more profitable to be a COOP member. SORENSEN (2005) indicates that the IOF in such a mixed market is crowded out by the COOP (since payoffs will always be higher in the COOP than in the IOF). She argues that, as the COOP produces more than the IOF does, the output price in the selling market ("linking the two firms' strategies together", p. 13) decreases for both firms. HIGL (2003, p. 33) argues that this result may explain the empirical observation of rather large COOPs in the food processing sector. ALBAEK AND SCHULTZ (1998) note that COOPs in Denmark grew due to mergers and that IOFs in many industries have been either driven out of business or taken over by COOPs. Based on their model, they conclude:

"In a market with only profit maximizing firms each farmer would generate more profit per head than in a market with cooperatives. In a sense, there is a prisoner's dilemma situation. Consider a market with two firms: given the organization of the other firm, profit maximizing or cooperative, the best organization for a firm is cooperative. Hence, a Nash equilibrium in organizational structure has both firms choosing cooperative. Nevertheless, it would be better for both firms if they both were profit maximizing firms" (ALBAEK AND SCHULTZ, 1998, p. 401).

Overproduction on the part of the COOP is a common finding in the theoretical mixed-market literature. In a standard Cournot model, quantities are strategic substitutes. Thus, if the COOP credibly produces more than an IOF does, the IOF will produce less in the mixed market (HIGL, 2003). SEN (1966; taken from TENNBAKK, 1995, p. 36; and HIGL, 2003) argues that the COOP tends to produce "too much" (i.e., more than the efficient quantity) if it cannot restrict individual supplies and if members are paid on a per-unit basis. ALBAEK AND SCHULTZ (1998) argue that the COOP in their model can be regarded as a Cournot oligopoly in itself because each member internalizes only the effect of its own supply on a (decreasing) price in the final market. Thus, "[…] the organization of the cooperative acts like a commitment device for pushing the reaction function of the cooperative outwards, and in the resulting equilibrium the profit maximizing firm ends up producing less" (ALBAEK AND SCHULTZ, 1998, p. 398).

HIGL (2003) aims to unify the models of TENNBAKK (1995) and ALBAEK AND SCHULTZ (1998) by analyzing the impact of member autonomy on the market outcome, assuming

Cournot-Nash behavior. He introduces a parameter that can be interpreted as the conjectural variation of members and thus as a COOP's cohesion. Entirely coordinated member behavior (i.e., perfect collusion or vertical integration) is equivalent to TENNBAKK's (1995) model. If, however, COOP members consider only their own quantity decisions and take the other members' quantities as given, this is equal to the standard Cournot assumption and equivalent to the model developed by ALBAEK AND SCHULTZ (1998). HIGL (2003) shows that a higher degree of COOP decentralization (i.e., a less collusive COOP) yields a more competitive market outcome (in terms of lower prices in the selling market of processors). This is a competitive yardstick effect because the COOP forces the IOF to behave more competitively.

KARANTININIS AND ZAGO (2001) modify the model of ALBAEK AND SCHULTZ (1998) in three respects: first, they assume perfect competition in the selling market of processors; second, they assume that the IOF maximizes only its own profits (i.e., the IOF is not a vertically integrated firm); and third, they analyze the choice of farmers to either join the COOP or the IOF. Thus, the number of COOP members in their model is endogenous, and the COOP is characterized by open membership. Since each member takes the supply of other COOP members as given (in a Cournot fashion), the COOP cannot control its members' supplies. Farmers decide whether to join the COOP or the IOF based on the profit they would receive; in equilibrium, all farmers are indifferent regarding which processor they will choose.

By assuming homogeneous farmers, KARANTININIS AND ZAGO (2001) note that the open-membership policy obviously generates fewer COOP members than a restricted-membership policy does, as examined by ALBAEK AND SCHULTZ (1998). Thus, the IOF is crowed out to a lesser extent (see also the discussion in SORENSEN, 2005).[112] In addition, KARANTININIS AND ZAGO (2001) show that the optimal number of COOP members is an inverted U-shaped function of farmers' costs of raw product production. Therefore, membership is lowest if the efficiency of all (homogeneous) farmers is in an intermediate range. Compared to the pure IOF duopsony, individual profits and supplies of farmers are higher in the mixed market. Farmers receive higher profits in the mixed market (relative to the pure IOF market) because of the implicit assumptions of members who integrate downstream and act as the residual claimants of profits. Thus, in the mixed market, the total supply is higher as well, and the total production of the COOP is higher relative to the IOF. However, individual supplies of COOP members are lower than that of IOF suppliers. By assuming heterogeneous farmers (in terms

[112] In discussing KARANTININIS AND ZAGO (2001), COTTERILL (2001 p. 1281) assigns their IOF a "[…] major leadership role, because the IOF knows the member supply function. It prices off of that supply function in a fashion that maximizes its own profit." COTTERILL (2001, p. 1280) notes that the open-membership COOP in KARANTININIS AND ZAGO (2001) is a "completely passive firm".

of efficiency), the preliminary results of the analytical mixed-market model of KARANTININIS AND ZAGO (2001) show that more of the inefficient farmers join the open-membership COOP.

Whether a mixed market is a stable equilibrium is discussed and addressed by TENNBAKK (2000 and 2004) and SORENSEN (2005). In her mixed-market model, TENNBAKK (2000, pp. 191) assumes an open-membership COOP and a three-stage game. In the first stage, the IOF maximizes profits by choosing a raw product price. In the second stage, the farmers choose their processor based on their profits. In the third stage, the COOP maximizes the aggregated returns of members (i.e., total member welfare) by choosing its quantity. Thus, the COOP decides on quantity by taking the number of COOP members as given; open membership is established since farmers maximize their individual profits by choosing their processor; and the IOF chooses a raw product price by anticipating the COOP's strategy and the farmers' choice of processors. As in KARANTININIS AND ZAGO (2001), the mixed-market equilibrium is determined by indifferent farmers. Given this game structure, TENNBAKK (2000) shows that any partition of farmers into COOP members and IOF suppliers can constitute a mixed-market equilibrium. Total welfare in the mixed market is higher than in the case where all farmers in the market join the COOP (i.e., in the case of a COOP monopoly). In another contribution to the theoretical literature that makes reference to the Norwegian egg market, TENNBAKK (2004) likewise shows that a mixed market can be sustained as an equilibrium and, thus, rejects the intuition of RHODES (1983) that mixed markets are generally off-equilibrium solutions. Due to the open-membership policy of the COOP, the IOF must ensure that individual profits of its suppliers are at least as high as the profits of a COOP member. TENNBAKK's (2004) model shows that competition between the total member welfare-maximizing COOP and the IOF mitigates the market power of IOFs over farmers. Likewise, competition in this mixed market mitigates the market power of the COOP over consumers because the IOF weakens the COOP's ability to restrict market supply.[113]

By assuming an open-membership COOP, SORENSEN (2005) sets up a more general mixed-market model whose aim is to reconcile conflicting results that have been obtained in the theoretical literature regarding the crowding out of IOFs (versus a stable mixed-market equilibrium). The model is set up as a two-stage game: in the first stage, farmers choose their processor; in the second stage, processors determine their optimal quantity. SORENSEN (2005) shows that a mixed-market equilibrium becomes more likely the more the payoffs of COOP

[113] With regard to the Norwegian egg market, TENNBAKK (2004) assumes that the IOF knows the COOP's objective and terms offered to its members. In addition, she analyzes two alternative strategies that IOFs may follow: either the IOF mimics the COOP by paying the same price for a fixed quantity, or the IOF pays a fixed price to its suppliers and farmers choose the supply by themselves.

members decrease with an additional supplier. Therefore, she concludes that result of a (stable) mixed market becomes more likely if the open-membership COOP prices according to NARP (relative to a total member welfare-maximizing COOP, which more likely crowds out an IOF), if there are diseconomies of scale in food processing, or if the output market is characterized by imperfect competition. The IOF in the model serves as a "yardstick of production" (p. 1) for the open-membership COOP: relative to the situation of a single COOP serving all farmers in the market, farmers' profits may be even higher due to the existence of an IOF as an outside option for farmers. SORENSEN (2005) suggests that product differentiation or heterogeneous farmers may contribute to a stable mixed-market equilibrium. Based on a literature review, HENDRIKSE (1998) suggests some theoretical explanations for the existence of stable mixed markets, like supply assurance, rationing, price discrimination, asymmetric information and incentives, stochastic cost differences and limited managerial attention (see references therein).[114]

4.3.2 SPATIAL MIXED-MARKET MODELS

As discussed in CHAPTERS 2 and 3, agricultural raw product markets are predominantly spatial markets and the transportation costs to the processing facility are high relative to the product's value. In the spatial competition literature, there are only a few analytical (and empirical) studies that address processing COOPs in mixed markets. This seems to be in contrast to the spatial mixed-market literature that examines competition between public and private firms.[115] In addition, most of the literature assumes FOB pricing (e.g., SEXTON, 1990; WANN AND SEXTON, 1992; and ROGERS AND SEXTON, 1994). One exception is FOUSEKIS (2010), who considers both FOB and UD pricing.

The study by SEXTON (1990) is a seminal example of a mixed-market model in at least two respects: first, it is an early contribution to the analytical mixed-market literature with a formal analysis of the competitive yardstick effect of marketing COOPs, and second, it is a spatial competition model assuming FOB pricing. Despite being one of the earliest formal mixed-market models that considers marketing COOPs, further contributions in a spatial context have been rather limited since then. SEXTON (1990) analyzes the relative farm-processor price spread of an IOF under different types of conjecture (Hotelling-Smithies,

[114] Although the difference between organizations is usually modeled by assuming different objective functions, HENDRIKSE (1998) assumes differences in the decision-making process in his model. Thus, the coexistence of COOPs and IOFs in the same market is explained by the organizational structure.

[115] One example of a spatial mixed-market model with public firms and IOFs is MATSUSHIMA AND MATSUMURA (2003) assuming UD pricing in a location-quantity model. Other examples are MATSUMURA AND MATSUSHIMA (2003 and 2004) and OGAWA AND SANJO (2007).

Cournot, and Löschian competition, and competition with a COOP) and under both different COOP objective functions (NARP and NMRP pricing) and different COOP membership policies (open and closed membership). The market for the processed good is characterized by perfect competition.

SEXTON (1990) presents the following results regarding the relative price spread of an IOF. If the IOF's competitor is a Löschian IOF, its relative price spread is highest. If the IOF's competitor is a NARP-pricing open-membership COOP that operates in the increasing portion of the NARP function, the IOF's relative price spread is lowest, i.e., the COOP creates more competitive behavior than does an IOF competitor. However, if the open-membership COOP is operating in the decreasing portion of the NARP function, the IOF's relative price spread is lowest if the IOF's competitor is a Hotelling-Smithies IOF.[116] In addition, as the freight rate approaches zero (i.e., space becomes unimportant), the open-membership COOP induces the IOFs to a competitive solution. SEXTON (1990) concludes that an open-membership NMRP-pricing COOP generates less competitive behavior from IOFs than a NARP-pricing COOP does. If the COOP has a restricted-membership policy, however, the rational conjecture of an IOF is Löschian competition, i.e., the IOF acts as a monopsonist within its market area. Even in the case of decreasing NARP, an open-membership COOP has a stronger pro-competitive effect than a restricted-membership COOP. SEXTON (1990) concludes that favorable policies towards COOPs are justified as long as COOPs employ an open-membership policy.

One study that extends the work by SEXTON (1990) is ROGERS AND SEXTON (1994). The (reduced-form) expression for the relative (farm-retail) price spread is a function of the number of firms in the market (i.e., market concentration), the type of conjecture (Hotelling-Smithies or Löschian competition) and the freight rate.[117] Again, ROGERS AND SEXTON (1994) assume FOB pricing and perfect competition in the food processors' selling market. Assuming IOFs under either conjecture and one COOP in the market, ROGERS AND SEXTON (1994, p. 1149) conclude, based on their simulation results: "The cooperative's impact on performance is especially significant when it replaces a Löschian competitor and when

[116] SEXTON (1990, p. 716) concludes for the open-membership NARP-pricing COOP: "[…] not only does the co-op fail to match a for-profit rival's price change, the co-op's price movement is opposite its rival's when NARP is decreasing." He notes that Löschian competition implies (full) price matching, whereas Cournot implies partial price matching. "[…] the greater the extent to which a raw product price increase is expected to be matched, the less profitable such competitive activity becomes, leading to high margins" (SEXTON, 1990, p. 716).

[117] The relative farm-retail spread can be interpreted as the performance in the raw product market: under competitive behavior it is zero, whereas under pure monopsony it is one (ROGERS AND SEXTON, 1994). In a pure IOF market, given the relatively aggressive form of Hotelling-Smithies competition, the relative price spread increases (decreases) as the freight rate (number of competitors) increases. However, under Löschian competition, the relative price spread decreases (increases) as the freight rate (number of competitors) increases; see ROGERS AND SEXTON (1994).

transportation costs are relatively low. High transportation costs vitiate the competitive impact of even a cooperative rival."

Focusing on the involvement of COOPs in cost-reducing process innovation activities in a mixed market, DRIVAS AND GIANNAKAS (2007) assume an open-membership marketing (i.e., processing) COOP that maximizes total member welfare. The modeling framework considers horizontal and vertical product differentiation. In their model, processors differ not only in their objective functions but also in the quality of processed products sold. Although it is not exclusively intended to be a spatial model, the work of DRIVAS AND GIANNAKAS (2007) can be considered a spatial mixed-market model under the assumption of FOB pricing and the Hotelling-Smithies conjecture.[118] Their results show that the presence of the COOP in the market increases raw product prices and welfare for all farmers in the market.

To my knowledge, the only spatial mixed-market model assuming processing COOPs and UD pricing is the study by FOUSEKIS (2010), which partly refers to HUCK ET AL. (2006) and TRIBL (2009a). The focus of his theoretical work is an analysis of the choice regarding the spatial pricing policy in a mixed market. Like ZHANG AND SEXTON (2001) in their work on a pure IOF market, he assumes a spatial mixed market in which an open-membership NARP-pricing COOP and an IOF compete in a two-stage game. In the first stage of the game, each processor chooses between UD and FOB pricing; in the second stage, the processors set their prices. Assuming the Hotelling-Smithies conjecture, FOUSEKIS (2010) shows that mutual UD pricing is a Nash equilibrium if the relative importance of space (in terms of the ratio of the freight rate to the net selling price of processors) is sufficiently low. For a pure IOF market, ZHANG AND SEXTON (2001) find that the mutual FOB-pricing strategy for a relatively low relative importance of space is in fact a quasi-collusive outcome, or „mutual forbearance" (FOUSEKIS, 2010, p. 18). In the mixed market analyzed by FOUSEKIS (2010), however, the COOP is a quite aggressive competitor at all levels of the relative importance of space because its objective is breaking even (i.e., paying the highest possible price to members). Thus, there is no opportunity for "mutual forbearance" (p. 19); price competition "escalates" (p. 19) due to the COOP, eliminating the quasi-collusive Nash equilibria. For a high relative importance of space, mutual FOB pricing (or UD pricing of the IOF) is a Nash equilibrium. For intermediate market structures, FOB pricing for the COOP and UD pricing for the IOF

[118] The mirror image, i.e., an input-supply COOP for farmers, is analyzed by GIANNAKAS AND FULTON (2005). Most recently, DRIVAS AND GIANNAKAS (2010) considered innovation activities of a consumer COOP that supplies goods in the final market. Using a similar framework, FULTON AND GIANNAKAS (2001) analyze membership commitment by assuming a consumer COOP. All of these models can be regarded as spatial FOB-pricing models in which transportation costs are borne either by consumers (in the case of a consumer COOP or farmers as consumers in the case of an input-supply COOP), or by farmers (in the case of a marketing COOP).

constitutes a Nash equilibrium. In addition, FOUSEKIS (2010) shows that the competitive yardstick effect is, in general, higher (lower) for a UD-pricing COOP than for a FOB-pricing COOP if the IOF's strategy is FOB pricing (UD pricing).

One example of the rare empirical evidence of spatial pricing in a mixed market is the study by GALLAGHER ET AL. (2005; see also the discussion in FOUSEKIS, 2010). Using cross-sectional data for 2003, they estimate price-distance functions for corn pricing close to ethanol plants in Iowa, U.S. They find that farm prices decline with increasing distance from the location of processors at the same rate that transportation costs increase; this observation is commonly regarded as FOB (or mill) pricing. However, COOPs in the market had no statistically significant effect on prices nearby. This result of an insignificant relation between prices near COOPs and distance from the processor is in line with UD pricing (see also FOUSEKIS, 2010).

WANN AND SEXTON (1992) empirically test the hypothesis developed by SEXTON (1990) regarding the competitive yardstick effect of (closed-membership) COOPs with reference to the Californian pear industry (1950-1986). In their study, they address imperfect competition in both the input market and the output market in the NEIO tradition. Their results show that oligopoly power was quite moderate. In addition, they reject monopsony power or Löschian competition in the raw product market. However, competition in the raw product market did not increase due to COOPs' growth; rather, the result that competition may have decreased is in accordance with the theoretical results of SEXTON (1990) regarding closed-membership COOPs.

4.3.3 CONCLUDING REMARKS

In general, most analytical mixed-market models indicate that these markets are more competitive due to the presence of a COOP, and thus, positive welfare effects can be expected. However, there are certain specific examples in the literature (see, e.g., SEXTON, 1990; BERGMAN, 1997; and FOUSEKIS, 2010), where a competitive yardstick effect may not exist. The consideration of different aspects (e.g., price discrimination, product differentiation, spatial competition) in analytical models helps examine the existence of the competitive yardstick effect. The present thesis aims to contribute to the mixed-market literature by analyzing spatial competition between COOPs and IOFs under UD pricing (see CHAPTER 7) because this specific aspect has received limited attention so far. Before considering such a mixed market, spatial competition in a pure IOF market and in a pure COOP market, respectively, will be analyzed (see CHAPTERS 5 and 6).

5 SPATIAL COMPETITION OF INVESTOR-OWNED FIRMS (IOFS)

CHAPTER 2 highlighted the relevance of the spatial dimension in markets of food processors, for example, in the dairy sector. Accounting for the spatial dimension requires considering transportation costs. This consideration, in turn, implies that the market is characterized by imperfect competition (see CHAPTER 3). The aim of CHAPTERS 5 to 7 is to theoretically analyze spatial competition of oligopsonistic food processors, which buy an input (e.g., raw milk) from farmers, process it and sell it on the processed goods market. More specifically, different legal forms of processors will be considered under the assumptions UD pricing and the price-matching conjecture. In the present chapter, processors are assumed to be IOFs. On the contrary, processors are assumed to be processing COOPs in CHAPTER 6; a mixed market with competition between a COOP and an IOF will be analyzed in CHAPTER 7.

Most research in the spatial economics literature has focused on firms as sellers rather than as buyers (see CHAPTER 3). The seminal work of ALVAREZ, FIDALGO, SEXTON AND ZHANG (2000), referred to in the following as *AFSZ*, is an exception. They analyze spatial competition of duopsonistic milk processors (IOFs) as buyers of raw milk under the assumption of UD pricing and the price-matching conjecture. In their model, *AFSZ* consider overlap of market areas of competing processors. An important result of their study is that processors "[…] may set prices above the monopsony level to minimise direct competition among themselves" (p. 347). The aim of this chapter is to review and discuss the analysis of *AFSZ* and to modify their model to assume a different market form. In particular, differences in the resulting UD price solutions and comparative statics of the model due to an alternative market form will be examined. In addition, the case of non-overlapping market areas under Löschian competition will be analyzed.

This chapter is organized as follows. CHAPTER 5.1 reviews the model of *AFSZ* and discusses the implications of the market form used in their model. They assume an unbounded line market in which two IOFs compete with each other. This market form allows two different situations of market overlap of competing processors under the price-matching conjecture: overlap between processors and overlap beyond the location of the competitor. CHAPTER 5.2 proposes a circular market as an alternative market form and analyzes these two situations of market overlap under this market form. CHAPTER 5.3 considers the case of Löschian competition with distinct, non-overlapping market areas. A summary of this chapter is provided in CHAPTER 5.4.

5.1 A REVIEW OF ALVAREZ ET AL. (2000)

AFSZ analyze spatial competition of UD-pricing IOFs given the price-matching conjecture.[119] In addition, they provide empirical evidence of spatial competition in the purchase of raw milk in the Asturias region of Spain. The assumption of UD pricing is justified by the following observations (see also CHAPTER 2.6 for the German and Austrian milk market). First, in the raw milk market, each processor pays an identical farm-gate price to each farmer within its market area. Second, processors are responsible for the cost of transporting the raw product to the processing facility. The assumption of price matching is rationalized by the observation of overlapping market areas of milk processors (see also CHAPTERS 2.6 and 3.3). Regarding the German raw milk market, the assumption of price matching can additionally be rationalized by the observation that milk processors set their prices based on a regional average milk price of other processors (see CHAPTER 2.4; see also GRAUBNER ET AL., 2011a).

Additional assumptions and notations in the *AFSZ* model are as follows: *AFSZ* consider a duopsony situation where two IOFs are located exogenously distance d away on an unbounded line. On this line, farmers are uniformly distributed with density $D = 1$ and produce a homogenous raw product according to the simple supply function with a unitary supply elasticity $q_I = u_I$, where u_I is the UD price paid by the IOF (indicated by index *I*) for the raw product.[120] Neither IOFs nor farmers have capacity constraints. Under the assumption of UD pricing, processing firms (i.e., IOFs) are responsible for transportation costs t per unit and distance r so that each farmer receives the same price. In the selling market, processors receive $\rho = P - c$, which is the price of the processed product net of constant per-unit processing costs. Thus, the selling market is characterized by perfect competition, whereas processors have duopsony power over farmers.[121]

As processors are assumed to be IOFs, their objective is to maximize their profit from buying, transporting, and processing the raw product and selling it to the final market. FIGURE 5-1 gives a graphical representation of the profits of an IOF operating in a spatial monopsonistic situation (see also HUCK ET AL., 2006). Processor *A* is located on an

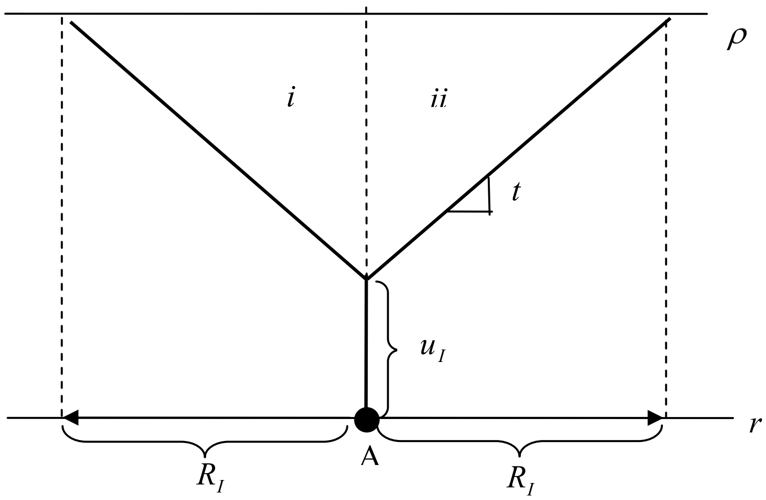
[119] As already mentioned in CHAPTER 3.3.1, *AFSZ* name their conjecture “Löschian competition”, but their model makes clear that they consider the price-matching conjecture; see also GRAUBNER ET AL. (2011a).

[120] Milk quotas for farmers, as in the Common Agricultural Policy (CAP) of the EU, can easily be incorporated by assuming a log-linear function like $q=\alpha u^{\beta}$ (HUCK AND SALHOFER, 2005; see also GRAUBNER ET AL., 2011a). Therefore, the underlying assumption of a supply function like $q_I=u_I$ is that the milk quota is not binding for any farmer; see also footnote 6 in *AFSZ*. To keep the models as simple as possible, milk quotas are not considered in all models in CHAPTERS 5 to 7.

[121] The assumption of perfect competition in the processed goods market can be justified by arguing that once the product is processed, it can be transported over longer distances. Then, firms face competition from other processors in the processed goods market nationally or internationally (KARANTININIS AND ZAGO, 2001; see also CHAPTER 3.1).

unbounded line *r*. The upper horizontal line gives the net selling price ρ. The distance between the bottom line and the *V*-lines gives the costs of buying and transporting one unit of the raw product from each market point along *r*. The profit of the monopsonistic IOF from buying one unit from each farmer along r up to its boundary of market area R_I in both directions is given by area *i* + *ii*. As it is assumed that the IOF is not a vertically integrated firm, farmers in this model are only input suppliers to the IOF without any claim to a share of the profits.[122]

FIGURE 5-1. Monopsony model of the IOF



The maximization problem of a monopsonistic IOF (indicated by index *M*) paying UD price u_I and serving all farmers up to a distance R_I in each direction is given by[123]

$$\text{(5-1)}\quad \Pi_I^M = \max_{R_I, u_I}\left[2\left(\int_0^{R_I}(\rho - u_I - tr)\mathrm{d}r\right)u_I\right] = \max_{R_I, u_I}\left[2\left(\rho - u_I - \frac{tR_I}{2}\right)u_I R_I\right].$$

The IOF must determine an optimal market area to serve and an optimal UD price to set. Because $(tR_I)/2$ represents average transportation costs, $\rho - u_I - (tR_I)/2$ represents the average profit margin. Multiplying this by $2R_I$ gives the profit from collecting one unit from each farmer in each direction; multiplying the result by u_I gives the total profits of the IOF. Given ρ, t, and, for the moment, u_I, the processor will collect the raw product up to the point where marginal costs $tr + u_I$ equal marginal revenue ρ (net of processing costs), i.e., up to the point in space where the marginal profit from going any further becomes negative.

[122] For example, as opposed to many other models, ALBAEK AND SCHULTZ (1998) assume that the IOF is a vertically integrated firm (see also CHAPTER 4.3.1).
[123] The case of the monopsonistic UD pricing IOF is also analyzed by LÖFGREN (1986); see CHAPTER 3.2.1.

Therefore, maximizing the profit function with respect to R_I and taking u_I for the moment as given yields the desired market area of the IOF:

$$(5\text{-}2)\quad R_I = \frac{\rho - u_I}{t}$$

Thus, the IOF serves distances up to $r = R_I$ where the (local) profit per unit ($\rho - u_I - tr$) is equal to zero (i.e., the marginal profit is zero at $r = R_I$); see also *AFSZ* and GRAUBNER ET AL., 2011a. Equation (5-2) shows that the optimal (monopsonistic) market area is decreasing in per-unit transportation costs t and in the UD price paid to farmers, u_I. Taking the market area R_I for the moment as given, the IOF maximizes profits with respect to the UD price. The resulting UD price depending on R_I is

$$(5\text{-}3)\quad u_I = \frac{\rho}{2} - \frac{tR_I}{4}.$$

Substituting equation (5-2) into equation (5-3), the optimal UD price of the monopsonistic IOF is

$$(5\text{-}4)\quad u_I^M = \frac{\rho}{3}.$$

The optimal monopsonistic UD price is independent of per-unit transportation costs t.[124] Substituting equation (5-4) into (5-2) gives the optimal market area of a monopsonistic IOF in each direction:

$$(5\text{-}5)\quad R_I^M = \frac{2\rho}{3t}$$

For the IOF to be in a monopsonistic position, it must hold that $R_I^M \leq d/2$, i.e., the distance to the nearest competitor d is at least twice as large as the optimal market area. Alternatively, *AFSZ* describe this situation by means of the relative importance of space s/ρ: the absolute importance of space s is defined by $s = td$, and s/ρ measures the importance of space relative to the net value of the product, ρ. Thus, according to equation (5-5), the IOF is in a monopsonistic position for $s/\rho \geq 4/3$. Consequently, the more important space becomes (i.e., the higher per-unit transportation costs t are or the longer the distance between processors d is) the more likely it becomes that the processor is in a monopsonistic position.

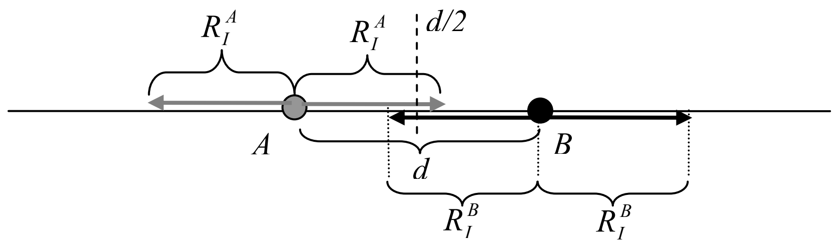
[124] This does not hold as soon as the assumption of a uniform distribution of farmers is relaxed; see CHAPTER 3.2.1.

Conversely, the less important space becomes, the more likely it is that the IOF will be in the situation of spatial competition with the IOF distance *d* away. Because this chapter focuses on spatial competition between processors, the case of $s/\rho < 4/3$ is considered in the following.

Under the price-matching conjecture and given UD pricing, market areas of competing processors can overlap (with $R_I > d/2$)[125] if processors do not collude regarding market areas (as is the case under Löschian competition; see CHAPTER 3.3.1). The desired market area varies inversely with the UD price for the raw product u_I (see equation (5-2) and *AFSZ*). Price matching implies cooperative behavior among food processors because they determine an optimal UD price under the condition that all processors' UD prices are equal (GRAUBNER ET AL., 2011a). Therefore, UD prices between two processors (e.g., processor *A* and processor *B*) engaged in direct competition must be equal in equilibrium: $u_I^A = u_I^B = u_I$. Likewise, both processors have the same desired market area: $R_I^A = R_I^B = R_I$.

AFSZ argue that the degree to which market areas overlap depends on the relative importance of space s/ρ. For their duopsony model, they identify two different situations of direct competition (see FIGURES 5-2 and 5-3). In the first situation, market areas can overlap in the area between the two processors *A* and *B*, i.e., $d/2 < R_I < d$ (see FIGURE 5-2). In the following, this situation will be referred to as "competition en route" (see also HUCK ET AL., 2006).

FIGURE 5-2. Competition en route (*AFSZ* model)



In the situation of competition en route (index *er*), the maximization problem of either IOF in the *AFSZ* model (index *AFSZ*) is

$$\text{(5-6)}\quad \Pi_I^{er-AFSZ} = \max_{u_I}\left[\left(\int_{0_I}^{R_I}(\rho - u_I - tr)\mathrm{d}r + \int_0^{d-R_I}(\rho - u_I - tr)\mathrm{d}r + \frac{1}{2}\int_{d-R_I}^{R_I}(\rho - u_I - tr)\mathrm{d}r\right)u_I\right]$$

for $R_I = \dfrac{\rho - u_I}{t}$.

[125] Market overlap cannot occur under FOB pricing because the common boundary of two competing IOFs is determined by the location *r* of the farmer who is indifferent about where to deliver (see CHAPTER 3.2.3).

The first term gives profits in the area to the left of processor *A*. On this market side, processor *A* exclusively serves distance R_I without direct competition with another processor. The second term gives profits on the exclusive area to the right of point *A*. The third term gives profits in the contested area with market overlap. In this area, it is assumed that farmers are shared equally between processors.[126] The solutions for the optimal UD price and, after substitution, for the optimal market area are

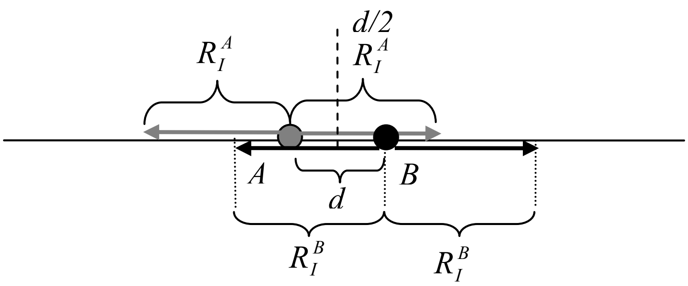
$$(5\text{-}7)\quad u_I^{er-AFSZ} = \frac{\rho}{2} - \frac{td}{8}$$

$$(5\text{-}8)\quad R_I^{er-AFSZ} = \frac{4\rho + td}{8t}.$$

Substituting equation (5-8) into the condition for competition en route, $d/2 < R_I < d$, gives the condition depending on the relative importance of space: $4/7 < s/\rho < 4/3$.

The second situation identified by *AFSZ* implies competition beyond the location of the nearest competitor, i.e., $R_I > d$ (see FIGURE 5-3). In the following, this situation will be referred to as "competition in the backyard" (index *by*); see also HUCK ET AL. (2006).

FIGURE 5-3. Competition in the backyard (*AFSZ* model)



The maximization problem in the situation of competition in the backyard is given by

$$(5\text{-}9)\quad \Pi_I^{by-AFSZ} = \max_{u_I}\left[\left(\begin{array}{l}\int_{R_I-d}^{R_I}(\rho - u_I - tr)\mathrm{d}r + \frac{1}{2}\int_0^{R_I-d}(\rho - u_I - tr)\mathrm{d}r \\ + \frac{1}{2}\int_0^{R_I}(\rho - u_I - tr)\mathrm{d}r\end{array}\right)u_I\right]$$

[126] In their oligopoly model under UD pricing and the price-matching conjecture, GRONBERG AND MEYER (1981, p. 761) argue, "[…] customers in the disputed market area are assumed to randomly select the firm with which they do business. Since price to the customer is the same for each firm, this is an acceptable assumption." Thus, they term profits derived from the area of market overlap "expected profits" (p. 761). Strictly speaking, in the duopsony framework with farmers supplying the raw product, it is the processor who decides which farmers to accept, not the farmers themselves. In their duopsony model, *AFSZ* (p. 353) assume that "[…] customers are shared equally in areas of market overlap."

for $R_I = \frac{\rho - u_I}{t}$

with the optimal solutions

(5-10) $u_I^{by-AFSZ} = \frac{4\rho - \sqrt{4\rho^2 - 6t^2 d^2}}{6}$

(5-11) $R_I^{by-AFSZ} = \frac{2\rho + \sqrt{4\rho^2 - 6t^2 d^2}}{6t}$.

In such a situation, space is even less important than it is in the situation of competition en route: $0 < s/\rho < 4/7$. Comparative statics of the *AFSZ* model are summarized in TABLE 5-1 (see also APPENDIX A1.1):

TABLE 5-1. Comparative statics: *AFSZ* model

	Monopsony: $s/\rho \geq 4/3$	**Competition en route:** $4/7 < s/\rho < 4/3$	**Competition in the backyard:** $0 < s/\rho < 4/7$
UD price			
$\frac{\partial u_I^{AFSZ}}{\partial t}$	0	-	+
$\frac{\partial u_I^{AFSZ}}{\partial d}$	0	-	+
$\frac{\partial u_I^{AFSZ}}{\partial \rho}$	+	+	+
Market area (not provided by *AFSZ*)			
$\frac{\partial R_I^{AFSZ}}{\partial t}$	-	-	-
$\frac{\partial R_I^{AFSZ}}{\partial d}$	0	+	-
$\frac{\partial R_I^{AFSZ}}{\partial \rho}$	+	+	+

Note: Table entries indicate the direction of a change of the endogenous variables (R_I and u_I, respectively) due to a change in the exogenous variables (t, d, and ρ, respectively).

Price transmissions in terms of the pass-through of changes in the net selling price ρ to the UD price are as follows (see also APPENDIX A1.1):

(5-12) $\frac{\partial u_I^M}{\partial \rho} = \frac{1}{3} > 0$ for $\frac{s}{\rho} \geq \frac{4}{3}$

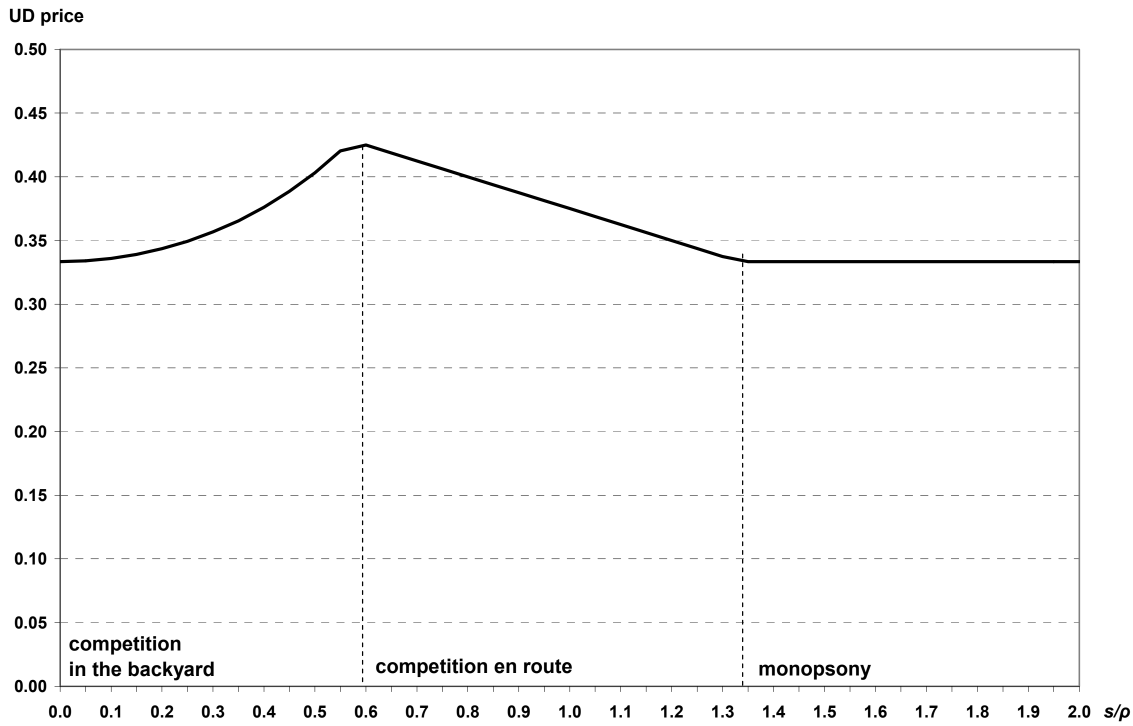
(5-13) $\frac{\partial u_I^{er-AFSZ}}{\partial \rho} = \frac{1}{2} > 0$ for $\frac{4}{7} < \frac{s}{\rho} < \frac{4}{3}$

(5-14) $$\frac{\partial u_I^{by-AFSZ}}{\partial \rho} = \frac{2}{3}\left[1 - \frac{\rho}{\sqrt{4\rho^2 - 6t^2d^2}}\right] > 0 \text{ for } 0 < \frac{s}{\rho} < \frac{4}{7}$$

In the monopsony situation and in the situation of competition en route, price transmission is constant. Price transmission is highest in the case of competition en route and lowest in the case of competition in the backyard. In the latter case, it ranges from 1/5 as $s \to 4/7$ to 1/3 (i.e., the monopsony level) as $s \to 0$.

From their results, *AFSZ* derive an inverted U-shaped function of the optimal UD price u_I depending on *s* (see FIGURE 5-4). Comparative statics concerning responses of the market area are illustrated in FIGURE 5-5a (with respect to changes in *t*) and FIGURE 5-5b (with respect to changes in *d*).[127]

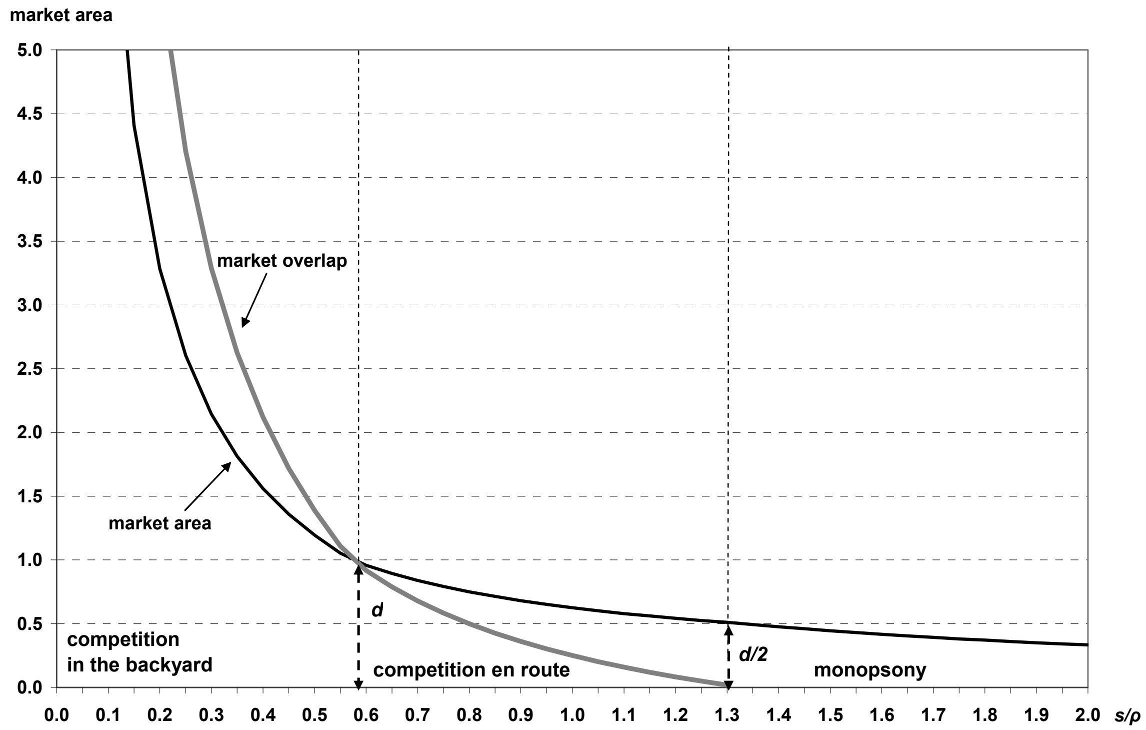
FIGURE 5-4. UD price (*AFSZ* model)



Note: In this figure, *s/ρ* varies due to increases in *t*. Both the net selling price *ρ* and the distance *d* between processors are normalized to *1*.

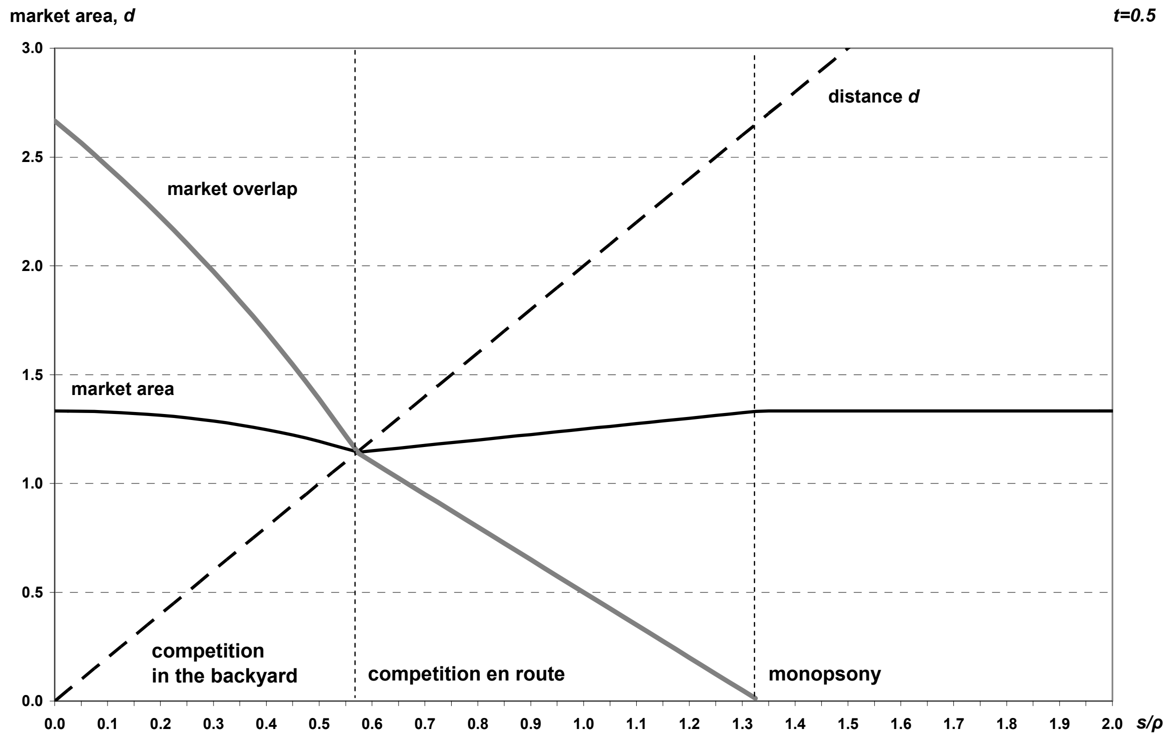
[127] In FIGURE 5-4, the optimal UD price is illustrated depending on increases in *t*. Illustrating the optimal UD price depending on increases in *d* gives the same figure. Comparative statics regarding the market area and FIGURES 5-5a and 5-5b are not provided by *AFSZ*.

FIGURE 5-5a. Market area (*AFSZ* model) depending on *t*



Note: In this figure, *s/ρ* is increasing due to increases in *t*. Both the net selling price *ρ* and the distance *d* between processors are normalized to *1*.

FIGURE 5-5b. Market area (*AFSZ* model) depending on *d*



Note: In this figure, *s/ρ* is increasing due to increases in *d*. Per-unit transportation costs are fixed at $t = 0.5$; the net selling price *ρ* is normalized to 1.

In the situation of competition en route ($4/7 < s/\rho < 4/3$), the optimal UD price is decreasing in s (due to either increasing shipping costs t - see FIGURE 5-4 - or an increasing distance d). *AFSZ* argue that this result is rather intuitive: FIGURE 5-5a shows that, in this situation, the market area is decreasing as *t* increases. As this effect reduces the area of market overlap (see the grey line, which is $2R_I - d$; i.e., the area of active competition decreases), the UD price is decreasing towards the monopsony level. In effect, lower UD prices have a positive impact on R_I (see equation (5-2)); to the contrary, higher shipping costs t have a negative impact on R_I. The total effect on R_I is negative as the effect of an increasing t outweighs the effect of a decreasing u_I. Contrary to comparative statics with respect to *t*, FIGURE 5-5b shows that the market area is increasing as distance *d* between competitors increases. As *d* increases, an increasing R_I still reduces the area of overlap (i.e., R_I increases at a lower rate than d). Again, this lower competition (in terms of less market overlap) is indicated by a decreasing UD price.

Interestingly, and contrary to competition en route, competition in the backyard in the *AFSZ* model ($0 < s/\rho < 4/7$) implies a UD price that is increasing in *s* beyond the monopsony level at *s=0* (see FIGURE 5-4). In addition, FIGURES 5-5a and 5-5b show that the market area is decreasing in both *t* and *d*. This decreasing market area reduces the area of market overlap. According to equation (5-2), a higher UD price has a negative impact on the market area. This effect is intensified as the transportation rate *t* increases (see FIGURE 5-5a). Referring to changes in distance *d* (FIGURES 5-5b), $s/\rho = 0$ in the *AFSZ* model likewise implies that $d = 0$, i.e., both processors are located at the same point in space and, thus, price like monopsonists (see also FIGURE 5-4). Therefore, the market area at $d = 0$ is equal to the monopsony situation ($s/\rho \geq 4/3$). Given *t* and ρ, the model of *AFSZ* implies that the UD price is highest at distance $d = (4\rho)/(7t)$.

AFSZ argue that the unexpected result of an increasing UD price above the monopsony level in the situation of competition in the backyard is due to the assumption of price matching ("Löschian (collusive) behaviour" in *AFSZ*, p. 355): "Essentially, the firms pay more than they otherwise would so as to credibly reduce the market area relative to the monopsony solution, thereby reducing the range of space in which they compete actively for suppliers" (p. 355). *AFSZ* note that this effect cannot arise in a model where processors cannot extend their market areas beyond the locations of competitors.[128] They explain that, in their model, a decreasing market area in the situation of competition in the backyard implies a decreasing overlap beyond the location of the competitor (see the situation to the left of

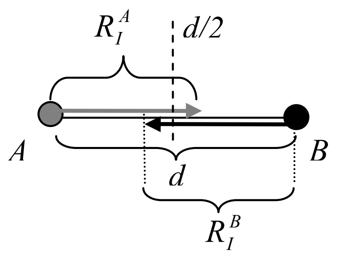
[128] *AFSZ* mention the line market models of SCHULER AND HOBBS (1982) and GREENHUT ET AL. (1987, chapter 8) and the model of KATS AND THISSE (1993) with two firms located on the circumference of a circular market.

processor *A* in FIGURE 5-3) and that less overlap implies a larger exclusive market area for the processor. As the market area of the competitor, R_I^B, decreases towards the location of processor *A*, processor *A* gains new input suppliers. "This newly acquired production is valuable to both A and B under UD pricing because it is located relatively close to each firm's plant and, thus, generates relatively high per-unit profits, [$\rho - u_I - tr$]" (p. 355).

5.2 MODIFICATION OF THE MARKET FORM

In the *AFSZ* model, processors face competition from one direction only, and the two IOFs are in a (local) monopsonistic position for significant parts of their (total) market area. Consequently, one might argue (and this will be shown later) that the resulting market power towards farmers will be higher relative to the outcome of a model where processors either face competition from both directions (an oligopsony model) or where processors are located at the endpoints of a bounded line (a more general duopsony model). This specific market form of *AFSZ* is, thus, a special case of a duopsony model, which is rationalized by *AFSZ*'s empirical analysis of spatial competition in the mountainous region of Asturias in Northern Spain. However, this specific model cannot be generalized to the oligopsony situation with more than two processors.[129] One step towards such a generalization is to assume that both IOFs are located at the endpoints of a line market; see FIGURE 5-6. This is the traditional "linear city" market form of HOTELLING (1929, taken from TIROLE, 1988, pp. 97), which is assumed, for example, in SCHULER AND HOBBS (1982) and ZHANG AND SEXTON (2001).

FIGURE 5-6. Competition en route (processors located at the endpoints)



Again, processors face competition from one direction only so that this market form implies the analysis of a duopsony situation as well. However, the model does not include an exclusive (i.e., monopsonistic) market area to the left of processor *A* or the right of processor

[129] More specifically, entry or exit of firms may not be possible in the *AFSZ* model. If firms enter the market, competition necessarily occurs in both directions of some processors and requires symmetry. *AFSZ* (p. 351, footnote 5) implement a model with each firm facing a competitor on one side only by arguing that any other approach implies "[…] a symmetry of location between firms that is generally not present in the real world […]."

B. In addition, the situation of competition in the backyard cannot occur in such a setup. However, the assumption that there is another competitor to the left of *A* and to the right of *B* and the assumption of symmetric locations (i.e., equal distances d between processors) result in competition in both directions in an unbounded line market and represent the oligopsony case (see FIGURE 5-7). It can be shown that there is no difference regarding optimal UD prices u_I and market areas R_I between the duopsony model in FIGURE 5-6 and the oligopsony model in FIGURE 5-7 (see CHAPTER 5.2.2; see also MÉREL ET AL., 2009; and CHAPTER 3.1). The only difference is that the profits of the IOF are twice as high in the oligopsony case because the market area extends in both directions.

FIGURE 5-7. Competition en route (competition in both directions)

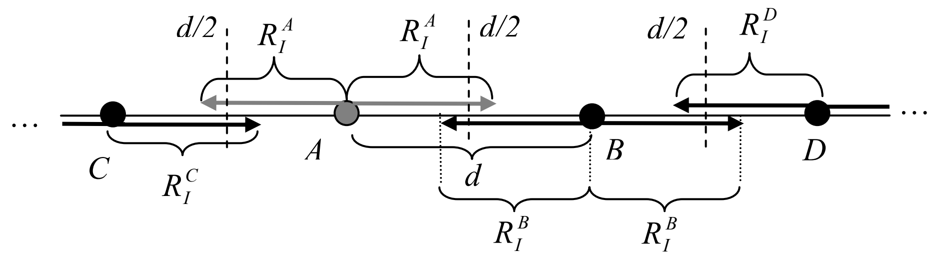
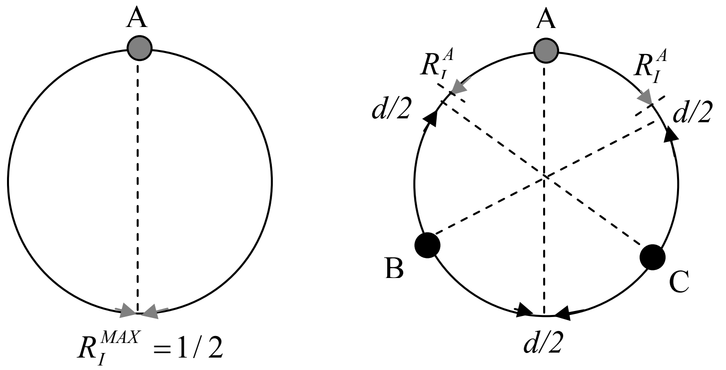


FIGURE 5-7 is the assumed market form in the oligopoly model of GRONBERG AND MEYER (1981). Although GRONBERG AND MEYER (1981) do not account for the situation of competition in the backyard, this market form allows such a situation.

The linear market in FIGURE 5-7 is similar to a circular market (regarding the latter, see, e.g., SALOP, 1979, taken from TIROLE, 1988, pp. 282). Assume for the following a circular market with a circumference of length 1. If there are *N* processors located on this circle, and assuming symmetry, the arc distance d between any two processors is $d = 1/N$ (see, e.g., TIROLE, 1988, p. 283). Hence, the more processors there are in a market, the closer together they will be.[130] A spatial monopsony can constitute two different situations: either $N = 1$ with $R_I \leq 1/2$ (see the left-hand side of FIGURE 5-8) or $N > 1$ with $R_I \leq d/2 = 1/(2N)$ (see the right-hand side of FIGURE 5-8). On the left-hand side, *A* is the only processor in the market. The largest possible market area in both directions is $R_I^{MAX} = 1/2$. On the right-hand side, it is assumed that $N = 3$. Then, the arc distance between two neighboring processors is $d = 1/N = 1/3$, and either processor is in a monopsonistic position if $R_I \leq d/2 = 1/6$.

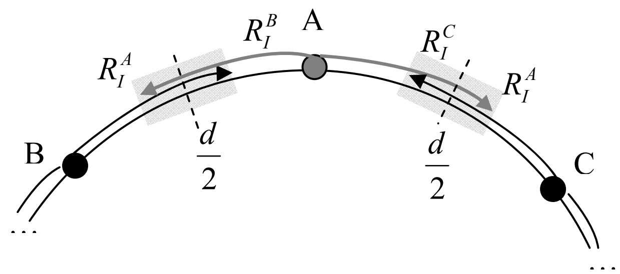
[130] The assumption of a fixed circumference of a circular market can be regarded as the given expansion of a certain region.

FIGURE 5-8. Monopsony in a circular market



The two situations of competition en route and competition in the backyard can now be analyzed in a framework with competition on both sides of either processor. Competition en route implies that $d/2 = 1/(2N) < R_I < d = 1/N$ (see FIGURE 5-9 for a certain number of processors *N*). The grey areas in in this figure highlight the areas of market overlap.

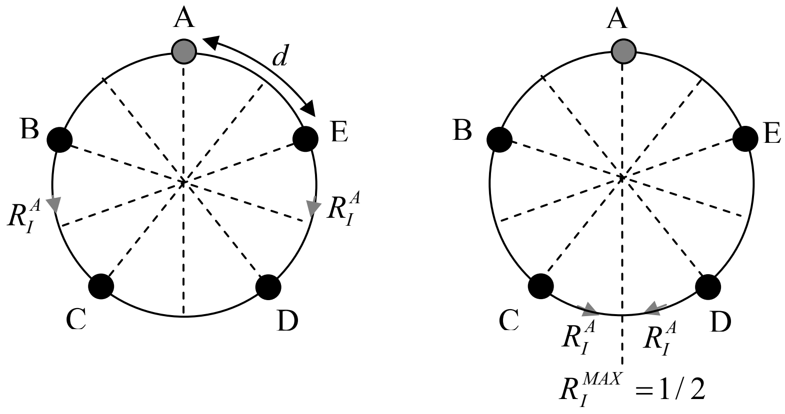
FIGURE 5-9. Competition en route in a circular market



In this oligopsony model, the situation of competition in the backyard is distinct from the situation in the duopsony model of *AFSZ* because it can be optimal for the representative processor to extend its market area not only beyond the location of the neighboring processor, but even beyond the locations of multiple processors. This situation implies that, irrespective of the number of processors in the market[131], the smallest possible range for the market area is $d = 1/N < R_I < (3d)/2 = 3/(2N)$ (see the left-hand side of FIGURE 5-10). The largest possible market area is $R_I^{MAX} = 1/2$ (see the right-hand side of FIGURE 5-10 for $N = 5$).

[131] More specifically, in a circular market, competition in the backyard can occur for any situation of $N \geq 3$.

FIGURE 5-10. Competition in the backyard in a circular market



In the following, the results for a circular market are derived to compare the results with the duopsony model by *AFSZ*. Throughout the analysis, the short-run equilibrium is considered. Thus, the following analysis assumes an exogenously given number of processors, *N*, and fixed costs equal to zero.[132]

5.2.1 MONOPSONY

The monopsony model of an IOF located on a circle is identical to the linear market model of *AFSZ* (see equations (5-4) and (5-5) for the optimal UD price and market area, respectively). Thus, IOFs are spatial monopsonists ($R_I \leq d/2 = 1/(2N)$) for $s/\rho (= (td)/\rho = t/(N\rho)) \geq 4/3$. In the circular market, space becomes more important the higher per-unit transportation costs *t* are or the lower the number of processors *N* in a market is. Given a fixed circumference of the circular market, a lower number of processors implies a longer distance *d* between processors.

5.2.2 COMPETITION EN ROUTE

The difference between the situation of competition en route in the circular market model and in the *AFSZ* model is that market overlap in the circular market model ($d/2 = 1/(2N) < R_I < d = 1/N$, see FIGURE 5-9) occurs on both sides of either processor. Consequently, this situation can be an outcome for any $N \geq 2$. The maximization problem of the IOF[133] is

[132] In the short run, the number of firms is given and firms realize positive profits (SCHÖLER, 1988, p. 171). In the long run, firms will enter the market until profits are equal to zero (see, e.g., GRONBERG AND MEYER, 1981).

[133] Equation (5-15) is the oligopsony version of the oligopoly model in GRONBERG AND MEYER (1981) under UD pricing and price matching (see equation (2) in their article). Each IOF faces competition on each side of its

(5-15) $$\Pi_I^{er} = \max_{u_I}\left[\left(\int_0^{d-R_I}(\rho - u_I - tr)\mathrm{d}r + \frac{1}{2}\int_{d-R_I}^{R_I}(\rho - u_I - tr)\mathrm{d}r\right)2u_I\right]$$

for $R_I = \dfrac{\rho - u_I}{t}$ and $d = \dfrac{1}{N}$.

The first term in equation (5-15) considers the segment of the market without overlap, and the second term considers the area of market overlap. Again, it is assumed that farmers are shared equally between processors in the area of market overlap. Multiplying the sum of both terms by $2u_I$ gives the total profit of the IOF in both directions. The solution to this problem is

(5-16) $$u_I^{er} = \frac{2(\rho - td)}{3} + \frac{\sqrt{4\rho^2 - 8\rho td + 10t^2d^2}}{6}$$

or in the notation of the circular market

(5-17) $$u_I^{er} = \frac{4N\rho - 4t + \sqrt{4N^2\rho^2 - 8\rho tN + 10t^2}}{6N}.$$

Substituting this result into equation (5-2) gives the optimal market area:

(5-18) $$\begin{aligned} R_I^{er} &= \frac{2\rho + 4dt - \sqrt{4\rho^2 - 8dt\rho + 10d^2t^2}}{6t} \\ &= \frac{2N\rho + 4t - \sqrt{4N^2\rho^2 - 8\rho tN + 10t^2}}{6Nt} \end{aligned}$$

It can be shown that these solutions are likewise the solutions for two IOFs located at the endpoints of a bounded line market with competition in only one direction (as in FIGURE 5-6; see also TRIBL, 2009b, regarding the pure IOF market), but total profits are only half as much. In the situation of competition en route, the comparative statics of the UD price and the market area are qualitatively equal to those reported by *AFSZ* (see TABLE 5-2).

market area. In contrast to GRONBERG AND MEYER (1981), the analysis here does not consider the free-entry equilibrium.

TABLE 5-2. Comparative statics: competition en route (*AFSZ* and circular market model)

UD price		**Market area**	
$\frac{\partial u_I^{er}}{\partial t}$	-	$\frac{\partial R_I^{er}}{\partial t}$	-
$\frac{\partial u_I^{er}}{\partial N} = -\left(\frac{\partial u_I^{er}}{\partial d}\right)$	+	$\frac{\partial R_I^{er}}{\partial N} = -\left(\frac{\partial R_I^{er}}{\partial d}\right)$	-
$\frac{\partial u_I^{er}}{\partial \rho}$	+	$\frac{\partial R_I^{er}}{\partial \rho}$	+

Note: Comparative statics are valid for *4/7 < s/ρ < 4/3* in the *AFSZ* model and *0 < s/ρ < 4/3* in the circular market model. First derivatives are given in APPENDIX A1.1 and APPENDIX A1.2.

In the following, the results of competition en route in the circular market (equations (5-16) and (5-18)) will be compared with the corresponding solutions of *AFSZ* (see FIGURE 5-2 and equation (5-7) for the optimal UD price and equation (5-8) for the optimal market area). FIGURE 5-11a and FIGURE 5-11b illustrate the results of competition en route in the circular market and in *AFSZ* depending on the relative importance of space, s/ρ (in particular, depending on *t*). In the situation of competition en route, the UD price is higher in the circular market than in the *AFSZ* duopsony model in which processors are spatial monopsonists on their respective market sides with no direct competition (see FIGURE 5-11a). Because $R_I = (\rho - u_I)/t$, market areas of processors are smaller compared to *AFSZ*. These smaller market areas have one implication (see FIGURE 5-11b): in the *AFSZ* model, processors are in the situation of competition en route for $4/7 \leq s/\rho < 4/3$ (i.e., $R_I^{er-AFSZ} = d$ for $s/\rho = 4/7$); in the circular market model, processors are in the situation of competition en route for a larger range of the relative importance of space: $0 < s/\rho < 4/3$ (i.e., $R_I^{er} \to d$ and $u_I^{er} \to \rho$ as $s/\rho \to 0$). To put it differently, if the relative importance of space is rather low, processors in the *AFSZ* model are in the situation of competition in the backyard with a UD price that is decreasing towards the monopsony level as $s/\rho \to 0$. For the same level of the relative importance of space, processors in the circular market can be in the situation of competition en route. Thus, a low importance of space does not necessarily imply the situation of competition in the backyard in the circular market. This is only the case for duopsonistic processors on an unbounded line market like in *AFSZ*.

FIGURE 5-11a. UD price (competition en route) depending on t

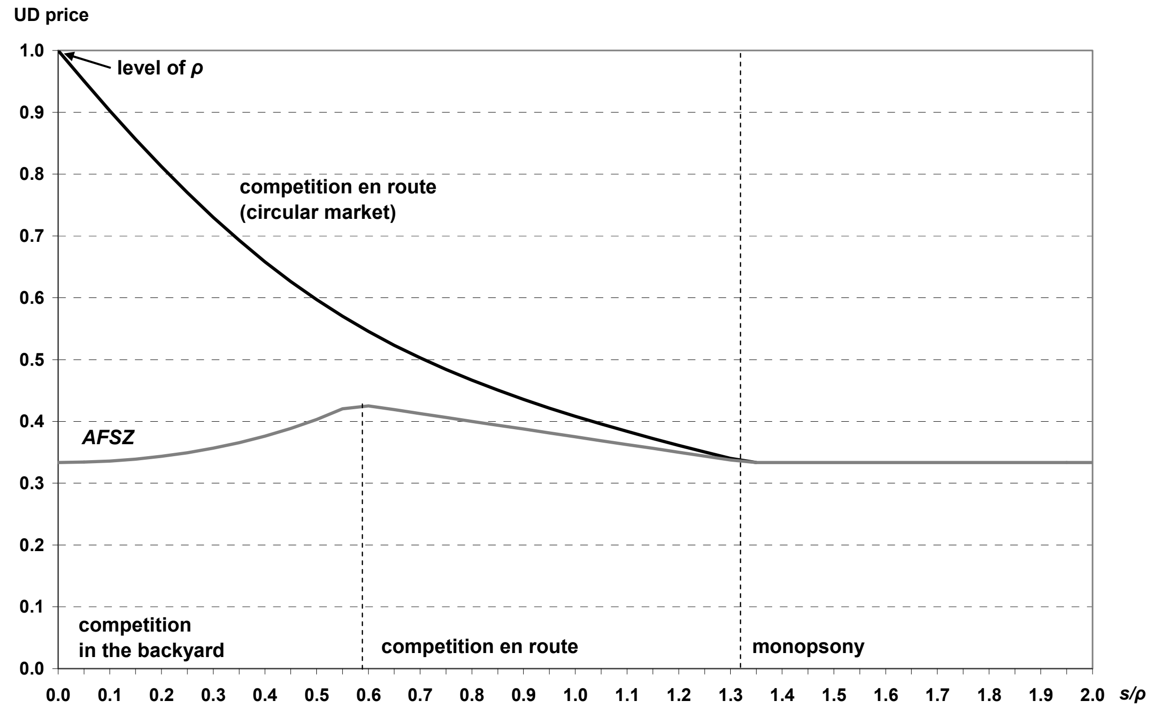
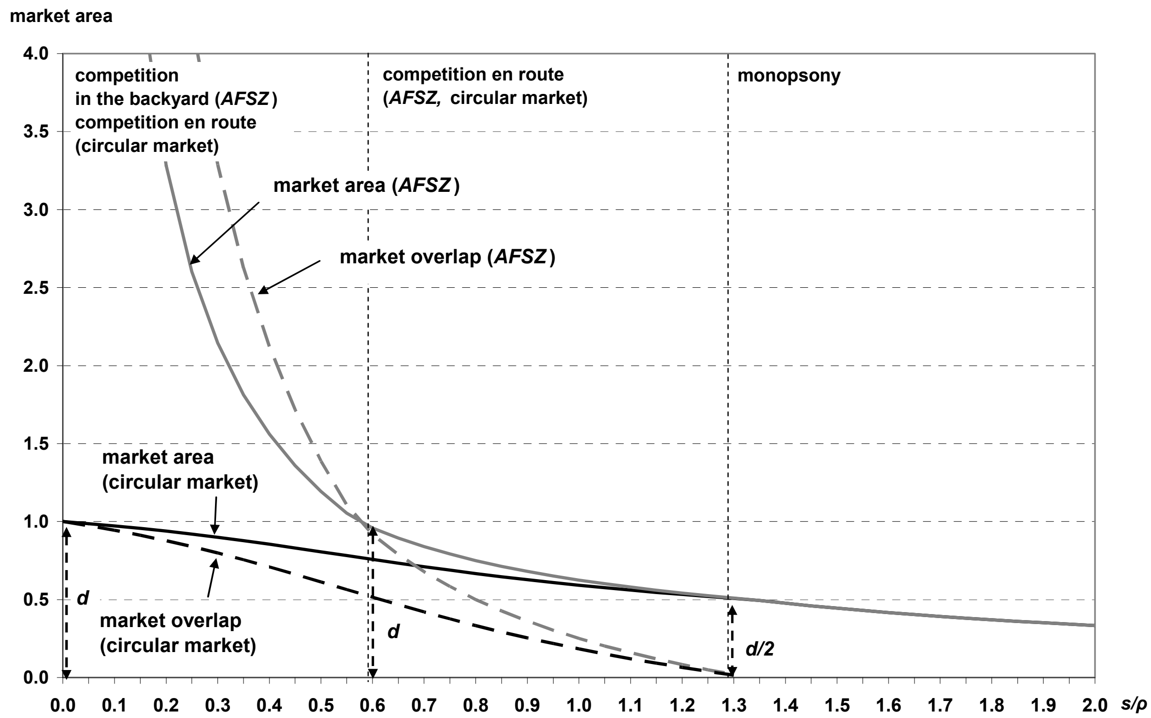


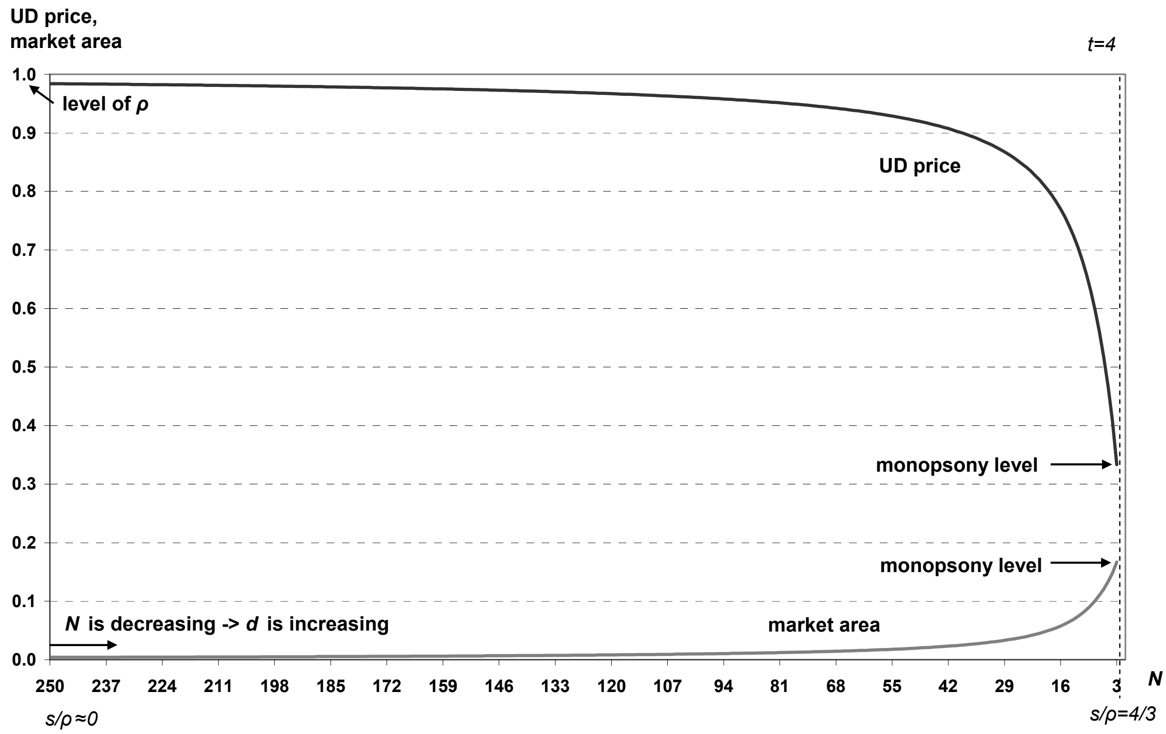
FIGURE 5-11b. Market area (competition en route) depending on t



Note: In these figures, s/ρ is increasing due to increases in per-unit transportation costs t. For reasons of simplicity, the distance between processors is normalized to $d = 1$. In this case, the length of the circumference is equal to N. Likewise, the net selling price is normalized to $\rho=1$.

Since $u_I^{er} > u_I^{er-AFSZ}$, the oligopsonistic power in the circular market model is lower than in the *AFSZ* model, where each IOF is exclusively operating on one side of its market without competition. A similar conclusion can be derived from the impact of changes in the number of processors N in the market. As N increases, the distance d between processors decreases and space becomes less important. FIGURE 5-12 shows for the circular market that the market area is decreasing as the number of processors N increases.[134] This implies less concentration, which decreases the oligopsonistic power over farmers. Such an interpretation may not apply in the *AFSZ* duopsony model. As mentioned in CHAPTER 5.1, a decreasing d in the *AFSZ* model implies that, for $d = 0$, both processors are located at the same point in space. Thus, for $s/\rho \to 0$, the UD price $u_I^{by-AFSZ}$ is again at the monopsony level (see FIGURE 5-11a).[135]

FIGURE 5-12. UD price and market area (competition en route) depending on N



Note: In this figure, *s/ρ* is increasing due to decreases in *N*. Per-unit transportation costs *t* are fixed at *t = 4*. Then, at the limit of the x-axis on the right-hand side (*s/ρ = 4/3),* the number of processors is *N = 3*. The net selling price is normalized to *ρ=1*.

The result of less duopsony power in the circular market can also be shown by means of price transmission. Price transmission in the *AFSZ* model for the situation of competition en route is constant: $\partial u_I^{er-AFSZ} / \partial \rho = 1/2$ (*AFSZ* note that this result is equivalent to that of the non-spatial monopsony). In the circular market model, price transmission in the situation of competition en route ($0 < s/\rho < 4/3$) is

[134] In the situation of competition en route in the circular market, the area of overlap ($2R_I$-d) is an inverted U-shaped function of d and N, respectively. However, the area of overlap as a share of distance d is decreasing in d.
[135] For comparison with the circular market model, *1/N* can be substituted for *d* in the *AFSZ* duopsony model, but *N* would only serve to change the distance *d* between the two firms.

(5-19) $$\frac{\partial u_I^{er}}{\partial \rho} = \frac{2}{3} + \frac{8(\rho - td)}{12\sqrt{4\rho^2 - 8\rho td + 10t^2 d^2}} = \frac{2\left(\sqrt{4\rho^2 N^2 - 8t\rho N + 10t^2} + \rho N - t\right)}{3\sqrt{4\rho^2 N^2 - 8t\rho N + 10t^2}},$$

which is greater than 3/5. In addition, $\partial u_I^{er} / \partial \rho \rightarrow 1$ as $s \rightarrow 0$, i.e., the circular market model approaches the result of the competitive market case (given constant per-unit processing costs) with perfect price transmission as the importance of space decreases towards zero. Taking ρ as given, an importance of space equal to zero implies that space is not an issue: either $t = 0$ (see FIGURE 5-11a and 5-11b) or $d = 0$ (see FIGURE 5-12).

5.2.3 COMPETITION IN THE BACKYARD

In the following, the situation of competition in the backyard as identified by *AFSZ* will be analyzed for the circular market. To my knowledge, this scenario has not yet been considered in the literature.[136] Competition in the backyard is a possible outcome if processors wish to serve farmers at a distance greater than *d*. If an equilibrium exists, competition in the backyard must be a situation within the interval $0 \leq s / \rho < 4/3$; i.e., for a given level of s / ρ there can be an equilibrium solution for competition en route and another for competition in the backyard.

For the analysis of competition in the backyard, two extreme cases of possible outcomes will be analyzed (see also APPENDIX A1.4). In one extreme case, the market area extends only beyond the nearest competitor on each market side (in the following referred to as the "lower extreme case" (LEC) of competition in the backyard). Then, each processor wishes to serve a market area of $d = 1/N < R_I^{by-LEC} \leq (3d)/2 = 3/(2N)$; see also Figure 5-10 on the left-hand side. The other extreme case is a situation where the optimal market area extends beyond the most distant competitor on each market side ("upper extreme case" (UEC) of competition in the backyard). Then, each processor wishes to serve a market area of $\frac{N-1}{2}d = \frac{N-1}{2N} < R_I^{by-UEC} \leq \frac{N}{2}d = \frac{1}{2}$; see also Figure 5-10 on the right-hand side. If the optimal market area is half the circumference of the circle ($R_I^{MAX} = 1/2$), all processors compete on each point along the circular market.[137]

The LEC of competition in the backyard (i.e., competition beyond the nearest competitor) implies that – irrespective of the number *N* of processors in the market - there are up to three

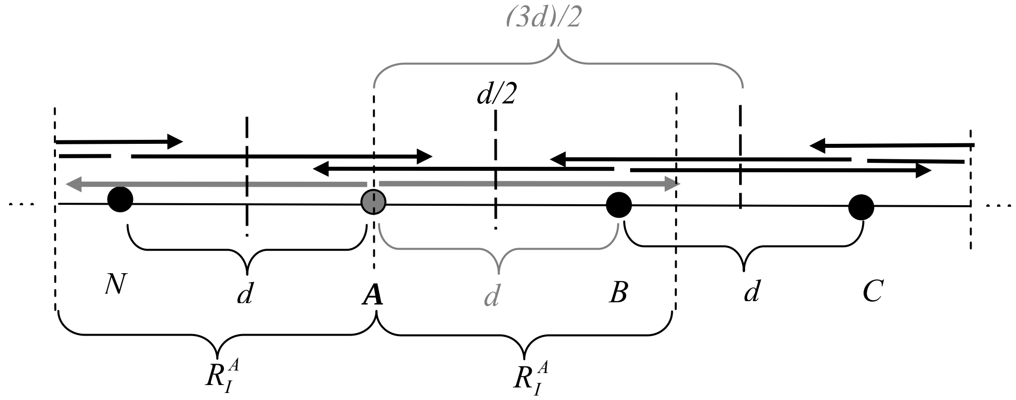
[136] For example, GRONBERG AND MEYER (1981) consider the case of market overlap between locations of firms, but not the case of competition in the backyard ("multiple overlap", p. 762).
[137] For *N=3,* the LEC and the UEC of competition in the backyard are equal (see also APPENDIX A1.4).

processors operating in the same area (see, for example, processor A in FIGURE 5-13). In such a situation, the profit function is given by

$$(5\text{-}20)\quad \Pi_I^{by-LEC} = \max_{u_I}\left[\left(\frac{1}{3}\int_0^{R_I-d}(\ldots)\mathrm{d}r + \frac{1}{2}\int_{R_I-d}^{2d-R_I}(\ldots)\mathrm{d}r + \frac{1}{3}\int_{2d-R_I}^{d}(\ldots)\mathrm{d}r + \frac{1}{3}\int_{d}^{R_I}(\ldots)\mathrm{d}r\right)2u_I\right]$$

for $(\ldots) = (\rho - u_I - tr)$, $R_I = \dfrac{\rho - u_I}{t}$ and $d = \dfrac{1}{N}$.

FIGURE 5-13. LEC of competition in the backyard in a circular market



Note: To simplify matters, the LEC of competition in the backyard in a circular market is illustrated here using a straight line.

The sequence of the integrals in equation (5-20) gives the per-unit profits of the respective sections on the right-hand side of processor A up to its market boundary R_I^A (see FIGURE 5-13). Again, it is assumed that farmers are shared equally between processors in the area of overlap. Multiplying the term in squared brackets by u_I gives the total profits on one side of processor A; multiplying the result by 2 gives the total profits of the IOF with competition on both sides. The optimal UD price in the LEC of competition in the backyard is

$$(5\text{-}21)\quad u_I^{by-LEC} = \frac{2\rho - 4td}{3} + \frac{\sqrt{4\rho^2 - 16\rho td + 46t^2d^2}}{6}$$

and in the notation of the circular market, the result is

$$(5\text{-}22)\quad u_I^{by-LEC} = \frac{4N\rho - 8t + \sqrt{4N^2\rho^2 - 16\rho Nt + 46t^2}}{6N}.$$

Substituting this result into equation (5-2) gives the optimal market area

$$(5\text{-}23)\quad R_I^{by-LEC} = \frac{2N\rho + 8t - \sqrt{4N^2\rho^2 - 16\rho Nt + 46t^2}}{6Nt}.$$

Given equation (5-23), the LEC of competition in the backyard ($1/N < R_I^{by-LEC} \leq 3/(2N)$) applies to situations in which $4/15 \leq s/\rho < 4/7$. The upper boundary of this range, $s/\rho = 4/7$, is equal to the upper boundary for competition in the backyard in *AFSZ*. Thus, market areas and UD prices are equal between the two models at $s/\rho = 4/7$.

In the UEC of competition in the backyard, each processor wishes to serve a market area of $(N-1)/(2N) < R_I^{by-UEC} \leq 1/2$ (i.e., beyond the most distant competitor). In this case, the composition of the profit function depends on *N* (see APPENDIX A1.4 for a derivation of profit functions and the corresponding optimal UD prices and market areas). Comparative statics with respect to *t* and *d* for the situation of competition in the backyard are given in TABLE 5-3:

TABLE 5-3. Comparative statics: competition in the backyard (*AFSZ* and circular market model)

	AFSZ	**Circular market**
UD price	$\frac{\partial u_I^{by-AFSZ}}{\partial t} > 0$, $\frac{\partial u_I^{by-AFSZ}}{\partial d} > 0$	$\frac{\partial u_I^{by-LEC}}{\partial t} < 0$, $\frac{\partial u_I^{by-LEC}}{\partial N} = -\left(\frac{\partial u_I^{by-LEC}}{\partial d}\right) > 0$ $\frac{\partial u_I^{by-UEC}}{\partial t} < 0$, $\frac{\partial u_I^{by-UEC}}{\partial N} = -\left(\frac{\partial u_I^{by-UEC}}{\partial d}\right) < 0$
Market area	$\frac{\partial R_I^{by-AFSZ}}{\partial t} < 0$, $\frac{\partial R_I^{by-AFSZ}}{\partial d} < 0$	$\frac{\partial R_I^{by-LEC}}{\partial t} < 0$, $\frac{\partial R_I^{by-LEC}}{\partial N} = -\left(\frac{\partial R_I^{by-LEC}}{\partial d}\right) < 0$ $\frac{\partial R_I^{by-UEC}}{\partial t} < 0$, $\frac{\partial R_I^{by-UEC}}{\partial N} = -\left(\frac{\partial R_I^{by-UEC}}{\partial d}\right) > 0$

Note: First derivatives of the LEC of competition in the backyard are given in APPENDIX A1.3 and first derivatives of the UEC in APPENDIX A1.5 (TABLE A1.5). As there is one distinct profit function for each possible number of processors, *N* (see APPENDIX A1.5), first derivatives of the UEC with respect to *N* cannot be derived analytically, but the comparative statics can be examined via a numerical simulation.

In the situation of competition in the backyard of *AFSZ*, the UD price is increasing both in *t* and in *d*. Thus, *AFSZ* conclude that the UD price is increasing in the importance of space *s=td*: $\partial u_I^{AFSZ} / \partial s > 0$ (see CHAPTER 5.1). In the circular market, comparative statics are qualitatively different from those reported in *AFSZ* in certain cases (see TABLE 5-3). Most importantly, comparative statics of the UD price are qualitatively equal to those reported in *AFSZ* only in the UEC with respect to distance *d*. Comparative statics of the market area are qualitatively equal to *AFSZ*, except for the LEC with respect to *d*. In the following, the comparative statics of UD prices and market areas are illustrated and discussed using numerical simulations.

The simulations in FIGURE 5-14a (UD price) and FIGURE 5-14b (market area) illustrate the comparative statics with respect to the transportation rate *t*. These simulations are exemplified by assuming *N=4*.[138]

In the circular market, and contrary to the *AFSZ* model, competition in the backyard implies that there is no exclusive share of the market area for either processor. In *AFSZ*, the UD price is increasing as the transportation rate *t* increases. In the circular market, however, the UD price is decreasing as *t* increases (in both the LEC and the UEC of competition in the backyard). Relative to the situation of competition en route, competition in the backyard in the circular market implies lower UD prices for any given level of t to sustain such a high market area. Although UD prices are decreasing, market areas ($R_I = (\rho - u_I)/t$) are decreasing as the transportation rate *t* increases. Thus, the effect of a higher *t* outweighs the effect of a lower UD price. In addition, FIGURES 5-14a and 5-14b illustrate the relevant ranges of the relative importance of space for the LEC and the UEC of competition in the backyard.[139] The analysis thus far shows the following: under the price-matching conjecture in a circular market, more than one equilibrium UD price can be identified for some levels of $s/\rho < 4/3$ (see also FIGURE 5-14a). For example, at $s/\rho = 0.30$ ($N = 4$, $t = 1.20$ and $\rho = 1$), the processor can either be in the situation of competition en route or in the LEC or UEC of competition in the backyard.

[138] For *N=4*, the total spectrum of competition in the backyard is considered (i.e., there is no situation in between the LEC and the UEC of competition in the backyard). However, *N=4* implies that the nearest competitor beyond which the processor competes is, at the same time, the most distant competitor. The LEC is relevant for $d<R_I\leq(3d)/2$ and the UEC for $(3d)/2<R_I\leq 1/2$ (see APPENDIX A1.4).

[139] The range of the relative importance of space *s/ρ* of the LEC of competition in the backyard is the same for any *N*: $4/15\leq s/\rho<4/7$. The relevant *s/ρ* range for the UEC, however, depends on *N*. A higher *N* implies that the UD-price curve for the UEC of competition in the backyard is located at a lower level of *s/ρ* (see also FIGURE 5-14a).

FIGURE 5-14a. UD prices (competition in the backyard) depending on *t*

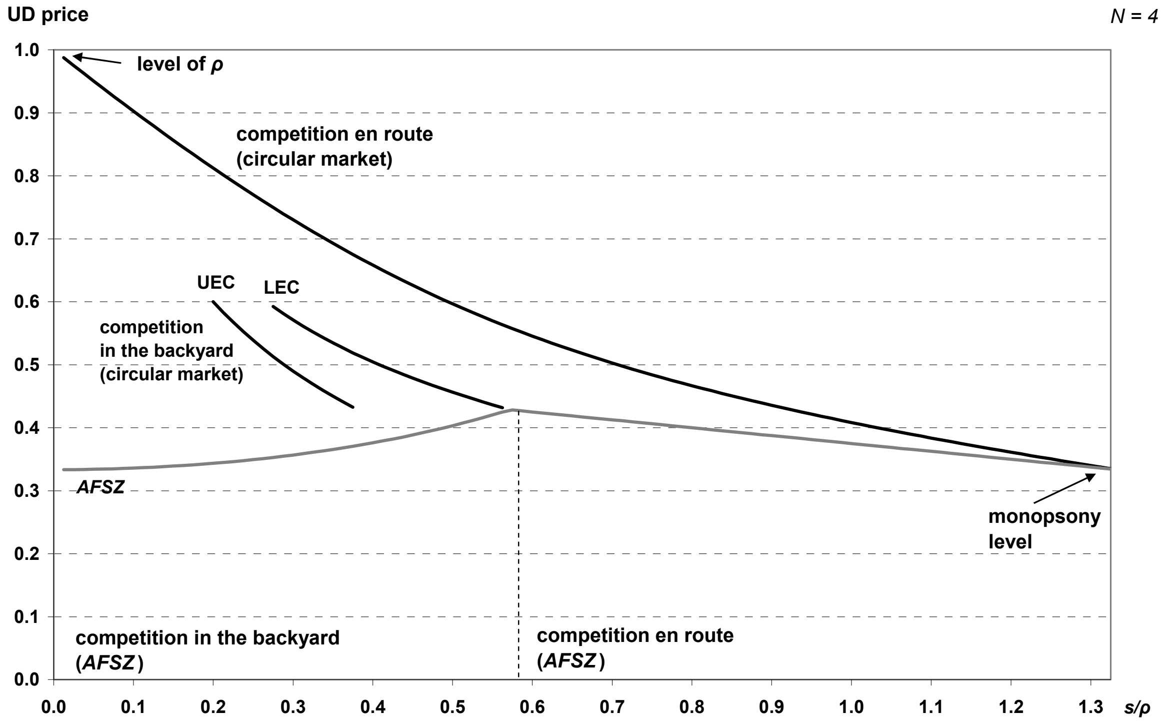
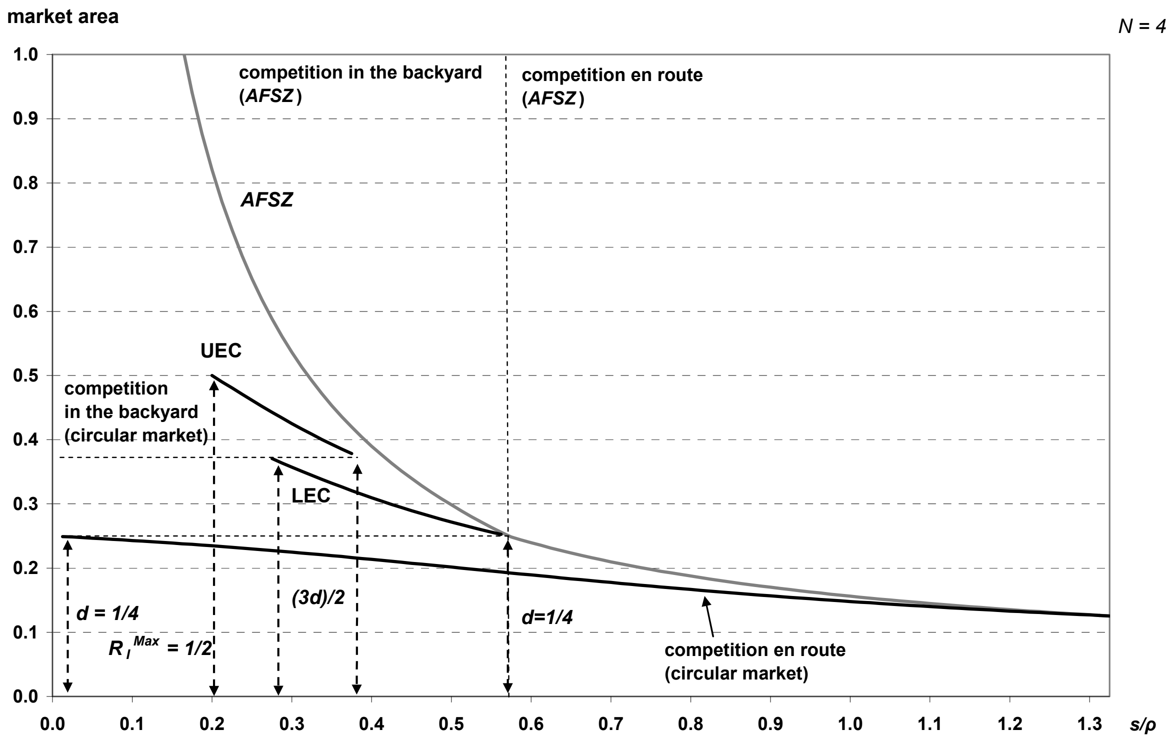


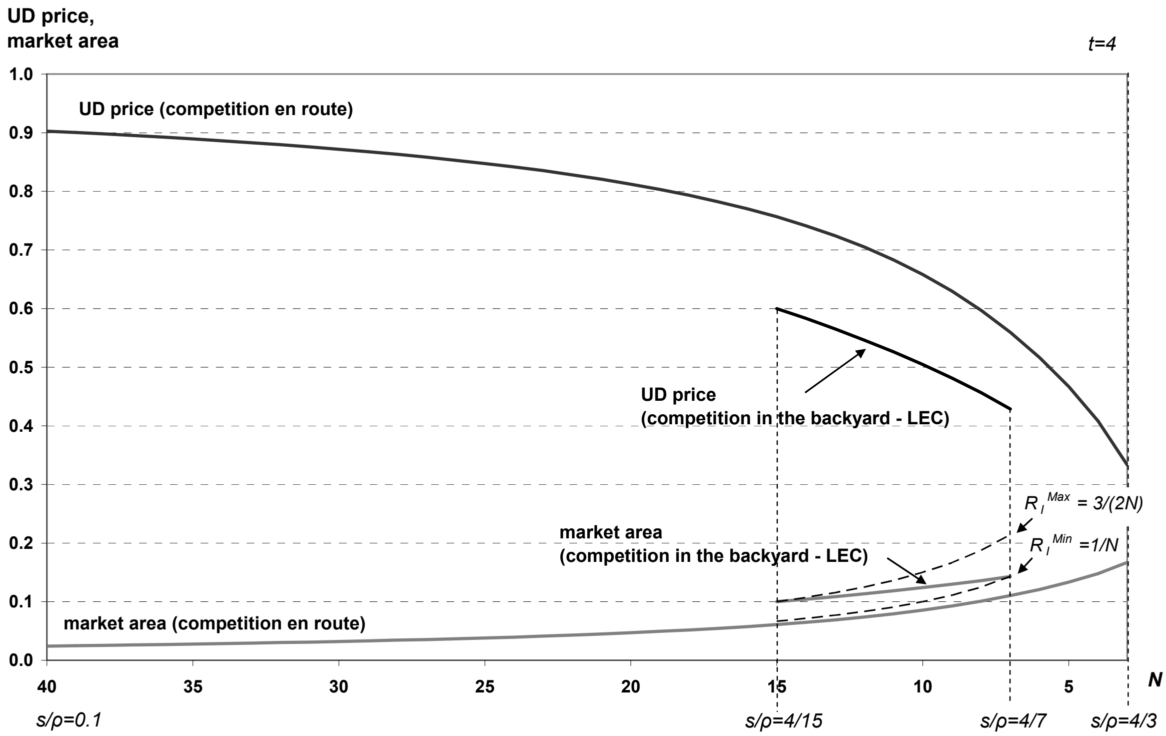
FIGURE 5-14b. Market areas (competition in the backyard) depending on *t*



Note: In these figures, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. The distance between processors is fixed at $d = 0.25$ as $N = 4$ (see also APPENDIX A1.5). The net selling price ρ is normalized to 1.

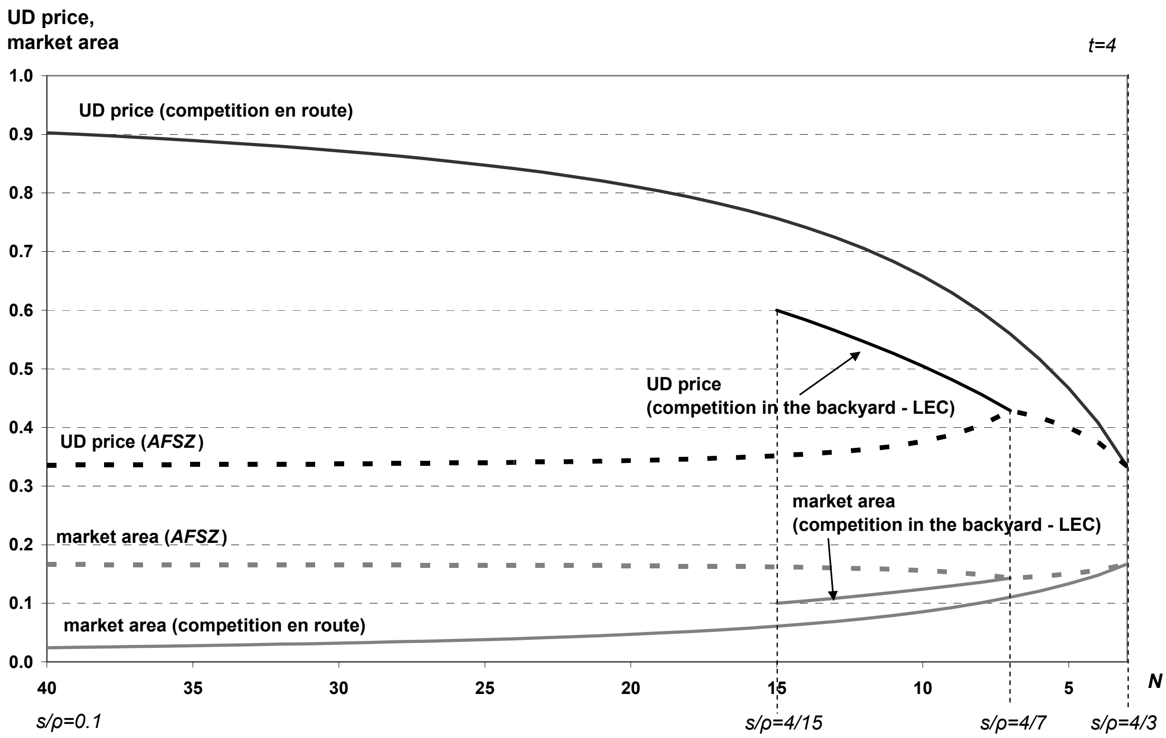
Comparative statics of the LEC of competition in the backyard with respect to the number of processors N (and, thus, with respect to the distance d between processors) are illustrated in FIGURES 5-15a and 5-15b.

FIGURE 5-15a. UD price and market area (LEC of comp. in the backyard) depending on *N*



Note: In this figure, *s/ρ* is increasing due to decreases in the number of processors *N*. Per-unit transportation costs *t* are fixed at *t* = *4*. The net selling price *ρ* is normalized to 1. R_I^{Max} and R_I^{Min} represent the largest and smallest possible market area, respectively, for processors to be in the LEC of competition in the backyard.

FIGURE 5-15b. UD price and market area (LEC of comp. in the backyard) depending on *N* (including *AFSZ*)



Note: In this figure, *s/ρ* is increasing due to decreases in the number of processors *N*. Per-unit transportation costs *t* are fixed at *t* = *4*. The net selling price *ρ* is normalized to 1. For the *AFSZ* results, *N* serves as a variable that changes the distance *d*.

FIGURE 5-15a shows for the LEC of competition in the backyard that the UD price is decreasing and the market area is increasing as N decreases (i.e., as d increases). FIGURE 5-15b additionally shows the corresponding UD price and market area for the *AFSZ* model (see the dotted lines). The comparative statics of UD price and market area in the LEC of competition in the backyard are contrary to the comparative statics of competition in the backyard in *AFSZ*.

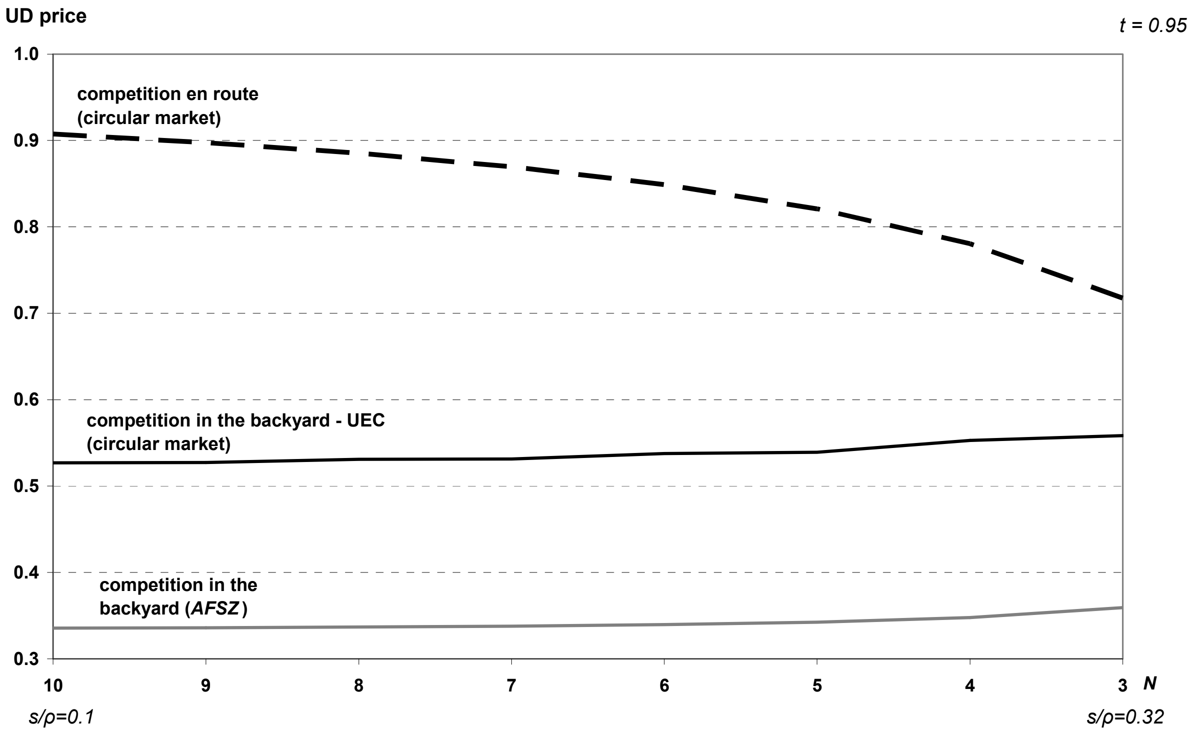
Regarding the UEC of competition in the backyard, comparative statics with respect to N cannot be derived mathematically but only numerically because there is one specific UD price equation for any given number of N (see APPENDIX A1.4). UD prices were calculated separately for $N = 3, ..., 10$ (see APPENDIX A1.5). Changes in UD prices due to changes in N for the UEC of competition in the backyard, given a rather low level of per-unit transportation costs ($t = 0.95$), are illustrated in FIGURES 5-16a and 5-16b.[140] In this case, s/ρ varies between 0.10 ($N = 10$) and 0.32 ($N = 3$). For this range of s/ρ, processors can be in a situation of either competition en route or in the UEC of competition in the backyard.

FIGURE 5-16a shows that the UD price increases as distance d increases (due to a lower number of processors) in the situation of competition in the backyard, even in the circular market, as in *AFSZ*. However, this result applies only to the UEC of competition in the backyard. This result is rather surprising as it implies that less competition (i.e., a higher concentration as N decreases) yields a higher UD price. For the situation illustrated in FIGURES 5-16a and 5-16b it can be shown that being in the situation of the UEC of competition in the backyard is more profitable for processors than being in the situation of competition en route. In order to stay in the situation of the UEC of competition in the backyard (as N decreases), processors need to reduce their market areas and, therefore, increase UD prices.

The numerical simulation shows that the relevant range of s/ρ for processors to be in the UEC of competition in the backyard decreases as the number of processors N increases (see APPENDIX A1.5, TABLE A1.4). It varies between a range of $4/15 \leq s/\rho < 12/21$ (for $N = 3$) and a range of $8/85 \leq s/\rho < 20/171$ (for $N = 10$). Consequently, for rather low levels of s/ρ (due to a very high number of processors N or very low per-unit transportation costs t), the UEC of competition in the backyard in the circular market is rather unlikely to be identified.

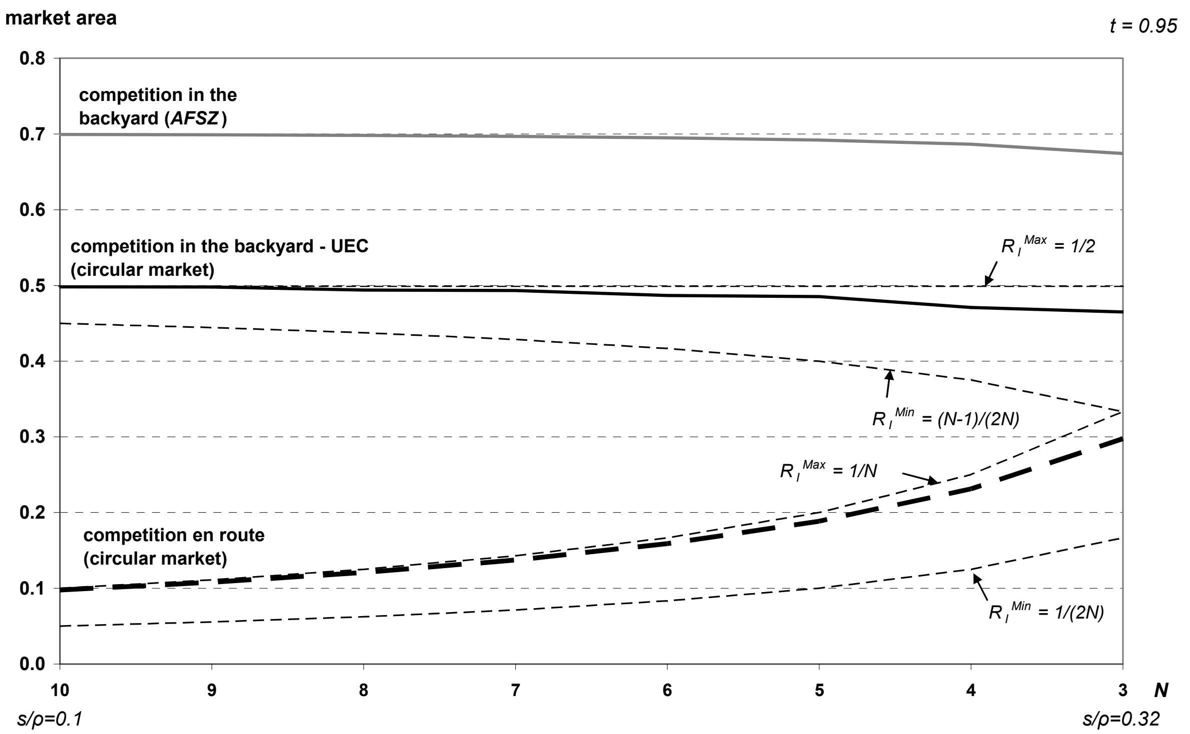
[140] For a justification of this level of per-unit transportation costs, see APPENDIX A1.5. The LEC of competition in the backyard is given for $4/15 \leq s/\rho < 4/7$ and is therefore not relevant at this level of t.

FIGURE 5-16a. UD price (UEC of competition in the backyard) depending in *N*



Note: In this figure, *s/ρ* is increasing due to decreases in the number of processors *N*. Per-unit transportation costs *t* are fixed at *t = 0.95* (see also APPENDIX A1.5). The net selling price *ρ* is normalized to 1. For the *AFSZ* results, *N* serves as a variable that changes the distance *d*.

FIGURE 5-16b. Market area (UEC of competition in the backyard) depending in *N*



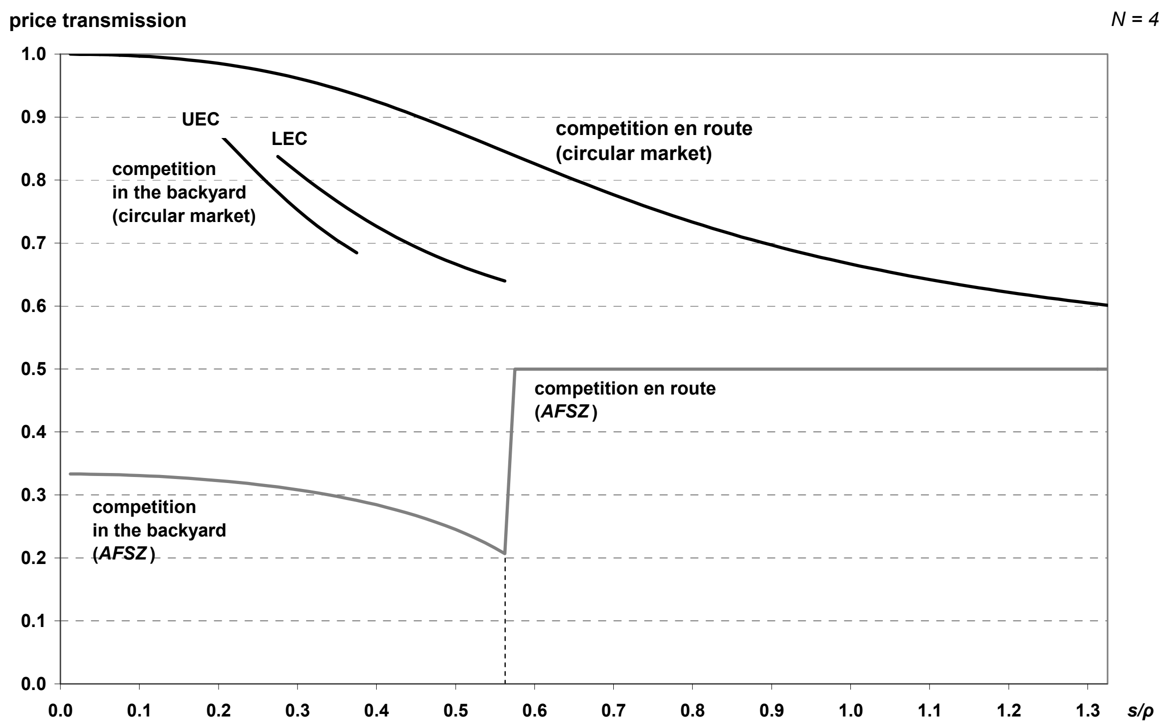
Note: In this figure, *s/ρ* is increasing due to decreases in the number of processors *N*. Per-unit transportation costs *t* are fixed at *t = 0.95* (see also APPENDIX A1.5). The net selling price *ρ* is normalized to 1. For the *AFSZ* results, *N* serves as a variable that changes the distance *d*. R_I^{Max} and R_I^{Min} represent the largest and smallest possible market area, respectively.

Price transmission in the circular market is illustrated in FIGURE 5-17 (with respect to changes in t). In the LEC of competition in the backyard, price transmission is

$$\text{(5-24)} \qquad \frac{\partial u_I^{by-LEC}}{\partial \rho} = \frac{2\left(\sqrt{4N^2\rho^2 - 16\rho Nt + 46t^2} + N\rho - 2t\right)}{3\sqrt{4N^2\rho^2 - 16\rho Nt + 46t^2}}.$$

Within the corresponding range of the relative importance of space ($4/15 \leq s/\rho < 4/7$), price transmission ranges from 11/13 to 7/11. More specifically, price transmission increases in the LEC of competition in the backyard as space becomes less important (due to a decreasing t or d). The UEC of competition in the backyard also implies an increasing price transmission as t decreases (see also APPENDIX A1.5). To compare, in the *AFSZ* model, price transmission in the situation of competition in the backyard ($0 < s/\rho < 4/7$) is given by equation (5-14) and implies a price transmission that ranges from 1/3 to 1/5. Thus, price transmission in the *AFSZ* model increases towards the monopsony result (1/3) as space becomes less important. FIGURE 5-17 shows that price transmission is lower in the *AFSZ* model than in the circular market and, additionally, indicates that market power towards farmers is higher in the *AFSZ* model than in the circular market.

FIGURE 5-17. Price transmission



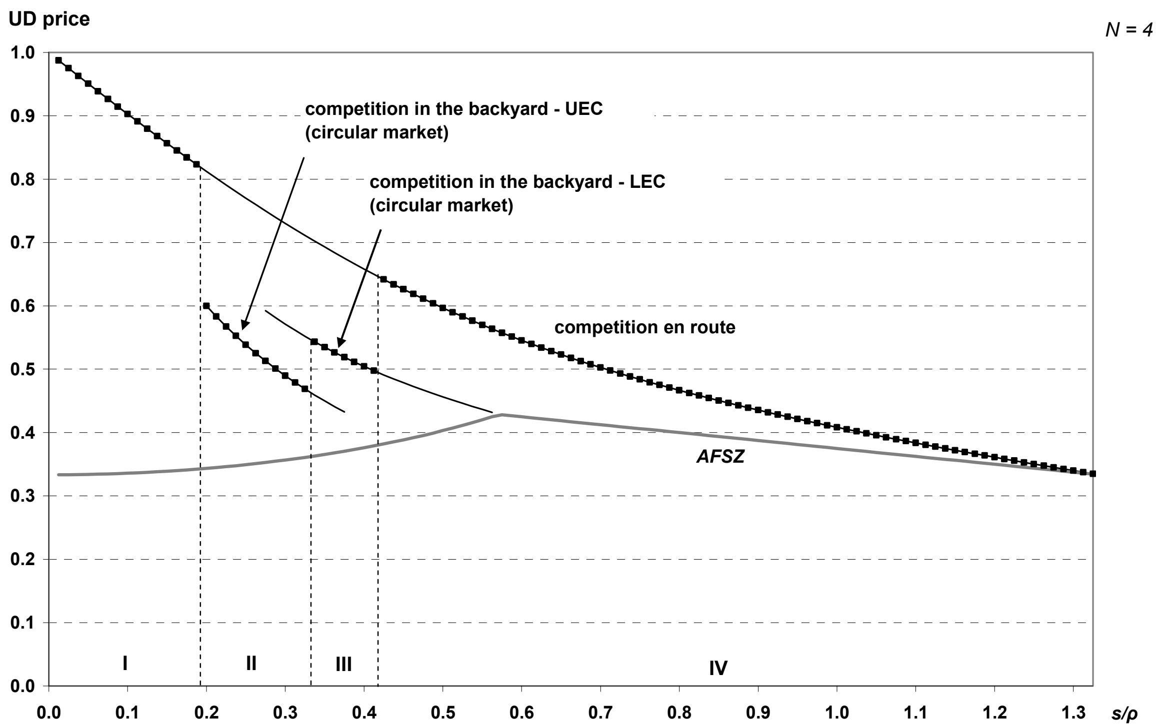
Note: In this figure, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. The distance between processors is fixed at *d = 0.25* as *N = 4*. The net selling price *ρ* is normalized to 1.

The analysis under the price-matching conjecture shows that more than one equilibrium UD price can be identified for some levels of s/ρ (depending on the situation of competition). For each level of s/ρ, the corresponding situation under price matching (i.e., competition en route or the LEC of competition in the backyard) that maximizes profits of processors can be determined. As a result, the LEC of competition in the backyard is more profitable than competition en route within the following range of the relative importance of space:[141]

$$(5\text{-}25) \quad \Pi_I^{by-LEC} > \Pi_I^{er} \text{ for } \frac{4}{15} < \frac{s}{\rho} < 0.421$$

This implies that, as s/ρ decreases, it becomes profitable for processors to leave the situation of competition en route by extending the market area beyond the location of the nearest competitor and thereby reducing the UD price. FIGURE 5-18 exemplifies the optimal UD prices depending on *t* for the case of $N = 4$.

FIGURE 5-18. UD price depending on the profit level



Note: In this figure, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. The distance between processors is fixed at *d = 0.25* as *N = 4* (see also FIGURE 5-14a). The net selling price *ρ* is normalized to 1.

In section I with very low levels of s/ρ (i.e., due to a low *t*), competition en route is the only possible situation of competition. In this section, competition in the backyard is not possible

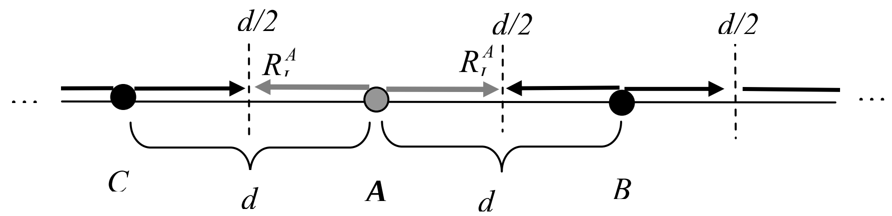
[141] A general result cannot be derived for the UEC of competition in the backyard because there is one specific condition for each possible number of firms *N* (see APPENDIX A1.4).

in the circular market since the extension of market areas of either processor is restricted by the circular market ($R_I^{Max} = 1/2$). Because this restriction does not exist in the *AFSZ* model, competition in the backyard is possible in *AFSZ* for such a low level of s/ρ. As s/ρ increases, the UEC of competition in the backyard becomes relevant (see section II): reducing the UD price at a lower level and thereby extending the market area beyond the most distant competitor is more profitable than staying in the situation of competition en route. In section III, the LEC of competition in the backyard is most profitable. In this section, the optimal market area are reduced, and the UD price is higher. Finally, in section IV, competition en route is more profitable than competition in the backyard. Again, the UD price is higher (and the market area is smaller).

5.3 LÖSCHIAN COMPETITION

In the models of spatial competition analyzed thus far (CHAPTERS 5.1 to 5.2), the price-matching conjecture with overlapping market areas was considered. Thus, it was assumed that farmers are shared equally between processors within the area of market overlap. In their oligopoly model under UD pricing, GRONBERG AND MEYER (1981) consider another solution for the case of price-matching firms that wish to serve a market area of $R_I > d/2$ (see also CHAPTER 3.3): "If the two firms overtly collude, deciding to split the market between them exactly, each taking the portion closest to themselves, we then have firms acting as if their market area is fixed at [$d/2$]. This assumption of a fixed market area is precisely the Löschian model of a spatially competitive firm" (p. 760). For the circular market, collusion regarding market areas (i.e., Löschian competition with $\overline{R}_I = d/2$) is illustrated in FIGURE 5-19.

FIGURE 5-19. Löschian competition



Under Löschian competition (index *L*), the maximization problem of the IOF in a circular market with competition in both directions is

(5-26) $$\Pi_I^L = \max_{u_I}\left[2\left(\int_0^{\overline{R}_I}(\rho - u_I - tr)\mathrm{d}r\right)u_I\right] = \max_{u_I}\left[2\left(\rho - u_I - \frac{td}{4}\right)u_I\frac{d}{2}\right]$$

for $\overline{R}_I = \frac{d}{2}$ and $d = \frac{1}{N}$,

i.e., the IOF maximizes profits with respect to the UD price by holding the market area fixed at $\overline{R}_I = d/2$ (see also GRONBERG AND MEYER, 1981). The optimal UD price under Löschian competition is

(5-27) $$u_I^L = \frac{\rho}{2} - \frac{td}{8} = \frac{\rho}{2} - \frac{t}{8N}.$$

Again, this is also the solution of Löschian competition in a linear market, where processors are located at the endpoints of the line market with competition in one direction only (see also TRIBL, 2009a and 2009b, regarding the pure IOF market). The solution shown in equation (5-27) is identical to the *AFSZ* solution for the case of competition en route with overlapping market areas (see equation (5-7); see APPENDIX A1.1 for the comparative statics).[142] Like in the situation of competition en route in the circular market, the relevant range of the relative importance of space for this outcome is $0 < s/\rho < 4/3$ (see FIGURE 5-20).

Again, the UD prices paid by IOFs are higher than the monopsony solution of $u_I = \rho/3$ for any $s/\rho < 4/3$; they are increasing towards $u_I = \rho/2$ as the relative importance of space decreases (due to either lower per-unit transportation costs t or a shorter distance between processors d).[143] FIGURE 5-20 shows that the UD price under Löschian competition is lower than it is in the case of competition en route with market overlap (see equation (5-16)) and lower than in the LEC of competition in the backyard (see equation (5-22)).[144] The low price transmission of $\partial u_I^L / \partial \rho = 1/2$ (see also equation (5-27)) also indicates that collusion regarding market areas (i.e., exclusive market areas) implies less competition and, therefore, a higher market power towards farmers.

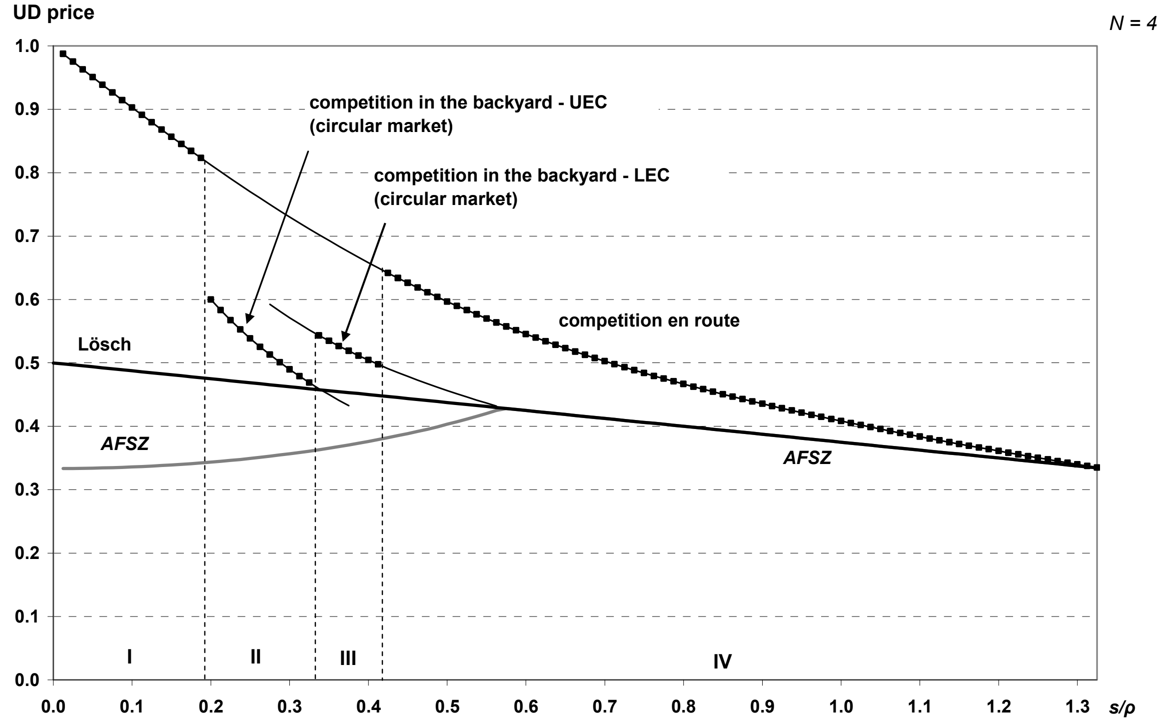
---

[142] In the *AFSZ* model with two processors located on an unbounded line market, Löschian competition can also imply asymmetric market areas of a processors: firms collude with regard to market areas between their locations, but they operate according to the optimal monopsonistic market area $R_I=(\rho-u_I)/t$ in the other direction.

[143] Following GRONBERG AND MEYER (1981), the UD price under Löschian competition approaches the monopsony price in the non-spatial model, $\rho/2$, as t or d approaches zero. GRONBERG AND MEYER (1981, p. 763) argue that Löschian competition "[…] is indeed noncompetitive as the effects of space are deleted." Likewise, *AFSZ* note that a price transmission equal to 1/2 is identical to the non-spatial monopsony.

[144] This result does not necessarily apply to the UEC of competition in the backyard. FIGURE 5-20 shows that the UD price in this situation can be lower than the UD price under Löschian competition for some range of s/ρ. This outcome, however, depends on the number of firms in the market, N.

FIGURE 5-20. UD price (Löschian competition)



Note: In this figure, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. The distance between processors is fixed at $d = 0.25$ as $N = 4$. The net selling price ρ is normalized to 1.

It can be shown that profits of processors in a circular market are higher under Löschian competition than under price matching with overlapping market areas. The fact that overlapping market areas can be observed in the German and Austrian milk market might imply that processors do not coordinate (or are not able to collude regarding) market areas. For example, GRAUBNER ET AL. (2011a, p. 104) note regarding Löschian competition that "[…] the enforcement of exclusive market areas necessitates a high degree of coordination and therefore high transaction costs." SCHÖLER (1988, p. 164) argues that different conjectures (e.g., price matching, Lösch) can be interpreted as different assumptions about information; the available information forms the basis to predict the behavior of competitors. In this sense, Löschian competition requires a large amount of information. Considered differently, overlapping market areas under the price-matching conjecture imply a rather high degree of competition. Thus, the existence of overlapping market areas could be regarded dynamically as a means of crowding out competitors by accepting market overlap in the short run.

5.4 SUMMARY

In CHAPTER 5, spatial competition between IOFs is analyzed based on the model developed by *AFSZ*. *AFSZ* consider a spatial duopsony with two IOF processors located on an unbounded line market. Under the assumptions of UD pricing and the price-matching conjecture, the market areas of the two processors can overlap between the locations of the processors (“competition en route”) or processors extend their market areas even beyond the location of a competitor (“competition in the backyard”). The specific market form of *AFSZ* implies that not all farmers in the market are served by processors engaged in spatial competition. *AFSZ* derive an inverted U-shaped UD-price function that is determined by the importance of space (in terms of the product of per-unit transportation costs and the distance between processors). If the importance of space is relatively low, IOFs are in the situation of competition in the backyard. If space is relatively important, IOFs are in the situation of competition en route. If space is even more important, IOFs are spatially separated monopsonists. The UD price under spatial competition is higher compared to the monopsony level. Interestingly, in the situation of competition in the backyard, the UD price is increasing (i.e., above the monopsony level) as the importance of space increases. *AFSZ* argue that IOFs increase the UD price in order to reduce the area of overlap. In the *AFSZ* model, IOFs face a competitor only on one side of the market. As the distance between these two processors decreases towards zero, both processors are located at the same point in space; i.e., the resulting market structure is, in effect, a monopsony.

To modify (and maybe generalize) the model, an alternative market form is analyzed: a circular market where processors are located on the circumference. Then, competition occurs on both sides of either processor. Another advantage of such a market form is the possibility to account for the number of processors. If the circumference of the circular market is fixed (which is equivalent to the given expansion of a certain region), then the distance between processors decreases as the number of processors increases. For this market form, the same situations of competition with overlapping market areas can be derived. Generally, UD prices in the circular market are higher relative to the UD prices derived by *AFSZ*. The results show that, in the situation of competition en route, the outcome of the model moves towards the competitive market case as space becomes less important. However, for this low level of the importance of space, IOFs are still in the situation of competition en route (whereas, at the same level in the *AFSZ* model, IOFs are in the situation of competition in the backyard). Therefore, competition in the backyard can be regarded as a rather special case of spatial competition. If processors wish to serve a market area that extends beyond the locations of neighboring competitors (i.e., the lower extreme case of competition in the backyard), they must significantly reduce UD prices paid to farmers (relative to competition en route). Again, the optimal UD price is increasing if space becomes less important.

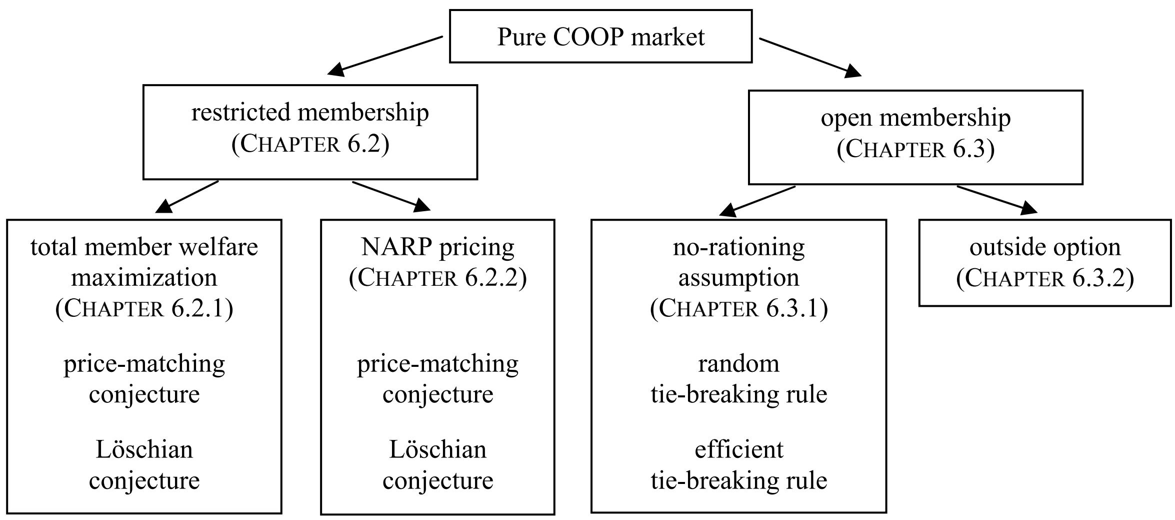
In the (upper) extreme case of competition in the backyard, processors wish to serve almost the entire market area available by competing beyond the location of the most distant competitor on each market side. Only in this case, a decreasing UD price can be identified as space becomes less important, as in *AFSZ*. In addition, this is only true if the importance of space decreases due to a decreasing distance between processors (i.e., due to an increasing number of processors). The effect of a decreasing importance of space due to decreasing per-unit transportation costs, however, implies an increasing UD prices.

Another situation under the price-matching conjecture involves processors colluding with regard to market areas such that each processor operates within an exclusive non-overlapping market area (i.e., Löschian competition). This type of competition in the circular market results in the highest market power towards farmers and thus in the highest profit level for processors. The (non-competitive) UD-price solution for Löschian competition with non-overlapping market areas in the circular market is exactly the same as the solution *AFSZ* derive for their situation of competition en route with overlapping markets.

6 SPATIAL COMPETITION OF COOPERATIVES (COOPS)

One strategy for farmers to evade the market power of IOF food processors is forward integration and the formation of a processing cooperative (COOP). CHAPTER 2.2 highlighted the importance of processing COOPs in the German and Austrian raw milk market. An example of spatial competition among COOPs can be found in the northernmost part of Germany, Schleswig-Holstein, which is (almost) exclusively served by COOPs. To my knowledge, despite the analytical and empirical contribution of HUCK ET AL. (2006) assuming the price-matching conjecture and the analytical work of FOUSEKIS (2011) assuming the Hotelling-Smithies conjecture, spatial competition among COOPs has not been analyzed in the literature thus far (see also CHAPTER 4).[145] The objective of the present chapter is to analyze differences in the outcome of spatial competition among COOPs relative to spatial competition among IOFs as examined in CHAPTER 5. Thus, the present chapter develops a spatial competition model for a pure COOP market under the assumptions of UD pricing and price matching. The analysis considers different COOP objective functions and different membership policies. FIGURE 6-1 illustrates the structure of this chapter.

FIGURE 6-1. Spatial competition models (pure COOP market)



Before setting up a model of spatial competition among COOPs and comparing the results with the pure IOF market, important assumptions for the pure COOP market are introduced in CHAPTER 6.1. The subsequent sections analyze spatial competition among COOPs depending on the membership policy. CHAPTER 6.2 considers restricted membership and analyzes

[145] First attempts to analyze different aspects of spatial competition in a pure COOP market are included in the conference contribution TRIBL (2009a) and in the working paper TRIBL (2009b). In this chapter, the models included in these papers have been improved in many ways and additional models are presented.

differences between total member welfare (TMW)-maximizing COOPs and NARP-pricing COOPs. Both the price-matching conjecture *per se* and Löschian competition will be considered. CHAPTER 6.3 analyzes open-membership COOPs using two different approaches: the no-rationing assumption (assuming the random and the efficient tie-breaking rule) and the existence of an outside option for farmers.

6.1 INTRODUCTION TO THE COOP MODELS

In the present chapter, the analytical models of a pure IOF market analyzed in CHAPTER 5.2 and 5.3 will be adopted to analyze spatial competition of food processing COOPs as a different legal form of processors (see also CHAPTER 4). Processing COOPs procure the raw product from their members, process it and sell it on the processed goods market (COTTERILL, 1987, p. 202). As in CHAPTER 5, the assumed pricing policy is UD pricing: COOPs account for the costs of transporting the raw product from the location of the farmer to the location of the processing facility, and all COOP members (i.e., farmers) receive the same UD price irrespective of their distance to the processor. Before beginning the analyses, the following paragraphs discuss important assumptions for the models by considering the market form, membership policy, COOP objective function, and conjecture.

First, in CHAPTER 5, the effect of different assumptions regarding the market form on the outcome in a pure IOF market was analyzed. In the situation of spatial competition, not all farmers are served by processors in an unbounded line market as in *AFSZ*; however, all farmers are served in the case of a bounded line market or a circular market. The present chapter assumes a bounded line market where both COOPs are located at the endpoints of the line. Therefore, the outcome of the model can be consistently compared with the pure IOF market, assuming a circular market as in CHAPTER 5.2 and CHAPTER 5.3.[146] The alternative model of a pure COOP market assuming the *AFSZ* market form is analyzed by HUCK ET AL., 2006; see also APPENDIX A2.2.

Second, a COOP's membership policy can be either restricted (i.e., closed) or open. According to the German and Austrian Cooperative Societies Acts, COOPs have an open-membership policy (see CHAPTER 2.3). Strictly speaking, under open membership, any farmer who wishes to join the COOP must be accepted. In addition, each member must deliver his total supply to the COOP, and the COOP, in turn, must accept all members' total supply.

[146] Spatial competition in a line market with processors located at the endpoints is equal to a circular market setting (see CHAPTERS 5.2 and 5.3), in particular, in the cases of Löschian competition and competition en route (i.e., price matching). For reasons of simplicity, a circular market will not be considered for the case of spatial competition among COOPs. Consequently, the situation of competition in the backyard with overlapping market areas beyond the location of the competitor cannot be analyzed.

Thus, open membership implies that, theoretically, the COOP cannot determine its optimal market area in a centralized manner as an IOF can. The COOP processor's exclusion of potential members located outside of a defined market area can be regarded as restricted membership. However, according to the BKA (2009, p. 81), COOPs are not obliged to accept every farmer as a member; in addition, COOPs need to determine an economically reasonable market area despite an open-membership policy (see the discussion in CHAPTER 2.3). Hence, in the models, both restricted and open membership will be considered:

i) Under restricted membership, it will be assumed that the COOP as a processor can determine its optimal market area. A restricted-membership policy is similar to an IOF's decision about the optimal market area. Analyzing a COOP with restricted membership in the first place implies that the pure COOP market model can be compared with the IOF market model, as in CHAPTER 5.2 and 5.3. Hence, differences in the outcome between the IOF and the COOP market models are based on differences between objective functions of processors only.

ii) Under open membership, it will be assumed that the COOP cannot exclude farmers. Open membership will be considered in two ways: given the "no rationing assumption" (IOZZI, 2004, p. 513), a COOP cannot exclude farmers from membership and consequently, must consider the total available area as its market area. Alternatively, open membership can be accounted for by assuming the existence of an outside option for farmers. The outside option determines the minimum UD price that COOPs must pay because there is a better option for farmers than supplying the COOP otherwise. The market area of the (monopsonistic) open-membership COOP is then determined by farmers' choice between supplying the COOP and the outside option.

Third, the aim of a COOP is to support its members ("promotion of members", see CHAPTER 2.3). As discussed in CHAPTER 4.1, the objective function of COOPs is different from that of IOFs. The theoretical literature discusses various assumptions regarding the objective function of COOPs. The most prominent examples of COOP objectives in the theoretical literature are TMW maximization (see, e.g., TENNBAKK, 1995; and SEXTON, 1990) and NARP pricing (see, e.g., HELMBERGER AND HOOS, 1962; and SEXTON, 1990); see CHAPTER 4.1. According to the review in CHAPTER 2.3, NARP pricing and TMW maximization seem to be good candidates for suitable objective functions of German (or even Austrian) milk processing COOPs. Under NARP pricing, the COOP's profits from processing and selling the product are equal to zero, i.e., farmers receive the highest possible price, subject to covering the processing costs of the COOP (see, e.g., LEVAY, 1983; and

COTTERILL, 1987, p. 206). The achievement of high prices is, in effect, the aim (or motivation) of farmers who become COOP members (see also BKA, 2009, p. 48 and pp. 85). In recent years, COOPs have begun to act more and more like vertically integrated firms with the objective of maximizing "total profits" (BKA, 2009, p. 48). This term can be interpreted as TMW maximization (i.e., maximization of the sum of the total profits of members from producing the raw product and the COOP's profits from processing and selling it on the processed goods market). In the spatial competition models in CHAPTERS 6.2 and 6.3, both TMW maximization and NARP pricing will be considered.

Finally, one would not expect processing COOPs to exercise market power towards their members. Such behavior would contradict to a COOP's aspect of member promotion. Perfect transmission of the net selling price to the UD price, or at least a higher price transmission than in the case of an IOF, can be expected. CHAPTER 5 demonstrated that the market areas of competing IOFs overlap under the price-matching conjecture *per se* (with "competition en route/in the backyard"); under Löschian competition, this is not the case. The outcome of the price-matching conjecture implies less oligopsonisic power towards IOF suppliers (the optimal UD price is higher) but lower profits for IOFs relative to the situation under the Löschian conjecture.[147] The cases of overlapping and non-overlapping market areas will be analyzed depending on the membership policy and on the COOP's objective function.

6.2 RESTRICTED MEMBERSHIP

The analysis of spatial competition in a pure market of processing COOPs starts by assuming a restricted-membership policy. Restricted membership implies that a COOP can determine its optimal market area in a centralized manner, similar to an IOF, and does not accept any farmer located beyond the market boundary as a member (and, in the models, as a supplier).

CHAPTERS 5.2 and 5.3 analyzed spatial competition of IOFs in a circular market under UD pricing and given the price-matching conjecture (i.e., price matching *per se* and Löschian competition). To keep the model as simple as possible, it is sufficient to reduce the circular market to a line market where processors are located at the endpoints separated by distance d (see also the discussion of the market form in CHAPTER 5). Consequently, the market area of processors extends only in one direction, and Löschian competition and competition en route (i.e., price matching with competition between the locations of competitors) can be considered. The objective functions of the COOPs are assumed to be either TMW

[147] This result is derived in the absence of fixed costs and represents the short-run equilibrium. The long-run (i.e., free entry) equilibrium is derived by GRONBERG AND MEYER (1981) for the oligopoly case. Given a certain level of fixed costs, firms will enter the market up to the point where the profits are zero.

maximization (CHAPTER 6.2.1) or NARP pricing (CHAPTER 6.2.2). All other assumptions are the same as for the IOF market models in CHAPTER 5: COOPs employ a UD-pricing policy and are thus responsible for transportation costs. Per-unit transportation costs are given by t. Farmers produce perfectly homogenous goods and are price takers with respect to UD prices received. Farmers are uniformly distributed along the line market of length d with density $D=1$. The processed goods market is characterized by perfect competition, with the selling price net of constant per-unit processing costs being ρ. In addition, there is no capacity constraint for either processors or farmers.

6.2.1 THE TOTAL MEMBER WELFARE-MAXIMIZING COOP

Assume that the objective of the UD-pricing COOP is to maximize TMW, i.e., to maximize "[…] members' profit from jointly producing and marketing their product […]" (SEXTON, 1990, p. 714); see also CHAPTER 4.1.1.[148] The COOP treats raw product production by its members as internal production and is therefore modeled as a vertically integrated organization (see also CHAPTER 4). Then, the objective function of the COOP (TMW Π_C, where index C indicates the COOP) is given by the sum of the profits of COOP members from producing the raw product (Π_C^f; farmers are indicated by index f) and the profits of the COOP from buying the raw product from its members, transporting it to the processing facility and selling the processed product on the processed goods market (Π_C^p, in the remainder referred to as "profits from processing" and index p). The following analysis of the monopsonistic TMW-maximizing COOP is based on HUCK ET AL. (2006). The derivation of profits of COOP members from producing the raw product, Π_C^f, requires additional assumptions about the cost function of farmers. Let a single farmer's technology be given by the quadratic cost function

$$(6\text{-}1)\quad c_C^f = \frac{1}{2} q_C^2$$

where q_C is the quantity produced by each COOP member. For reasons of simplicity, fixed costs of farmers are assumed to be equal to zero. Each farmer receives a UD price u_C and maximizes the following profit function from producing the raw product with respect to q_C:

[148] In his article, assuming FOB pricing, SEXTON (1990, p. 714) specifies this objective as net marginal revenue product pricing, i.e., "NMRP pricing".

(6-2) $\pi_C^f = \max_{q_C}\left[u_C q_C - c_C^f\right]$

The solution of the first-order condition gives the simple unity supply function as assumed in *AFSZ* and FOUSEKIS (2010) as well as in the pure IOF market in CHAPTER 5:[149]

(6-3) $q_C = u_C$

Now, the profit function of a single farmer from equation (6-2) can be reformulated into[150]

(6-4) $\pi_C^f = \frac{1}{2}u_C^2$.

From (6-4), per-unit profits of a COOP member from producing the raw product are given by

(6-5) $\frac{\pi_C^f}{q_C} = \frac{u_C}{2}$.

The sum of profits of all COOP members supplying the COOP processor within its market area R_C in one direction is given by

(6-6) $\Pi_C^f = \frac{u_C}{2}R_C u_C = \frac{u_C^2 R_C}{2}$.

A COOP located at the endpoint of a line market of length *d* is in a monopsonistic position as long as $R_C \le d/2$. Adding the profits of the COOP from processing (which is mathematically equal to the profits of an IOF; see equation (5-1) for competition in both directions) and the sum of profits that COOP members earn from producing the raw product (equation (6-6)) gives the TMW function of the monopsonistic COOP, Π_C^M (see also HUCK ET AL., 2006, assuming the *AFSZ* market form):

(6-7)
$$\begin{aligned}\Pi_C^M &= \max_{R_C,u_C}\left[\Pi_C^f + \Pi_C^p\right] = \max_{R_C,u_C}\left[\left(\int_0^{R_C}\left(\frac{u_C}{2}\right)\mathrm{d}r + \int_0^{R_C}(\rho - u_C - tr)\mathrm{d}r\right)u_C\right]\\ &= \max_{R_C,u_C}\left[\left(\int_0^{R_C}\left(\rho - \frac{u_C}{2} - tr\right)\mathrm{d}r\right)u_C\right] = \max_{R_C,u_C}\left[\left(\rho - \frac{u_C}{2} - \frac{tR_C}{2}\right)R_C u_C\right]\end{aligned}$$

The objective of the COOP is assumed to be the maximization of TMW. Like in the case of a single farmer's cost function it is assumed that the COOP's fixed costs are equal to zero.[151] As

[149] The profits of a single COOP member are derived by assuming a specific cost function of farmers; see equation (6-1). HUCK ET AL. (2006) take a different route: they derive a farmer's profit function by taking the supply function $q_C=u_C$ as given. Both approaches yield the same profit function of a farmer, equation (6-4).

[150] Note that given a farmer's cost function (equation (6-1)) and a strictly positive UD price, the profits of a single farmer will always be positive in the absence of fixed costs.

the COOP treats the raw product production of its members as internal production, $u_C/2$ in the last reformulation in equation (6-7) represents the per-unit production costs of each farmer, given the quadratic cost function in equation (6-1) (likewise, $u_C/2$ represents a farmer's per-unit profits; see equation (6-5)). Like for an IOF, $(tR_C)/2$ represents the average transportation costs per unit of the raw product. The term in parentheses in the last formulation of equation (6-7) is therefore TMW per unit processed. Multiplying this term by R_C gives TMW if the COOP collects exactly one unit from each member within the market area in one direction; multiplying the result by $u_C (= q_C)$ gives TMW.

Due to the restricted-membership policy, the monopsonistic COOP determines an optimal market area in a centralized manner, similar to an IOF. Taking the UD price u_C as given for the moment and maximizing TMW with respect to R_C as in equation (6-7) gives the optimal market area:

(6-8) $$R_C = \frac{\rho - \frac{u_C}{2}}{t}.$$

TMW per unit from serving a farmer located distance r from the location of the COOP is $\rho - u_C/2 - tr$ (see also equation (6-7)). Thus, the marginal TMW from serving a farmer located distance R_C from the location of the COOP, as in equation (6-8), is zero. To put it differently, the COOP serves distances up to location r where local per-unit TMW is zero: $\rho - u_C/2 - tr = 0$.[152] If the COOP pays a UD price that is equal to that of an IOF ($u_C = u_I$), the optimal market area of the COOP will be larger relative to the IOF's ($R_I = (\rho - u_I)/t$; see equation (5-2) in CHAPTER 5.1). In addition, the optimal market area of the COOP is positive, even if the UD price for the raw product is higher than the price in the processed goods market: $R_C \geq 0$ for $u_C \leq 2\rho$.

151 Under the objective of TMW maximization, the assumption of positive fixed costs of the COOP does not change the solutions of the model. Under the alternative objective of NARP pricing (see CHAPTER 6.2.2), positive fixed costs and no fixed costs of the COOP yield different solutions.

152 This expression shows that the COOP collects milk as long as marginal revenues from raw milk production and processing are equal to marginal costs ($\rho + u_C/2 = u_C + tr$; see also HUCK ET AL., 2006). The equality of *marginal* TMW and *local* TMW per unit (both being equal to zero) only applies in the absence of fixed costs. In the presence of fixed costs F of the COOP, *marginal* TMW is equal to zero at R_C as in equation (6-8) as well. TMW is maximized but negative in the presence of fixed costs F. However, *local* TMW per unit (i.e., TMW per unit at point r) in the presence of fixed costs F is zero for $\rho - u_C/2 - tr = F/r$.

Maximizing TMW with respect to the UD price u_C, as in equation (6-7), and taking the market area R_C as given for the moment yields:[153]

(6-9) $$u_C = \rho - \frac{tR_C}{2}$$

According to equation (6-9), the optimal UD price of the monopsonistic COOP is determined by the difference between the net selling price and average transportation costs. After substitution of equations (6-8) and (6-9), the optimal UD price and the optimal market area of the monopsonistic COOP are, respectively,

(6-10) $$u_C^M = \frac{2}{3}\rho = 2u_I^M$$

(6-11) $$R_C^M = \frac{2\rho}{3t} = R_I^M \ .$$

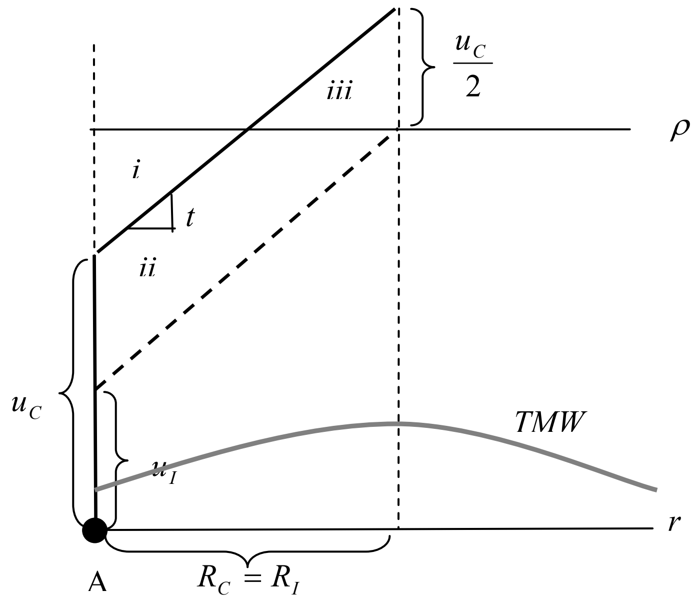
The monopsonistic COOP pays double the UD price of the monopsonistic IOF, but the optimal market areas of the COOP and the IOF are equal in size (see also equations (5-4) and (5-5)). In addition, equation (6-10) shows that price transmission is not perfect for the case of the monopsonistic COOP, but it is higher than for the case of the monopsonistic IOF: $\partial u_C^M / \partial\rho = 2/3 = 2(\partial u_I^M / \partial\rho)$ (see also equation (5-12)). Like for an IOF, the optimal UD price of the monopsonistic COOP is independent of per-unit transportation costs, *t* (see also the discussion in CHAPTER 3.2.1). Due to the UD-pricing policy of the COOP, the market area decreases in *t* and increases in ρ (see equation (6-11)). Consequently, a higher transportation rate implies a smaller market area and, thus, a restriction of the number of members (by paying a UD price that is independent from *t*).

Differences between the monopsonistic COOP and the monopsonistic IOF are illustrated in FIGURE 6-2. Compared to the IOF (see CHAPTER 5.1), the UD price paid by the monopsonistic COOP is twice as high; the market areas for the COOP and the IOF are equal in size. The COOP's per-unit profits from collecting and processing one unit of the raw product from each COOP member are *i - iii*; the sum of per-unit profits of all members is *ii + iii*. Per-unit TMW (*i + ii)* is therefore equal to per-unit profits of an IOF. However, given the supply function $q_C = u_C$, the quantity supplied by each COOP member is twice as large compared to an IOF supplier. Therefore, the TMW of the monopsonistic COOP is double the profits of the monopsonistic IOF. In FIGURE 6-2, *TMW* is the stylized TMW function if the COOP takes the

[153] At the same time, equation (6-9), i.e., the solution of the first-order condition with respect to u_C (for a given market area R_C) is the NARP function of the COOP; see CHAPTER 6.2.2.

UD price as given and determines an optimal market area according to equation (6-8). Then, TMW is maximized at the point where $r = R_C$. In addition, *local* TMW per unit at point $r = R_C$ is equal to zero as the (negative) per-unit profits from processing ($u_C / 2$) are equal to the (positive) per-unit profits of a single farmer ($u_C / 2$).

FIGURE 6-2. Monopsony model of the restricted-membership COOP compared to the IOF



Note: See also HUCK ET AL. (2006)

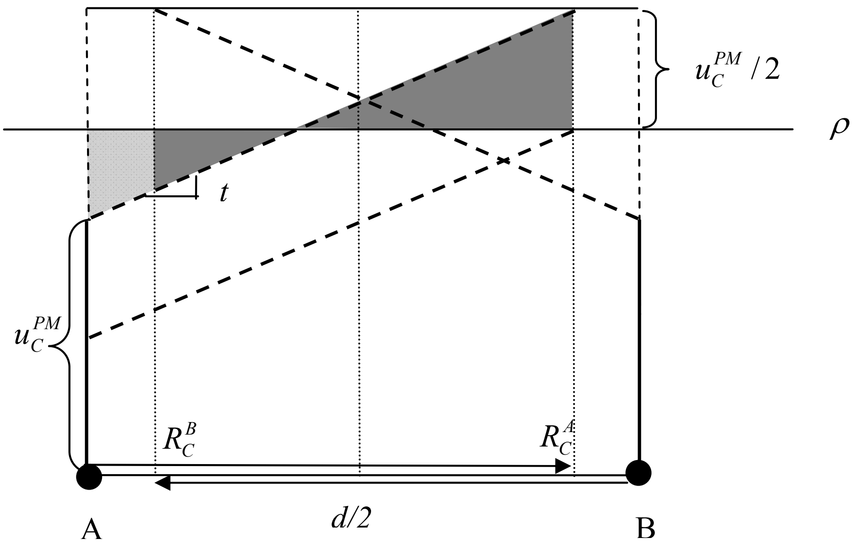
The TMW-maximizing COOP pays a higher UD price than the IOF does at the costs of profits from processing. Profits from processing of the COOP (Π_C^{M-p}) are mathematically equal to the profits of an IOF:

$$(6\text{-}12) \qquad \Pi_C^{M-p} = \left(\rho - u_C^M - \frac{tR_C^M}{2} \right) u_C^M R_C^M$$

Substituting the optimal UD price (equation (6-10)) and the optimal market area (equation (6-11)) into equation (6-12) gives $\Pi_C^{M-p} = 0$. Hence, in the monopsony situation, the TMW-maximizing COOP pays a UD price such that profits from processing are equal to zero, i.e., the COOP breaks even. In FIGURE 6-2, area *i* is equal to area *iii*. To put it differently, the monopsonistic TMW-maximizing COOP shares TMW among its members. Consequently, the resulting TMW of the monopsonistic COOP only consists of total profits of COOP members from producing the raw product (Π_C^f, see equation (6-6)).

As $R_C^M = R_I^M$, the TMW-maximizing COOP is in a monopsonistic position like an IOF for $s/\rho \geq 4/3$ and $s=td$. If the relative importance of space s/ρ is decreasing, the COOP enters the situation of spatial competition with the neighboring COOP.[154] Assuming the price-matching conjecture, two situations are possible (see also CHAPTER 3.3.1): market areas either overlap (price matching *per se,* index *PM*) or do not overlap (Löschian competition, index *L*); see, e.g., GRONBERG AND MEYER (1981) or the cases of cooperative spatial competition in GRAUBNER ET AL. (2011a). FIGURE 6-3 illustrates the situation under price matching with two COOPs A and B located at the endpoints of a line market. Thus, the following analysis is different from the analysis in HUCK ET AL. (2006).

FIGURE 6-3. COOP duopsony under price matching (TMW maximization)



The light grey area in FIGURE 6-3 represents the profits from processing of COOP A (if it collects one unit of the raw product from each farmer) within its exclusive share of the market area. The dark grey area illustrates profits from processing in the area of market overlap. As UD prices between competing COOPs must be equal in equilibrium, it can be assumed that farmers in the disputed area patronize a specific COOP on a random basis (i.e., farmers are shared equally between COOPs within the area of overlap). Therefore, profits from processing are given by the light grey area plus half of the dark grey area. Equation (6-7) is no longer the TMW function of the COOP because not all farmers supply the COOP within its market area, $R_C = (\rho - u_C/2)/t$. TMW under the price-matching conjecture is given by

[154] Throughout the analysis in CHAPTER 6, only pure markets are considered; i.e., it is assumed that the objective functions of both COOPs in the market are equal.

$$(6\text{-}13)\quad \Pi_{C-TMW}^{PM} = \max_{u_C}\left[\left(\int_0^{d-R_C}\left(\rho-\frac{u_C}{2}-tr\right)\mathrm{d}r+\frac{1}{2}\int_{d-R_C}^{R_C}\left(\rho-\frac{u_C}{2}-tr\right)\mathrm{d}r\right)u_C\right]$$

for $R_C = \dfrac{\rho - \frac{u_C}{2}}{t}$.

Index *TMW* indicates that it is the objective of the COOP to maximize TMW. As both COOPs are located at the endpoints of a line market, market areas can only overlap between them.[155] The first term in equation (6-13) gives the section of the market area without overlap. The second term gives the area of overlap, where farmers are shared equally between processors. Substituting for R_C (equation (6-8)) and maximizing TMW as in equation (6-13) with respect to u_C gives the optimal UD price

$$(6\text{-}14)\quad u_{C-TMW}^{PM} = \frac{4(\rho-dt)+\sqrt{4\rho^2-8dt\rho+10d^2t^2}}{3} = 2u_I^{er}.$$

Substituting equation (6-14) into equation (6-8) gives the optimal market area under price matching:

$$(6\text{-}15)\quad R_{C-TMW}^{PM} = \frac{2\rho+4dt-\sqrt{4\rho^2-8dt\rho+10d^2t^2}}{6t} = R_I^{er}$$

Again, the market area of the COOP is equal to the IOF in the situation of competition en route (*er*, see equation (5-18)), but the UD price is double the UD price of the IOF (see equation (5-16)). Likewise, price transmission in the pure COOP market is twice as high:

$$(6\text{-}16)\quad \frac{\partial u_{C-TMW}^{PM}}{\partial\rho} = \frac{4}{3}+\frac{8(\rho-dt)}{6\sqrt{4\rho^2-8dt\rho+10d^2t^2}} = 2\frac{\partial u_I^{er}}{\partial\rho}$$

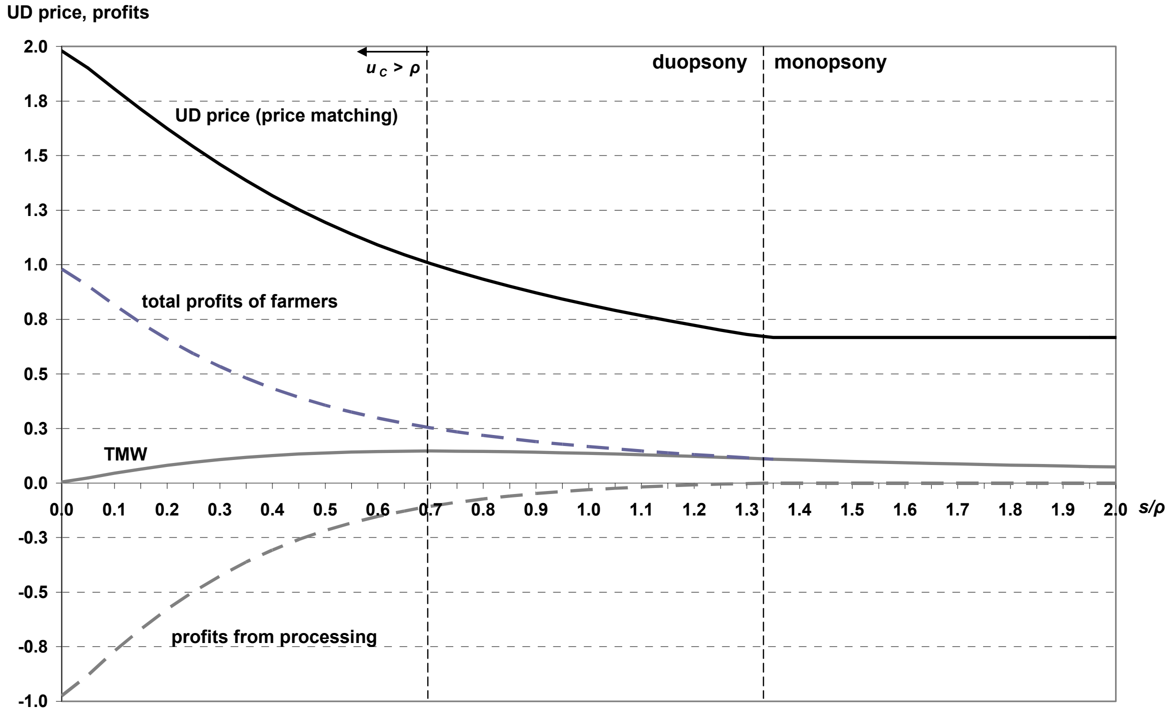
(see also equation (5-19)). Comparative statics of the UD price and the market area are given in APPENDIX A2.1.1 and are qualitatively equal to the optimal UD prices and market area in the pure IOF market. Because $R_{C-TMW}^{PM} = R_I^{er}$, spatial competition is given for the same range of the relative importance of space as in the pure IOF market in CHAPTER 5: $d/2 < R_C \le d$ or $0 < s/\rho < 4/3$. As s/ρ decreases towards zero, the market area increases towards $R_C \to d$.

FIGURE 6-4 illustrates the optimal UD price and components of TMW depending on the relative importance of space. In the situation of spatial competition ($s/\rho < 4/3$), the UD

[155] This is equivalent to "competition en route" (*er*) in CHAPTER 5.

price increases as the relative importance of space decreases; in the monopsony situation ($s/\rho \geq 4/3$), the UD price is constant.

FIGURE 6-4. UD price and components of TMW of the TMW-maximizing COOP (restricted membership)



Note: In this figure, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. Both the net selling price *ρ* and the distance *d* between processors are normalized to *1*.

For the monopsony situation, it was shown that the COOP's profits from processing are equal to zero such that the COOP breaks even. In the situation of spatial competition with overlapping market areas, however, the TMW-maximizing COOP fails to break even (see also SEXTON, 1990, for the case of FOB pricing). FIGURE 6-4 shows that profits from processing are negative for any $s/\rho < 4/3$. These negative profits from processing increase as *s/ρ* decreases. TMW, however, is positive because the high total profits of COOP members from producing the raw product outweigh the COOP's negative profits from processing. As farmers are shared equally between processors in the area of overlap, a share of farmers in the market equal to *d/2* patronizes one specific COOP. Thus, total supply to a COOP, Q_{C-TMW}^{PM}, is given by

$$(6\text{-}17) \quad Q_{C-TMW}^{PM} = u_C \frac{d}{2}.$$

Therefore, total profits of farmers are

(6-18) $\Pi_{C-TMW}^{PM-f} = \frac{u_C^2}{2}\frac{d}{2} = \frac{u_C}{2}Q_C = \frac{u_C^2 d}{4}$.

It can be concluded that total profits of farmers are only determined by the optimal UD price and the distance between processors, but these profits are independent from the market area of the COOP.

FIGURE 6-4 shows that for $s/\rho \leq \sqrt{2}/2$, the UD price paid to COOP members is higher than the net selling price ρ.[156] This result is at least analytically possible because the COOP is modeled as a vertically integrated organization, which also considers total profits of farmers in its objective function: $\rho - u_C/2 - (tR_C)/2$ is the per-unit TMW, with a single farmer's per-unit production costs being represented by $u_C/2$. Assuming that the UD price will never be higher than the net selling price, $s/\rho = \sqrt{2}/2$ can be regarded as the lowest possible relative importance of space of a TMW-maximizing COOP under price matching.[157] FIGURE 6-4 also shows that TMW is highest at $s/\rho = \sqrt{2}/2$. In addition, price transmission (see equation (6-16)) is greater than 1 for any $s/\rho < 4/3$.

As the TMW-maximizing COOP does not satisfy the break-even constraint under price matching, it must allocate profits/losses from processing among members. Members of such a COOP face a two-part pricing schedule (see also SEXTON, 1990, for the case of FOB pricing). According to SEXTON (1990), losses/profits from processing must be allocated to members as fixed charges/rebates (e.g., lump sum levies or rebates per member, or allocations based on a fixed input such as acreage) so that members cannot adjust their supply behavior accordingly. However, "Allocations, that can be linked back to patronage, e.g., patronage refunds, do not work in this regard because members rationally i[m]pute the refund or levy as part of their net price and adjust their supply behavior accordingly" (SEXTON, 1990, p. 714, footnote 9).

Whether the COOP allocates negative profits from processing by adjusting each farmer's profit or by adjusting the UD price is inconsequential in this model. For demonstration purposes, an adjusted UD price can be calculated (i.e., a UD price after allocation of profits from processing at a later time, e.g., after year-end statements). Per-unit profits/losses from processing (k), are given by[158]

---

[156] This point of the relative importance of space constitutes the maximum of the TMW function over the range $0 \leq s/\rho < 4/3$; see also FIGURE 6-4. Assuming the *AFSZ* market form for a pure COOP market as in HUCK ET AL. (2006), the situation $u_C > \rho$ does not arise; see APPENDIX A2.2.

[157] This situation can be ruled out by assumption. However, this situation is illustrated in the numerical simulations to demonstrate the model results and compare them with the outcome in a pure IOF market.

[158] In SEXTON's (1990) model of a mixed market under FOB pricing, the NMRP-pricing COOP allocates the total deficit/surplus to the COOP among members as fixed charges/rebates. The corresponding denominator of

$$\text{(6-19)} \quad k = \frac{\Pi_{C-TMW}^{PM-p}}{Q_{C-TMW}^{PM}} = \frac{\Pi_{C-TMW}^{PM-p}}{\left(u_C \frac{d}{2}\right)}$$

After allocation of per-unit profits/losses from processing, total profits of COOP members from producing the raw product are equal to TMW (as profits from processing are equal to zero after allocation). Consequently, total profits of COOP members from producing the raw product (Π_{C-TMW}^{PM-f}) after allocation of profits/losses from processing are given by

$$\text{(6-20)} \quad \Pi_{C-TMW}^{PM-f} = \left((u_C + k) - \frac{u_C}{2}\right) u_C \frac{d}{2} = \left(\frac{u_C}{2} + k\right) u_C \frac{d}{2} = \Pi_{C-TMW}^{PM}.$$

In equation (6-20), $u_C / 2$ are per-unit profits of a single COOP member from producing the raw product, and a share of members equal to *d/2* supplies a quantity of $q_C = u_C$ each. After accounting for the allocation of per-unit profits/losses from processing, the per-unit profits of a single farmer are $u_C / 2 + k$ (see also equation (6-18)). In effect, the UD price adjusted by per-unit profits/losses from processing is

$$\text{(6-21)} \quad u_C^k = u_C + k$$

(see also APPENDIX A2.1.2). Total supply to a COOP is determined by u_C (i.e., according to the supply function $q_C = u_C$) and by *d/2* (see also equation (6-19)).

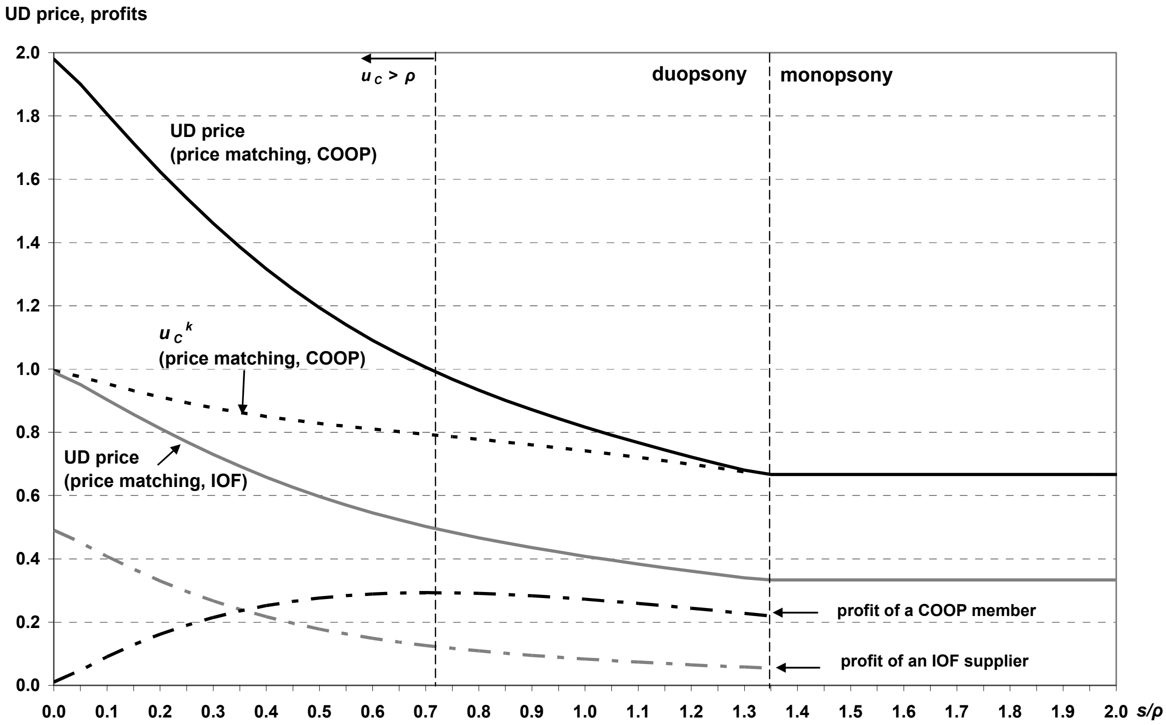
The comparative statics of *k* and u_C^k are summarized in APPENDIX A2.1.2. It can be shown that price transmission regarding the adjusted UD price $\partial u_C^k / \partial \rho$ is less than 1 and approaches 1, both as $s \to 0$ and as $s \to 4/3$ (i.e., price transmission is an inverted U-shaped function of *s*). In FIGURE 6-5, *k* is given by the vertical distance between the UD price and the adjusted UD price. After the allocation of negative profits from processing, the UD price is still higher in the pure COOP market than in the pure IOF market (see the grey line in FIGURE 6-5) but it is lower than ρ.

FIGURE 6-5 also illustrates the profits of a single COOP member after allocation of negative profits from processing. The fact that the UD price paid to COOP members is higher compared to that paid to IOF suppliers implies that production costs of a COOP member, $u_C^2 / 2$, are higher as well. As both u_C and *k* increase as *s/ρ* decreases, the profits of a single COOP member are decreasing for $s / \rho \leq \sqrt{2} / 2$ and are even lower than the profits of an IOF

the final term in equation (6-19) would be the share of COOP members across space patronizing a specific COOP (i.e., *d/2*).

supplier for $s/\rho \leq 16/45$. As mentioned before, this situation can be ruled out, as it would imply a UD price that is higher than the net selling price ρ.

FIGURE 6-5. UD price of the TMW-maximizing COOP (restricted membership)



Note: In this figure, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. Both the net selling price *ρ* and the distance *d* between processors are normalized to *1*.

So far, the COOPs in the market were assumed to follow the price-matching conjecture *per se*, which implies overlapping market areas. The Löschian conjecture implies price matching as well, but market areas are assumed to be fixed at $\overline{R}_C = d/2$ so that there is no overlap. This conjecture can be understood as collusion regarding market areas or as coordination of market areas (in addition to UD prices); see CHAPTER 3.3.1 for a literature review and CHAPTER 5.3 for the pure IOF market. Given a restricted-membership policy, this interpretation is possible for the COOP model as well. Maximization of TMW for the case of Löschian competition (index *L*) implies the following problem:

$$\text{(6-22)} \qquad \Pi^{L}_{C-TMW} = \max_{u_C}\left[\left(\int_0^{\overline{R}_C}\left(\rho - \frac{u_c}{2} - tr\right)\mathrm{d}r\right)u_C\right] \text{ for } \overline{R}_C = \frac{d}{2}$$

The solution of the first-order condition gives the following optimal UD price:[159]

[159] As Löschian competition implies non-overlapping market areas, this result can be equivalently derived by considering the solution of the first-order condition of the monopsonistic COOP that takes the market area as

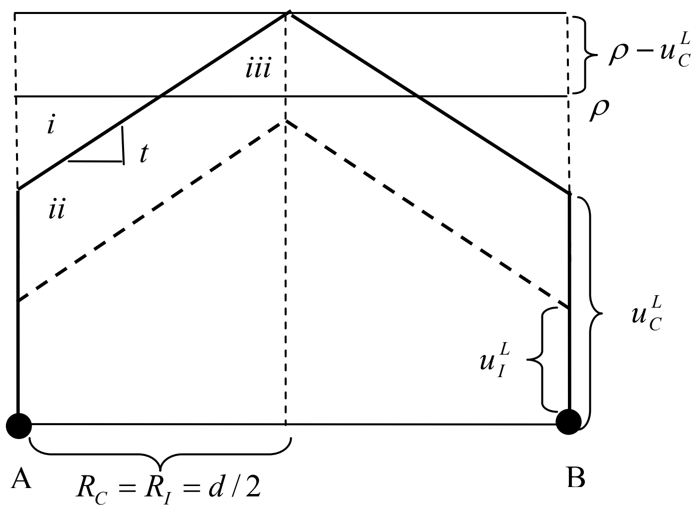
$$\text{(6-23)} \quad u^L_{C-TMW} = \rho - \frac{td}{4} = 2u^L_I$$

Comparative statics of the UD price under Löschian competition are given in APPENDIX A2.1.1. Again, the UD price in the pure COOP market is double the UD price in the pure IOF market under Löschian competition (see equation (5-27)). In addition, price transmission is perfect for any relative importance of space under Löschian competition:

$$\text{(6-24)} \quad \frac{\partial u^L_{C-TMW}}{\partial \rho} = 1 = 2\frac{\partial u^L_I}{\partial \rho}$$

As in the monopsony case, profits from processing are equal to zero for any $0 < s/\rho < 4/3$. Thus, under Löschian competition, the TMW-maximizing COOP breaks even. The COOP model under Löschian competition is illustrated in FIGURE 6-6:

FIGURE 6-6. COOP duopsony under Löschian competition



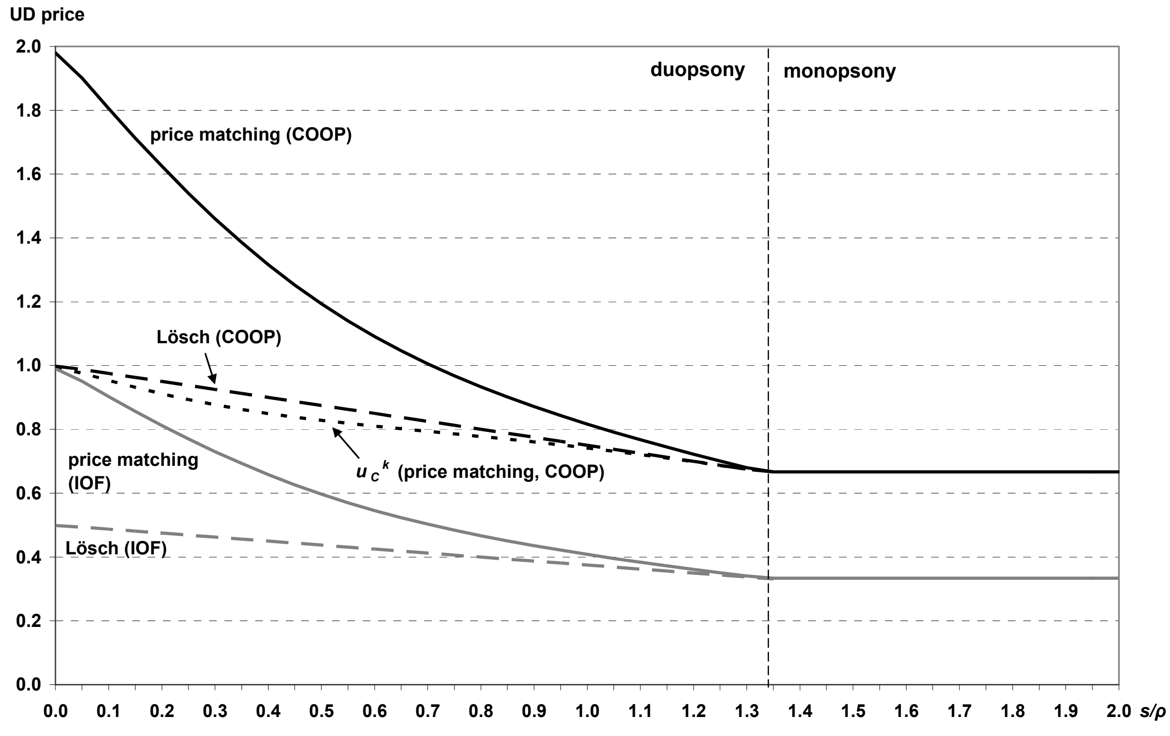
Under Löschian competition, the market area is fixed at $R_C = d/2$. Given the UD price, which maximizes TMW, profits from processing are equal to zero. Therefore, area *i* is equal to area *iii*. If per unit-costs *t* change, the upward sloping lines will rotate around the point of intersection with the horizontal line ρ (i.e., at *r=d/4* for COOP A and *r=(3d)/4* for COOP B). Consequently, a decrease in *t* will increase the UD price u_C.

Relative to price matching with overlapping market areas, Löschian competition yields a higher TMW of the COOP (the same is true regarding the profits of an IOF, see CHAPTER 5.3). However, like in the pure IOF market, FIGURE 6-7 shows that the UD price under Löschian

given, equation (6-9). Substituting for the market area under Löschian competition, R_C=*d/2*, gives the result shown in equation (6-23).

competition is lower relative to that under the price-matching conjecture with overlapping market areas. On the contrary, the UD price under Löschian competition is higher relative to that under the price-matching conjecture after adjustment for negative profits from processing (u_C^k). The aim of the COOP is promotion of its members. As the COOP cannot sustain negative profits from processing in the long run, COOP members are better off under Löschian competition. It can be shown that the allocation of negative profits from processing among members under price matching yields lower individual profits for farmers than they would have under Löschian competition. On the contrary, individual suppliers of an IOF are always worse off under Löschian competition because the individual profits of farmers are lower than they are under price matching (see CHAPTER 5.3; see also FIGURE 6-7 for UD prices). The reason for this difference is that an IOF need not allocate profits and losses among suppliers.

FIGURE 6-7. UD prices of the TMW-maximizing COOP (restricted membership)



Note: In this figure, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. Both the net selling price *ρ* and the distance *d* between processors are normalized to *1*.

6.2.2 THE NARP-PRICING COOP

So far, the analysis of the pure COOP market has assumed the objective of TMW maximization. In the following, an alternative objective of the COOP, net average revenue product (NARP) pricing, will be analyzed. For different input levels, NARP shows the maximum price a COOP can pay for an input given that all other costs have been met (YOUDE

AND HELMBERGER, 1966). Consequently, the NARP function specifies the maximum break-even price a COOP can pay for a given amount of a raw product (SEXTON ET AL., 1989) or the (UD) price, which maximizes TMW subject to satisfying the break-even constraint (SEXTON, 1990); see also CHAPTER 4.1.2. The COOP breaks even if profits from processing are equal to zero. These profits from processing are mathematically equal to profits of an IOF and are given in the monopsony situation by

$$(6\text{-}25) \qquad \Pi_C^{M-p} = \left(\int_0^{R_C} (\rho - u_C - tr) \mathrm{d}r \right) u_C = \left(\rho - u_C - \frac{tR_C}{2} \right) u_C R_C$$

(see also equation (6-7)). NARP can be derived from the net revenue product (NRP), which is as follows for the monopsonistic COOP:

$$(6\text{-}26) \qquad NRP = \left(\rho - \frac{tR_C}{2} \right) u_C R_C$$

$$(6\text{-}27) \qquad NARP = \frac{NRP}{Q_C} = \frac{NRP}{u_C R_C} = \left(\rho - \frac{tR_C}{2} \right)$$

NRP is the revenue net of costs (except the costs of the raw product), which is available for purchasing the raw product; consequently, NARP is the net revenue per unit of the processed product, i.e., the price the COOP can pay for the raw product (see, e.g., LEVAY, 1983; and COTTERILL, 1987, p. 204; see also CHAPTER 4.1.2). Under NARP pricing and given any market area R_C, the COOP sets the UD price u_C equal to NARP as in equation (6-27). NARP pricing results in profits from processing equal to zero, i.e., the COOP breaks even. To put it differently, profits from processing are equal to zero as long as the average TMW of the COOP across space is equal to the profits of a single COOP member:

$$(6\text{-}28) \qquad \frac{\Pi_C^M}{R_C} \overset{!}{=} \frac{u_C^2}{2},$$

i.e., this problem is, in effect, the problem of sharing TMW among members, i.e., $\Pi_C^M \overset{!}{=} \Pi_C^f$. The NARP function in equation (6-27) is decreasing in space. Because the fixed costs of the COOP are assumed to be zero, the NARP function has no maximum, and only its decreasing portion is considered.[160] Fixed costs are not assumed because they would significantly complicate the model (see APPENDIX A2.3.1).

[160] A possible explanation for a downward sloping NARP function is (net) diseconomies of scale (see, e.g., YOUDE AND HELMBERGER, 1966).

Like the TMW-maximizing COOP in CHAPTER 6.2.1, the NARP-pricing COOP under restricted membership needs to determine both a market area to serve and a UD price to pay. In the following, it is assumed that the NARP-pricing COOP determines its optimal market area in the same way as the TMW-maximizing COOP. By taking the UD price as given, the monopsonistic COOP serves a distance up to the point in space where local TMW per unit (or marginal TMW) is equal to zero:

$$(6\text{-}29) \quad R_C^M = \frac{\rho - \frac{u_C}{2}}{t}$$

(see also equation (6-8)). Taking the market area as given, the COOP determines its UD price according to the NARP-pricing rule (such that profits from processing are equal to zero):

$$(6\text{-}30) \quad u_C \overset{!}{=} NARP = \left(\rho - \frac{tR_C}{2}\right)$$

After substitution of equations (6-29) and (6-30), the UD price and the market area of the monopsonistic NARP-pricing COOP are given by

$$(6\text{-}31) \quad u_C^M = \frac{2\rho}{3} = 2u_I^M$$

$$(6\text{-}32) \quad R_C^M = \frac{2\rho}{3t} = R_I^M .$$

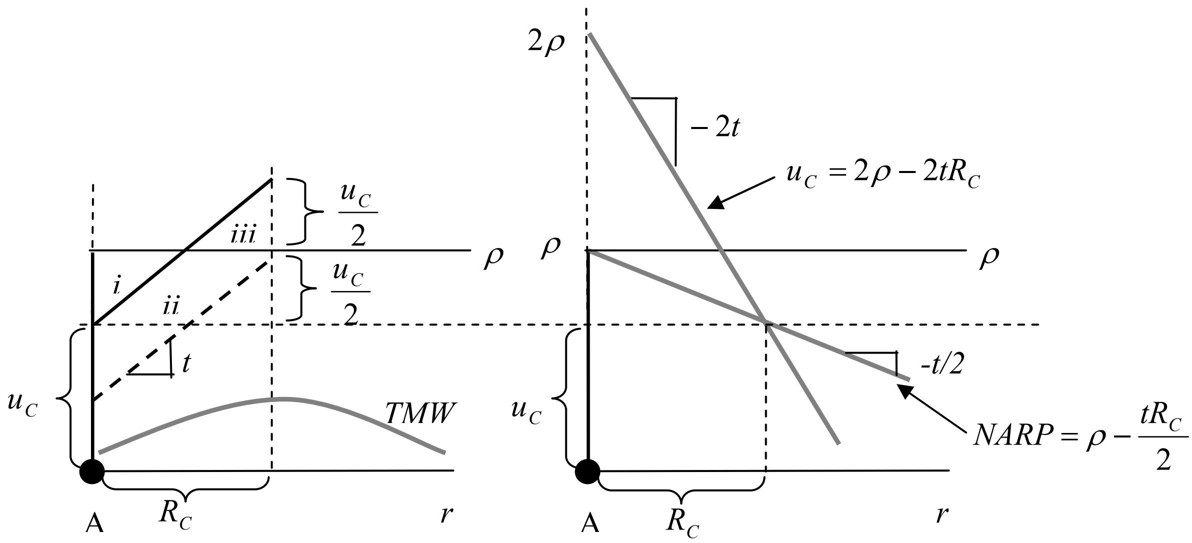
In the absence of fixed costs, the NARP-pricing rule (equation (6-30)) is equal to the solution of the first-order condition of a COOP that maximizes TMW with respect to the UD price, taking R_C as given (see equation (6-9)).[161] Therefore, and as already mentioned in CHAPTER 6.2.1, the TMW-maximizing monopsonistic COOP is at the same time a NARP-pricing COOP (see the solutions in equations (6-10) and (6-11)). Again, the NARP-pricing COOP is in a monopsonistic position ($R_C^M \leq d/2$) for $s/\rho \geq 4/3$.

A graphical representation of the monopsonistic COOP and its differences from the monopsonistic IOF is given in FIGURE 6-8. The left-hand side of FIGURE 6-8 is equal to FIGURE 6-2 for the TMW-maximizing COOP. NARP pricing implies by assumption that profits from processing are equal to zero. Thus, area *i* must be equal to area *iii a priori*. The

[161] Note that this equality is only valid in the absence of fixed costs of the COOP. In the presence of fixed costs, the solution of the first-order condition of a COOP that maximizes TMW with respect to the UD price is the same as in equation (6-30) and (6-9), respectively. However, the TMW-maximizing COOP will make negative profits from processing, which are equal to the level of fixed costs. For the NARP-pricing COOP, the solution is different from equation (6-30) in the presence of fixed costs (see also APPENDIX A2.3.1).

vertical distance above the horizontal ρ-line at the point $r = R_C$ represents (negative) per-unit profits from processing at this point, i.e. $-(u_C/2)$. At the same point in space (and on every point along r), per-unit profits of a single farmer are $u_C/2$. On the right-hand side, FIGURE 6-8 illustrates the NARP function across space, which is decreasing in space r (see equation (6-30)). Given any market area, this function yields a UD price such that profits from processing are equal to zero. The steeper line is a reformulation of the equation for the optimal market area, equation (6-29): $u_C = 2(\rho - tR_C)$. The intersection of this line with the NARP function gives the optimal market area and the corresponding UD price of the monopsonistic COOP.

FIGURE 6-8. Monopsony model of the NARP-pricing COOP



For any $s/\rho < 4/3$, two NARP-pricing COOPs located at the endpoints of a line market are in the situation of spatial competition. Again, the price-matching conjecture (with overlapping market areas) and Löschian competition (with a fixed market area of $\overline{R}_C = d/2$) will be analyzed. The COOP determines the UD price by setting profits from processing equal to zero:[162]

$$(6\text{-}33)\qquad \Pi_{C-NARP}^{p-PM} = \left(\int_0^{d-R_C} (\rho - u_C - tr)\mathrm{d}r + \frac{1}{2} \int_{d-R_C}^{R_C} (\rho - u_C - tr)\mathrm{d}r \right) u_C \overset{!}{=} 0 \text{ for } R_C = \frac{\rho - \frac{u_C}{2}}{t}$$

[162] Alternatively (and similar to equation (6-28), the problem of the NARP-pricing COOP under both price matching (with overlapping market areas) and Löschian competition can be formulated as $\Pi_C^{PM,L}/(d/2)=u_C^2/2$. This formulation implies that average TMW across space must equal the profits that a single farmer receives from producing the raw product.

(6-34) $$\Pi^{p-L}_{C-NARP} = \left(\int_0^{\overline{R}_C} (\rho - u_C - tr) \mathrm{d}r \right) u_C \overset{!}{=} 0 \text{ for } \overline{R}_C = \frac{d}{2}$$

where index *NARP* indicates the objective of NARP-pricing. As before, it is assumed under the price-matching conjecture that farmers (i.e., COOP members) in the area of overlap between processors are shared equally between these processors. As Löschian competition implies non-overlapping market areas, the NARP function under this conjecture is equal to the monopsony situation (see equation (6-30)). Under price matching, the NARP function reads

(6-35) $$NARP^{PM} = \frac{NRP^{PM}}{Q_C} = \frac{\left(\int_0^{d-R_C} (\rho - tr) \mathrm{d}r + \frac{1}{2} \int_{d-R_C}^{R_C} (\rho - tr) \mathrm{d}r \right) u_C}{u_C \left(\frac{d}{2} \right)} \quad \text{for } R_C = \frac{\rho - \frac{u_C}{2}}{t}.$$
$$= \rho - t \left(\frac{d}{2} - R_C \left(1 - \frac{R_C}{2} \right) \right)$$

The solutions to the problems stated in equations (6-33) and (6-34) are

(6-36) $$u^{PM}_{C-NARP} = 2\rho - 3td + \sqrt{7d^2t^2 - 4dt\rho}$$

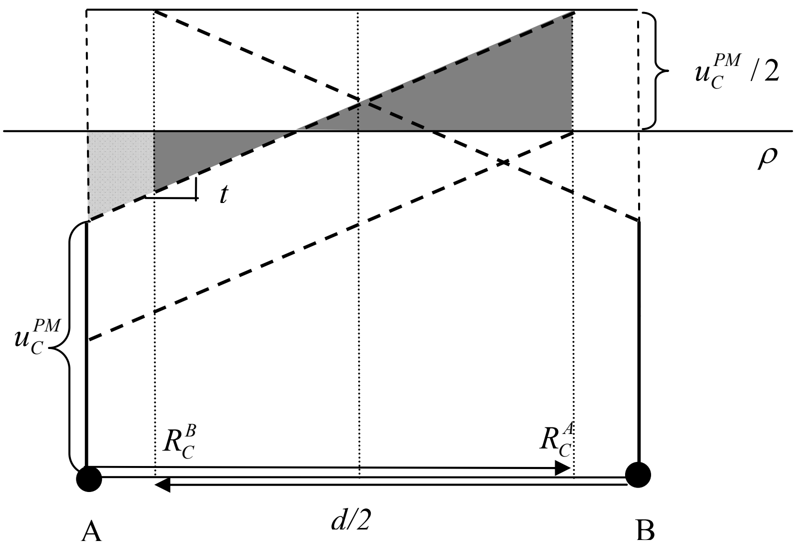
(6-37) $$u^{L}_{C-NARP} = \rho - \frac{td}{4} = 2u^{L}_{I}.$$

In the case of Löschian competition (and in the absence of fixed costs), there is no difference in UD prices between a NARP-pricing COOP (equation (6-37)) and a TMW-maximizing COOP (equation (6-23)) because the TMW-maximizing COOP also makes zero profits from processing under Löschian competition (see CHAPTER 6.2.1). Substituting equation (6-36) into equation (6-29), the optimal market area for the price-matching conjecture is given by

(6-38) $$R^{PM}_{C-NARP} = \frac{3dt - \sqrt{7d^2t^2 - 4dt\rho}}{2t}.$$

FIGURE 6-9 illustrates the model under the price-matching conjecture. The market area of the COOP is determined by the point in space where marginal TMW is equal to zero. This is the case at the point in space where the (negative) per-unit profits from processing $u_C / 2$ are equal to the per-unit profits of farmers, $u_C / 2$. In addition, and for the COOP to break even, the light grey area and half of the dark grey area (due to market overlap) add up to zero.

FIGURE 6-9. COOP duopsony under price matching (NARP-pricing COOPs)



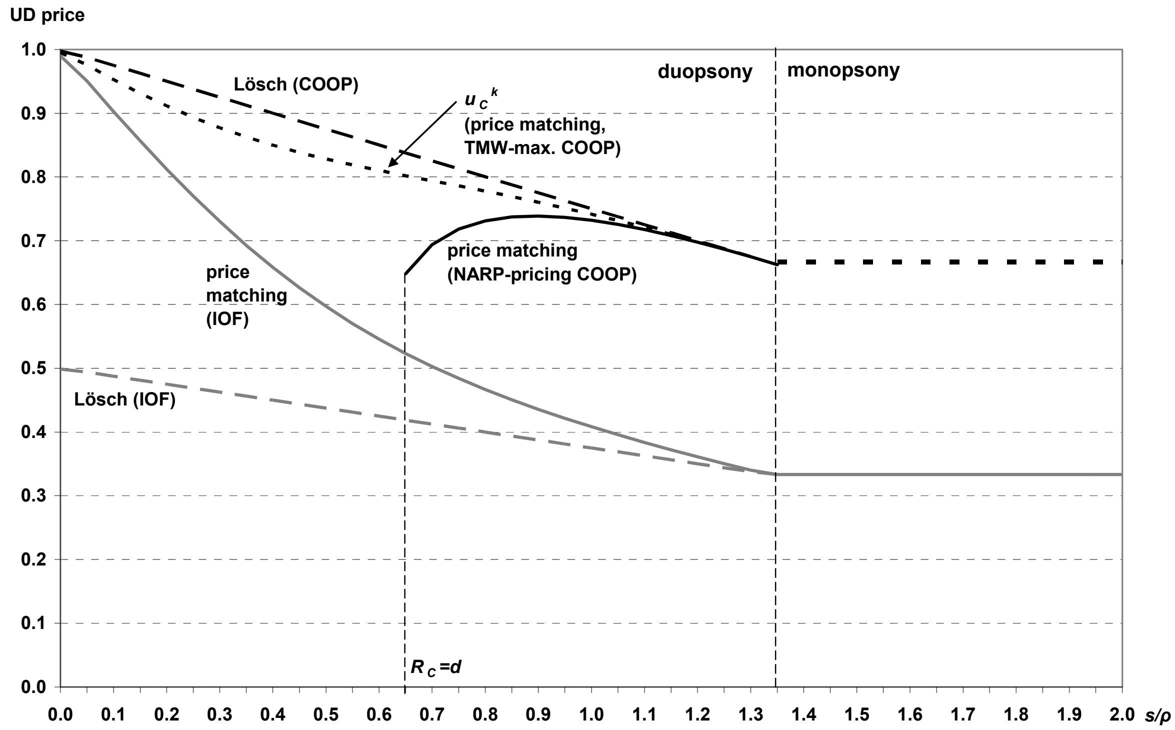
Comparative statics of the UD price and the market area under the price-matching conjecture are given in APPENDIX A2.3.2 (regading Löschian competition, see APPENDIX A2.1.1). Price transmission is perfect in the case of Löschian competition, but it is increasing towards 1 under price matching as the importance of space increases:

(6-39) $$\frac{\partial u_{C-NARP}^{L}}{\partial \rho} = 1$$

(6-40) $$\frac{\partial u_{C-NARP}^{PM}}{\partial \rho} = 2 - \frac{2dt}{\sqrt{7d^2t^2 - 4dt\rho}}; \quad \frac{\partial u_{C-NARP}^{PM}}{\partial \rho} \rightarrow 1 \text{ for } s \rightarrow \frac{4}{3}$$

Thus, under price matching of NARP-pricing COOPs, price transmission changes in the opposite direction than it does in the corresponding cases of a pure IOF market and of a pure market of TMW-maximizing COOPs, respectively. In addition, it can be shown that price transmission is even lower relative to a pure IOF market under price matching if space is rather unimportant. This result is obviously driven by the assumption regarding the market area: under the price-matching conjecture, the COOP does not consider the market area of a competitor. It is assumed that the COOP wants to serve a market area $R_C = (\rho - u_C/2)/t$. Maintaining such a market area while guaranteeing profits from processing equal to zero results in an inverted U-shaped UD price function depending on the relative importance of space (see FIGURE 6-10).

FIGURE 6-10. UD price of the NARP-pricing COOP (restricted membership)



Note: In this figure, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. Both the net selling price *ρ* and the distance *d* between processors are normalized to *1*.

Even if per-unit transportation costs decrease, the NARP-pricing COOP must decrease its UD price at some level of *s/ρ* towards the monopsony solution to guarantee break-even results. Due to the relatively large increase in the market area as *s/ρ* decreases, the price-matching conjecture is only possible within $2/3 \le s/\rho < 4/3$. For $s/\rho = 2/3$, the market area is equal to *d* and therefore constitutes the lower boundary of the relative importance of space of a NARP-pricing COOP under the price-matching conjecture.

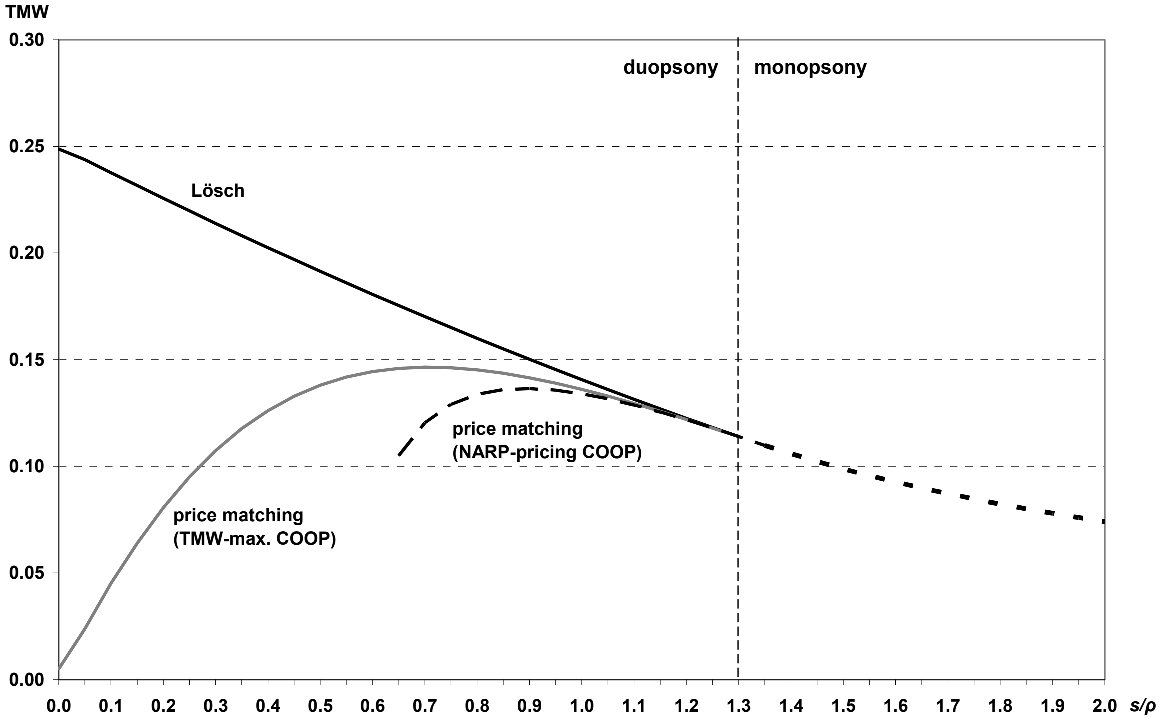
Given the restricted-membership policy, FIGURE 6-10 compares the UD price of the NARP-pricing COOP with the UD price of the TMW-maximizing COOP as in CHAPTER 6.2.1. First, the UD price of the NARP-pricing COOP is higher under Löschian competition than it is under price matching.[163] The reason for this result is that overlapping market areas imply rather high transportation costs and, thus, a lower NARP. Second, the TMW-maximizing COOP is also a NARP-pricing COOP under Löschian competition. Therefore, UD prices under Löschian competition are equal for both COOP objectives. Third, the UD price under the price-matching conjecture is higher for a TMW-maximizing COOP than it is for a NARP-pricing COOP. Fourth, given either conjecture and either COOP objective function, the UD prices are higher for the COOP relative to the IOF under either conjecture.

[163] This outcome is the same as in the case of the TMW-maximizing COOP if the UD price under price matching is adjusted by negative per-unit profits from processing; see CHAPTER 6.2.1.

Finally, FIGURE 6-10 shows that individual COOP members are better off under Löschian competition because the UD price is higher relative to price matching (under either objective function). On the contrary, individual IOF suppliers receive a higher UD price under the price-matching conjecture.

FIGURE 6-11 compares TMW of the results derived under restricted membership. The outcome of Löschian competition implies the highest TMW (which is equal for the NARP-pricing COOP and the TMW-maximizing COOP). Given the price-matching conjecture, the TMW-maximizing COOP generates, by assumption, a higher TMW than the NARP-pricing COOP does. A similar figure can be obtained if individual profits of COOP members are illustrated.

FIGURE 6-11. Comparison of TMW (restricted membership)



Note: In this figure, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. Both the net selling price *ρ* and the distance *d* between processors are normalized to *1*.

6.3 OPEN MEMBERSHIP

Under UD pricing, the processor accounts for transportation costs. Strictly speaking, the farmer does not deliver the raw product, but the processor collects the raw product, taking into account an optimal market area (see also IOZZI, 2004, and CHAPTER 3.2). Consequently, farmers facing UD pricing processors occupy a rather passive position, because the processor determines its optimal market area. As a result, farmers located beyond the market boundary cannot supply that particular processor because the processor will not procure raw product from these farmers' locations. For the COOP in CHAPTER 6.2, "restricted membership" was implemented by assuming that the COOP determines an optimal market area. As the optimal market area is endogenously determined by the COOP itself, it restricts acceptance of prospective members located outside of this area.[164]

On the contrary, an open-membership COOP cannot refuse any farmer who wishes to become a member and, thus, cannot determine an optimal market area in a centralized manner. In the following, an open-membership policy will be accounted for by using two different concepts: the no-rationing assumption and the existence of an outside option. First, because the open-membership COOP cannot determine its optimal market area in a centralized manner, the COOP cannot ration the (total) supply of farmers (via its choice of market area). As any farmer located along the line market might wish to become a member of the COOP, the COOP needs to consider the total available area as its market area. Second, the market area of the COOP is determined by the farmers themselves because they decide whether to join the COOP or choose an outside option. If farmers have an outside option available, then the most distant farmer who is indifferent between patronizing the COOP and choosing the outside option determines the market area of the (monopsonistic) COOP.

6.3.1 THE NO-RATIONING ASSUMPTION

Under open membership, any farmer wishing to patronize a particular COOP should be allowed to do so. Consequently, the COOP must consider the total area available as its market area. The difference from the restricted-membership policy analyzed in CHAPTER 6.2 is the assumption that the market area is not endogenously determined by the COOP. For example, a COOP located at one endpoint of a bounded line market of length d will need to consider the total length d as its market area since any farmer along this line might wish to join the COOP.[165] This assumption is similar to the "no-rationing assumption", as in IOZZI (2004), for the case of a UD pricing duopoly (see also the literature review in CHAPTER 3.3.1). According

[164] The restricted-membership policy of a COOP assumed in CHAPTER 6.2 can alternatively be viewed as an open-membership policy as well. In this sense, the COOP can define a "service area" (by determining an optimal market area), either by maximizing TMW or by NARP pricing. The COOP must accept the patronage of any farmer located within this area, but it can refuse the patronage of farmers located beyond the boundary of the service area. Thus, such a membership policy is defined as open membership subject to an optimal market area. Given this interpretation, however, there would be no difference from a restricted-membership COOP. In his spatial mixed market model, FOUSEKIS (2010) derives an optimal COOP market area similar to the model in CHAPTER 6.2. He argues, "An endogenously determined [market area] is consistent with an open-membership COOP" (FOUSEKIS, 2010, p. 5, footnote 5).

[165] Such an assumption is not possible in the *AFSZ* setup with processors located on an unbounded line (see CHAPTER 5.1).

to IOZZI (2004), firms may be unable to ration the supply of a good to consumers due to regulatory requirements to satisfy all demand (e.g., network utilities like the electricity market in the UK or German car insurance companies); alternatively, firms may not want to ration their supply because refusing customers may be costly, for example, in terms of reputation.

In the duopoly framework of IOZZI (2004), assuming no rationing, the situation of firms charging the same (consumer) price allows the analysis of two different tie-breaking rules (TBRs)[166] that originate from the behavior on the part of consumers (see also CHAPTER 3.3.1). Under the *efficient* TBR, consumers choose to buy from the nearest firm. According to IOZZI (2004), this choice is regarded as socially optimal because total transportation costs are minimized as each firm serves exactly half of the market line. He notes that this TBR is similar to Löschian competition as in GRONBERG AND MEYER (1981). Thus, IOZZI (2004) argues the efficient TBR can likewise be interpreted as the result of the behavior on the part of firms. In this sense, the efficient TBR is the result of collusion between firms with regard to market areas and each firm exclusively serves the location where it has a comparative cost advantage relative to its competitor. Under the *random* TBR in the IOZZI (2004) framework, demand in each local market is equally split between firms. "[…] as firms are identical, customers randomise their choice and buy from either firm with the same probability" (IOZZI, 2004, p. 522). As a result, market areas are equal to the total distance between firms and, thus, overlap. Referring to the price-matching conjecture *per se* (with overlapping market areas) as in GRONBERG AND MEYER (1981), IOZZI (2004) argues that the random TBR can likewise be interpreted as the outcome if firms are not able (or not allowed) to reach a collusive agreement regarding an exclusive market area.

In the following model with processing COOPs, the implementation of the no-rationing assumption due to an open-membership policy implies that a COOP located at one endpoint of the line market must consider $R_C = d$ as its market area. Let us assume for the moment that there is only one COOP located at one endpoint of the line market, but no other at the other endpoint (i.e., the COOP is in a monopsonistic position). Unlike under restricted membership, as in CHAPTER 6.2, all farmers along the line must be served under open membership. Since the open-membership COOP takes the market area is given, it is sufficient to consider the solution of the first-order condition of a (monopsonistic) COOP that maximizes TMW with respect to the UD price (equation (6-9)) or the NARP function

166 In the duopoly framework, tie-breaking rules are "[…] rules for the resolution of the conflict between firms when they charge equal prices in the same market" (IOZZI, 2004, p. 514).

(equation (6-30)); both are identical in the absence of fixed costs. Thus, the pricing schedule of the open-membership COOP is

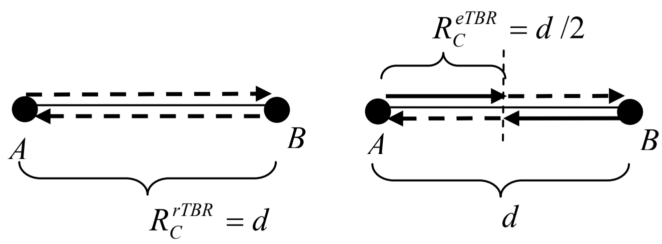
$$(6\text{-}41) \quad u_C = \rho - \frac{tR_C}{2}.$$

Substituting $R_C = d$ into equation (6-41) gives the UD price of the COOP monopsony:

$$(6\text{-}42) \quad u_C^M = \rho - \frac{td}{2}$$

The fact that all farmers along the line market must be served under open membership implies the following: if there is another COOP located at the other endpoint distance *d* away, and given the no-rationing assumption, each open-membership COOP cannot be a spatially separated monopsonist as in CHAPTER 6.2. These two COOPs (*A*, *B*) will always be in the situation of spatial competition. Any farmer along distance *d* might wish to join COOP *A* (*B*), even if the farmer is located closer to COOP *B* (*A*). Therefore, each COOP is constrained to consider the total distance *d* as its market area. Assuming the price-matching conjecture, two outcomes are possible: the random TBR (index *rTBR*) and the efficient TBR (index *eTBR*); see FIGURE 6-12.

FIGURE 6-12. Random and efficient TBR



Under the *random* TBR (see the left-hand side of FIGURE 6-12), each COOP considers $R_C = d$ as its market area. As both COOPs are identical, and given the price-matching conjecture, UD prices of processors must be equal in equilibrium. “However, if processors set the same UD price and there is no market share agreement, the allocation depends on the supplier’s decision where to deliver” (GRAUBNER ET AL., 2011a, p. 105). Thus, farmers randomize their choice of which COOP to patronize. Each farmer will choose each COOP with equal probability because, according to the no-rationing assumption, each COOP must serve the total distance *d* to the location of the competitor. Consequently, there is a total overlap of market areas. The expected outcome is that, within the area of overlap, half of the farmers deliver to one of the two COOPs. Due to the absence of fixed costs, the UD prices under the random TBR between a TMW-maximizing COOP and a NARP-pricing COOP are equal. For the TMW-maximizing COOP, the solution of the first-order condition of the following objective function

$$(6\text{-}43) \quad \Pi_C^{rTBR} = \max_{u_C}\left[\frac{1}{2}\left(\int_0^{\overline{R}_C}\left(\rho - \frac{u_c}{2} - tr\right)\mathrm{d}r\right)u_C\right] \text{ for } \overline{R}_C = d$$

gives the UD price

$$(6\text{-}44) \quad u_C^{rTBR} = \rho - \frac{td}{2}.$$

Alternatively, the resulting UD price of the NARP-pricing COOP can be derived from profits from processing:

$$(6\text{-}45) \quad \Pi_C^{rTBR-p} = \frac{1}{2}\left(\left(\rho - u_c - \frac{td}{2}\right)u_C d\right) = \left(\rho - u_c - \frac{td}{2}\right)u_C \frac{d}{2}$$

Then, NARP is defined by

$$(6\text{-}46) \quad NARP = \frac{NRP}{Q_C} = \frac{\left(\rho - \frac{td}{2}\right)u_C \frac{d}{2}}{u_C \frac{d}{2}} = \rho - \frac{td}{2}.$$

Therefore, the UD price of the NARP-pricing COOP is equal to the UD price of the TMW-maximizing COOP (equation (6-44)), and profits from processing are equal to zero.[167] The UD price under the random TBR is equal to the UD price of a COOP, which is the only processor in the market located at one endpoint of a line (see equation (6-42)).

Under the *efficient* TBR (see FIGURE 6-12 on the right-hand side), each farmer along d chooses to patronize the nearest COOP. The outcome of this TBR implies $R_C = d/2$. Substituting this market area into the COOP's pricing schedule, equation (6-41), gives:[168]

$$(6\text{-}47) \quad u_C^{eTBR} = \rho - \frac{td}{4}.$$

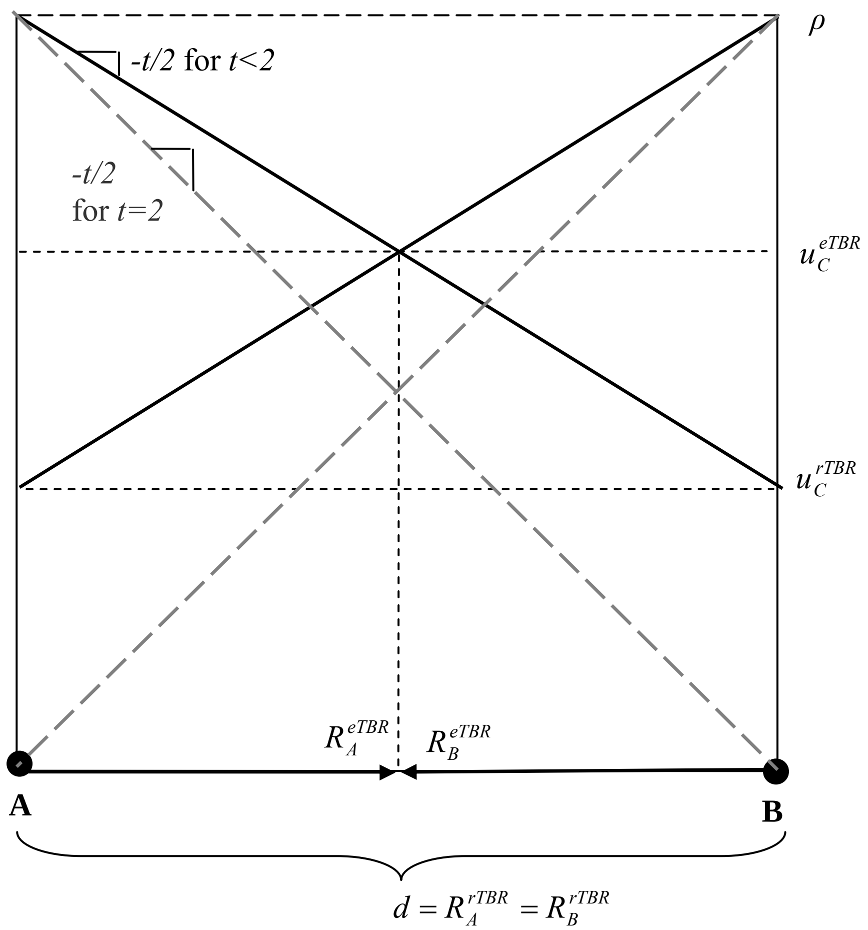
[167] Equation (6-44) is likewise the UD price solution in the case of two IOFs with a fixed market area R_C=d under the Hotelling-Smithies conjecture (see GRAUBNER ET AL., 2011a, equation 11). Given this conjecture, overbidding the competitor decreases profits towards zero. Zero profits of an IOF is equal to a NARP-pricing COOP (with profits from processing equal to zero).

[168] In effect, the pricing schedule of an open-membership COOP under either objective and TBR is given by equation (6-41). Substituting for R_C (R_C=$d/2$ for the efficient TBR or R_C=d for the random TBR and the monopsony) gives the results shown in equations (6-42), (6-44), and (6-47).

This result is equal to the result of Löschian competition between restricted-membership COOPs (see equation (6-23) for a TMW-maximizing COOP or equation (6-37) for a NARP-pricing COOP under restricted membership). However, the difference from Löschian competition is that COOPs do not choose a market area by themselves by colluding with regard to market areas; instead, farmers determine the market area, $R_C = d/2$, by choosing to patronize the nearest processor.

FIGURE 6-13 illustrates the outcome of the efficient and random TBR for two COOPs located at the endpoints of a line market.

FIGURE 6-13. Efficient/random TBR in a pure COOP market



The black downward-sloping lines are the pricing schedules of each COOP, equation (6-41). Under the *random* TBR, the market area served by either COOP is the total distance between processors. Under the *efficient* TBR, the resulting market area is $R_C = d/2$ so that there is no overlap. Even though no farmers can be excluded from patronizing a specific COOP (i.e., no rationing), the assumption here is that farmers patronize the nearest processor. Then, each

COOP can lose the constraint to consider the total distance d as farmers determine the resulting market area of $d/2$ by themselves. As a result, the UD price is higher relative to the random TBR (as average transportation costs are lower). According to equations (6-44) and (6-47), the UD price under the random (efficient) TBR is positive as long as $s/\rho < 2$ ($s/\rho < 4$). The grey dashed line in FIGURE 6-13 illustrates a situation in which $s/\rho = 2$, which implies a UD price equal to zero under the random TBR. As mentioned before, no rationing implies that both COOPs cannot be spatially separated monopsonists. In addition, only any $s/\rho < 2$ qualifies for either TBR of the no-rationing assumption.[169]

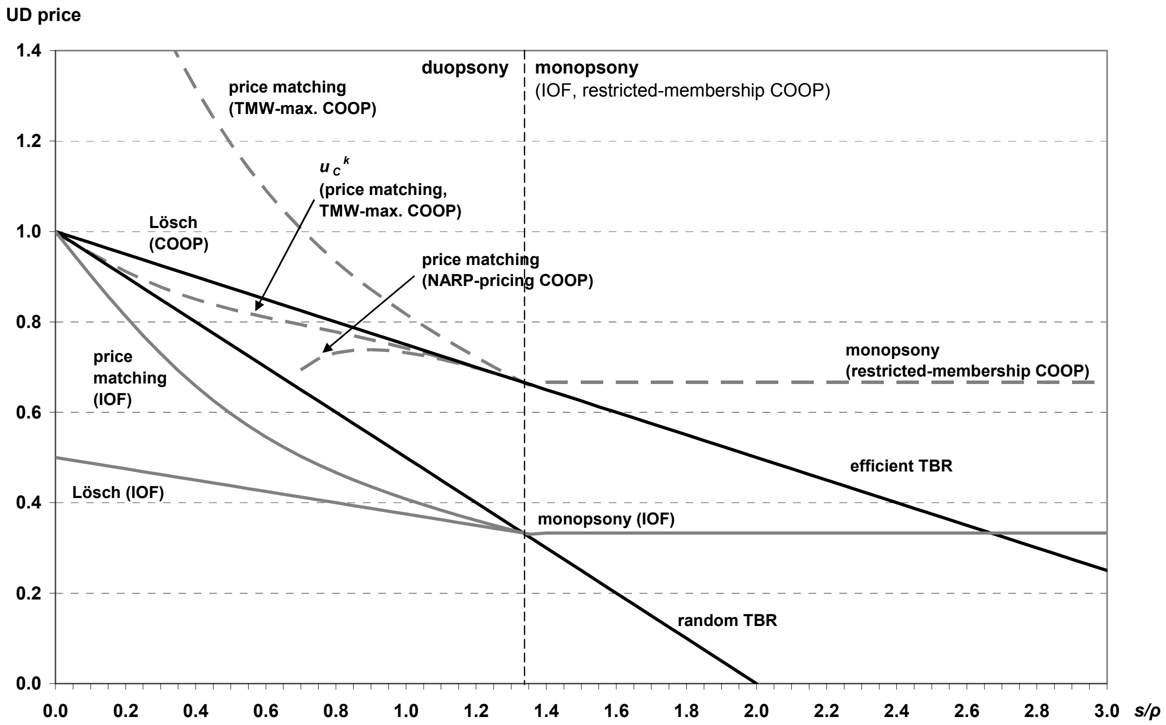
It may be argued that all farmers would always choose the nearest open-membership COOP (efficient TBR), rationally anticipating that market overlap (and, thus, a higher market area) will reduce the UD price relative to the non-overlap solution. This is because the NARP function as well as the solution of the first-order condition of a TMW-maximizing COOP is decreasing in space. Referring to the random TBR, however, it can likewise be argued that the benefit of switching to the nearest COOP might be rather low for an individual farmer if the farmer does not assume (or know) that all other farmers do the same. The costs of switching to the nearest COOP (e.g., a farmer has confidence in the more distant processor and does not know the nearer processor) may be higher than the perceived benefit from switching so that it may be individually rational not to switch to the nearest competitor. This might be one reason for empirically observable overlapping market areas of milk processors. Using a simulation, APPENDIX A2.4.2 considers a pure COOP market with overlapping market areas due to supply contracts.

Under both TBRs, however, the price transmission of the net selling price ρ is equal to 1 (see equations (6-44) and (6-47)). Comparative statics for UD prices under both TBRs are given in APPENDIX A2.4.1. FIGURE 6-14 illustrates UD prices under the no-rationing assumption depending on *s/ρ* and compares them with UD prices under restricted membership (see CHAPTER 6.2) and with UD prices in a pure IOF market (see CHAPTER 5.2).

---

[169] Note that for any *s/ρ>4*, COOPs can be regarded as spatially separated monopsonists paying a UD price equal to zero. For both COOPs to be able to serve each market point along *d* and pay a strictly positive UD price, under either TBR, the necessary condition according to equation (6-41) is *s/ρ<2*.

FIGURE 6-14. UD prices in a pure COOP market (efficient/random TBR)



Note: In this figure, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. Both the net selling price *ρ* and the distance *d* between processors are normalized to *1*.

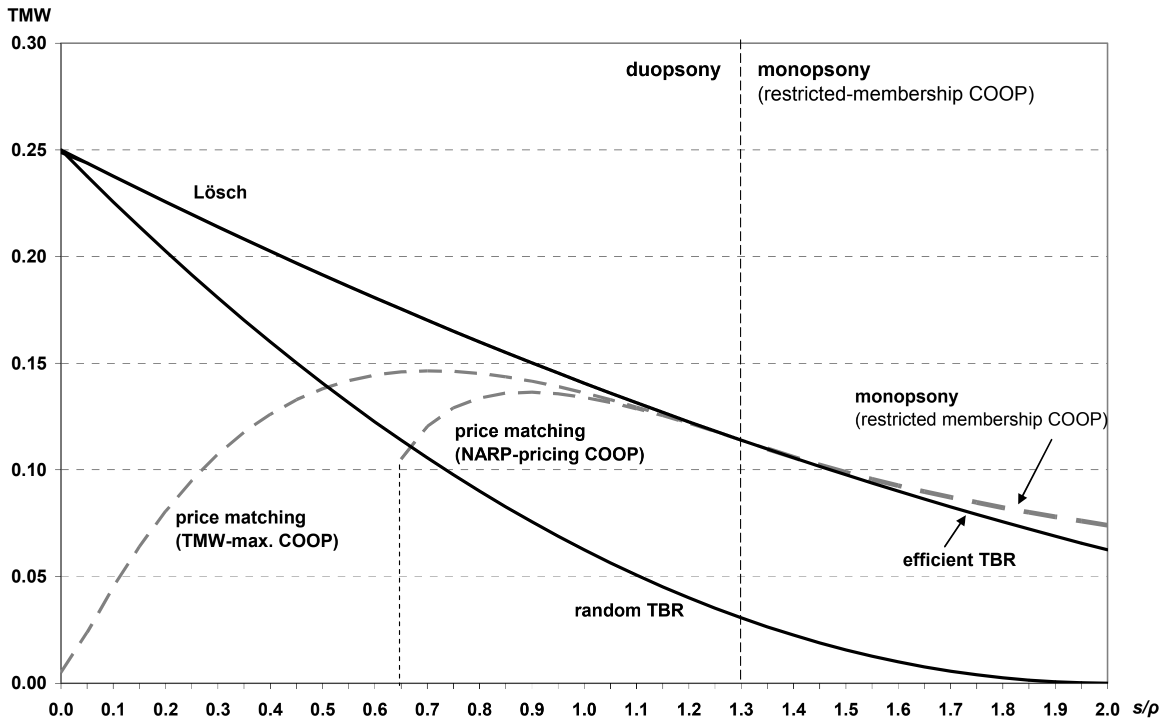
Given the no-rationing assumption, COOPs cannot determine an optimal market area like an IOF (or a restricted-membership COOP) can.[170] In addition, COOPs in the market cannot be spatially separated monopsonists. Consequently, the no-rationing assumption also applies for $s/\rho > 4/3$ (i.e., for a situation where an IOF or a restricted-membership COOP is already in the situation of a spatial monopsony; see FIGURE 6-14). First, consider the situation of $s/\rho < 4/3$, where the UD price of a restricted-membership COOP under Löschian competition is equal to the UD price of an open-membership COOP under the efficient TBR. In these cases, the UD price is highest in a pure COOP market. In addition, it is higher compared to the UD prices in a pure IOF market. Under the random TBR of an open-membership COOP, the UD price is also higher than in the pure IOF market. However, for any $s/\rho > 2/3$, the UD price is even lower under the random TBR than it is in a restricted-membership COOP monopsony, and it approaches the level of the UD price of a

[170] For any s/ρ, the processing margin of the open-membership COOP (under either TBR), $\rho-u_C-tr$, is negative at the COOP's market boundary $r=R_C$. At the location of the COOP, its processing margin $\rho-u_C$ is positive for any s/ρ. More specifically, the following condition applies: $-(\rho-u_C-tR_C) = \rho-u_C$. Thus, the COOP's profits from processing are equal to zero. In FIGURE 6-14, the TMW margin of the (open-membership) COOP, $\rho-u_C/2-tr$, at the COOP's market boundary ($r=R_C$) is positive (negative) for any $s/\rho<4/3$ ($s/\rho>4/3$) under the efficient TBR (and also under Löschian competition of a restricted-membership COOP) and positive (negative) for any $s/\rho<2/3$ ($s/\rho>2/3$) under the random TBR. In the case of a restricted-membership policy under price-matching, the COOP serves farmers located up to the point in space where the TMW margin is equal to zero ($\rho-u_C/2-t\,R_C=0$).

monopsonistic IOF at $s/\rho = 4/3$. Second, consider the situation of $s/\rho > 4/3$. In this situation, the UD price under the random TBR is lower than the monopsonistic UD price of an IOF. Under the efficient TBR (i.e., in an open-membership COOP), the UD prices is lower than the UD price in a COOP monopsony (i.e., restricted membership) and, for any $s/\rho > 8/3$, even lower than the UD price in an IOF monopsony.

Similar to FIGURE 6-11, FIGURE 6-15 illustrates TMW depending on *s/ρ* for all COOP models analyzed so far.

FIGURE 6-15. Comparison of TMW (restricted and open membership)



Note: In this figure, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. Both the net selling price *ρ* and the distance *d* between processors are normalized to *1*.

TMW is lower under the efficient TBR relative to a restricted-membership COOP monopsony for any $s/\rho > 4/3$. For low levels of *s/ρ*, TMW under the random TBR is higher than TMW under the price-matching conjecture of a TMW-maximizing COOP with restricted membership. A reason for this result is that the open-membership COOP under the random TBR breaks even (i.e., there are no negative profits from processing).

6.3.2 EXISTENCE OF AN OUTSIDE OPTION

In CHAPTER 6.3.1, an open-membership policy was implemented using the no-rationing assumption: the open-membership COOP cannot determine an optimal market area in a centralized manner in the same way that a restricted-membership COOP can. Under the no-rationing assumption, the COOP must consider the total available distance *d* to the competitor as its market area because any farmer might wish to patronize the COOP. The resulting outcome is either the random TBR (where farmers choose their COOP on a random basis, i.e., the market areas of competing COOPs overlap) or the efficient TBR (where farmers choose the nearest COOP and competing COOPs' market areas do not overlap).

Implementing open membership using the no-rationing assumption has several implications. First, two COOPs located at the endpoints of a line market cannot be spatially separated monopsonists because no farmer can be excluded from COOP membership. Second, the COOP is constrained to consider the total distance *d* as its market area. Under the random TBR, this is the actual market area of the COOP. For COOPs to be able to operate within the total distance *d,* space must be relatively unimportant ($s/\rho<2$). Third, the no-rationing assumption cannot be implemented for the market form proposed by *AFSZ* where two processors are located on an unbounded line market (see CHAPTER 5.1).

In the present chapter, an alternative way of implementing an open-membership policy is considered: the existence of an outside option for farmers. Assuming an outside option, the supply function of farmers is modified for the following analysis in this chapter:

(6-48) $q_C = u_C$ for $u_C \geq \overline{u}$ and zero otherwise

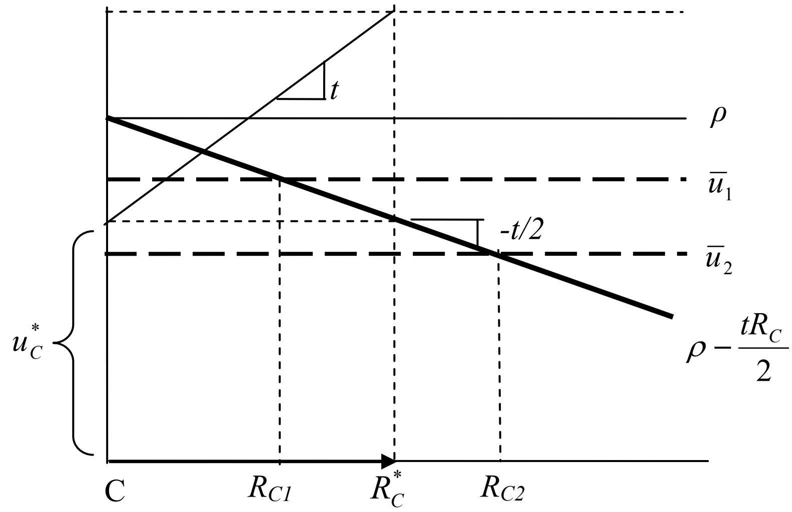
Therefore, if the COOP undercuts a certain (minimum) UD-price level, farmers have a better option other than supplying the COOP. In the model, $\overline{u}$ (for $\overline{u} > 0$) represents the opportunity cost of producing the raw product, i.e., the value of producing an alternative product utilizing the same resources.[171] For reasons of simplicity, $\overline{u}$ is referred to as the "outside option" in the following.

As before, the (monopsonistic) COOP is located at one endpoint of a line market; see FIGURE 6-16. The downward-sloping line represents the pricing schedule of the COOP, $u_C = \rho - (tR_C)/2$ (this pricing schedule is both the NARP function, equation (6-30) and the

[171] The variable $\overline{u}$ can also be interpreted in a different way. Assuming positive fixed costs *f* of farmers, $\overline{u}$ represents the minimum UD price such that profits of a single farmer are at least equal to zero. Given the profit function of a single farmer, $\pi_C^f = u_C^2/2 - f$ (see also equation (6-4) for the absence of fixed costs), a farmer will cease production if profits are negative. Consequently, in the long run, $u_C \geq \overline{u} = \sqrt{2}\sqrt{f}$ is the minimum UD price the COOP must pay to its members so that a single farmer's profits are (at least) equal to zero.

pricing schedule of a TMW-maximizing COOP, which takes the market area as given, equation (6-9)). Under restricted membership, the monopsonistic COOP would set its UD price at u_C^* and serve a market area R_C^* (see CHAPTER 6.2.2). Assume now an open-membership COOP and the existence of an outside option $\bar{u}$. FIGURE 6-16 illustrates two different levels of $\bar{u}$: $\bar{u}_1 > u_C^*$ and $\bar{u}_2 < u_C^*$.

FIGURE 6-16. Open-membership COOP monopsony given an outside option



In the first case, $\bar{u}_1 > u_C^*$. According to the supply function in (6-48), no farmer wants to supply the COOP. As the UD price u_C^* of the COOP is – for the moment – lower than the outside option $\bar{u}_1$, farmers within the market area R_C^* will leave the COOP and choose the outside option. This choice reduces the market area and implies a higher UD price along the pricing schedule. Members will leave the COOP up to the point in space R_{C1} where the UD price paid by the COOP is equal to $\bar{u}_1$. At this point, COOP members are indifferent between supplying the COOP and choosing the outside option.

In the second case, $\bar{u}_2 < u_C^*$. As the UD price of the COOP, u_C^*, is – for the moment - higher than $\bar{u}_2$, farmers located beyond R_C^* (i.e., farmers choosing the outside option so far) will choose the COOP. Therefore, the market area R_C increases and the UD price decreases along the pricing schedule. Farmers will join the COOP up to the point in space R_{C2} where the UD price of the COOP is equal to $\bar{u}_2$. At any UD price below $\bar{u}_2$, no farmer will supply the COOP given the supply function in (6-48).

To conclude thus far, the only stable equilibrium in such an open-membership COOP implies that the UD price of the monopsonistic COOP is equal to the outside option:

(6-49) $u_C^M = \bar{u}$

A situation $u_C > \bar{u}$ would imply that farmers join the COOP (i.e., the market area becomes larger) and, consequently, that the UD price decreases; the situation $u_C < \bar{u}$ would imply farmers leaving the COOP and, consequently, an increasing UD price. The resulting market area is determined by the intersection of $\bar{u}$ and the pricing schedule. According to the pricing schedule ($u_C = \rho - (tR_C)/2$) and a UD price equal to $\bar{u}$, the resulting market area is given by the inverse of the pricing schedule:

(6-50) $R_C^M = \dfrac{2(\rho - \bar{u})}{t}$

This solution is determined by the behavior of the farmer located at $r = R_C$, who is the most distant farmer wishing to patronize the COOP. He will not switch to the outside option because this choice would imply a UD price that is higher than the outside option. This solution satisfies NARP pricing (i.e., profits from processing are equal to zero) and a monopsony situation with open membership because farmers determine this market area by themselves. The higher $\bar{u}$ is, the smaller the resulting market area will be.

Given another competing COOP distance *d* away, each COOP is in a monopsonistic position (i.e., $R_C^M \leq d/2$) as long as[172]

(6-51) $\dfrac{s}{\rho} \geq 4 - \dfrac{4\bar{u}}{\rho}$.

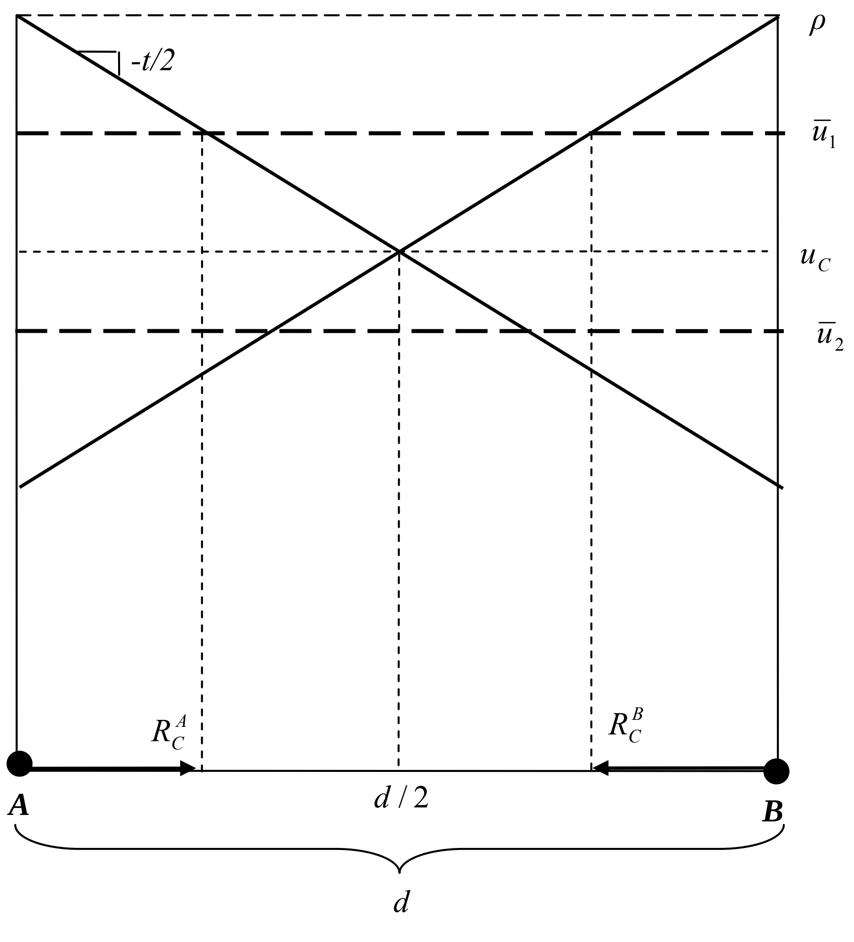
To put it differently, by rearranging equation (6-51), it can be shown that both COOPs have a market area equal to *d/2* if $\bar{u} = \rho - (td)/4$. According to equation (6-51), the relative importance of space depends on the level of $\bar{u}$: the higher $\bar{u}$ is, the lower the relative importance of space will be for COOPs to be spatially separated monopsonists. Given any (exogenous) level of $\bar{u}$, an increasing transportation rate *t* implies a market area that is smaller than *d/2* (i.e., COOPs are spatially separated monopsonists). Farmers located between the two processors who are not served by the COOP choose the outside option (because switching to the COOP would imply a UD price lower than $\bar{u}$).

FIGURE 6-17 illustrates an open-membership COOP duopsony in the presence of an outside option. Given a relatively high level of an outside option (for example, $\bar{u}_1$ in FIGURE 6-17),

[172] Given that the outside option is defined as being strictly positive, the UD price paid by the COOP will be strictly positive regardless of the level of *(td)/ρ*.

both COOPs are spatially separated monopsonists. Both COOPs set the UD price at $u_C = \bar{u}_1$, and market areas are determined by the intersection of the horizontal line $\bar{u}_1$ and the downward-sloping pricing schedules (R_C^A and R_C^B, respectively). As the outside option $\bar{u}$ decreases, the market area R_C of either COOP will increase up to the point $R_C = d/2$, where both pricing schedules intersect. At this point ($\bar{u} = \rho - (td)/4$), all farmers in the market are served by either COOP. As the outside option further decreases (for example, to the level of $\bar{u}_2$), the UD price according to the pricing schedule (u_C) is higher than $\bar{u}_2$. In this situation, the outside option $\bar{u}_2$ becomes obsolete.

FIGURE 6-17. Open-membership COOP duopsony given an outside option



An equilibrium in this open-membership duopsony with COOPs *A* and *B* can be defined by a set of UD prices (u_C^A, u_C^B) for each COOP and patronage decision for each farmer such that

1) the COOP breaks even, given its price and the distribution of farmers who patronize it, and

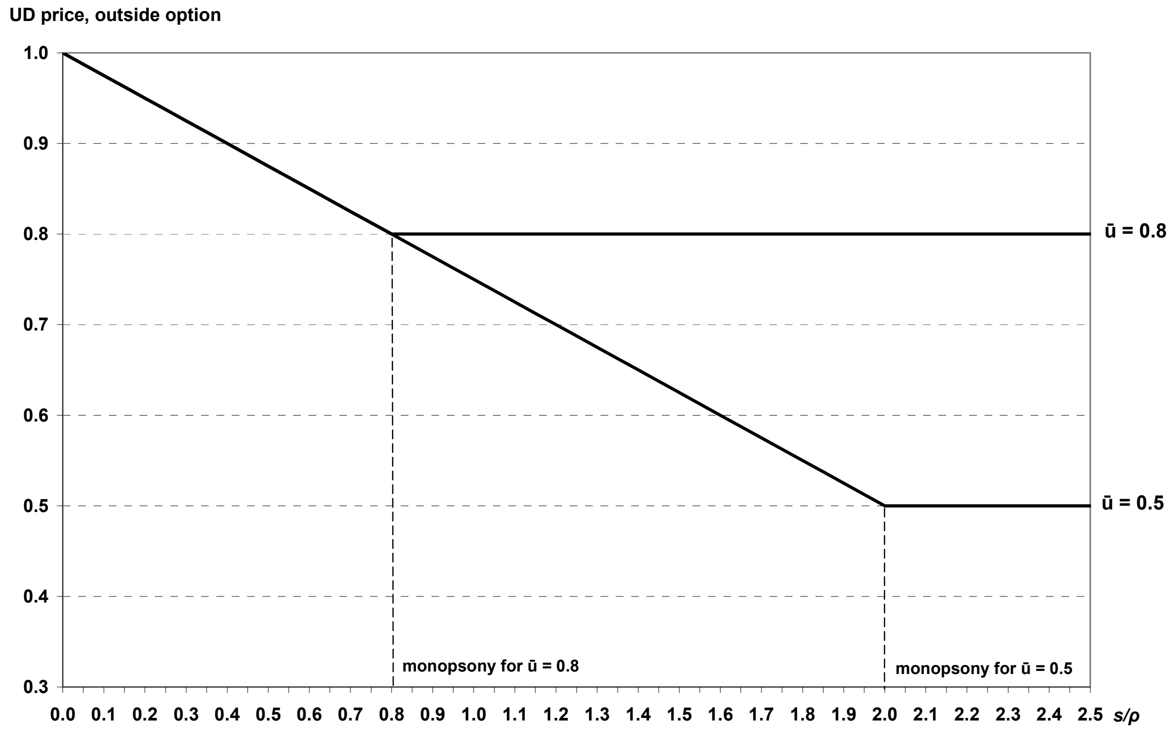
2) no farmer wishes to change his patronage decision, given $\left(u_C^A, u_C^B\right)$, based on rationally considering how his decision would affect $\left(u_C^A, u_C^B\right)$ and assuming that no other farmer changes his decision.

All farmers to the left of point *d/2* patronize COOP *A,* and all farmers to the right of point *d/2* patronize COOP *B*. Solving the pricing schedule of either COOP, $u_C = \left(\rho - \left(tR_C\right)/2\right)$ for $R_C = d/2$ gives UD prices

$$\text{(6-52)} \quad u_C^A = u_C^B = \rho - \frac{td}{4}.$$

Condition (1) of the equilibrium is satisfied by the construction of the pricing schedule shown in equation (6-41). Condition (2) is satisfied at the point $R_C^A = R_C^B = d/2$ (provided that $\bar{u} < \rho - \left(td\right)/4$): the farmer supplying COOP *A* and located close to the market boundary at $r = d/2$ will not switch to the neighboring COOP *B*. This action would increase the market area of COOP *B* and would cause $u_C^B < u_C^A$, and thus, the farmer will not switch (the same is true for any other farmer). As there is no overlap of market areas, this is likewise the solution for Löschian competition in a restricted-membership COOP (see equation (6-23) or (6-37)) and the solution of the efficient TBR (see equation (6-47)). However, contrary to the analysis in CHAPTER 6.3.1 with the no-rationing assumption, the equilibrium considered here (including the existence of an outside option) does not necessarily involve price-matching behavior of COOPs. The UD price depending on *s/ρ* is illustrated in FIGURE 6-18 for two different levels of $\bar{u}$:

FIGURE 6-18. UD price in a pure COOP market given an outside option



Note: In this figure, *s/ρ=(td)/ρ* is increasing due to increases in per-unit transportation costs *t*. Both the net selling price *ρ* and the distance *d* between processors are normalized to *1*.

The downward-sloping line shows the UD price from equation (6-52) depending on the relative importance of space. A relatively low level of $\bar{u}$ implies a relatively high relative importance of space for each COOP to be in the monopsony situation paying a UD price equal to $\bar{u}$. For example, given $\bar{u}=0.5$ and $\rho=1$, both COOPs are spatially separated monopsonists for any $s/\rho>4-(4\cdot 0.5)/\rho=2$ (see equation (6-51)). Thus, for $\bar{u}=0.5$ and $s/\rho>2$, each COOP pays $u_C=\bar{u}=0.5$ and is a spatially separated monopsonist; for any $s/\rho<2$, the UD price is given by the downward-sloping line. A higher level of $\bar{u}$ implies a lower level of the relative importance of space for COOPs to be spatially separated monopsonists.[173]

It can be concluded that, first, in the monopsony situation, the market area is determined by the farmer who is indifferent between supplying the COOP and choosing the outside option. In this case, the UD price of the monopsonistic COOP is equal to the outside option. Second, if COOPs (located at the endpoints of a line market) are in the situation of spatial competition, they will pay a UD price that is higher than the outside option. If the outside option is rather low, all farmers are served by either COOP, and the outside option becomes obsolete.

[173] For example, if the outside option is higher than (2*ρ*)/3, this level of *s/ρ* is lower than in the case of a restricted-membership COOP, as in CHAPTER 6.2 with *s/ρ*>4/3.

6.4 SUMMARY

In CHAPTER 6, spatial competition is analyzed for a market consisting only of COOPs under the assumption of UD pricing. Open membership is a legal requirement for COOPs in Germany and Austria. This requirement can be interpreted strictly (i.e., any farmer wishing to join must be accepted) or more loosely (e.g., members decide whether to accept additional farmers, which is similar to restricted membership); see CHAPTER 2.3. Therefore, both restricted and open membership are considered in the models. In addition, and based on BKA (2009), two different possible objective functions of COOPs are employed (see also CHAPTER 2.3): TMW maximization and NARP pricing. A TMW-maximizing COOP jointly maximizes farmers' profits from producing the raw product and the COOP's profits from processing. A NARP-pricing COOP sets a UD price such that the profits from processing are equal to zero (i.e., the COOP breaks even). Some important results from the analysis of spatial competition among COOPs are summarized in TABLE 6-1.

Under restricted membership, the COOP does not accept every farmer who wishes to join the COOP. In the spatial model, this restriction is incorporated by assuming that the COOP can determine an optimal market area, i.e., it does not accept any farmer located beyond the market boundary. A restricted-membership policy is similar to the behavior of an IOF, which determines its optimal market area and does not accept any farmer located outside of this area. Hence, the assumption of restricted membership allows an analysis of the differences between COOPs and IOFs and shows the impact of different objective functions only.

TABLE 6-1. Summary: spatial competition among COOPs

Membership policy	**Restricted-membership COOP**				**Open-membership COOP**	
COOP objective	TMW-maximizing COOP		NARP-pricing COOP		TMW-maximizing COOP = NARP-pricing COOP	
Conjecture/ no-rationing assumption	Price-matching	Lösch	Price-matching	Lösch	Random TBR	Efficient TBR
Price transmission	$\frac{\partial u_C}{\partial \rho} \neq 1$	$\frac{\partial u_C}{\partial \rho} = 1$	$\frac{\partial u_C}{\partial \rho} \neq 1$	$\frac{\partial u_C}{\partial \rho} = 1$	$\frac{\partial u_C}{\partial \rho} = 1$	$\frac{\partial u_C}{\partial \rho} = 1$

Note: The grey areas indicate identical analytical results.

For reasons of mathematical simplicity, the fixed costs of processors are assumed to be zero. Then, the outcome of the objective of TMW maximization is equal to the outcome of a NARP-pricing COOP in the monopsony situation. The monopsonistic market areas of the

COOP and of the IOF are equal, and the UD price of the COOP is twice as high as that of the IOF. If the spatial dimension becomes less important (e.g., due to a lower transportation rate or a shorter distance between processors), COOPs are in the situation of spatial competition. Assuming the price-matching conjecture, price matching *per se* (with overlapping market areas) and Löschian competition (with non-overlapping market areas) can be analyzed.

In the situation of spatial competition with overlapping market areas, maximization of TMW implies that the COOP pays a rather high UD price relative to an IOF so that profits from processing are negative. This outcome necessitates the implementation of a two-part pricing schedule. Allocating the negative per-unit profits from processing among members in a second stage constitutes an adjustment of the UD price to a lower level, but it is still higher than in the IOF duopsony. However, the UD price in the pure COOP market that is adjusted by negative profits from processing is lower than the UD price under Löschian competition. This result is contrary to the findings in the pure IOF market, where overlapping market areas always imply a higher UD price than is observed under Löschian competition. To conclude, under the objective of TMW maximization, the restricted-membership COOP and its members are better off under Löschian competition with non-overlapping market areas than under the price-matching conjecture with overlapping market areas.

Similar results apply for spatial competition of NARP-pricing COOPs under restricted membership. The NARP-pricing COOP sets its UD price such that profits from processing are equal to zero; i.e., the COOP breaks even. As market overlap implies higher average transportation costs, NARP is reduced, and the UD price is lower than it is under Löschian competition with non-overlapping market areas. Under Löschian competition, the TMW-maximizing COOP is also a NARP-pricing COOP; i.e., the results under both COOP objectives are identical.

As expected, price transmission (in terms of the pass-through of the net selling price to the UD price) is higher in COOP markets than in IOF markets. In the monopsony situation, price transmission is twice as high compared to an IOF monopsony. However, even for a COOP, price transmission is not perfect in the monopsony situation. In the situation of spatial competition, price transmission is also twice as high relative to an IOF market. Under Löschian competition, price transmission is perfect. Under the price-matching conjecture involving overlapping market areas, price transmission is higher in the case of a TMW-maximizing COOP than in a pure IOF market as well. Price transmission in the case of the adjusted UD price of the TMW-maximizing COOP under price matching (i.e., the UD price which is corrected by per-unit profits/losses from processing) approaches the result of a perfect pass-through as the importance of space decreases towards zero. For a NARP-pricing COOP under the price-matching conjecture, the opposite result is obtained: price transmission approaches the perfect result as the relative importance of space increases towards the monopsony situation. In addition, for a rather low relative importance of space, price transmission is even lower compared to a pure IOF market over some range.

The model of the restricted-membership COOP can also be interpreted as an open-membership COOP where the COOP can determine its market area to maintain an economically reasonable area of raw product collection. Within this market area, the COOP must accept every farmer wishing to supply the COOP. However, open membership can also be interpreted as meaning that the COOP must collect the raw product from any farmer who wants to supply it. Hence, it is the most distant farmer who wants to patronize the COOP who determines the COOP's market area. Two different ways to account for open membership are presented: the no-rationing assumption and the existence of an outside option.

Under the no-rationing assumption, the COOP must consider the total distance available as its market area because any farmer along the line market might wish to patronize the COOP. In the literature, the no-rationing assumption involves two different TBRs. Under the random TBR, any farmer along the market line might patronize a certain COOP. In equilibrium, and given the price-matching conjecture of COOPs, the expected outcome is that each farmer in the market will patronize either COOP with equal probability, causing a total overlap of market areas. Under the efficient TBR, farmers patronize the nearest processor such that the COOPs' market areas do not overlap. This result is equivalent to the result of Löschian competition, where COOPs determine the market area by themselves. Under both TBRs, price transmission is perfect. However, the UD price is higher under the efficient TBR relative to the random TBR. Consequently, farmers are better off patronizing the nearest COOP.

Given the no-rationing assumption, COOPs cannot be spatially separated monopsonists. In addition, there is no solution involving a positive UD price if the relative importance of space is rather high. Another way of incorporating open membership is to assume the existence of an outside option for farmers, which allows spatially separated monopsonistic COOPs. This "outside option" can be represented, for example, by the opportunity cost of producing the product. For a monopsonistic COOP, the UD price is equal to the outside option. In this situation, the market area is determined by the farmer who is indifferent between patronizing the COOP and choosing the outside option. If processors are located at the endpoints of a line market, COOPs pay a UD price, which is higher than the outside option in the situation of spatial competition because all farmers are served in the market (provided that the outside option is rather low). The resulting UD price is equal to the UD prices obtained under the efficient TBR and under Löschian competition.

7 SPATIAL COMPETITION IN A MIXED MARKET

In many agricultural markets, COOPs and IOFs compete directly with each other in a mixed market. An example of this situation is the market structure of milk processors in southern regions of Germany, such as Bavaria or Baden-Württemberg (HUCK ET AL., 2006). Generally speaking, in a mixed market, the objective function of at least one processor differs from those of other processors (DE FRAJA AND DELBONO, 1990; see also CHAPTER 4.3). The IOF's objective function of profit maximization is not plausible for a COOP, which is mostly set up for the benefits of its members (see, e.g., LEVAY, 1983). Therefore, in CHAPTER 6, the objectives of TMW maximization and NARP pricing were assumed for a COOP.

According to the "yardstick of competition" hypothesis, COOPs constitute a legal form that can improve competition by mitigating the oligopsony power of IOFs (see CHAPTER 4.2.2). Hence, according to this hypothesis, one would expect higher farm-level prices in a mixed market than in a pure IOF market.[174] To examine a possible competitive yardstick effect (CYE), a spatial duopsony consisting of both a COOP and an IOF is analyzed, given UD pricing. To my knowledge, such a mixed-market structure has only been considered by FOUSEKIS (2010) so far, assuming the Hotelling-Smithies conjecture (see also CHAPTER 4.3 for a literature review on non-spatial and spatial mixed-market models).[175] If a CYE can be confirmed for the case of UD pricing, then the presence of a COOP drives the IOF to less duopsonistic behavior towards farmers (relative to a pure IOF duopsony).

The mixed-market model assumes an open-membership COOP because this is the legal requirement for COOPs, for example in Germany and Austria (see CHAPTER 2.3). Under this membership policy, the COOP does not determine an optimal market area in a centralized manner (see CHAPTER 6.3). As in CHAPTER 6.3, two options for implementing an open-membership policy will be considered: the no-rationing assumption and the existence of an outside option for farmers.

[174] One result of CHAPTER 6 for a pure COOP market is that UD prices paid to COOP members are higher relative to UD prices in a pure IOF market. According to COTTERILL (1987, pp. 206), even such a result constitutes a CYE (see CHAPTER 4.2.2).

[175] SEXTON (1990) analyzes a spatial mixed market with direct competition between a COOP and of an IOF under the assumption of FOB pricing. In a recent contribution, FOUSEKIS (2010) analyzes the choice of the spatial pricing policy (UD or FOB pricing) in a mixed duopsony market, referring to the conference contribution TRIBL (2009a), among others. Similar to ZHANG AND SEXTON (2001) for the pure IOF market case, FOUSEKIS (2010) assumes the Hotelling-Smithies conjecture. To examine a CYE, FOUSEKIS (2010) compares the mixed market with the IOF monopsony. The conference contribution TRIBL (2009a) and the working paper TRIBL (2009b) are first attempts to model a spatial mixed market under UD pricing. The mixed-market models in this chapter are different from those in TRIBL (2009a and 2009b), since they have been improved in many dimensions.

The present chapter is organized as follows. In CHAPTERS 7.1 and 7.2, open membership of the COOP is implemented by invoking the no-rationing assumption (see also IOZZI, 2004, and CHAPTER 6.3.1). Under the no-rationing assumption, the COOP cannot refuse any farmer wishing to become a COOP member. Consequently, all locations in space along the distance between processors must be considered by the COOP; as the COOP is constrained to consider this total distance as its market area, both processors cannot be spatially separated monopsonists. First, the efficient TBR will be analyzed (see CHAPTER 7.1), which results in distinct, non-overlapping market areas. Three different mixed-market models are proposed. All three of these models have in common that the COOP offers its pricing schedule. The resulting mixed-market equilibrium depends on three different assumptions regarding the behavior of the IOF in such a mixed market: a sequential moves game and two different simultaneous moves games.

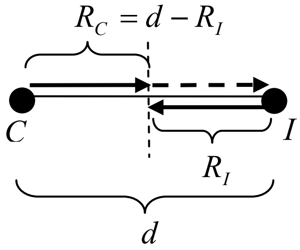
Second, having analyzed the outcome under the efficient TBR, CHAPTER 7.2 considers the random TBR. Under the random TBR, market areas between processors can overlap; the COOP's market area is equal to the total distance to the neighboring IOF as any farmer located between the processors might wish to patronize the COOP. For both TBRs, the CYE will be analyzed by comparing the mixed-market results with the results of a pure IOF market as in CHAPTERS 5.2.2 and 5.3.

Finally, CHAPTER 7.3 examines an alternative way of implementing a COOP's open-membership policy: an outside option for farmers. Relative to the no-rationing assumption in CHAPTERS 7.1 and 7.2, this alternative implies three advantages: first, both processors can be spatially separated monopsonies; second, the COOP's constraint to consider the total available distance as its market area becomes obsolete; and third, this model may be more general because it is not restricted to a market form where processors are located at the endpoints of a line market. Before analyzing the mixed-market result, the case of a pure IOF market is examined in the presence of an outside option. Then, the mixed market is analyzed using the same assumptions as in CHAPTER 7.1. The CYE will be analyzed by comparing the mixed-market results with the result of a pure IOF market in the presence of an outside option.

7.1 MIXED MARKET UNDER THE EFFICIENT TIE-BREAKING RULE

Assume a line market of length d, where processors are located at the endpoints of the line market; see FIGURE 7-1.

FIGURE 7-1. Mixed market under the no-rationing assumption (efficient TBR)



Given the no-rationing assumption, the open-membership COOP cannot refuse any farmer located along d who wishes to patronize the COOP (see CHAPTER 6.3.1). Thus, the open-membership COOP cannot choose its market area in a centralized manner and is constrained to consider the total distance d as its market area (i.e., up to the location of the IOF in FIGURE 7-1). In contrast to the COOP, the IOF does not have an open-membership policy and, therefore, determines an optimal market area R_I. In a pure COOP market framework, where processors are symmetric and employ an open-membership policy, the efficient TBR results in farmers choosing the nearest processor. Thus, there is no overlap of market areas and each processor serves an exclusive market area (see also CHAPTER 6.3.1). In a mixed market with asymmetric processors, however, the efficient TBR can be interpreted such that no farmer within the market area of the IOF patronizes the COOP when both processors pay the same UD price; see also IOZZI, 2004, for a pure market with symmetric firms. This behavior yields distinct non-overlapping market areas of processors. The IOF serves its optimal market area R_I, and all remaining farmers not served by the IOF will patronize the COOP: $R_C = d - R_I$. Consequently, all farmers are a priori served in the market and both processors cannot be spatially separated monopsonists.

Assume that the COOP sets its UD price according to NARP. Then, because the COOP shares TMW (Π_C) among its members, the COOP sets average TMW across space (for $R_C = d - R_I$) equal to the profits of a single farmer from producing the raw product:

$$(7\text{-}1)\quad \frac{\Pi_C}{d - R_I} \overset{!}{=} \frac{u_C^2}{2} \text{ for } \Pi_C = \left(\rho - \frac{u_C}{2} - \frac{t(d - R_I)}{2}\right) u_C (d - R_I)$$

The solution to this problem is the pricing schedule offered by the COOP:

$$(7\text{-}2)\quad u_C = \rho - \frac{t(d - R_I)}{2}$$

Given a certain COOP market area $R_C = d - R_I$, equation (7-2) is both the NARP function of a NARP-pricing COOP and the solution of the first-order condition of a TMW-maximizing COOP that takes the market area as given (see also equation (6-9) in CHAPTER 6.2.1 and equation (6-30) in CHAPTER 6.2.2). Thus, so far, there is no difference between a TMW-maximizing COOP and a NARP-pricing COOP. As the COOP breaks even (i.e., profits from processing are zero), TMW is equal to the sum of profits of all COOP members from producing the raw product. For any possible market area of the IOF, R_I (and, thus, also for that of the COOP), this pricing schedule gives the UD price of the (TMW-maximizing or NARP-pricing) COOP. If the COOP located at one endpoint were the only processor in the market (i.e., $R_I = 0$), and given that the open-membership COOP must serve the total distance d in such a situation ($R_C = d$), the UD price of the COOP in equation (7-2) is equal to zero at $s/\rho = 2$ (see also CHAPTER 6.3).

In contrast to the COOP, the IOF determines an optimal market area by itself. Under the efficient TBR (and, thus, with no market overlap) the IOF exclusively serves IOF suppliers within its market area. Consequently, the IOF's profit function is that of a monopsonistic IOF (see also CHAPTER 5):[176]

$$\text{(7-3)}\quad \Pi_I = \max_{u_I, R_I}\left[\left(\int_0^{R_I}(\rho - u_I - tr)\mathrm{d}r\right)u_I\right] = \max_{u_I, R_I}\left[\left(\rho - u_I - \frac{tR_I}{2}\right)u_I R_I\right]$$

Generally, the IOF in a mixed market must consider the choice of the COOP and pay a UD price that is at least equal to the UD price of the COOP. If the IOF pays a UD price that is lower than the UD price of the COOP, IOF suppliers will leave the IOF and switch to the open-membership COOP (which must accept them). The IOF can pay a higher UD price than the COOP because the IOF has the ability to restrict its market area (i.e., it can refuse any farmer located beyond its market boundary who wants to be an IOF supplier in case of a higher UD price). However, the IOF cannot prevent farmers from switching to the open-membership COOP (e.g., if the COOP's UD price should be higher). Thus, in a mixed market, the IOF has two choices. First, it can match UD prices with the COOP by setting $u_I = u_C$.

[176] Likewise, and according to FIGURE 7-1, where the IOF is located at the right endpoint of the line market (i.e., at point $r=d$), the profit function using integrals can also be written in the following way:

$$\Pi_I = \left(\int_0^{R_I}(\rho - u_I - tr)\mathrm{d}r\right)u_I = \left(\int_{d-R_I}^{d}(\rho - u_I - t(d-r))\mathrm{d}r\right)u_I$$

Second, it can pay its monopsonistic UD price u_I^M and operate within its optimal monopsonistic market area R_I^M. The latter option, however, is only possible if $u_I^M \geq u_C$.

Assume for the moment that the IOF is able to operate as a monopsonist. Generally, an IOF has two decisions to make: to serve an optimal market area and to pay an optimal UD price. First, taking the UD price u_I for the moment as given, the IOF maximizes profits as in equation (7-3) with respect to its market area R_I. The solution to the problem gives the monopsonistic market area:

$$(7\text{-}4)\quad R_I^M = \frac{\rho - u_I}{t}$$

The inverse of equation (7-4) gives the UD price as a function of the market area and will be relevant for the graphical illustration, FIGURE 7-2, below:

$$(7\text{-}5)\quad u_I = \rho - tR_I^M$$

Equation (7-5) is the maximum price an IOF is willing to pay to the farmer located at point r in space so that the local per-unit profit (i.e., margin) from purchasing the product from this farmer is equal to zero (see also ZHANG AND SEXTON, 2001): $\rho - u_I - tr \overset{!}{=} 0$, which is the case for $u_I = \rho - tr$.[177] Likewise, given any UD price u_I, the IOF will operate up to point $r = R_I = (\rho - u_I)/t$, as the marginal profit from purchasing the raw product at distance $r = R_I$ is zero (*AFSZ*). Thus far, there are two statements: the IOF determines its maximum UD price for any given point in space, or the IOF determines its market area for any given UD price.

Second, taking the market area R_I for the moment as given, the solution for an IOF maximizing profits (equation (7-3)) with respect to the UD price u_I gives

$$(7\text{-}6)\quad u_I = \frac{\rho}{2} - \frac{tR_I^M}{4}.$$

After substitution of equations (7-4) and (7-6), the optimal monopsonistic UD price and the optimal market area are

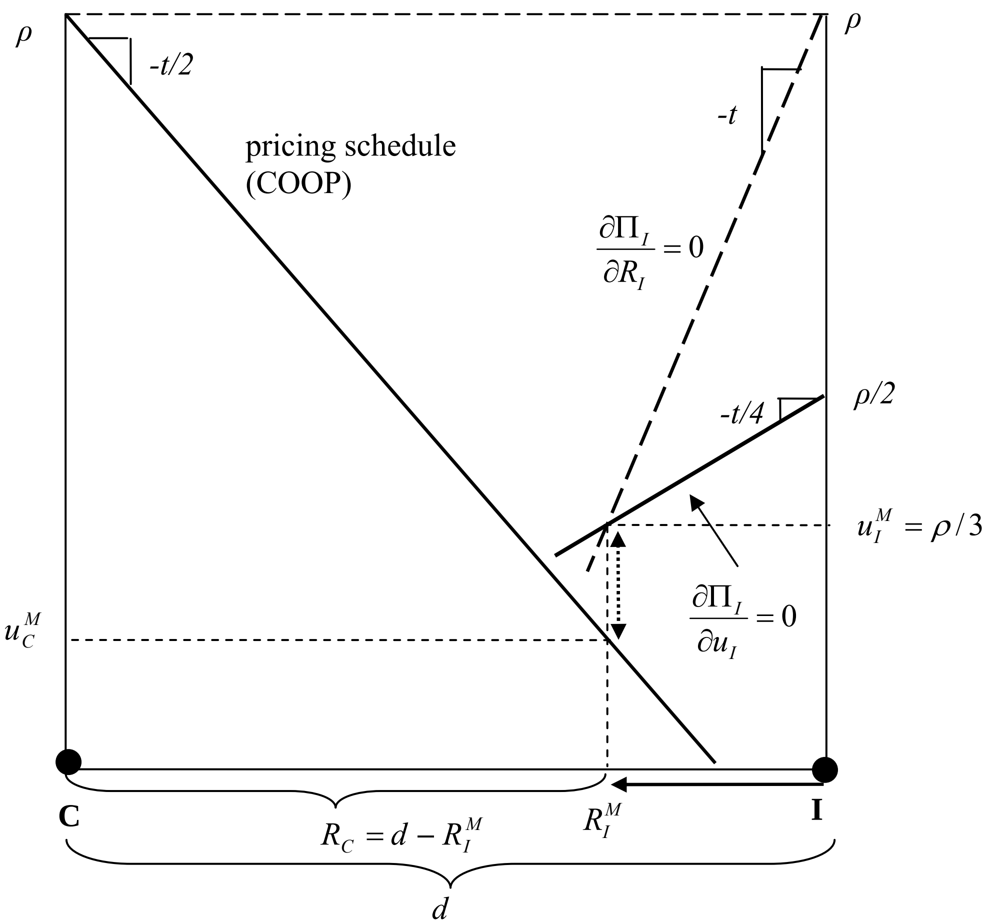
[177] Note the difference from, for example, an open-membership NARP-pricing COOP: the COOP's profits from processing are mathematically equal to the profits of an IOF. However, the open-membership COOP does not determine a market area, but only a UD price for any given market area. To satisfy NARP pricing, profits from processing must be equal to zero *over the total extension* of the market area R_C: $(\rho - u_C - (tR_C)/2)u_C R_C = 0$. The resulting UD price is the NARP-pricing schedule $u_C = \rho - (tR_C)/2$; see equation (7-2).

$$(7\text{-}7)\quad u_I^M = \frac{\rho}{3}$$

$$(7\text{-}8)\quad R_I^M = \frac{2\rho}{3t}$$

(see also CHAPTER 5.1). Thus, the IOF has, in effect, two different (pricing) schedules (see FIGURE 7-2, which illustrates these considerations for one specific value of the relative importance of space for $s/\rho > 2$).

FIGURE 7-2. Mixed market – the IOF as a monopsonist ($s/\rho > 2$)



The vertical distance is the net selling price ρ. The IOF is located on the right-hand side; the distance between the COOP and the IOF is *d*. Thus, UD prices can be measured by the vertical axis and the market area of either processor by the horizontal axis. The first schedule of the IOF, equation (7-5), is the result of determining an optimal market area (by taking the UD price as given); in the following, this schedule is referred to as the "market area schedule". Likewise, this schedule gives the maximum UD price an IOF is willing to pay, given any market area. The market area schedule is illustrated by the downward-sloping dashed line on the right-hand side with intercept ρ and slope *–t*. The second schedule of the IOF, equation (7-6), is the IOF equivalent of the pricing schedule of the COOP. This pricing schedule is the result of determining an optimal UD price (by taking the market area as given). This schedule is illustrated by the second downward-sloping line on the right-hand side with intercept $\rho / 2$ and slope *–t/4*. Setting these two schedules equal gives the optimal market area as in equation (7-8). Substituting this optimal market area into either pricing schedule of the IOF gives the optimal monopsonistic UD price, equation (7-7). Thus, the intersection of these two lines gives the solutions for the optimal UD price u_I^M and market area R_I^M of a monopsonistic IOF (see equations (7-7) and (7-8), respectively).

According to the assumption of an open-membership COOP under the efficient TBR, the market area of the COOP, R_C, is determined by the fraction of farmers who are not served by the IOF. Substituting the optimal monopsonistic market area of the IOF (equation (7-8)) into the pricing schedule of the COOP, equation (7-2) gives the UD price of the COOP in the presence of a monopsonistic IOF:

$$\text{(7-9)} \quad u_C = \frac{4\rho}{3} - \frac{td}{2}$$

The UD price of the COOP in the presence of a monopsonistic IOF (equation (7-9)) and the monopsonistic UD price of the IOF (equation (7-7)) are equal for $s / \rho = 2$. Therefore, for $s / \rho > 2$, the IOF pays its optimal monopsonistic UD price, which is higher than the UD price of the COOP.[178] Such a situation is illustrated in FIGURE 7-2. The COOP is located on the left-hand side. According to the no-rationing assumption, all remaining farmers who are not served by the IOF will patronize the open-membership COOP. The COOP pays a UD price according to its pricing schedule, which is represented by the solid downward-sloping line on the left-hand side; it has intercept ρ and slope $-(t/2)$; see equation (7-2). Consequently, this pricing schedule gives any possible UD price paid by the COOP for any $R_C \in [0, d]$ or $R_I \in [0, d]$, respectively. As R_C increases, the COOP's UD price will decrease. The market area of the COOP, however, is determined by farmers wishing to patronize it; under the

[178] One might argue that, under the no-rationing assumption, any situation like *s/ρ>2* is impossible. In the absence of an IOF (or if the behavior of the IOF is not known, i.e., any R_I is possible), this situation would imply a negative UD price of the COOP (if $R_C=d$) or a non-binding constraint to consider distance *d* as the COOP's market area ($u_C=0$ for $R_C<d$); see FIGURE 7-2. Limiting the relative importance of space to *s/ρ<2* would imply that a monopsony situation of the IOF is not possible. However, it can likewise be argued that any *s/ρ>2* is still consistent with the no-rationing assumption. The constraint to consider distance *d* is still binding, but *in the presence of the IOF* (and provided that the behavior of the IOF is known), the UD price of the COOP is positive. In the presence of a monopsonistic IOF, the UD price of the COOP, u_C^M (equation (7-9)), is equal to zero for *s/ρ=8/3*; see APPENDIX A3.1.

efficient TBR, it is determined by the fraction of farmers not served by the IOF. Given that $s/\rho > 2$ in FIGURE 7-2, the monopsonistic UD price of the IOF (u_I^M) is higher than the UD price of the COOP (u_C^M), but the IOF will not serve any farmer located beyond its optimal monopsonistic market area.[179]

Assume now that the transportation rate t decreases (i.e., s/ρ decreases). Thus, all downward-sloping lines in FIGURE 7-2 will rotate upwards (with the intercept being constant). Referring to the IOF on the right-hand side, the intersection of its two respective schedules will remain at the same vertical level because the monopsonistic UD price of the IOF is independent from the transportation rate: $u_I^M = \rho/3$. However, market area R_I will increase. At $s/\rho = 2$, all three lines intersect such that $u_C = u_I^M$. For any $s/\rho < 2$, the UD price of the COOP would be higher than the optimal monopsonistic UD price of the IOF ($u_C > u_I^M$). Consequently, farmers would leave the IOF and patronize the COOP. Therefore, for any $s/\rho < 2$, the COOP and the IOF are in the situation of spatial competition, which will be analyzed in the following. The COOP offers a pricing schedule only. As before, the IOF must pay a UD price that is at least equal to the UD price of the COOP for the situation where $s/\rho < 2$. Three different mixed-market models are proposed, depending on the behavior of the IOF:

(i) In a sequential moves game, first, the open-membership COOP offers its pricing schedule. Second, the IOF must pay a UD price that is at least equal to the UD price of the COOP. The IOF anticipates the pricing schedule of the COOP in its profit function (i.e., it pays a UD price according to the same pricing schedule) by noting that farmers who are not served by the IOF will choose the COOP. Thus, the IOF determines its optimal market area.

(ii) In a simultaneous moves game, the COOP offers its pricing schedule as well. At the same time, and in contrast to (i), the IOF does not anticipate the UD pricing schedule of the COOP, but it takes the UD price as given. Therefore, the IOF operates according to its "market area schedule". The market areas of processors are determined by the point in space where UD prices are equal between the COOP and the IOF (i.e., by the location of the farmer who is indifferent between patronizing the COOP and supplying the IOF).

(iii) In another simultaneous moves game, the COOP offers its pricing schedule. The IOF takes the market area as given, i.e., it offers an optimal pricing schedule only, like the COOP. The market areas of processors are determined by the point in space where the UD prices of

[179] If the IOF operates as a monopsonist (*s/ρ>2*), price transmission of the COOP is 4/3 (see equation (7-9)).

the COOP and the IOF are equal. Again, this point in space is determined by the farmer who is indifferent between patronizing the COOP and supplying the IOF. Under this assumption, the IOF implements an "open-membership" policy similarly to the COOP.

The COOP determines its pricing schedule in the same manner in all of these mixed-market models; see equation (7-2). Therefore, only the behavior of the IOF needs to be analyzed in the following.[180]

7.1.1 SEQUENTIAL MOVES GAME

Assume, first, a sequential moves game as in (i). After the COOP has determined its pricing schedule, equation (7-2), the IOF anticipates this pricing schedule and offers the same pricing schedule to its suppliers. To put it differently, once the pricing schedule of the COOP has been set, the IOF mimics this schedule:

$$(7\text{-}10) \qquad u_I = \rho - \frac{t(d - R_I)}{2} = \rho - \frac{td}{2} + \frac{t}{2} R_I$$

After substitution of the COOP's pricing schedule into the profit function of the IOF, the IOF maximizes profits with respect to its market area R_I:

$$(7\text{-}11) \qquad \Pi_I^{seq} = \max_{R_I} \left[\left(\rho - u_I - \frac{tR_I}{2} \right) u_I R_I \right] \text{for } u_I = \rho - \frac{t(d - R_I)}{2} \ ,$$

where index *seq* denotes the sequential moves game. Equation (7-11) shows that the IOF pays a UD price according to the pricing schedule of the COOP; the level of the UD price in the mixed market, however, is determined by the IOF when it chooses an optimal market area. The solution of the first-order condition gives the optimal market area of the IOF:

$$(7\text{-}12) \qquad R_I^{seq} = \frac{3dt - 4\rho + \sqrt{16\rho^2 - 12dt\rho + 3d^2t^2}}{6t}$$

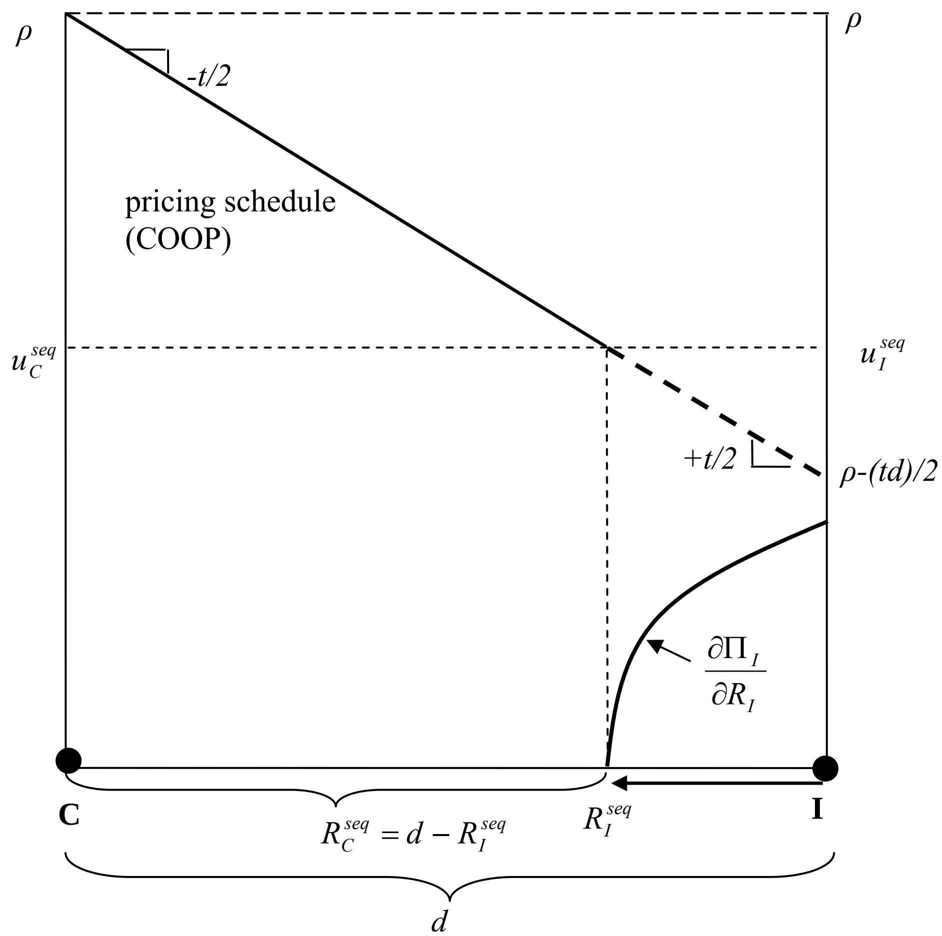
Substituting this into the anticipated pricing schedule of the IOF, equation (7-10), gives the UD price u^{seq} in this mixed market:

$$(7\text{-}13) \qquad u^{seq} = \frac{2\rho}{3} - \frac{td}{4} + \frac{\sqrt{16\rho^2 - 12dt\rho + 3d^2t^2}}{12}$$

[180] In equilibrium, the UD prices of the (open-membership) COOP and the IOF must be equal. However, as processors are not symmetric in the mixed market, this situation will not be termed "price-matching conjecture" in the models.

The corresponding market area of the COOP is $R_C^{seq} = d - R_I^{seq}$. The sequential moves game is illustrated in FIGURE 7-3 for a certain level of *t* $(s/\rho < 2)$.

FIGURE 7-3. Mixed market – sequential moves game



Again, the solid downward-sloping line on the left-hand side is the pricing schedule of the COOP; see equation (7-2). As the IOF pays a UD price according to the same pricing schedule, this is also the pricing schedule of the IOF. However, for the IOF located on the right-hand side, the pricing schedule is upward sloping. According to the reformulation in equation (7-10), it has intercept $\rho - (td)/2$ and a (positive) slope of *+t/2*. As the market area of the IOF increases, the UD price in the mixed market increases. The IOF determines its optimal market area by following this pricing schedule up to the point where marginal profits (illustrated by the stylized downward-sloping curve on the right-hand side of FIGURE 7-3) are equal to zero.[181]

[181] For this curve, the vertical axis measures the change in profits of an IOF due to changes in the market area. This is due to the fact that the first derivative of IOF profits with respect to the market area is not a function of the UD price (see the solution of the first-order condition, equation (7-12)). As the market area of the IOF increases, profits per unit of the processed product decrease. On the contrary, the total quantity of the product processed (Q_I=$u_I R_I$) increases, which explains the existence of a maximum of total profits at the point R_I^{seq}.

According to the pricing schedule, the resulting UD price in this mixed market is given by $u_C^{seq} = u_I^{seq} = u^{seq}$. This solution constitutes a stable equilibrium: the most distant IOF supplier located at the market boundary of the IOF (at $r = R_I^{seq}$) will not switch to the COOP because this choice would reduce both R_I^{seq} and the UD price. The most distant COOP member cannot switch to the IOF as the IOF restricts acceptance of suppliers outside of its optimal market area (i.e., it does not accept a larger market area).

FIGURES 7-4a and 7-4b illustrate the resulting UD price and market areas in the mixed market depending on the relative importance of space. A solution for the UD price in the mixed market is possible for any $0 < s/\rho \leq 2$, i.e., range *B* to *A* in FIGURE 7-4a. As the relative importance of space increases, for example, due to an increase in the transportation rate *t*, the UD price in the mixed market will decrease towards the monopsony price level of the IOF at $s/\rho = 2$ (see point *A*). If s/ρ increases further, the IOF will pay its optimal monopsonistic UD price, which is higher than the UD price of the COOP.

Market areas are illustrated in FIGURE 7-4b. The market area of the COOP is larger than the market area of the IOF. Consequently, the optimal market area of the IOF is smaller than *d/2* for any s/ρ. As the relative importance of space increases, the optimal market area of the IOF in the mixed market will increase up to the point where the UD price in the mixed market is equal to the monopsonistic UD price of the IOF (see range *B* to *A*).[182] For any $s/\rho > 2$, the IOF's market area (which is its optimal monopsonistic market area) decreases.

Comparative statics of the sequential moves model are given in APPENDIX A3.2. Price transmission of the net selling price ρ in such a mixed market is not perfect, but it is increasing towards 1 as the importance of space decreases towards zero.

[182] For any s/ρ, the processing margin of the COOP, $\rho\text{-}u_C\text{-}tr$, is negative at the COOP's market boundary $r=R_C$. However, at the location of the COOP, its processing margin $\rho\text{-}u_C$ is positive for any s/ρ. The following condition applies: $-(\rho\text{-}u_C\text{-}tR_C) = \rho\text{-}u_C$. Thus, the COOP's profits from processing are equal to zero. In FIGURES 7-4a and 7-4b, the TMW margin of the (open-membership) COOP, $\rho\text{-}u_C/2\text{-}tr$, is positive at the COOP's market boundary ($r=R_C$) for any $s/\rho<0.91$. For any $s/\rho>0.91$, the TMW margin is negative at $r=R_C$. In the case of a restricted-membership policy, the COOP would serve farmers located up to the point in space where the TMW margin is equal to zero ($\rho\text{-}u_C/2\text{-}tr =0$).

FIGURE 7-4a. UD price in the mixed market (sequential moves game)

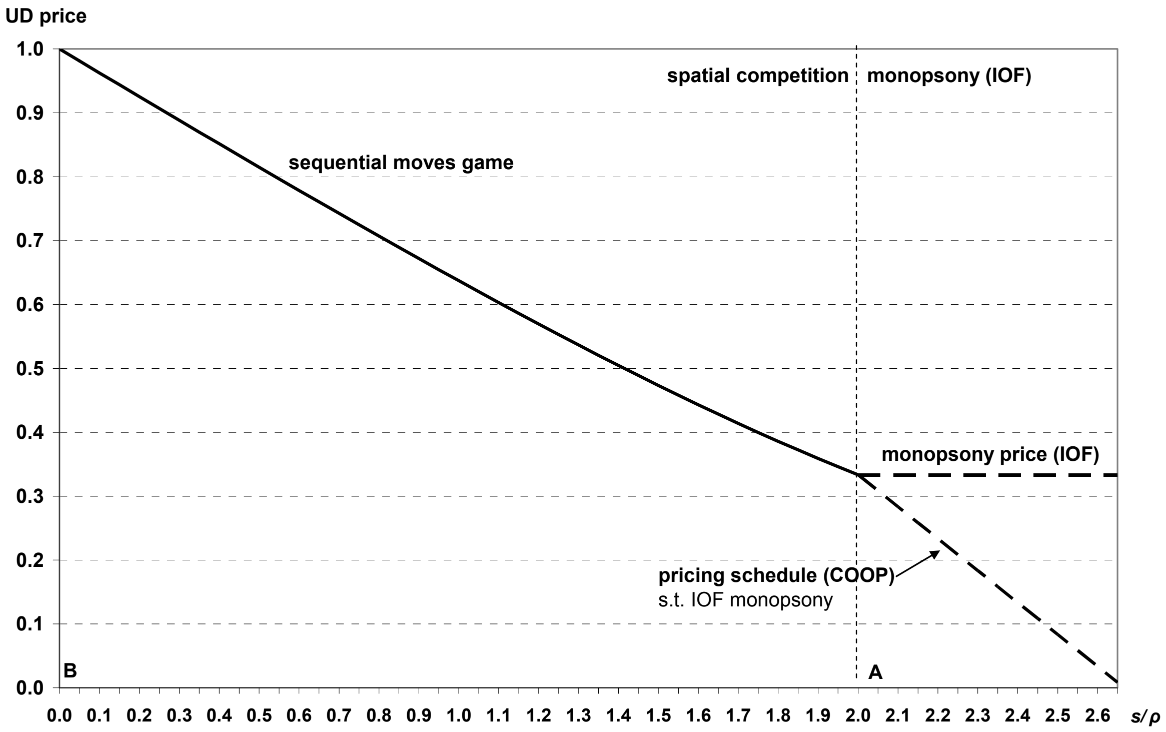
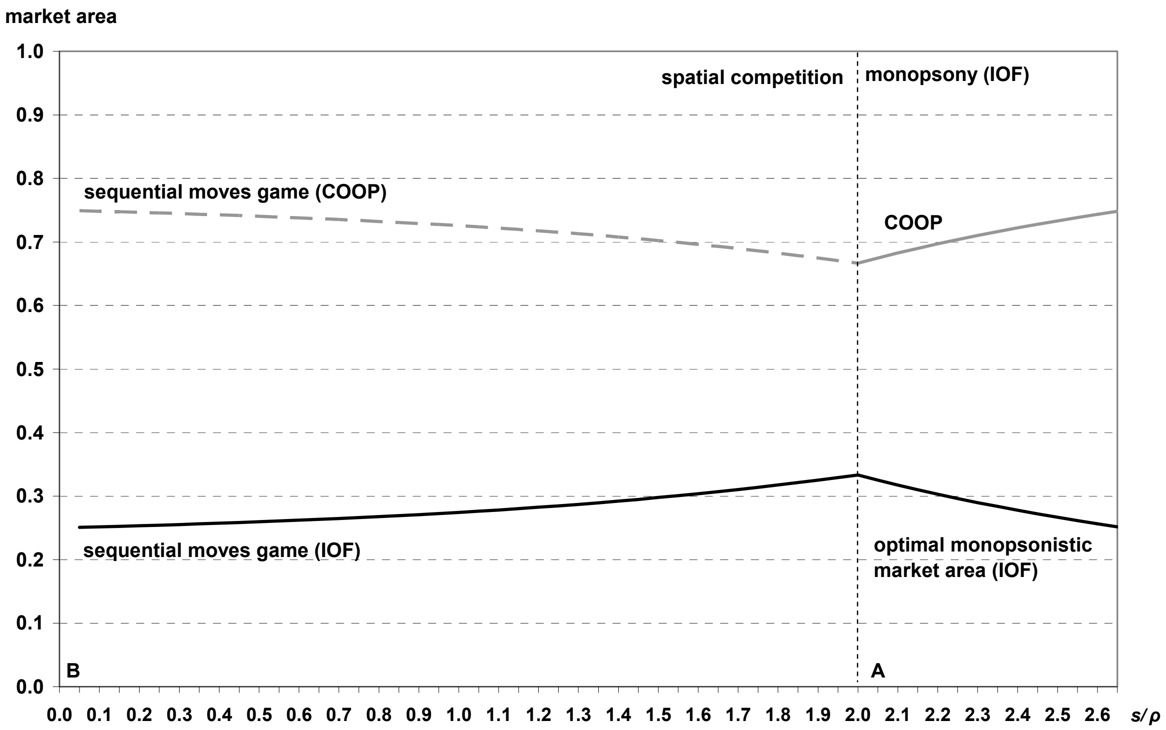


FIGURE 7-4b. Market areas in the mixed market (sequential moves game)



Note: In these figures, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. Both the net selling price *ρ* and the distance *d* between processors are normalized to *1*.

7.1.2 SIMULTANEOUS MOVES GAME 1

In the simultaneous moves game as in (ii), the IOF does not consider the pricing schedule of the COOP; rather, the IOF takes the UD price as given. Thus, this behavior of the IOF is similar to the Hotelling-Smithies conjecture (see also CHAPTER 3.3.2). Again, in equilibrium, the UD price of the IOF must be equal to the UD price of the COOP. The open-membership COOP offers its pricing schedule according to equation (7-2), i.e., the COOP determines its optimal UD price by taking the market area as given. At the same time, the IOF maximizes profits with respect to its market area by taking the UD price as given:

$$(7\text{-}14) \quad \Pi_I^{sim1} = \max_{R_I}\left[\left(\rho - u_I - \frac{tR_I}{2}\right)u_I R_I\right]$$

where index $sim1$ indicates this simultaneous moves game. The solution to this maximization problem is the optimal (monopsonistic) market area

$$(7\text{-}15) \quad R_I = \frac{\rho - u_I}{t}.$$

For the graphical representation below, this can be reformulated to

$$(7\text{-}16) \quad u_I = \rho - tR_I.$$

Equation (7-16) is the “market area schedule” (i.e., the pricing schedule of the IOF that takes the UD price as given) or the maximum UD price the IOF is willing to pay at point $r = R_I$ (see also equation (7-5) in CHAPTER 7.1). Now, farmers will decide which processor to serve up to the point where the two processors’ pricing schedules are equal. Setting equation (7-2) equal to equation (7-16) and solving this for the market area of the IOF gives

$$(7\text{-}17) \quad R_I^{sim1} = \frac{d}{3}.$$

The corresponding market area of the COOP is

$$(7\text{-}18) \quad R_C^{sim1} = \frac{2d}{3}.$$

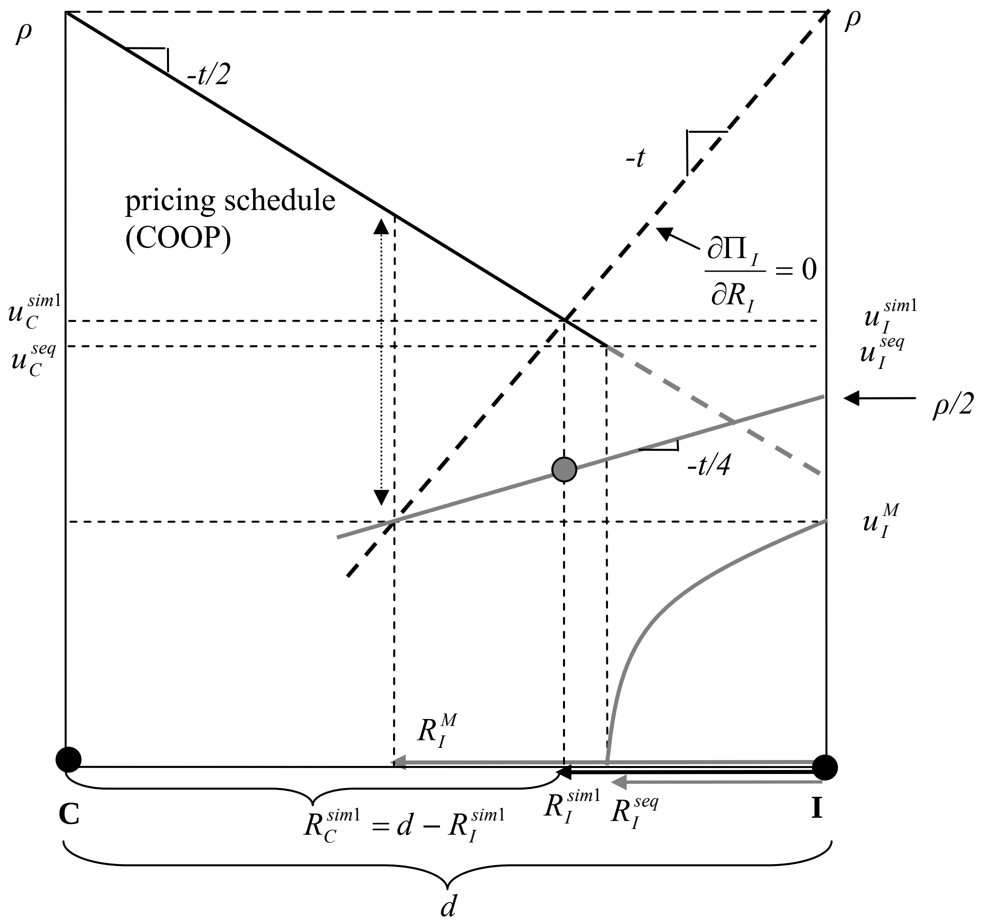
Substituting this into either pricing schedule (equation (7-2) or equation (7-16)) gives the resulting UD price in the mixed market:

$$(7\text{-}19) \quad u^{sim1} = \rho - \frac{td}{3}$$

This result, however, implies that the IOF is in effect not able to control its market area. Rather, the market area of the IOF is determined by farmers' choice of where to deliver their product. In effect, the IOF's market boundary is determined by the location of the farmer who is indifferent between supplying the COOP and supplying the IOF. In this equilibrium, the resulting market areas of processors are independent from the transportation rate *t*.

This model is illustrated in FIGURE 7-5 for one specific $s/\rho < 2$. The black downward-sloping dashed line on the right-hand side is the reformulated "market area schedule" of the IOF, as in equation (7-16), with intercept ρ and slope *–t*. This line represents the maximum UD price the IOF is willing to pay to a farmer located at point *r*. The intersection of this schedule with the pricing schedule of the COOP gives the solutions as in equations (7-17) to (7-19). Compared to the sequential moves game in CHAPTER 7.1.1, this simultaneous moves game results in a higher market area of the IOF ($R_I^{sim1} > R_I^{seq}$). In addition, the UD price in such a mixed market is higher ($u^{sim1} > u^{seq}$).

FIGURE 7-5. Mixed market – simultaneous moves game 1



In CHAPTER 7.1, it was noted that an IOF has, in effect two different (pricing) schedules. In this simultaneous moves game in a mixed market, the IOF operates according to its "market area schedule" only (by maximizing profits with respect to the market area by taking the UD price as given). If the IOF were in a monopsonistic position, it would also make a second choice: it sets an optimal UD price for any given market area according to its pricing schedule (see the flatter downward-sloping line on the right-hand side of FIGURE 7-5 or equation (7-6)). Then, the resulting optimal UD price would be the monopsonistic UD price $u_I^M = \rho/3$ and the resulting monopsonistic market area R_I^M (given by the intersection of both schedules). However, since the resulting UD price of the COOP would be higher (which is indicated by the vertical dotted arrow), farmers would leave the IOF. As the market area of the IOF decreases, its UD price will increase along the downward-sloping dashed line up to the point where the UD price is equal to the UD price of the COOP according to its pricing schedule ($u_C^{sim1} = u_I^{sim1}$). The resulting market area is given by R_I^{sim1}. This is a stable equilibrium because no farmer in the market will switch to the other processor. The most distant IOF supplier located at $r = R_I^{sim1}$ (and also any other IOF supplier) will not switch to the COOP because this would imply a higher UD price of the IOF and a lower UD price of the COOP; the most distant COOP member located at $r = R_C^{sim1}$ (and also any other COOP member) will not switch to the IOF because this would imply a higher UD price of the COOP and a lower UD price of the IOF.

The resulting UD price and market areas depending on the relative importance of space are illustrated in FIGURES 7-6a and 7-6b. Again, the IOF will compete with the COOP for any $s/\rho < 2$ (i.e., to the left of point *A*). In this simultaneous moves game, the UD price is higher than in the sequential moves game for any $s/\rho < 2$. Consequently, an IOF that effectively restricts acceptance of farmers in a mixed market (sequential moves game) implies a lower UD price compared to the situation where the IOF takes the UD price as given (simultaneous moves game 1). At the point $s/\rho = 2$, the UD price in the mixed market is equal to the UD price of a monopsonistic IOF, $u_I^M = \rho/3$. The market area of the IOF is larger if compared to the sequential moves game and constant for any transportation rate *t*.[183] Comparative statics are summarized in APPENDIX A3.2. As can easily be derived from equation (7-19), price

[183] In FIGURES 7-6a and 7-6b, the TMW margin, $\rho - u_C/2 - tr$, is positive at the (open-membeship) COOP's market boundary ($r=R_C$) for any $s/\rho<1$; for any $s/\rho>1$ it is negative. However, profits from processing are equal to zero for any s/ρ, as the following condition regarding the processing margin applies for any s/ρ: $-(\rho - u_C - tR_C) = \rho - u_C$.

transmission in the mixed market under a simultaneous moves game is perfect: $\partial u^{sim1} / \partial \rho = 1$ for any relative importance of space.

FIGURE 7-6a. UD price in the mixed market (simultaneous moves game 1)

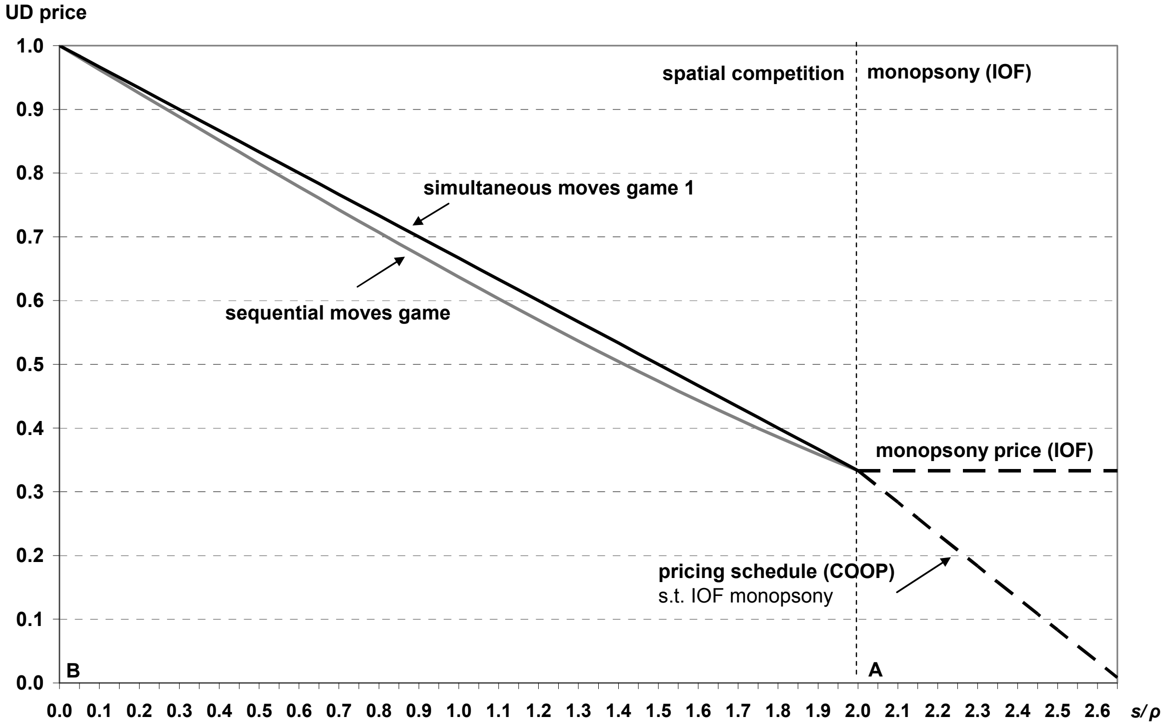
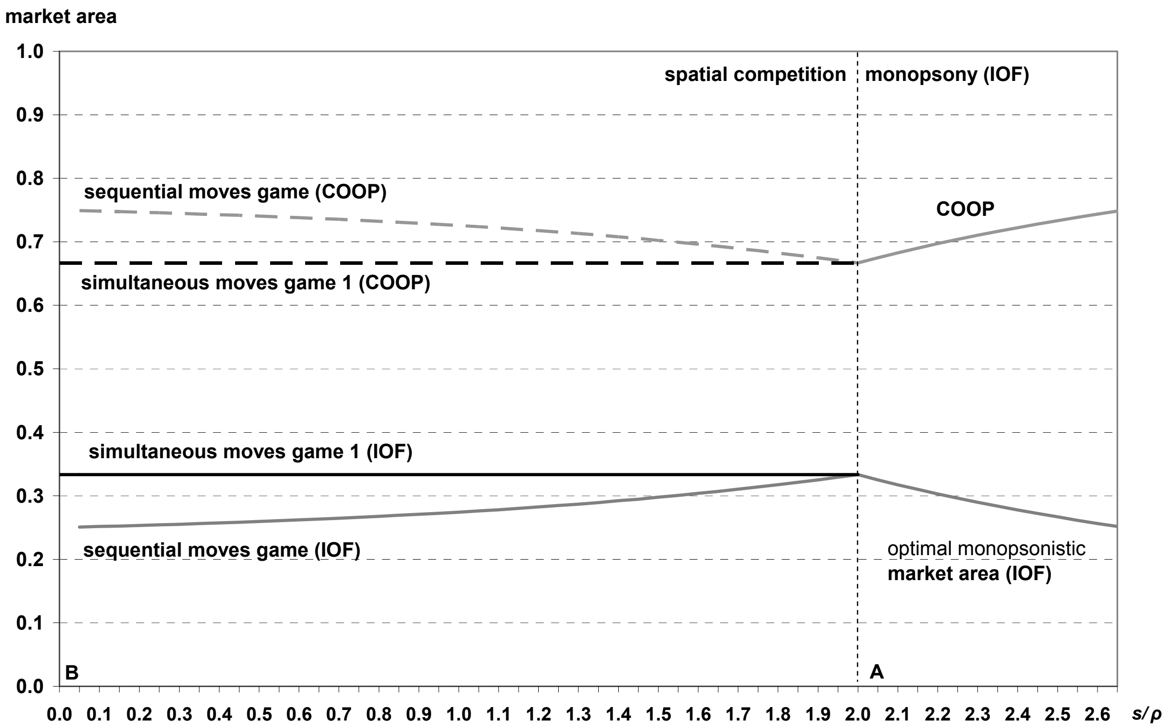


FIGURE 7-6b. Market areas in the mixed market (simultaneous moves game 1)



Note: In these figures, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. Both the net selling price *ρ* and the distance *d* between processors are normalized to *1*.

Although derived in a different way, the UD-price solution in the mixed market under this simultaneous moves game (equation (7-19)) is likewise the solution in FOUSEKIS (2010, chapter 3.4) for the COOP's UD price in a mixed market under the assumption of the Hotelling-Smithies conjecture and for any $s/\rho<1$. The market areas of processors are equal to equations (7-17) and (7-18), respectively. However, in FOUSEKIS (2010), the COOP overbids and the IOF concedes; thus, the UD price of the COOP is higher than the UD price of the IOF. This result is possible since the COOP in FOUSEKIS (2010) obviously restricts its market area to the inverse of the (NARP) pricing schedule: $R_C=(2(\rho-u_C))/t$. Given any UD price, this is the resulting market area so that profits from processing are equal to zero (see also CHAPTER 6.3.2). If $u_C=\rho-(td)/3$, the COOP's resulting market area is $R_C=(2d)/3$. The IOF takes this market area as given and determines an optimal UD price (i.e., it operates according to the pricing schedule in equation (7-6) for $R_I^M=d-R_C$; see the grey dot in FIGURE 7-5).

7.1.3 SIMULTANEOUS MOVES GAME 2

Finally, another possible equilibrium, as in (iii), will be examined. In CHAPTER 7.1.2, the IOF sets UD price according to its "market area schedule" (i.e., by taking the UD price as given). Thus, it can likewise be assumed that the IOF determines a UD price only according to its pricing schedule and similarly to the open-membership COOP (i.e., by taking the market area as given). The market area of either processor is determined by the farmer who is indifferent between supplying the IOF and patronizing the COOP. This is the case at the point in space where UD prices are equal for the COOP and the IOF. Again, this is a simultaneous moves game in terms of the decisions of either processor. The IOF maximizes profits with respect to the UD price by taking its market area as given:

$$(7\text{-}20)\qquad \Pi_I^{sim2}=\max_{u_I}\left[\left(\rho-u_I-\frac{tR_I}{2}\right)u_IR_I\right]$$

where index *sim2* indicates this simultaneous moves game. The solution of the first-order condition is

$$(7\text{-}21)\qquad u_I=\frac{\rho}{2}-\frac{tR_I}{4},$$

which is the pricing schedule of the IOF (see also equation (7-6)). The pricing schedule of the COOP is given by equation (7-2). In equilibrium, the UD price of the COOP, equation (7-2), and the UD price of the IOF, equation (7-21), must be equal. Since farmers themselves choose their processor, the market area of each processor is determined by the point in space where the UD prices are equal. Setting equation (7-2) equal to equation (7-21) gives the resulting market area of the IOF:

$$(7\text{-}22) \qquad R_I^{sim2} = \frac{2(dt - \rho)}{3t}$$

The market area of the COOP is given by $R_C^{sim2} = d - R_I^{sim2}$:

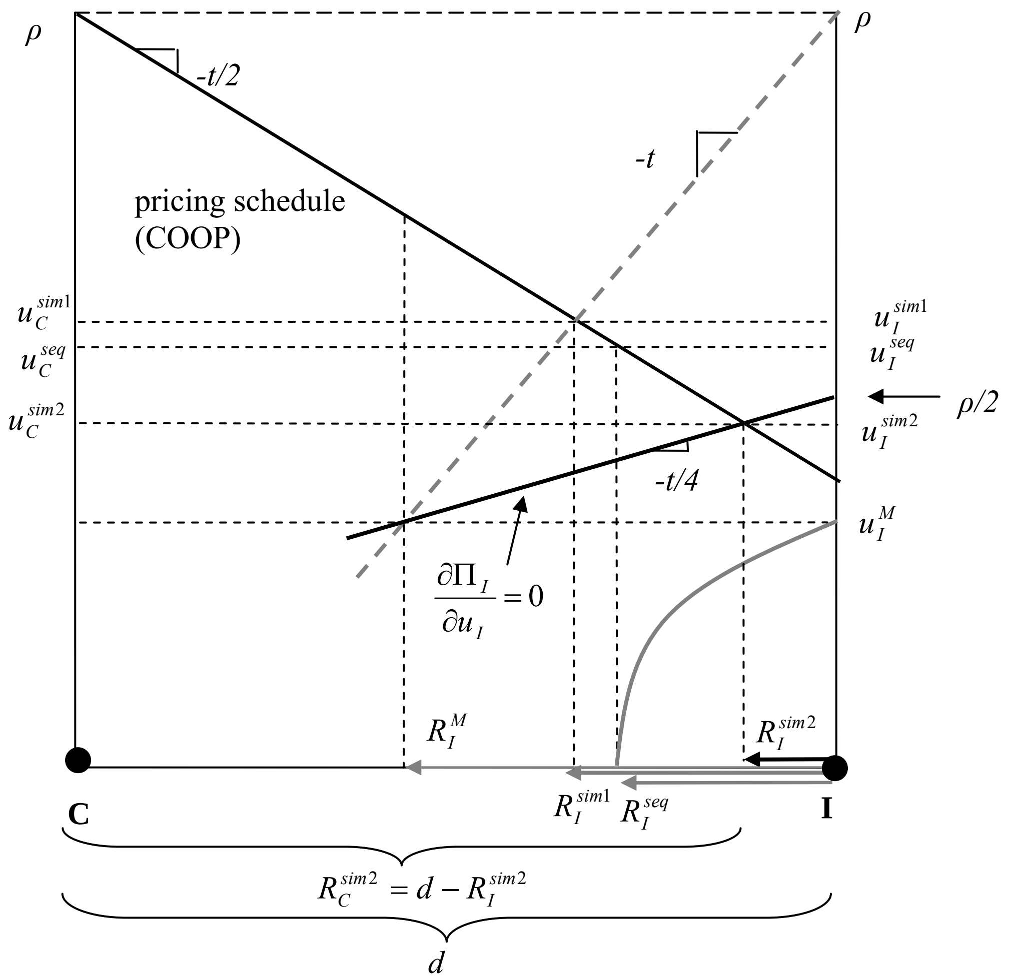
$$(7\text{-}23) \qquad R_C^{sim2} = \frac{2\rho + dt}{3t}$$

Substituting this into either pricing schedule of processors (equation (7-2) for the COOP or equation (7-21) for the IOF) gives the resulting UD price in such a mixed market:

$$(7\text{-}24) \qquad u^{sim2} = \frac{2\rho}{3} - \frac{td}{6}$$

For one specific level of the relative importance of space, the analytical model is illustrated in FIGURE 7-7. The pricing schedule of the IOF is given by the flatter downward-sloping line on the right-hand side (see equation (7-21)) with intercept $\rho / 2$ and slope *–t/4*. The market area of either processor is determined by the intersection of the pricing schedules of the COOP and of the IOF. The resulting UD price is given by $u_{I,C}^{sim2}$ and the market area of the IOF by R_I^{sim2}. Again, this is a stable equilibrium where no farmer will switch to the other processor. The IOF's most distant supplier (and also any other IOF supplier) will not switch to the COOP because he will rationally anticipate that this change will reduce the UD price of the COOP below the UD price of the IOF. The COOP's most distant member (and also any other COOP member) will not switch to the IOF as doing so would reduce the UD price of the IOF below the UD price of the COOP. FIGURE 7-7 illustrates that this equilibrium gives the lowest UD price and the smallest market area of the IOF relative to the other mixed-market solutions. In addition, FIGURE 7-7 shows that the UD price in such a mixed market can never be higher than $\rho / 2$.

FIGURE 7-7. Mixed market – simultaneous moves game 2



FIGURES 7-8a and 7-8b illustrate the UD price and market areas depending on the relative importance of space. A decreasing relative importance of space (e.g., due to a decreasing transportation rate *t*) implies that the market area of the IOF decreases and, consequently, that the market area of the COOP increases (see the black line for the IOF and the black dashed line for the COOP in FIGURE 7-8b).[184] The market area of the COOP is equal to distance *d* for $s/\rho = 1$ (see point *B'*). At this point, the UD price is highest: $u^{sim2} = \rho/2$. Therefore, such behavior of the IOF is possible within the range $1 < s/\rho \leq 2$ (i.e., range *B'* to *A* in FIGURES 7-8a and 7-8b). However, FIGURES 7-8a and 7-8b also illustrate the result if the IOF operates similarly to an open-membership COOP even in the situation $s/\rho > 2$. Since the IOF does not restrict its market area in this case, the UD price of the COOP (IOF) is higher (lower) relative to the situation where the IOF operates as a monopsonist.

[184] In FIGURES 7-8a and 7-8b, the TMW margin $\rho - u_C/2 - tr$ is negative at the (open-membership) COOP's market boundary ($r = R_C$) for any relevant s/ρ. However, since $-(\rho - u_C - tR_C) = \rho - u_C$, the COOP's profits from processing are equal to zero for any s/ρ.

FIGURE 7-8a. UD price in the mixed market (simultaneous moves game 2)

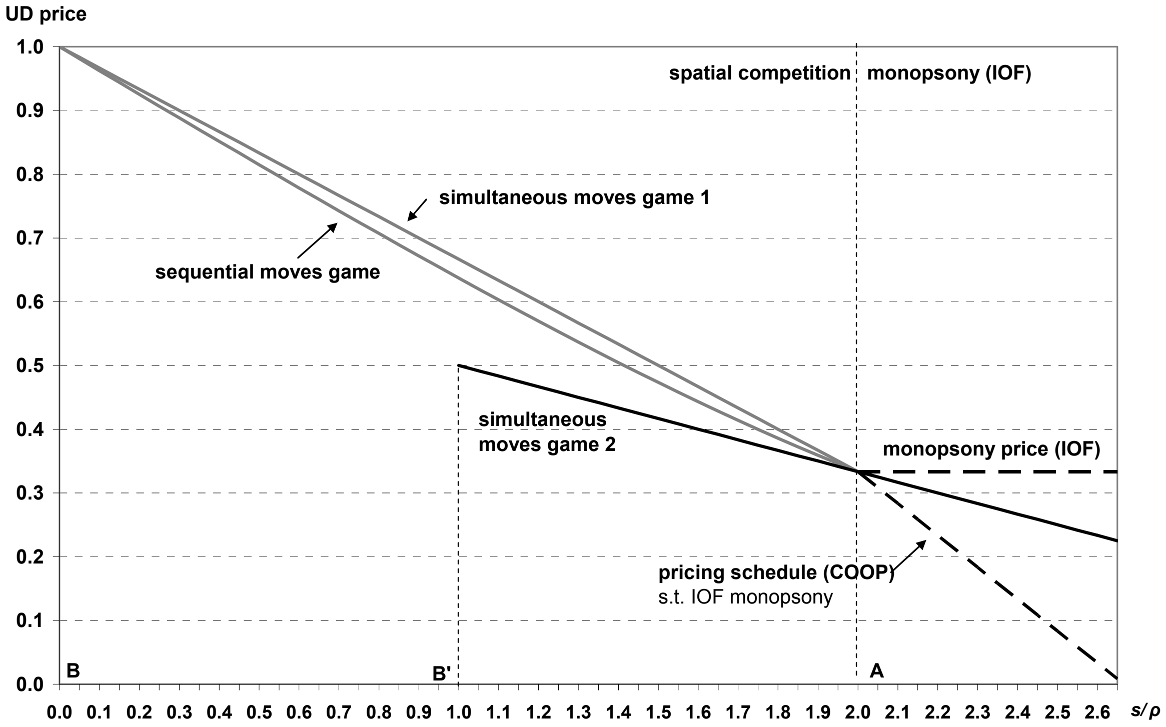
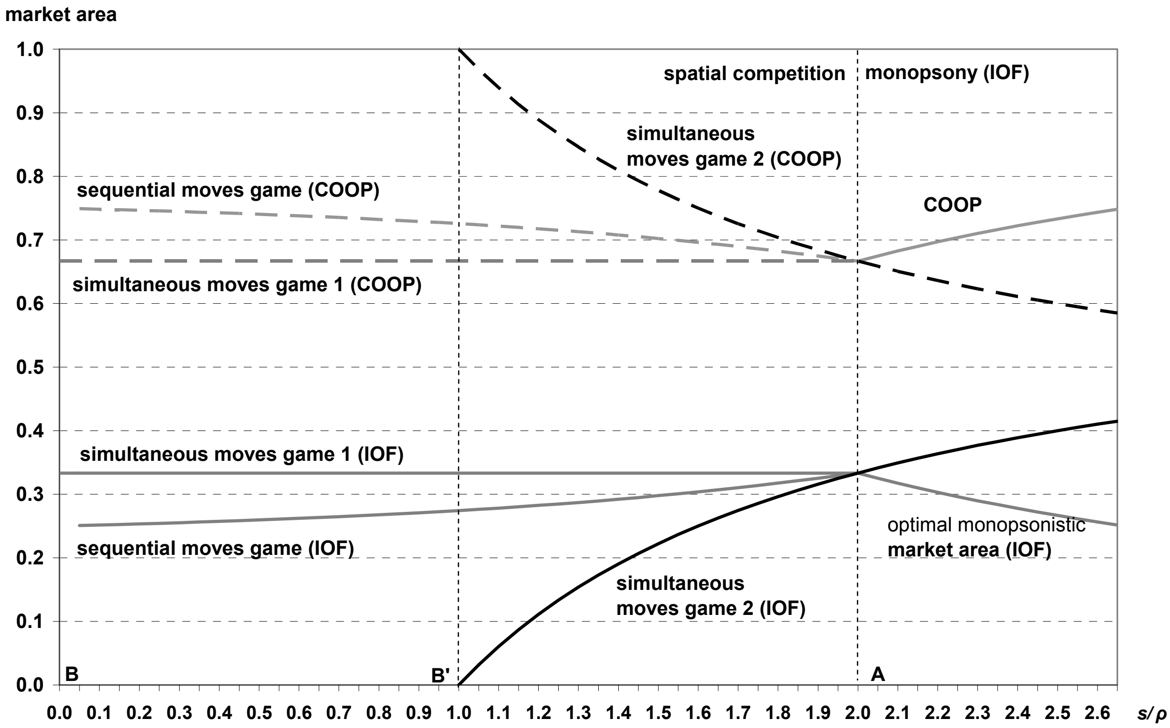


FIGURE 7-8b. Market areas in the mixed market (simultaneous moves game 2)



Note: In these figures, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. Both the net selling price *ρ* and the distance *d* between processors are normalized to *1*.

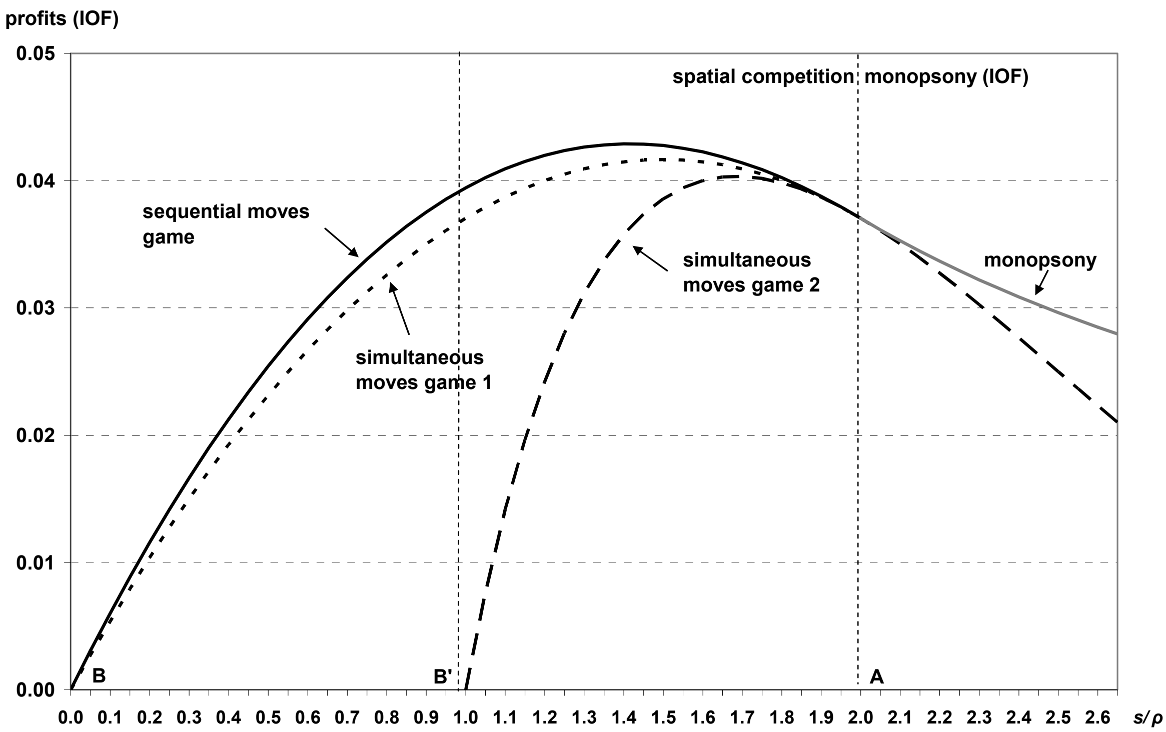
According to equation (7-24), price transmission is not perfect in such a mixed market ($\partial u^{sim2} / \partial \rho = 2/3$), which is equal to the price transmission in the case of a monopsonistic

COOP under restricted membership (see CHAPTER 6.2.1). Comparative statics of this model are summarized in APPENDIX A3.2.

FIGURES 7-8a and 7-8b also show the differences between the mixed-market models (see range *B* to *A*). The UD price in the mixed market and the market area of the IOF are lowest if the IOF takes the market area as given, similarly to an open-membership COOP (simultaneous moves game 2). However, an IOF that determines its optimal market area and anticipates the pricing schedule of the COOP (sequential moves game) implies a higher UD price. Likewise, the share of farmers supplying the IOF is higher. Consequently, an IOF, which is able to determine an optimal market area by itself (sequential moves game), prevents the open-membership COOP from becoming "too large" in terms of its market area (relative to the simultaneous moves game of type 2). This, in turn, leads to a higher UD price in the mixed market. However, the share of farmers patronizing the COOP is lowest if the IOF takes the UD price as given (simultaneous moves game 1). This yields the highest possible UD price in the mixed market.

In addition, it can be shown that the IOF's profits are highest under the sequential moves game (see FIGURE 7-9).

FIGURE 7-9. Profits of the IOF in the mixed market



Note: In this figure, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. Both the net selling price *ρ* and the distance *d* between processors are normalized to *1*.

In the sequential moves game, the IOF has more information (i.e., it knows and anticipates the pricing schedule of the COOP) relative to the simultaneous moves games. In addition, the IOF can effectively restrict its market area. If the IOF operates according to its pricing schedule, similarly to the COOP (simultaneous moves game 2) even in the situation where $s/\rho > 2$, the IOF's profits were necessarily lower than the corresponding monopsonistic profits.

7.1.4 COMPETITIVE YARDSTICK EFFECT

The "yardstick of competition" hypothesis presumes that farm-level prices should be higher in the mixed market than in the pure IOF market. According to this hypothesis, a COOP competing with an IOF mitigates the oligopsony power of the IOF (see also CHAPTER 4.2.2). To analyze the CYE, the resulting UD prices in the mixed market are compared with the UD prices in a pure IOF market.[185] The corresponding UD prices in the pure IOF market under the price-matching conjecture (index *PM*) and under Löschian competition (index *L*) were derived in CHAPTER 5:

$$\text{(7-25)} \quad u_I^{PM} = \frac{2(\rho - dt)}{3} + \frac{\sqrt{4\rho^2 - 8dt\rho + 10d^2t^2}}{6} \quad \text{for } 0 < \frac{s}{\rho} < \frac{4}{3}$$

$$\text{(7-26)} \quad u_I^{L} = \frac{\rho}{2} - \frac{td}{8} \quad \text{for } 0 < \frac{s}{\rho} < \frac{4}{3}$$

FIGURE 7-10a compares UD prices in the pure IOF market (the black lines) with UD prices in the mixed market (the grey lines) depending on the relative importance of space. Given a sequential moves game or a simultaneous moves game of type 1 in the mixed market, a CYE can be confirmed for any $0 < s/\rho \leq 2$ (i.e., range *B* to *A*). If the IOF in the mixed market takes the market area as given similarly to the COOP and accepts any farmer who wishes to supply it (simultaneous moves game 2), then a CYE only exists for $1 < s/\rho \leq 2$ (i.e., range *B'* to *A*). FIGURE 7-10b illustrates differences between UD prices in the mixed market and UD prices in the pure IOF market. A larger difference implies a higher CYE. For any relative importance of space between points *B* and *A'*, processors in the mixed market and IOFs in the pure IOF market, respectively, are in the situation of spatial competition. Black (grey) lines indicate UD-price differences to Löschian competition (price matching) in the pure IOF market.

[185] To analyze a CYE, FOUSEKIS (2010) compares the prices paid by the IOF in the mixed market under UD and FOB pricing, respectively, to the corresponding prices paid by a monopsonistic IOF (see also footnote 9 in his article for a comparison with the results of ZHANG AND SEXTON (2001) for a pure IOF duopsony under UD and FOB pricing).

FIGURE 7-10a. CYE – UD prices

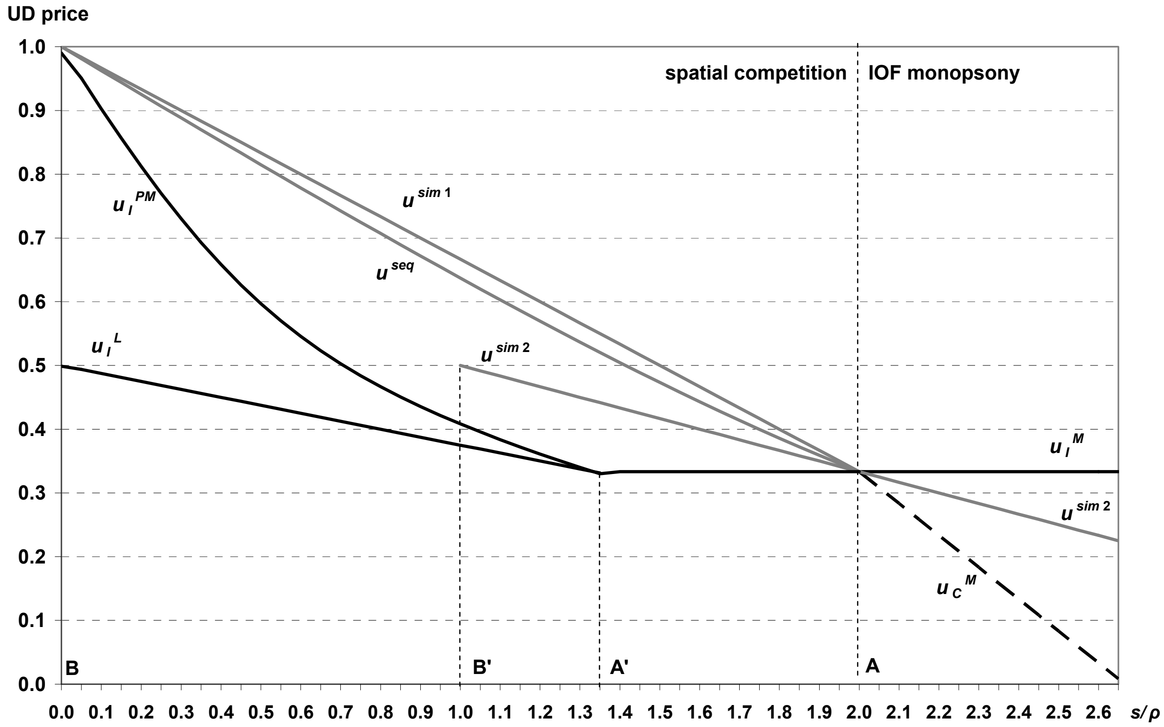
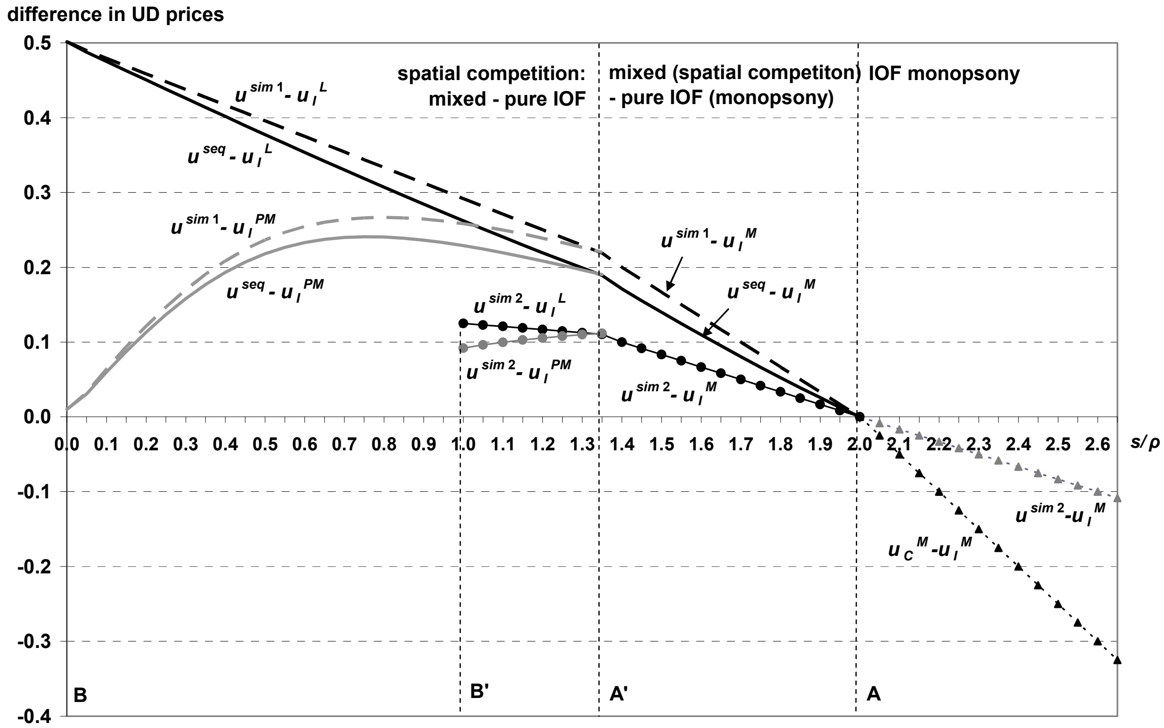


FIGURE 7-10b. CYE – differences in UD prices



Note: In these figures, s/ρ is increasing due to increases in per-unit transportation costs t. Both the net selling price ρ and the distance d between processors are normalized to *1*.

Given any behavior of the IOF in the mixed market, a COOP replacing a Löschian IOF competitor yields a higher CYE (relative to a price-matching IOF). The CYE is highest for the simultaneous moves game of type 1 (the IOF takes the UD price as given) and if the COOP replaces a Löschian IOF competitor; this result is also supported by the result of perfect price transmission in such a mixed market. The CYE is lowest if the IOF takes the market area as given (simultaneous moves game 2) and if the COOP replaces an IOF under price matching (range *B'* to *A'*). Therefore, an IOF that takes the UD price as given (simultaneous moves game 1) helps to prevent an open-membership COOP from becoming "too large" in terms of membership relative to the situation where the IOF operates similarly to the open-membership COOP (simultaneous moves game 2); this behavior implies a higher CYE. As noted, the profits of an IOF are highest in the sequential moves game (i.e., if the pricing schedule of the COOP is known to the IOF). However, in this case, the CYE is lower relative to the simultaneous moves game of type 1.

For any relative importance of space between points *A'* and *A* ($4/3 < s/\rho \leq 2$), processors in the mixed market are in the situation of spatial competition; for the same range of the relative importance of space, IOFs in a pure IOF market are in a monopsony situation. Again, the CYE is highest in the simultaneous moves game of type 1 and lowest in the simultaneous moves game of type 2.

For any $s/\rho > 2$ (i.e., to the right of point *A*), no CYE can be confirmed. For such a high relative importance of space, IOFs in a pure IOF market are monopsonies. In the mixed market, however, the IOF will operate as a monopsonist as well, but the UD price of the COOP (u_C^M) is lower compared to that of the IOF. In this situation, the COOP cannot drive the IOF to less monopsonistic behavior.

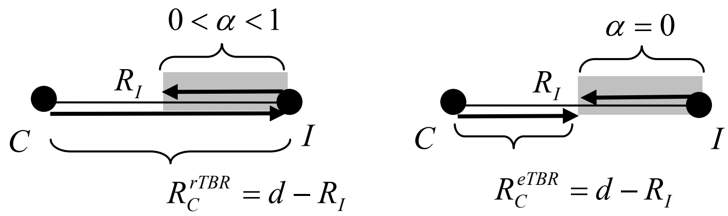
Likewise, even if the IOF in the mixed market takes the market area as given like an open-membership COOP does (simultaneous moves game 2) and given a high relative importance of space ($s/\rho > 2$), the UD price in the mixed market is lower than the optimal monopsonistic UD price of the IOF (u_I^M), but higher than the UD price of the COOP facing a monopsonistic IOF (u_C^M). Thus, in this situation, only an IOF's behavior similar to the COOP (simultaneous moves game 2) would imply a higher UD price for COOP members.

7.2 MIXED MARKET UNDER THE RANDOM TIE-BREAKING RULE

In CHAPTER 7.1, the open-membership policy of the COOP in a mixed market was implemented under the assumption of the efficient TBR with non-overlapping market areas of processors: $R_C = d - R_I$. Under the random TBR (since the COOP cannot ration the supply of farmers via its choice of market area), however, market areas will overlap and farmers choose a processor on a random basis. The COOP's market area equals distance *d*. In addition, the underlying assumption of the random TBR is that farmers do not anticipate the effect of a larger COOP market area on the UD price. One reason for the existence of the random TBR may be high switching costs of farmers (e.g., in terms of confidence in a processor) so that it may not be rational for an individual farmer to switch to the other processor (see also CHAPTER 6.3.1).

Given the random TBR, the market area of the COOP is predetermined and is given by $R_C = d$ for any s/ρ. The area of market overlap is determined by the market area of the IOF, R_I, see FIGURE 7-11 on the left-hand side.

FIGURE 7-11. Mixed market under the no-rationing assumption (random/efficient TBR)



Thus, in the following, it is assumed that some farmers within the market area of the IOF patronize the COOP. In the pure IOF market and in the (restricted-membership) pure COOP market, it is assumed that farmers are shared equally between processors within the area of overlap given symmetric processors (see CHAPTERS 5 and 6). In the mixed market (i.e., non-symmetric processors), however, the shares of farmers of each type (COOP member or IOF supplier) within the area of overlap need not necessarily be equal. Let α be the share of farmers within the area of market overlap (i.e., within R_I) patronizing the COOP. Consequently, $1-\alpha$ is the share of farmers supplying the IOF. Given equal UD prices between processors in equilibrium, the expected outcome of the random TBR is that farmers supply either processor with equal probability in the area of overlap, i.e., $\alpha = 1/2$ (i.e., as in the pure IOF or COOP market, respectively).[186]

Similar to the case of the efficient TBR (see CHAPTER 7.1), the COOP offers a pricing schedule. Assume a NARP-pricing COOP. Taking the market area of the IOF as given, the NARP-pricing COOP solves the following problem:

[186] If $\alpha=0$ (i.e., no farmer within R_I patronizes the COOP), then distinct non-overlapping market areas result from the efficient TBR (see CHAPTER 7.1 and the right-hand side of FIGURE 7-11).

(7-27) $$\frac{\Pi_C}{d-R_I/2} \overset{!}{=} \frac{u_C^2}{2} \text{ for } \Pi_C = \left(\int_0^{d-R_I} \left(\rho - \frac{u_C}{2} - tr \right) \mathrm{d}r + \frac{1}{2} \int_{d-R_I}^{d} \left(\rho - \frac{u_C}{2} - tr \right) \mathrm{d}r \right) u_C$$

(see also APPENDIX A3.1). The second term of the TMW function in equation (7-27) gives the area of overlap (with $\alpha = 1/2$), which is determined by the market area of the IOF. The solution to the problem in equation (7-27) gives the pricing schedule of the COOP under the random TBR:

(7-28) $$u_C = \rho - \frac{t(2d^2 - 2dR_I + R_I^2)}{2(2d - R_I)}$$

Given any possible solution for R_I, the COOP breaks even (i.e., profits from processing are equal to zero). This pricing schedule is also the pricing schedule of a TMW-maximizing COOP (see APPENDIX A3.1). In the following, the sequential moves game (as in Chapter 7.1.1) will be analyzed.

Under the random TBR and assuming a sequential moves game, the IOF pays its suppliers according to the same pricing schedule of the COOP, as in equation (7-28):

(7-29) $$u_I = \rho - \frac{t(2d^2 - 2dR_I + R_I^2)}{2(2d - R_I)}$$

The IOF maximizes profits with respect to its market area by anticipating the pricing schedule of the COOP:

(7-30) $$\Pi_I^{seq} = \max_{R_I} \left[\frac{1}{2} \left(\int_0^{R_I} (\rho - u_I - tr) \mathrm{d}r \right) u_I \right] \text{ for } u_I = \rho - \frac{t(2d^2 - 2dR_I + R_I^2)}{2(2d - R_I)}.$$

Unlike the open-membership COOP, the IOF can ration the raw product supply of farmers in the sequential moves game. More specifically, if farmers within R_I are shared between the IOF and the COOP, the IOF determines the most distant farmer it is willing to serve. Substituting the anticipated pricing schedule of the IOF (equation (7-29)) into equation (7-30) and maximizing profits of the IOF with respect to R_I does not yield an explicit analytical solution. To derive a solution, a numerical simulation is employed as follows. The market area of the IOF can have a minimum value of 0 and a maximum value of d: $R_I \in [0, d]$. Within this range of R_I, the profit function of the IOF has a (local) maximum for each possible relative importance of space, s/ρ. For each possible s/ρ, the corresponding numerical value for the resulting optimal market area (see FIGURE 7-12b) is substituted into equation (7-29), which gives the resulting UD price in the mixed market under the random TBR; see FIGURE 7-12a.

FIGURE 7-12a. UD price in the mixed market (random TBR)

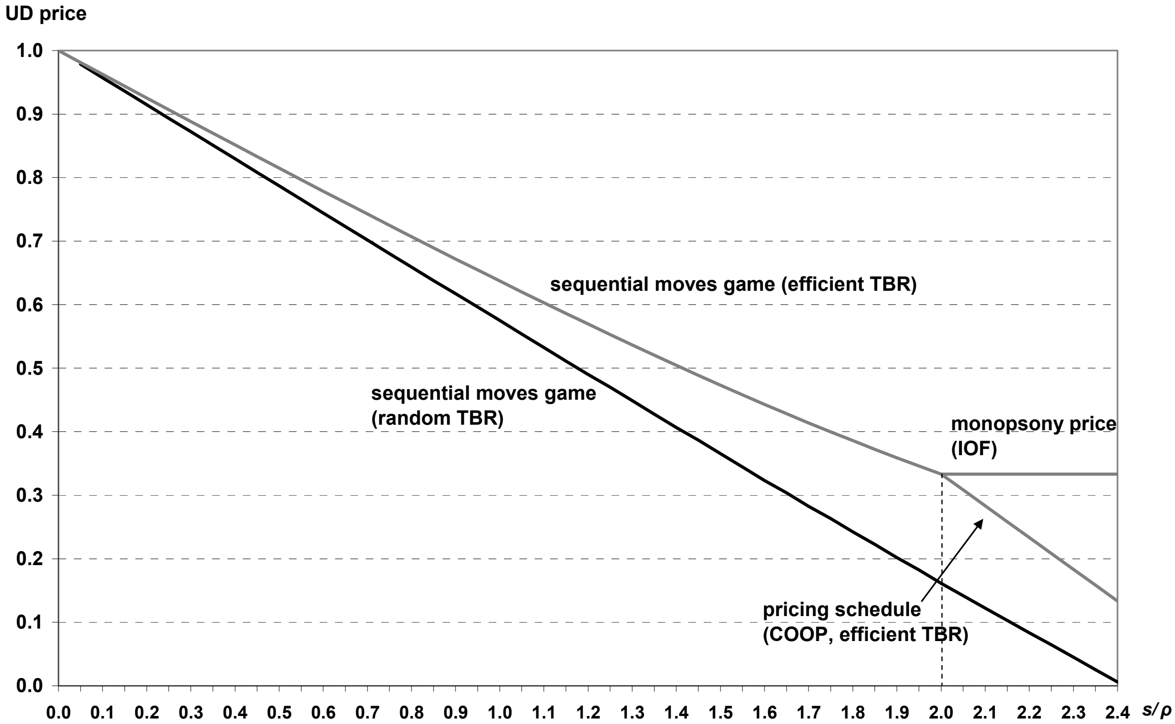
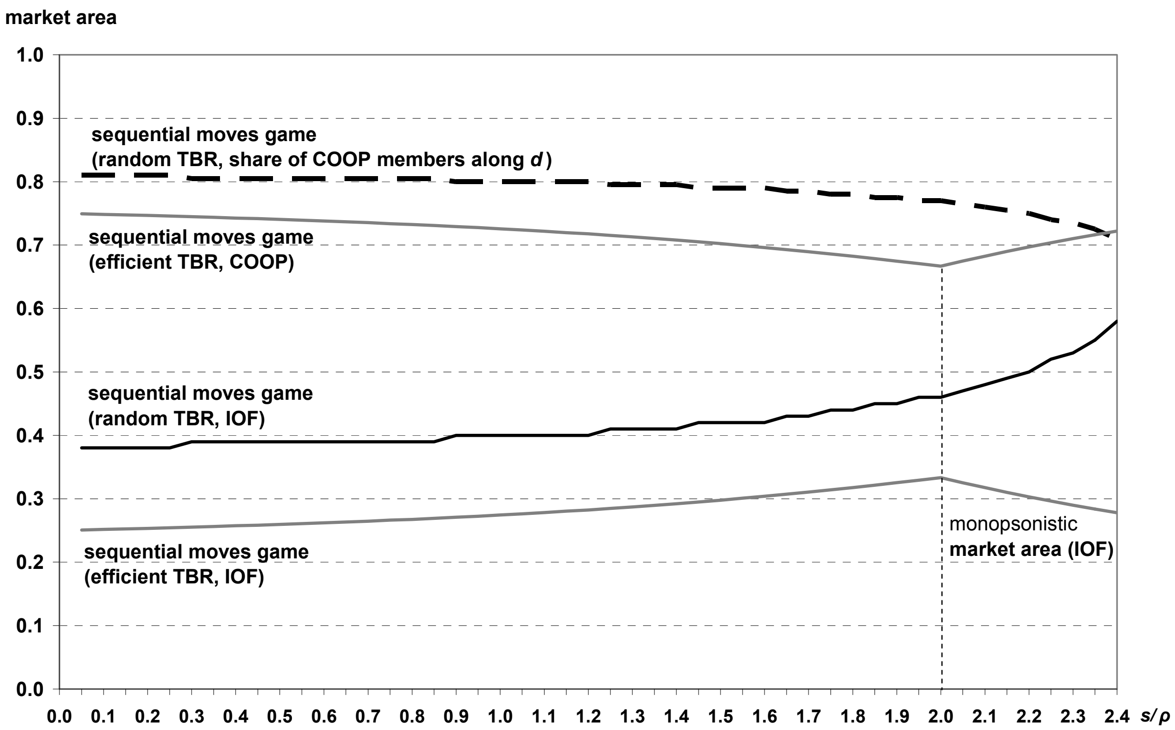


FIGURE 7-12b. Market areas in the mixed market (random TBR)



Note: In these figures, s/ρ is increasing due to increases in per-unit transportation costs t. Both the net selling price ρ and the distance d between processors are normalized to 1.

The UD price is decreasing as the relative importance of space increases and approaches zero for $s/\rho \sim 2.4$.[187] As the UD price decreases, the market area of the IOF increases (see the black line in FIGURE 7-12b). The total share of COOP members along distance *d* consists of farmers within the exclusive market area of the COOP ($d - R_I$) and of farmers patronizing the COOP within the market area of the IOF ($(1/2)R_I$). As a result, the total share of COOP members in the market is given by $d - R_I/2$ (see also equation (7-27)). Consequently, the total share of COOP members in the market decreases as R_I increases (see the black dashed line in FIGURE 7-12b).

Because the COOP serves a larger market area, the UD price in such a mixed market is lower under the random TBR than under the efficient TBR (see FIGURE 7-12a). Given that half of the farmers within the area of overlap patronize the COOP, FIGURE 7-12b shows that the total share of COOP members in the market is higher under the random TBR relative to the efficient TBR.

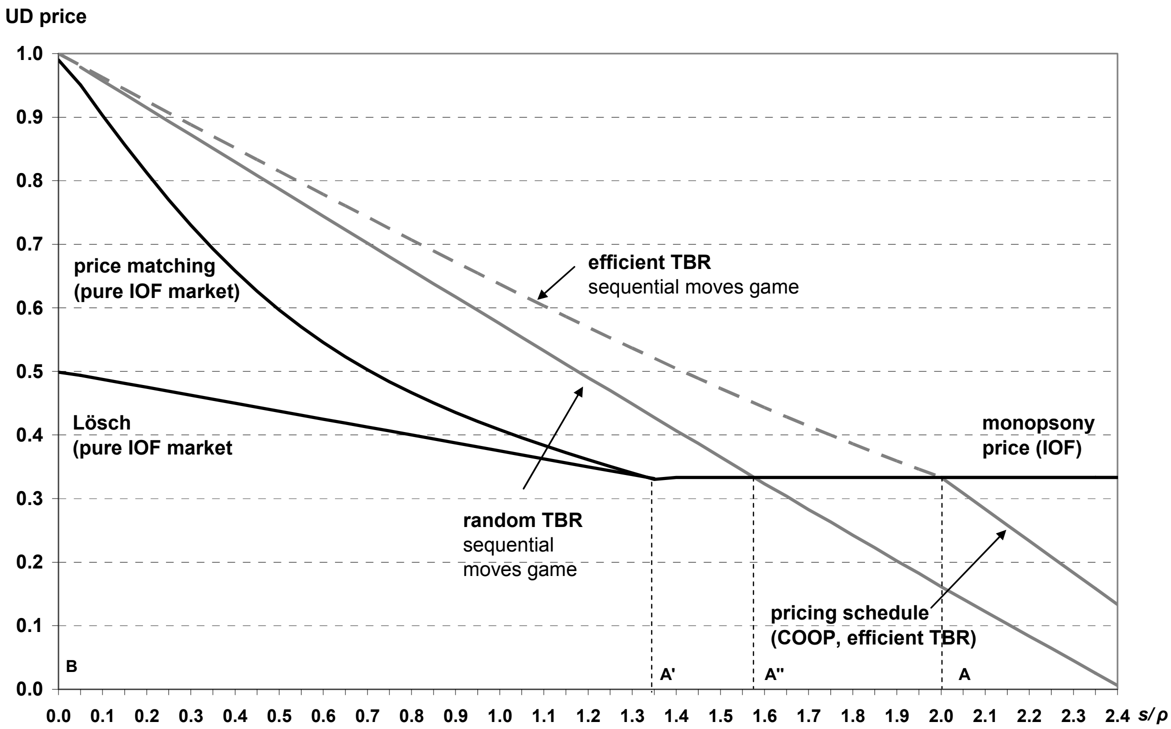
To examine any possible CYE under the random TBR, this result will be compared to the outcome of the pure IOF market; see FIGURE 7-13. As the COOP's market area is equal to distance *d* under the random TBR, the UD price in the mixed market is necessarily lower than in the case of the efficient TBR. However, even under the random TBR, a CYE can be confirmed. In FIGURE 7-13, a CYE is given for any relative importance of space to the left of point *A"*. This point is determined by the relative importance of space, where the UD price in the mixed market is equal to the UD prices of an IOF monopsony ($s/\rho \sim 1.6$). To the right of point *A'* ($s/\rho \geq 4/3$), both IOFs in the pure IOF market are in a monopsonistic position, paying a UD price $u_I^M = \rho/3$. However, any relative importance of space to the right of point *A"* implies a UD price (under the random TBR) that is lower in the mixed market relative to that of an IOF monopsony. Thus, for such a high relative importance of space, no CYE effect exists under the random TBR.

Under the random TBR and given a sequential moves game, the IOF determines its optimal market area; i.e., the most distant farmer the IOF is willing to serve. Within this market area, however, half of the farmers patronize the COOP. This situation is not contradictory to the quasi "closed-membership" policy of an IOF because the IOF will not

[187] Generally, for any relative importance of space where the UD price in the mixed market is lower than the monopsonistic UD price of the IOF ($s/\rho > 1.6$, see FIGURE 7-12a), the IOF might consider operating as a monopsonist by paying its optimal monopsonistic UD price $u_I^M = \rho/3$. All farmers within R_I will switch to the IOF (i.e., there is no market overlap). Then, in turn, the UD price of the COOP will be higher than the optimal monopsonistic UD price of the IOF, and some farmers will switch to the COOP (see CHAPTER 7.1). Thus, within $1.6 < s/\rho < 2$, the result may be the outcome of the efficient TBR as in CHAPTER 7.1.1 or CHAPTER 7.1.2.

serve any additional farmer by extending its market boundary. In contrast to the efficient TBR, however, the IOF does not serve an exclusive market area under the random TBR.

FIGURE 7-13. CYE (random TBR)



Note: In this figure, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. Both the net selling price *ρ* and the distance *d* between processors are normalized to *1*.

Under this sequential moves game, the IOF anticipates the pricing schedule of the COOP and determines the most distant farmer it is willing to serve. Since the IOF can restrict its market area in the sequential moves game, it may be argued that only this game yields a stable solution under the random TBR. For the simultaneous moves games under the efficient TBR in CHAPTERS 7.1.2 and 7.1.3 it was shown that the IOF cannot control its market area and the common market boundary of the processors is determined by the location of the indifferent farmer. Under the simultaneous moves game of type 1, the IOF takes the UD price as given and operates according to its "market area schedule". Under the simultaneous moves game of type 2, the IOF takes the market area as given and offers its pricing schedule, similarly to the open-membership COOP. However, contrary to the sequential moves game in this chapter, analytical results can be derived for the simultaneous moves games under the random TBR (see APPENDIX A3.3).

7.3 MIXED MARKET GIVEN AN OUTSIDE OPTION

In CHAPTER 6.3.2, the open-membership policy of a COOP was accounted for by assuming the existence of an outside option for farmers. In this approach, an open-membership COOP can be a spatially separated monopsonist: the market area of the monopsonistic COOP is determined by the farmer who is indifferent between patronizing the COOP and choosing the outside option. Two results from CHAPTER 6.3.2 are the following. In the monopsony situation, the UD price of the COOP is equal to $\bar{u}$, i.e., the "outside option". However, if all farmers in the market are served by COOPs in a pure COOP duopsony, the UD prices of the COOPs are higher than the outside option. Before analyzing a mixed market under the assumption of an outside option, the corresponding outcome in a pure IOF market given an outside option will be analyzed.

7.3.1 PURE IOF MARKET GIVEN AN OUTSIDE OPTION

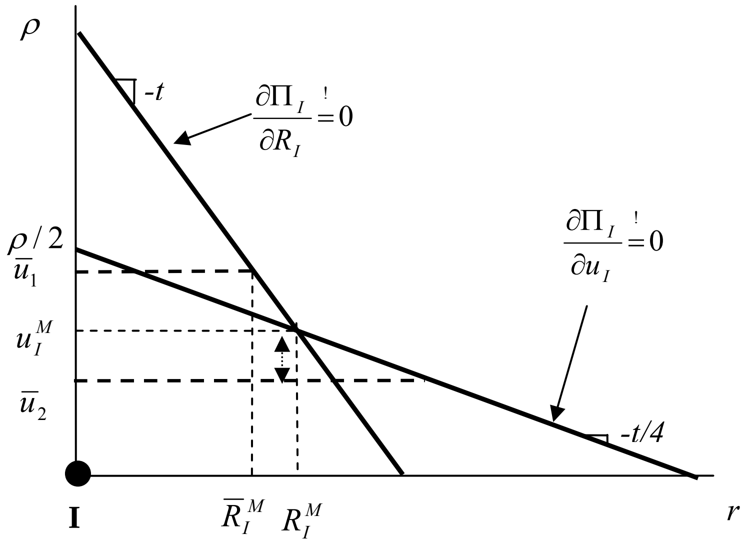
The market area of the monopsonistic COOP under open membership is determined by the level of the outside option for farmers (see CHAPTER 6.3.2). In the following, the effect of an outside option for farmers is analyzed for a (monopsonistic) IOF. As before, the supply function of farmers in the presence of an outside option is defined as

(7-31) $q_I = u_I$ for $u_I \geq \bar{u}$ and zero otherwise.

Thus, $\bar{u}$ determines the minimum UD price of the IOF (for $\bar{u} > 0$). As in CHAPTER 6.3.2, $\bar{u}$ can be interpreted, for example, as the opportunity cost of producing the product and will be referred to as the "outside option" in the following for reasons of simplicity.

The difference between an IOF and an open-membership COOP is that the IOF does not have an open-membership policy and, therefore, determines an optimal market area. Consequently, the IOF must determine the optimal market area to serve and the optimal UD price to pay (see also CHAPTER 5 and CHAPTER 7.1). The monopsonistic IOF pays its optimal UD price $u_I^M = \rho / 3$ and has an optimal market area of $R_I^M = (2\rho)/(3t)$. This situation is illustrated in FIGURE 7-14. The IOF is located at the endpoint of a line market. The steep downward-sloping line is the reformulation of the solution of the first-order condition with respect to R_I (i.e., the "market area schedule" where the IOF maximizes profits by taking the UD price as given or the maximum UD price the IOF is willing to pay at point *r*; see equation (7-5)). The flatter downward-sloping line represents the solution of the first-order condition with respect to u_I (i.e., the pricing schedule where the IOF maximizes profits by taking the market area as given; see equation (7-6)). The intersection of these two lines gives the optimal monopsonistic UD price u_I^M and the corresponding market area R_I^M.

FIGURE 7-14. IOF monopsony given an outside option



Assume now the presence of an outside option $\bar{u} > 0$, where two cases can be distinguished: $\bar{u} > u_I^M$ and $\bar{u} < u_I^M$.

First, if $\bar{u} > u_I^M$ (i.e., $\bar{u} > \rho/3$), farmers will leave the IOF and choose the outside option according to the definition of the supply function (equation (7-31)). In such a situation, the IOF will maximize profits with respect to its market area only by setting $u_I = \bar{u}$. To put it differently, the IOF takes the UD price as given and determines an optimal market area:

$$\text{(7-32)} \quad \bar{u} > \frac{\rho}{3} : u_I = \bar{u} \text{ and } \bar{R}_I^M = \frac{\rho - \bar{u}}{t}$$

In FIGURE 7-14, this situation is illustrated by a rather high level of the outside option, $\bar{u}_1$. Since $\bar{u}_1 > u_I^M$, the IOF matches $\bar{u}_1$ (i.e., $u_I = \bar{u}_1$), and the resulting market area according to the market area schedule is given by $\bar{R}_I^M$.

Second, if $\bar{u} < u_I^M$ (i.e., $\bar{u} < \rho/3$), farmers prefer to supply the IOF. However, the IOF does not have an open-membership policy and, consequently, need not accept all of them. In such a situation, the IOF can operate within its optimal monopsonistic market area and pay an optimal monopsonistic UD price, which is higher than the outside option:[188]

[188] In this situation and due to maximization of profits with respect to both variables (UD price and market area), profits of the IOF are necessarily higher than they would be if the IOF set the UD price equal to the outside option and determined an optimal market area only.

(7-33) $\bar{u} < \frac{\rho}{3}$: $u_I = \frac{\rho}{3}$ and $R_I^M = \frac{2\rho}{3t}$

In FIGURE 7-14, this situation is illustrated by outside option $\bar{u}_2$: the IOF will pay the UD price u_I^M and will not accept any farmer beyond R_I^M.

To conclude thus far, in the (open membership) COOP monopsony, the UD price is equal to the outside option (see CHAPTER 6.3.2). In the IOF monopsony, however, the outside option is obsolete if it is lower than the monopsonistic UD price because the IOF can determine an optimal market area and thus refuse any farmer located beyond the boundary. Assume now two IOFs located at the endpoints of a line market distance d away. Each IOF is in a monopsonistic position ($R_I^M \leq d/2$) if the relative importance of space is rather high:

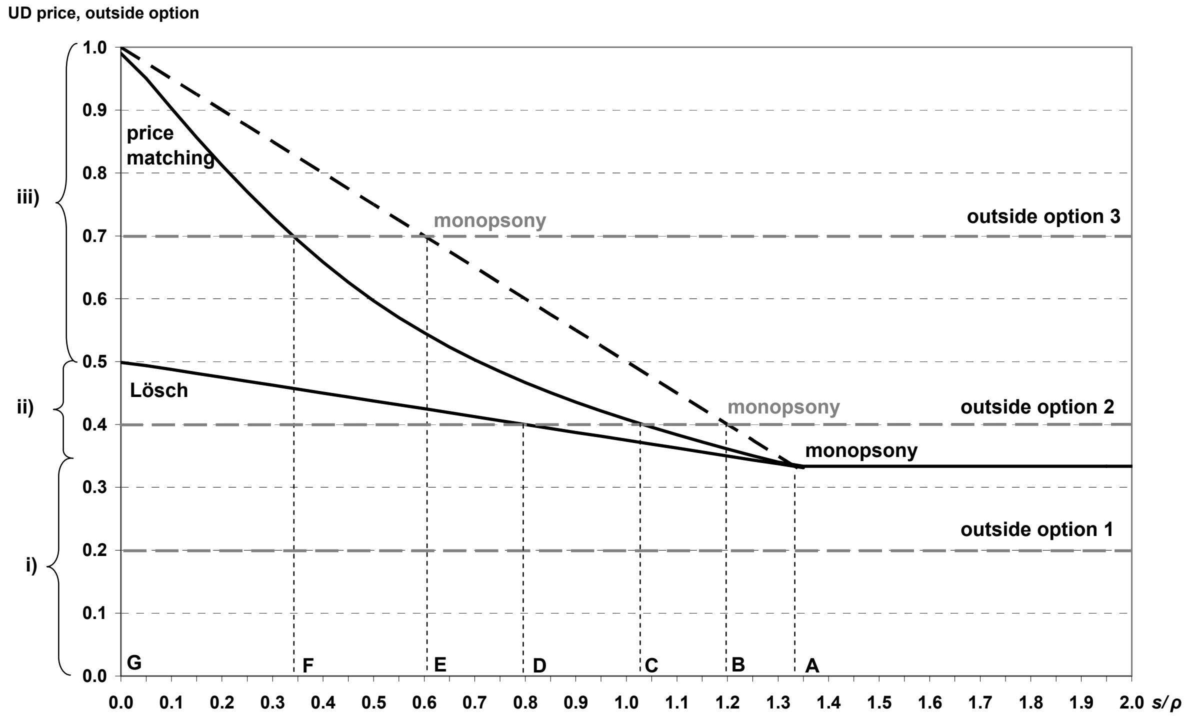
(7-34) $\frac{s}{\rho} \geq 2 - \frac{2\bar{u}}{\rho}$ for $\bar{u} \geq \frac{\rho}{3}$ and $R_I^M = \frac{\rho - \bar{u}}{t}$

(7-35) $\frac{s}{\rho} \geq \frac{4}{3}$ for $\bar{u} < \frac{\rho}{3}$ and $R_I^M = \frac{2\rho}{3t}$

The range of the relative importance of space for IOFs to be in a monopsonistic position is now influenced by the level of the outside option; see condition (7-34) and FIGURE 7-15.

Consider the case of $\bar{u} > \rho/3$. Depending on s/ρ, the downward-sloping dashed line indicates the necessary level of the outside option $\bar{u}$, such that the market area of an IOF paying this specific level of $u_I = \bar{u}$ (and, thus, operating within a market area of $R_I^M = (\rho - \bar{u})/t$) is equal to *d/2*. This level is given by $\bar{u} = \rho - (td)/2$ (see also equation (7-34)). Thus, the intersection of this line with any given outside option (see, for example, outside option 2 or 3 in FIGURE 7-15) determines the relative importance of space above which each IOF is in a monopsonistic situation. For example, consider outside option 3. This outside option is higher than $u_I^M = \rho/3$ so that the IOF must match the outside option. Consequently, the IOF is in a monopsonistic position (with $u_I^M = \bar{u}$ and $R_I^M = (\rho - \bar{u})/t$) for any relative importance of space to the right of point *E*; it is in the situation of spatial competition to the left of point *E* (i.e., within the interval from *G* to *E*). If the level of the outside option increases, the range of the relative importance of space for an IOF to be in the situation of spatial competition decreases (e.g., if the level outside option 3 in FIGURE 7-15 increases, point *E* moves to the left).

FIGURE 7-15. UD prices in the pure IOF market given an outside option



Note: In this figure, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. Both the net selling price *ρ* and the distance *d* between processors are normalized to *1*.

The UD price in a pure IOF market is lowest if both IOFs are in a monopsonistic situation (see also CHAPTER 5). As the relative importance of space decreases, the two IOFs compete with each other and the UD price will increase. Consequently, in the situation of spatial competition in a pure IOF market, any $\bar{u} < \rho/3$ is obsolete. UD prices under the price matching conjecture (*PM*) and under Löschian competition (*L*), respectively, are

$$(7\text{-}36) \quad u_I^{PM} = \frac{2(\rho - dt)}{3} + \frac{\sqrt{4\rho^2 - 8dt\rho + 10d^2t^2}}{6}$$

$$(7\text{-}37) \quad u_I^{L} = \frac{\rho}{2} - \frac{td}{8}$$

(see CHAPTER 5.2.2 and CHAPTER 5.3). As the relative importance of space decreases towards zero, the UD price increases towards the net selling price ρ under the price-matching conjecture and towards $\rho/2$ under Löschian competition (see FIGURE 7-15). Consequently, under the price-matching conjecture, any outside option $\rho/3 \le \bar{u} < \rho$ (range (ii) + (iii) in FIGURE 7-15) is relevant for the IOF. Under Löschian competition, only any $\rho/3 \le \bar{u} < \rho/2$ (range (ii)) must be considered.

First, assume $\rho/3 \le \overline{u} < \rho/2$, i.e., range (ii). In FIGURE 7-15, such a situation is exemplified by outside option 2. The IOF pays a UD price equal to $\overline{u}$ in the monopsony situation (to the right of point *B*). To the left of point *B*, the optimal UD prices under spatial competition would be lower than the outside option for some range of the relative importance of space, i.e., range *B* to *C* under the price-matching conjecture and range *B* to *D* under the Löschian conjecture. This range of s/ρ is determined by the relative importance of space for which $u_I^{PM} = \overline{u}$ or $u_I^L = \overline{u}$ (the lower boundary of this range; i.e., point *C* or *D*) and the monopsony situation (the upper boundary, point *B*):

(7-38) monopsony for $\frac{s}{\rho} > 2 - \frac{2\overline{u}}{\rho}$ (to the right of point *B*)

(7-39) $u_I^{PM} < \overline{u}$ for $\frac{2\rho - 4\overline{u} + \sqrt{2\rho^2 - 8\rho\overline{u} + 10\overline{u}^2}}{\rho} < \frac{s}{\rho} \le 2 - \frac{2\overline{u}}{\rho}$ (range *C* to *B*)

(7-40) $u_I^L < \overline{u}$ for $\frac{4(\rho - 2\overline{u})}{\rho} < \frac{s}{\rho} \le 2 - \frac{2\overline{u}}{\rho}$ (range *D* to *B*)

For a lower relative importance of space, the IOF can pay optimal UD prices according to price matching (equation (7-36)) or the Löschian conjecture (equation (7-37)):

(7-41) $u_I^{PM} > \overline{u}$ for $0 < \frac{s}{\rho} \le \frac{2\rho - 4\overline{u} + \sqrt{2\rho^2 - 8\rho\overline{u} + 10\overline{u}^2}}{\rho}$ (to the left of point *C*)

(7-42) $u_I^L > \overline{u}$ for $0 < \frac{s}{\rho} \le \frac{4(\rho - 2\overline{u})}{\rho}$ (to the left of point *D*)

Second, assume $\rho/2 < \overline{u} \le \rho$ (i.e., range (iii)), which is exemplified by option 3 in FIGURE 7-15. Pricing according to the optimal UD price under the Löschian conjecture (equation (7-37)) is not possible for such a high level of $\overline{u}$. The IOF pays a UD price equal to $\overline{u}$ in the monopsony situation to the right of point *E* (see also equation (7-38)). For a lower relative importance of space than point *F* (see also equation (7-41)), the IOF can pay an optimal UD price according to the price-matching conjecture.

To conclude, as the outside option increases, the range of the relative importance of space that places IOFs in the situation of spatial competition decreases. Thus, if the outside option is rather high, IOFs can be in the situation of spatial competition only for a rather low relative importance of space. Given any $\overline{u} > \rho/3$, there will always be a certain range of the relative importance of space with the following characteristics. First, IOFs are already in the situation of spatial competition. Second, the IOFs cannot pay optimal UD prices (according to the price-matching or Löschian conjecture) because this would imply UD prices that are lower than the outside option. Given outside option 2, this range stretches from point *C* to point *B* (price matching) or from point *D* to point *B* (Löschian conjecture). Given outside option 3, the range is point *F* to point *E* (price matching). Within these ranges, IOFs have three different options regarding their behavior (see APPENDIX A3.4). The resulting UD prices for these ranges can be either equal to the outside option or equal to the downward-sloping dashed line, i.e., $u_I = \rho - (td)/2$.

7.3.2 MIXED MARKET GIVEN AN OUTSIDE OPTION

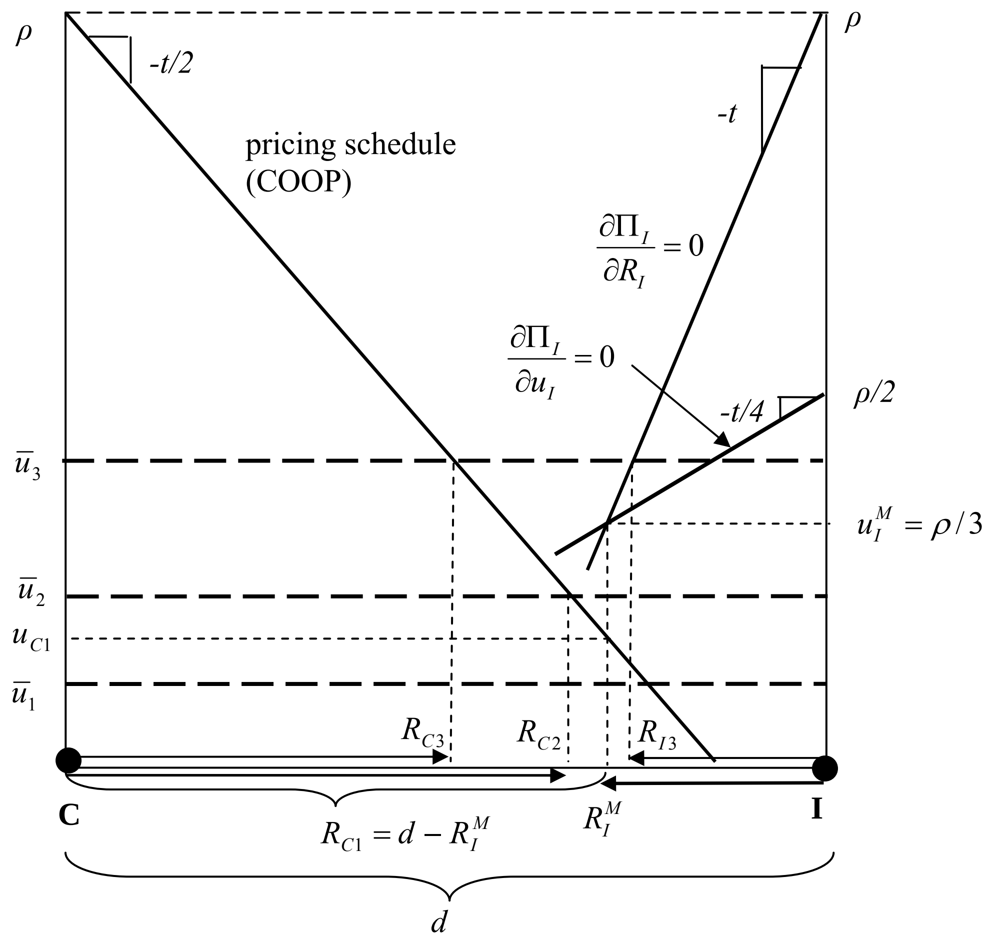
Assume now a mixed market with an open-membership COOP and an IOF located at the endpoints of a line market in the presence of an outside option for farmers. For this situation, the same models for the situation of spatial competition between the COOP and the IOF as in CHAPTER 7.1 are proposed. The difference from CHAPTER 7.1, however, is that not all farmers are necessarily served by either processor when an outside option is available. In such a situation, the COOP and the IOF operate as spatially separated monopsonists.

One result of CHAPTER 6.3.2 is that the UD price of a monopsonistic open-membership COOP will be equal to the outside option: $u_C^M = \bar{u}$. The market area of the COOP is determined by the members themselves, i.e., by the point in space where the UD price of the COOP is equal to the outside option. As the monopsonistic COOP offers a pricing schedule $u_C = \rho - (tR_C)/2$ (see equation (7-2)), the UD price is equal to the outside option at $R_C^M = (2(\rho - \bar{u}))/t$ (see equation (6-50)).

For a monopsonistic IOF, the outside option determines the minimum UD price it has to pay to its farmers as well (see CHAPTER 7.3.1). If $\bar{u} < \rho/3$, the monopsonistic IOF will pay its optimal monopsonistic UD price $u_I^M = \rho/3$ and operate within its monopsonistic market area $R_I^M = (2\rho)/(3t)$. If $\bar{u} > \rho/3$, the IOF will match the outside option ($u_I^M = \bar{u}$) and maximize profits only with respect to the market area: $R_I^M = (\rho - \bar{u})/t$.

In the mixed-market model in CHAPTER 7.1 (in the absence of an outside option), it was demonstrated that the IOF can pay a higher UD price than the COOP under the efficient TBR for any $s/\rho > 2$. Given the existence of an outside option, a situation where the COOP and the IOF are in a monopsonistic position is illustrated in FIGURE 7-16 for $s/\rho > 2$.

FIGURE 7-16. Mixed market – the IOF as a monopsonist ($s/\rho > 2$) given an outside option



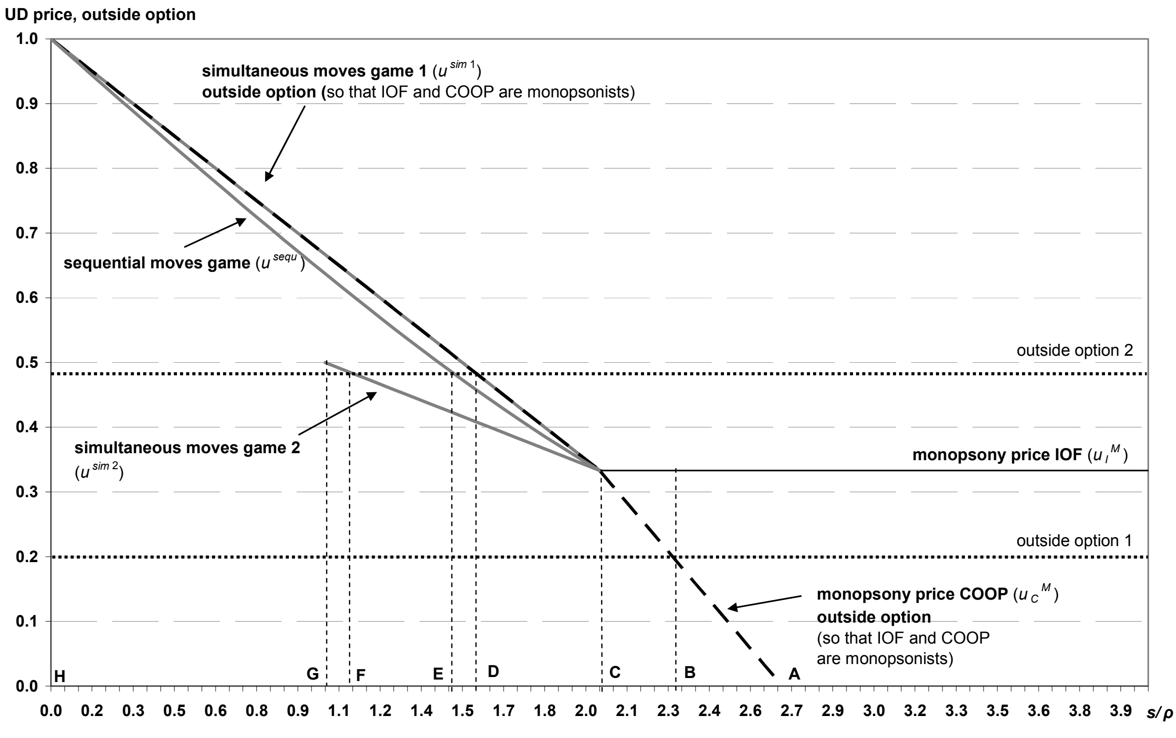
Assume first a very low level of the outside option, $\bar{u}_1 < \rho/3$ (see FIGURE 7-16). The IOF will operate within its optimal monopsonistic market area $R_I^M = (2\rho)/(3t)$, paying its optimal monopsonistic UD price $u_I^M = \rho/3$. The COOP pays a UD price according to its pricing schedule ($u_C = \rho - (t(d - R_I^M))/2$). Given the low level of $\bar{u}_1$ and the situation $s/\rho > 2$, no farmer in the market chooses the outside option, i.e., all farmers are served by either processor. Thus, given that $R_{C1} = d - R_I^M$, the UD price of the COOP is $u_{C1} = (4\rho)/3 - (td)/2$ (see equation (7-9) in CHAPTER 7.1). As $u_{C1} < u_I^M$, COOP members would like to switch to the IOF, which will not accept them because they are located outside of its optimal market area. In turn, IOF suppliers will not leave the IOF because its UD price is higher.

Assume now a higher level of the outside option, $\bar{u}_2 < \rho/3$ (see FIGURE 7-16). Again, the IOF pays u_I^M and operates within R_I^M. However, processors are spatially separated monopsonists in this situation. The resulting UD price of the COOP is $u_C = \bar{u}_2$ and its market area is R_{C2} with $R_{C2} + R_I^M < d$. As $u_I^M > \overline{u}_2$, farmers supplying the outside option would like to switch to the IOF, but the IOF is not willing to serve them. If the outside option, for example $\overline{u}_3$, is higher than the optimal monopsonistic UD price of the IOF, then both processors are separated monopsonies (R_{C3}, R_{I3}), but the UD prices of the COOP and the IOF are equal: $u_C = u_I = \overline{u}_3$.

These considerations are illustrated in FIGURE 7-17 depending on the relative importance of space. If $\overline{u} \le \rho/3$ (e.g., outside option 1), the COOP and the IOF are spatially separated monopsonies ($R_C + R_I^M \le d$ with $u_C = \overline{u}$ and $u_I^M = \rho/3 \ge \overline{u}$) for

(7-43) $\quad \dfrac{s}{\rho} \ge \dfrac{8}{3} - \dfrac{2\overline{u}}{\rho}$ (to the right of point B)

FIGURE 7-17. UD prices in the mixed market given an outside option



Note: In this figure, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. Both the net selling price *ρ* and the distance *d* between processors are normalized to *1*.

To put it differently, provided that $\overline{u} < \rho/3$, the downward-sloping dashed line to the right of point *C* is given by $\overline{u} = (4\rho)/3 - td/2$ and indicates the level of an outside option depending on s/ρ so that $R_C + R_I^M = d$. As the relative importance of space decreases (from *B* to *C*), the COOP pays a UD price that is higher than $\overline{u}$ ($u_C = (4\rho)/3 - td/2$; see equation (7-9) or the downward-sloping dashed line to the right of point *C*), but lower than u_I^M. Within this range (*B* to *C*), $R_C + R_I^M = d$. At point *C* (i.e., $s/\rho = 2$), $u_C = u_I^M = \rho/3$. For a lower level of s/ρ (to the left of point *C*), processors are in the situation of spatial competition in a mixed market, as proposed in CHAPTERS 7.1.1 to 7.1.3.

Now, assume an outside option that is higher than the monopsonistic UD price of the IOF, $\bar{u} > \rho/3$, see outside option 2 in FIGURE 7-17. For a high level of s/ρ (to the right of point *D*), the IOF will set its UD price equal to $\bar{u}$ and will operate within the market area $R_I^M = (\rho - \bar{u})/t$. Likewise, farmers will choose the COOP so that its UD prices is equal to $\bar{u}$ and the COOP's market area is $R_C^M = (2(\rho - \bar{u}))/t$. In this situation, the COOP and the IOF are spatially separated monopsonists (i.e., $R_C^M + R_I^M \leq d$) and some farmers choose the outside option. Provided that $\bar{u} > \rho/3$, this is the situation for any

(7-44) $\quad \dfrac{s}{\rho} \geq 3 - \dfrac{3\bar{u}}{\rho}$ (to the right of point *D*).

To put it differently, the level of the outside option depending on s/ρ so that $R_C^M + R_I^M = d$ is given by $\bar{u} = \rho - (td)/3$ (see the downward-sloping dashed line within the range from point *H* to point *C*). This is at the same time the resulting UD price in a mixed market under a simultaneous moves game of type 1 (i.e., the IOF takes the UD price as given); see equation (7-19) in CHAPTER 7.1.2. If s/ρ further decreases (i.e., any s/ρ to the left of point *D*), processors are in the situation of spatial competition.

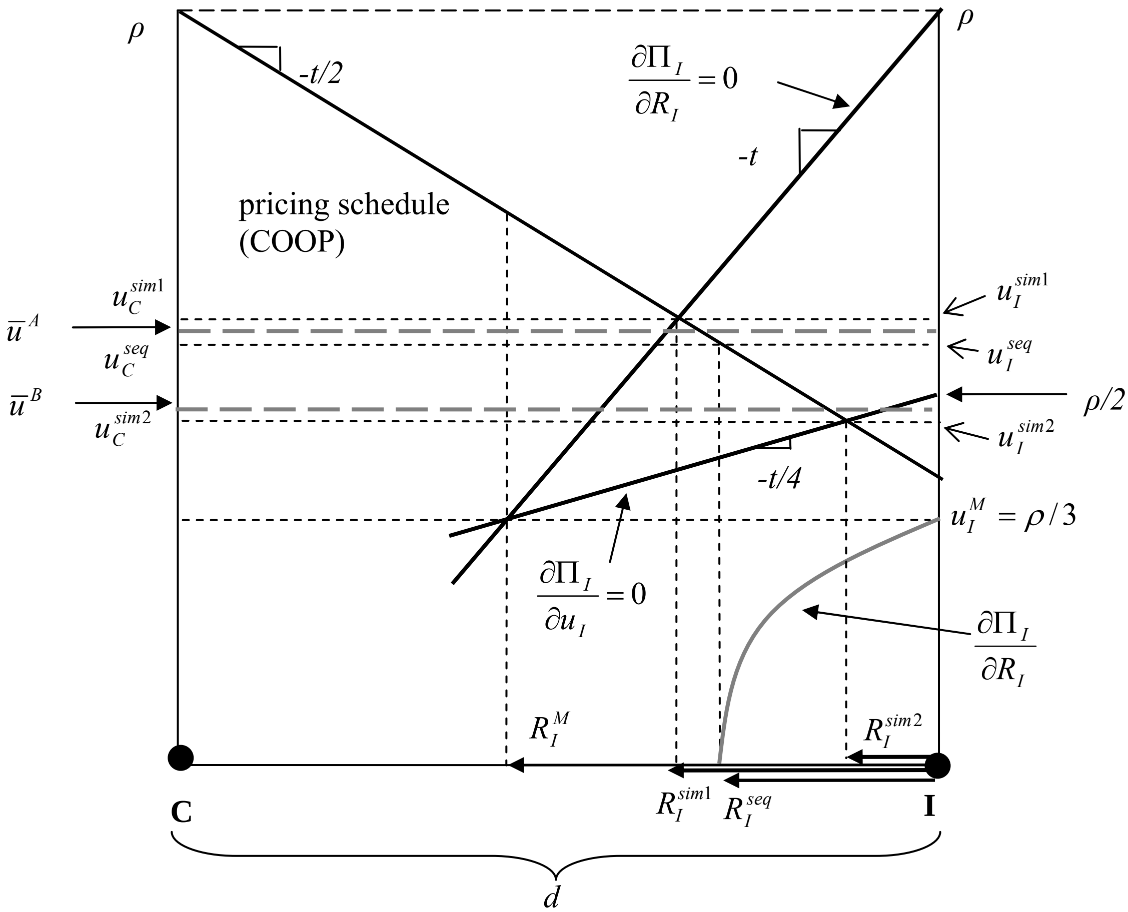
Thus, the simultaneous moves game of type 1 proposed in CHAPTER 7.1.2 is possible for any $s/\rho < 3 - (3\bar{u})/\rho$ (to the left of point *D*) because the resulting UD price is higher than the outside option 2. Given outside option 2, however, FIGURE 7-17 makes clear that the corresponding UD price in the mixed market under a sequential moves game and under the simultaneous moves game of type 2 (where the IOF takes the market area as given) is lower than the level of outside option 2 within the s/ρ-range from point *F* to point *D*. UD prices under these two mixed-market models are lower than the outside option for the following ranges:

(7-45) $\quad u^{seq} < \bar{u}$ for $\dfrac{3\rho - 6\bar{u} + \sqrt{12\bar{u}^2 - 4\rho\bar{u} + \rho^2}}{\rho} \leq \dfrac{s}{\rho} < 3 - \dfrac{3\bar{u}}{\rho}$ (range *E* to *D*)

(7-46) $\quad u^{sim2} < \bar{u}$ for $\dfrac{2(2\rho - 3\bar{u})}{\rho} \leq \dfrac{s}{\rho} < 3 - \dfrac{3\bar{u}}{\rho}$ (range *F* to *D*)

Regarding this range of s/ρ (point *F* to point *D*), such a situation is illustrated in FIGURE 7-18 for a specific level of s/ρ.

FIGURE 7-18. Mixed market given an outside option



Given outside option $\bar{u}^A > \rho/2$, a mixed-market solution where the IOF takes the market area as given (u^{sim2}) is not possible.[189] The mixed-market solution given a sequential moves game (u^{seq}) would yield a UD price that is lower than $\bar{u}^A$. Thus, a possible mixed-market solution is the solution of the simultaneous moves game of type 1 (u^{sim1}).

For the same level of s/ρ, assume a lower outside option, $\rho/3 < \bar{u}^B < \rho/2$ (see FIGURE 7-18). In this situation, UD prices under the sequential moves game (u^{seq}) and under the simultaneous moves game of type 1 (u^{sim1}) are higher than $\bar{u}^B$ and, thus, represent possible solutions. However, the assumption that the IOF takes the market area as given, like the COOP (u^{sim2}), would yield an optimal UD price that is lower than outside option $\bar{u}^B$.

[189] This is due to the fact that the pricing schedule of the IOF (by taking its market area as given) has intercept *ρ/2* and is downward sloping; see FIGURE 7-19.

Another possibility is the following. Assume that the IOF takes the market area as given, similarly to an open-membership COOP (see the flatter downward-sloping line on the right-hand side). As $u^{sim2} < \bar{u}^B$, some farmers in the market will choose the outside option, and an equilibrium is established where $u_C = \bar{u}^B$ and $u_I = \bar{u}^B$. In this situation, the COOP and the IOF are spatially separated monopsonists ($R_I = \left(2\left(\rho - 2\bar{u}^B\right)\right)/t$ and $R_C = \left(2\left(\rho - \bar{u}^B\right)\right)/t$).[190]

To conclude, UD prices in the corresponding ranges of the relative importance of space (see equations (7-45) and (7-46), i.e., range *F* to *D* in FIGURE 7-17) are the following. If $\rho/3 < \bar{u} < \rho/2$, then the simultaneous moves game of type 1 or separated monopsonies paying UD prices equal to the outside option are possible solutions (range *D* to *E*). For a lower s/ρ (range *F* to *E*), the sequential moves game is possible as well. However, for a higher outside option ($\rho/2 < \bar{u} < \rho$), only the simultaneous moves game of type 1 qualifies as a possible solution within the s/ρ-range as determined by equation (7-45).

7.3.3 COMPETITIVE YARDSTICK EFFECT GIVEN AN OUTSIDE OPTION

Generally, the range of the relative importance of space for processors to be in the situation of spatial competition is larger in a mixed market than in a pure IOF. For example, if the transportation rate is sufficiently high, an IOF in a pure IOF market is a spatial monopsonist, but an IOF in a mixed market is in the situation of spatial competition (see also CHAPTER 7.1.4 in the absence of an outside option).

In the presence of an outside option, the CYE depends on the level of $\bar{u}$ (see FIGURES 7-19a and 7-19b). The higher the outside option is, the smaller will be the range of the relative importance of space for processors to be in the situation of spatial competition. To put it differently, the higher the outside option is, the wider the range of the relative importance of space for processors to be spatial monopsonies will be. In FIGURE 7-19a and given outside option 2, this range of the relative importance of space starts to the right of point *C* (for the pure IOF market) and to the right of point *A2* (for the mixed market), respectively. In addition, no CYE exists in such situations because UD prices in the pure IOF market and in the mixed market are equal to the outside option for any $\bar{u} > \rho/3$.

---

[190] Such behavior of the IOF, however, would yield the lowest profits for the IOF.

FIGURE 7-19a. CYE – low outside option

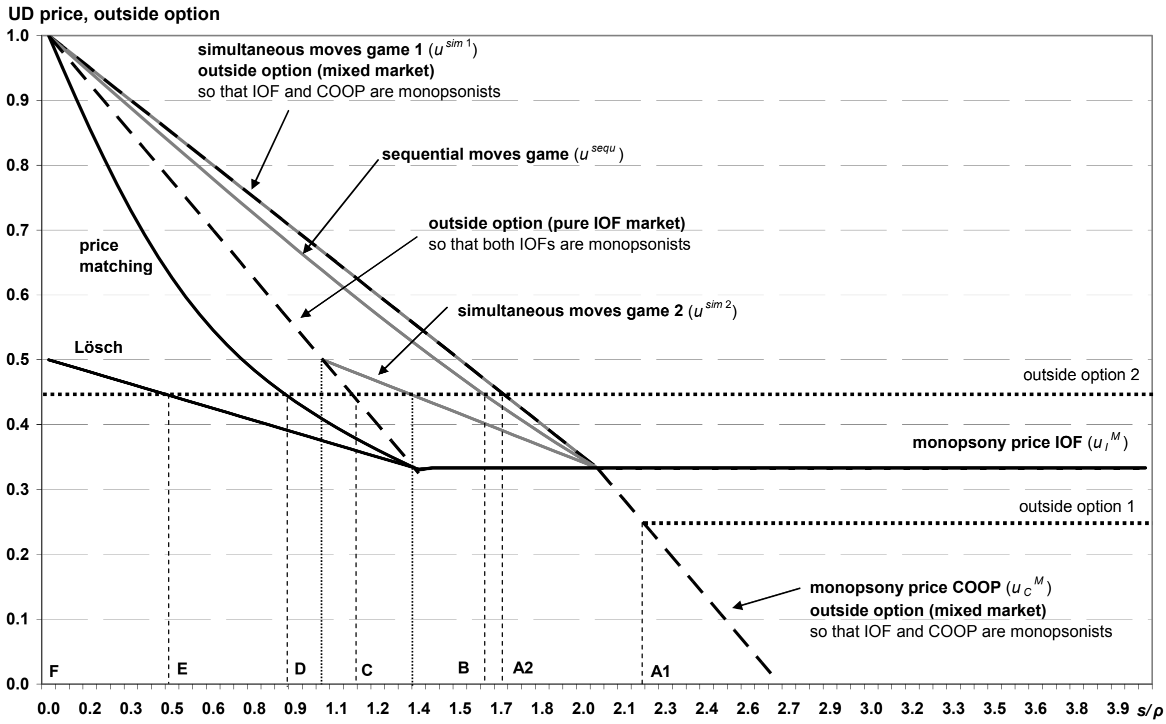
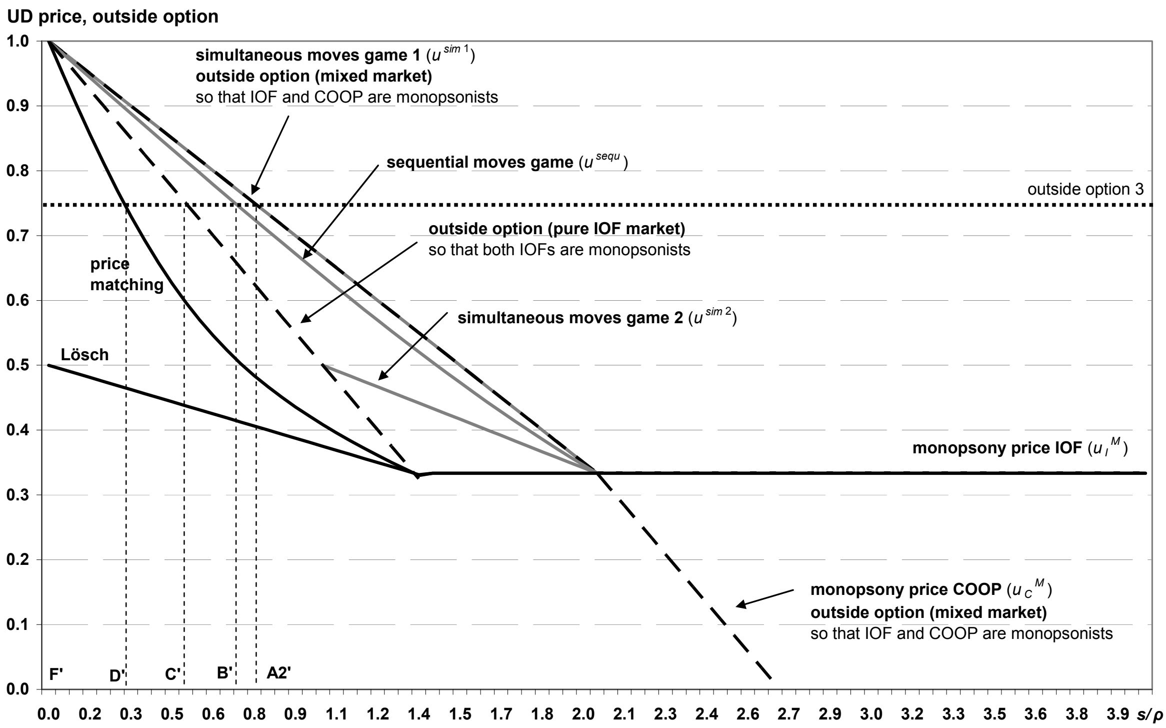


FIGURE 7-19b. CYE – high outside option



Note: In these figures, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. Both the net selling price *ρ* and the distance *d* between processors are normalized to *1*.

The existence of an outside option limits the possible behavior of an IOF both in the pure IOF market and in the mixed market. First, in the pure IOF market, there is always a certain range of the relative importance of space in which IOFs are already in the situation of spatial competition (i.e., they are not monopsonies), but paying optimal UD prices according to the Löschian or price-matching conjecture would yield UD prices that are lower than the outside option.[191] In addition, Löschian competition in the pure IOF market is not possible for any $\bar{u} > \rho/2$ (see FIGURE 7-19b). Second, in the mixed market, the simultaneous moves game of type 1 (in which the IOF takes the UD price as given) is possible for any relative importance of space. However, there is always a certain range of the relative importance of space where a sequential moves game is not possible.[192] In addition, the simultaneous moves game of type 2 (in which the IOF takes the market area as given, like an open-membership COOP) is not possible for any $\bar{u} > \rho/2$ and $s/\rho < 1$ (see FIGURE 7-19b).

To conclude, the levels of the relative importance of space below which processors pay optimal UD prices (i.e., UD prices higher than $\bar{u}$) are

$$\text{(7-47)} \quad \text{for } \frac{\rho}{3} < \bar{u} < \frac{\rho}{2}: \left(\frac{s}{\rho}\right)_{IOF}^{L} < \left(\frac{s}{\rho}\right)_{IOF}^{PM} < \left(\frac{s}{\rho}\right)_{IOF}^{M} < \left(\frac{s}{\rho}\right)_{mixed}^{seq} < \left(\frac{s}{\rho}\right)_{mixed}^{sim1,\,M}$$

(i.e., *E<D<C<B<A2* in FIGURE 7-19a)[193]

$$\text{(7-48)} \quad \text{for } \frac{\rho}{2} < \bar{u} < \rho: \left(\frac{s}{\rho}\right)_{IOF}^{PM} < \left(\frac{s}{\rho}\right)_{IOF}^{M} < \left(\frac{s}{\rho}\right)_{mixed}^{seq} < \left(\frac{s}{\rho}\right)_{mixed}^{sim1,\,M}$$

(i.e., *D'<C'<B'<A2'* in FIGURE 7-19b). Thus, given an outside option, Löschian competition in a pure IOF market requires a low relative importance of space and is possible only within a relatively small range. Conversely, a simultaneous moves game of type 1 in the mixed market (in which the IOF takes the UD price as given) is possible for the largest range of the relative importance of space. A CYE can be identified for any $\frac{s}{\rho} < \left(\frac{s}{\rho}\right)_{mixed}^{sim1,M} = 3 - \frac{3\bar{u}}{\rho}$ (to the left of points *A2* and *A2'*, respectively; see also equation (7-44)). If $\bar{u} \leq \rho/3$, a CYE exists for any $s/\rho \leq 2$.

[191] For example, in FIGURE 7-19a (outside option 2), this range corresponds to the interval from point *E* to point *C*; in FIGURE 7-19b (outside option 3), this range corresponds to the interval from point *D'* to point *C'*.
[192] For example, in FIGURE 7-19a (outside option 2), a sequential moves game is not possible from point *B* to point *A2,* and in FIGURE 7-19b (outside option 3), a sequential moves game is not possible from point *B'* to point *A2'*.
[193] In condition (7-47), index *IOF* indicates the pure IOF market and index *mixed* indicates the mixed market. The simultaneous moves game where the IOF takes the market area as given (index *sim*2) is not included in this condition as this game is not possible for any *s/ρ<1*.

7.4 SUMMARY

In CHAPTER 7, a mixed market under the assumption of UD pricing is analyzed. In a mixed market with an open-membership COOP and an IOF, the open-membership policy is implemented by invoking two different approaches. First, under the no-rationing assumption, (i.e., the COOP cannot refuse any farmer), two outcomes are possible. Under the efficient TBR, the COOP serves the remaining farmers in the market who are not served by the IOF; i.e., processors operate within distinct non-overlapping market areas. Under the random TBR, the COOP serves the total distance to the IOF. In this case, the market area of the IOF constitutes the area of market overlap of the competing processors. Second, in the presence of an alternative for farmers (in addition to that of supplying either processor), processors need to consider this outside option when setting their UD prices. For example, if there is a single COOP in the market, the market area of the COOP is determined by the farmer who is indifferent between patronizing the COOP and choosing the outside option.

In the mixed market, the COOP offers a pricing schedule. In equilibrium, the UD prices of the COOP and the IOF must be equal. Three different models are proposed, depending on the behavior of the IOF. First, in a sequential moves game, the IOF anticipates the pricing schedule of the COOP and determines an optimal market area. In this game, the IOF can effectively control its market area. Second, in a simultaneous moves game, the IOF takes the UD price as given (similar to the Hotelling-Smithies conjecture) and offers its "market area schedule". Finally, in another simultaneous moves game, the IOF takes the market area as given and offers its pricing schedule, like an open-membership COOP.

Under the efficient TBR, a high relative importance of space ($s / \rho > 2$) allows the IOF to operate as a monopsonist by paying an optimal monopsonistic UD price and restricting its market area to maximize profits. As the IOF need not accept every farmer wishing to supply it (and thereby effectively restricts its market area), it can pay a UD price to its suppliers that is higher than the UD price paid by the COOP. As the relative importance of space decreases (and, thus, the UD price of the COOP increases), the IOF needs to consider the UD price of the COOP. In this situation of spatial competition, the simultaneous moves game in which the IOF takes the UD price as given results in the highest UD price in the mixed market and the smallest market area of the COOP. However, if the IOF operates similarly to an open-membership COOP (by taking the market area as given), the lowest UD price in the mixed market and the largest market area of the COOP can be observed. Such behavior of the IOF is not possible for a rather low relative importance of space because the maximum market area of the COOP is constrained by the distance to the IOF. Therefore, an IOF that takes the UD price as given in a simultaneous moves game hinders the open-membership COOP from becoming "too large" and, thus, prevents the UD price in the mixed market from becoming rather low. The profits of an IOF are highest under the sequential moves game, which, however, requires a high amount of information on the part of the IOF with respect to the COOP. A CYE can be confirmed for either behavior of the IOF. This effect is largest if the COOP replaces a Löschian IOF and if there is a simultaneous moves game in the mixed market in which the IOF takes the UD prices as given. If the relative importance of space is rather high ($s/\rho > 2$), no CYE exists because the UD price of the COOP is lower than the optimal monopsonistic UD price of the IOF.

The sequential moves game was also analyzed for the random TBR. Under the random TBR, market areas of processors overlap and the UD price in the mixed market is necessarily lower relative to the efficient TBR because the market area of the COOP is larger and equal to the total distance to the IOF. Due to the overlap of market areas (and, thus, the existence of COOP members within its market area), the IOF determines its market boundary, but it has no influence on the affiliation of farmers within its market area. Under the random TBR, a CYE can be confirmed, but the corresponding range of the relative importance of space is smaller relative to that under the efficient TBR. Again, the CYE is highest if the COOP replaces a Löschian IOF. If the relative importance of space is rather high, there is no CYE. In this situation, the UD price in the mixed market is lower than the UD price in the pure IOF market, where IOFs are already in the monopsony situation.

The existence of an outside option for farmers (this "outside option" can be represented, for example, by the opportunity cost of producing the product) limits the possibilities of an IOF. First, IOFs need to consider every outside option that exceeds the optimal monopsonistic UD price. Second, the higher the outside option becomes, the smaller will be the range of the relative importance of space where spatial competition between processors is possible. In addition, spatial competition is only possible if the relative importance of space is rather low. Third, paying optimal UD prices under Löschian competition or price matching in a pure IOF market is not possible for every value of the relative importance of space. This is relevant for any relative importance of space where IOFs are no longer monopsonies but where the optimal UD price under spatial competition would be lower than the outside option. If the outside option is rather high, Löschian competition is only possible for a rather low relative importance of space and over a rather small range. Price matching is possible within a larger range. Finally, for an IOF in the mixed market, a simultaneous moves game (in which the IOF takes the UD price as given) is possible for any relative importance of space and level of an outside option. However, a sequential moves game or behavior similar to that of an open-membership COOP (i.e., the IOF takes the market area as given) is not possible for every value of the relative importance of space. In addition, the latter behavior is only possible if the outside option is rather low. Generally, a CYE can be confirmed in the situation of spatial competition, with processors paying a UD price that is higher than the outside option.

8 SUMMARY AND DISCUSSION

The milk processing industry in Germany and Austria in particular is characterized by the following: first, the number of milk processors continuously declined implying an increasing concentration of processors; second, the perishableness of raw milk and the multitude of farmers distributed across space involve relatively high costs of transporting the raw product to the location of only a few processors. Due to these transportation costs, the raw milk market is a spatial market, which additionally limits the number of alternative buyers of the raw product. Finally, the share of milk processors that are cooperatives (COOPs) is rather high. Therefore, the dominance of COOPs and the importance of space cause either spatial competition between COOPs or competition between COOPs and investor-owned firms (IOFs) in a "mixed market".

Generally, a high concentration of processors raises concerns about the possible exercise of oligopsony power towards farmers. In addition, the spatial dimension of a market necessarily implies (at least) local market power (see, e.g., GREENHUT ET AL., 1987, p. 2). Thus, the options of farmers to switch processors are determined by the spatial dimension, i.e., by the number of processors competing for raw milk in the same region. In this regard, the interim report of the German Federal Cartel Office (*Bundeskartellamt*) on the milk sector argues that a dominant position of milk processors in certain regions due to the high concentration may limit the options for farmers to choose among processors and may reduce competition at a regional level (BKA, 2009, p. 105). In addition, these switching possibilities are determined by the design of supply contracts between farmers and processors and also by the membership policy of COOPs. Generally, patronizing a processing COOP is considered a means for farmers to evade market power of IOFs. According to the "'yardstick of competition' hypothesis", i.e., "the notion that a cooperative may have a salutary effect on its rivals' behavior" (SEXTON, 1990, p. 709), COOPs are even regarded as a means to mitigate oligopsony power of IOFs in a mixed market.

This concluding chapter summarizes and discusses the main findings of this thesis including the literature reviews and the analytical models in three different sections: the spatial dimension of food processing and spatial competition among IOF processors (CHAPTER 8.1), characteristics of processing COOPs, the underlying theory and spatial competition among COOPs (CHAPTER 8.2), and the theory of mixed markets and spatial competition between COOPs and IOFs (CHAPTER 8.3).

8.1 Spatial competition and pure IOF markets

In 2006, for example, approximately 25% of the raw milk in Germany and even more than 50% in Austria was processed by the respective three largest milk processors (see data sources in BMLEV, 2008, chapter F; Fahlbusch et al., 2009, p. 41; BMLFUW, 2007, p. 18; and BMLFUW, 2008, p. 17). Generally, a high concentration allows economies of scale and the potential to realize cost savings. Additionally, a more concentrated food processing sector may imply a higher bargaining power of processors towards food retailers (see, e.g., Weindlmaier, 2007, p. 60). However, farmers can only gain from economies of scale in food processing or from a higher bargaining power of processors, if at least parts of cost savings or higher product prices are transmitted to farm-level prices. Potentially decreasing processing costs, however, might be negated by higher transportation costs (Buschendorf, 2007) since the costs of transporting raw milk from the location of the farm to that of the the processing facility are generally borne by the milk processor.

Such a pricing policy is referred to as "uniform delivered (UD) pricing" and implies that, first, each farmer theoretically receives the same price, irrespective of his distance to the processor and, second, that each processor needs to consider an economically reasonable market area of raw milk collection. According to the BKA (2009, pp. 42), the average distance (i.e., the radius) of this catchment area ("*Einzugsgebiet*") is 220 km in Germany. Actual collection areas ("*Erfassungsgebiete*") seem to be smaller (170 km on average). The spatial dimension of the raw milk market implies that farmers' possibilities to choose between milk processors are limited on a regional scale.

Chapter 3 provides a review of the spatial economics literature. The different possible pricing policies, i.e., UD pricing, free-on-board (FOB) pricing, and optimal discriminatory (OD) pricing, establish the extent of transportation costs that are passed on from processors to farmers. One extreme case is UD pricing as implemented by milk processors in Germany and Austria. This pricing policy involves total freight absorption because processors account for transportation costs. Since local prices across space do not reflect transportation costs, UD pricing is an extreme case of price discrimination across space in favor of more distant input suppliers and against closer suppliers. UD pricing allows processors to ration supply by determining an optimal market area, i.e., the processor refuses a farmer located beyond the market boundary. The other extreme case is FOB pricing in which farmers are responsible for transportation costs. Therefore, under FOB pricing it is the farmer wishing to supply a certain processor who determines the market area of the processor. FOB pricing is non-discriminatory because all suppliers receive the same mill price at the processing location. In the absence of any institutional constraints, a spatial monopsonist will choose OD pricing (or, "spatial price discrimination") with partial freight absorption because it is most profitable (see, e.g., LÖFGREN, 1986). The literature review in CHAPTER 3 shows that the relative results of different pricing policies of the spatial monopoly/monopsony strongly depend on assumptions regarding the spatial distribution of customers, the shape of demand or supply functions and on the assumption of fixed or endogenous market areas. In most cases, FOB pricing is considered as socially superior because total welfare is highest for this pricing policy.

Generally, the literature confirms the empirical relevance of UD pricing in certain industries, and most analytical models of spatial competition show that firms tend to employ UD pricing. For the dairy industry in Asturias, Spain, ALVAREZ ET AL. (2000) argue that UD pricing has been implemented due to its administrative simplicity. A pricing policy like UD pricing facilitates the overlap of market areas of competing oligopsonistic processors. Market overlap is generally not possible under FOB pricing because this pricing policy involves the existence of a certain farmer in space who is indifferent as to which processor to supply. The feature of overlapping market areas also depends on a firm's conjecture, i.e., a firm's consideration of the expected reaction of competitors. In the spatial competition literature, three different conjectures received special attention (see also GREENHUT ET AL., 1987, p. 20): i) under the Hotelling-Smithies conjecture, firms assume that prices of competitors are fixed; ii) under the Löschian conjecture, firms assume that market areas are fixed (i.e., there is price matching); iii) under the Greenhut-Ohta conjecture, firms assume that the price at the market boundary is fixed. While there is no non-spatial analogue for Greenhut-Ohta competition, the Hotelling-Smithies conjecture is comparable to Bertrand-Nash competition und suggests non-cooperative behavior of processors. Löschian competition is similar to collusion and implies cooperative behavior. Thus, Hotelling-Smithies competition is regarded as highly competitive, whereas Löschian competition is regarded as non-competitive.

The outcome of spatial competition is the result of both the employed pricing policy and the assumed conjecture. Under UD pricing and Hotelling-Smithies conjecture, no equilibrium in pure strategies exists and several approaches have been developed in the literature to obtain an equilibrium. Under Löschian competition, however, "perverse" comparative statics are derived (see, e.g., CAPOZZA AND VAN ORDER, 1978), which are more severe under FOB pricing than under UD pricing. By mirroring spatial oligopoly results from the literature (see, e.g., CAPOZZA AND VAN ORDER, 1977; and GRONBERG AND MEYER, 1981) to the case of the spatial oligopsony, prices paid to farmers under UD pricing and FOB pricing are lowest under

Löschian competition. Consequently, individual farmers are better off under Hotelling-Smithies competition. Löschian competition is an interesting case because the fixed market area assumption *per se* only applies for the case of FOB pricing (see also ALVAREZ ET AL., 2000). Under UD pricing, the market area of a processor varies inversely with the price paid to farmers. Thus, Löschian competition under UD pricing can be regarded as a special case of the more general "price-matching conjecture". In this sense, Löschian competition involves non-overlapping market areas (i.e., collusion so that processors operate as monopsonists within their market area), whereas price matching *per se* involves market overlap in the UD pricing case only.

The review of the spatial economics literature in CHAPTER 3 demonstrates that results derived from analytical models strongly depend on the underlying assumptions. This is generally not surprising, but it seems to be especially the case in the spatial economics literature: the consideration of "space" requires an additional set of variables and assumptions relative to the non-spatial literature. The review shows that the modification of some of these assumptions can even change the qualitative results, which might impede any empirical test of the analytical models.

Empirical findings for Germany show that market areas of milk processors overlap, in particular in regions with both a high milk density and processor density (see, e.g., HUBER, 2007a; 2007b; and 2009). In almost half of the area of Germany, regions are served by more than one milk processor. Such an overlap of market areas suggests that competition between processors is rather high and that collection areas are rather large, relative to a situation where processors are able to reach an agreement on exclusive market areas. Although transportation costs are a significant cost component for processors, HUBER (2009, p. 36) concludes that higher acquisition expenses due to larger market areas may play a minor part for some processors who are willing to expand processing. This feature of overlapping market areas of competing milk processors in the German and Austrian milk markets suggest the practice of cooperative behavior among processors (i.e., price matching). In addition, the interim report of the BKA (2009, pp. 57) notes that raw milk prices of IOFs are determined by average prices of other milk processors or regions ("*Referenzpreissystem*"; see also HELLBERG-BAHR ET AL., 2010, p. 14). This observation also supports the assumption of the price-matching conjecture in the dairy sector (GRAUBNER ET AL., 2011a). For Germany, cooperative behavior among milk processors was empirically confirmed by GRAUBNER ET AL. (2011a) and KOLLER (2012). Price-matching competition is also assumed for the case of milk processors in Asturias, Spain, by ALVAREZ ET AL. (2000).

ALVAREZ ET AL. (2000) set up an analytical model of spatial competition between IOF processors under UD pricing and their empirical application confirms the results of the analytical model. CHAPTER 5 reviews their analytical model and modifies their assumption regarding the market form. The UD price to be paid to farmers is a function of the "importance of space", i.e., the product of per-unit transportation costs and the distance between processors. If space is relatively important, processors are spatially separated monopsonies. In this situation, market power over farmers is relatively high and the UD price is lowest. As space becomes less important, processors enter the situation of direct competition with each other and market areas of competing processors overlap in between their locations under the price-matching conjecture ("competition en route").

Usually, the UD price increases as space becomes less important (which is also the case in ALVAREZ ET AL., 2000, in the situation of competition en route). A special feature of the model by ALVAREZ ET AL. (2000) is the assumption of a duopsony located on an unbounded line market. Thus, each IOF faces a competitor only on one side of the market and not all farmers in the market are served in the situation of spatial competition. An unexpected result due to this market form is that the UD price is an inverted U-shaped function of the importance of space: if space is rather unimportant, the market area of each processor extends beyond the location of the competitor ("competition in the backyard"). In this situation, a further decrease in the importance of space towards zero decreases the UD price towards the monopsony level. One reason for this effect is that both processors in the market are located at the same point in space if the distance between them becomes zero. Conversely, increasing per-unit transportation costs or an increasing distance between processor leads to a higher UD price. ALVAREZ ET AL. (2000) argue that paying a higher UD price helps to reduce competition (in terms of a smaller overlap) and thereby increases the share of a processor's exclusive market area with relatively high per-unit profits.

The model of ALVAREZ ET AL. (2000) assuming IOF processors under UD pricing and the price-matching conjecture can be generalized to a circular market framework. This market form allows overlapping market areas as well. However, changes in the distance between processors can be expressed as changes in the number of processors in the market. Given a fixed circumference (i.e., a given expansion of a region), a higher number of processors (i.e., less concentration) is equal to a shorter distance between processors. The results derived by the modification of the model of ALVAREZ ET AL. (2000) in CHAPTER 5 are the following. First, if the importance of space decreases towards zero, processors are still in the situation of competition en route, and the UD price increases towards the net selling price. In this situation, the model approaches the result of the competitive market case. Second, in addition to competition en route, competition in the backyard is another possible equilibrium solution over a certain range of the importance of space. Thus, contrary to the result of ALVAREZ ET AL. (2000), the UD price as an inverted U-shaped function of the importance of space cannot be identified in the circular market model. Relative to the situation of competition en route, it may be profitable for processors in the circular market to extend their market areas beyond the location of competitors and therefore pay a lower UD price to farmers. Third, the unexpected result of ALVAREZ ET AL. (2000) with an increasing UD price as space becomes more important can only be identified if processors extend their market area beyond the most distant competitor and if space becomes more important due to an increasing distance between processors. In other words, the model shows that a higher concentration of processors can lead to the unexpected result of an increasing UD price. In this situation, the corresponding importance of space enables each processor to almost cover the entire region (i.e., the circumference of the circular market). Such a situation can be more profitable for processors relative to a situation with smaller market areas (e.g., competition en route). In order to stay in such a situation (as the number of processors decreases), processors need to reduce their market areas and therefore increase the UD price.

The observation of overlapping market areas in real markets may indicate that milk processors are not be able to reach a market share agreement with exclusive market areas (i.e., Löschian competition), albeit IOFs' profits would be highest. Thus, the incentives (or preconditions) to collude with regard to market areas seem to be rather limited: either the transaction costs to coordinate market areas are rather high (GRAUBNER ET AL., 2011a) or the degree of information available to predict the behavior of competitors is rather low (see the interpretation of different conjectures in SCHÖLER, 1988, p. 164). Regarded dynamically, processors may even accept market overlap in the short run as one means of crowding out competitors. Consequently, public policies that are able to effectively prevent market share agreements in a pure IOF market may be beneficial for farmers. If processors are less able (or willing) to collude with regard to market areas for whatever reason, the feature of overlapping market areas constitutes a higher degree of competition relative to Löschian competition and farmers are thus better off individually. In this regard, the final report of the BKA (2012, p. 123) on the milk sector concludes that cooperations between processors in milk collection mitigate competition if such cooperations result in either a segmentation of markets ("*Marktaufteilung*") or coordinated behavior of processors involved ("*Verhaltenskoordinierung der beteiligten Molkereien*").

Generally, the business relationship between farmers and processors is regulated via supply contracts, the importance of which will increase in the future due to the abolishment of the milk quota regime in the EU as of 2014/15. Long-run contract periods are favored by both sides, farmers and processors, although farmers opt for shorter termination periods to seize potentially better price conditions by another processor (see survey results by STEFFEN ET AL., 2009, and SCHMID ET AL., 2011, pp. 54). The BKA (2009, p. 82 and p. 92) rather favors short-run supply contracts, which may increase competition between processors. Thus, farmers' possibilities to switch between processors may be complicated by relatively long contract periods and/or termination periods. However, as supply contracts may constitute a dynamic problem, they are not explicitly considered in the analytical models in CHAPTER 5 to 7. Likewise, the analytical models do not explicitly consider the current policy of milk quotas. The assumption of elastic supply functions of farmers implies either the situation with no milk quotas or milk quotas that are not binding at the farm level. Therefore, these analytical models are rather general and probably applicable to a wide range of food processing sectors that are characterized by a high concentration and a spatial dimension.

8.2 PROCESSING COOPS

Even though the milk processing industry is highly concentrated, it is also characterized by a high share of processing COOPs. In 2006, for example, 29% of the German milk processing facilities were owned by COOPs, which processed 45.6% of total milk supply (BMLEV, 2008, chapter F). In Austria in 2008, even 46.6% of the milk processors were COOPs (BMLFUW, 2009, p. 27). Despite of the COOP principle of "cooperation among COOPs", the high share of COOPs may suggest competition between COOPs in certain regions. This is the case, for example, in the northernmost region of Germany, Schleswig-Holstein, and certainly in some parts of Austria.

In a COOP, farmers are owners (via share subscriptions) and users (of the services provided) at the same time. According to the COOP's aim of "member promotion", COOP members benefit from special services and/or from the distribution of any profits that the COOP has earned in the processed goods market. Consequently, one would not expect market power being exercised over farmers. Due to the principle of democratic member control (in terms of "one member - one vote") members can co-determine a COOP's business strategy at least via representatives. However, large and growing COOPs in Germany have outsourced parts of their business operations so that, in practice, the extent of members' co-determination or influence may be limited (BKA, 2009, p. 84). This is confirmed by SCHMID ET AL. (2011,

p. 34) in a survey among Austrian dairy farmers according to which only approximately one quarter of the responding COOP members confirm possibilities of co-determination.

The COOP principle of "open membership" is established in the German and Austrian Cooperatives Societies Acts and, theoretically, implies an unrestricted number of members. Generally, an open-membership policy contributes to the free-rider problem as new members benefit from the COOP's duty of member promotion without any previous contribution to investments (see, e.g., COTTERILL, 1987, p. 175). The review in CHAPTER 2 suggest that, in practice, the principle of open membership obviously does not comprise the legal duty to accept every farmer wishing to supply the COOP (on the part of the COOP), but the right to apply for membership (on the part of the farmer). In a spatial context, this implies that some COOPs may determine an economically reasonable market area like IOFs in a centralized manner, despite an "open" membership policy. Thus, the membership policy practiced by COOPs also determines the possibilities of farmers to switch processors. The same applies for the design of supply contracts. In addition, shares of COOP members are tied for several years in order to qualify as equity capital (BKA, 2009, p. 76). This fact might contribute to the finding that commitment to a certain processor is generally higher among COOP members than among IOF suppliers (STEFFEN ET AL., 2009, pp. 11; SCHMID ET AL., 2011, p. 37), although this commitment can also be interpreted as "solidarity" (e.g., as in SCHMID ET AL., 2011, p. 55).

The literature regarding the theory on COOPs is reviewed in CHAPTER 4. While it is commonly accepted in the economics literature that an IOF maximizes its own profit, several different objective functions are assumed regarding COOPs. Most prominent examples are the objective of (total) member welfare maximization and the objective of net average revenue product (NARP) pricing. Generally, total member welfare maximization (or net marginal revenue product (NMRP) pricing) gives the Pareto optimal result and is, thus, a first-best optimum (LEVAY, 1983; SEXTON ET AL., 1989). Under this objective, the COOP jointly maximizes members' profits from producing the raw product and the COOP's earnings. However, as the COOP generally fails to break-even under this objective, an optimum can only be established by introducing a multi-part pricing scheme or by supply quotas (SEXTON ET AL., 1989; SEXTON, 1990). Under the alternative objective of NARP pricing, the COOP maximizes the raw product price for farmers subject to the break-even constraint. This is the only long-run equilibrium if members consider any patronage refunds in their production decisions (COTTERILL, 1987, p. 206), and profits from processing of the COOP are equal to zero. Total output of such a COOP is higher than under any other objective (see, e.g., COTTERILL, 1987, p. 207). Whether open or closed membership is the optimal membership policy depends on a decreasing or increasing NARP function over the relevant range of members' supply (SEXTON, 1990). The point of membership restriction, however, is subject to discussion in the literature.

The task to assign a particular COOP objective function to certain sectors is rather challenging (see, e.g., TENNBAKK, 2004, for the egg market in Norway). According to the BKA (2009, p. 85), the objective of dairy COOPs in Germany is to achieve the highest possible raw product price for the benefit of their members. This observation suggests that a suitable objective function for the analytical models in CHAPTERS 6 and 7 is NARP pricing. Paying the highest possible price may limit the possibilities for long-run investments and partly explains the lower brand share of COOPs relative to IOFs (see, e.g., SCHRAMM ET AL., 2005, for German COOPs in milk and meat processing). According to the literature reviewed in CHAPTER 2, raw milk prices in COOPs are determined ex post and according to the utilization of the processed product ("*Verwertungssystem*"; see, e.g., BKA, 2009, and HELLBERG-BAHR ET AL., 2010, p. 13). For this reason, the BKA (2009, p. 56) argues that food retailers directly affect raw milk prices. Despite favorable views among farmers regarding COOPs, survey results among Austrian and German farmers show that the majority of farmers is rather critical towards this kind of price determination (STEFFEN ET AL., 2009, p. 9; SCHMID ET AL., 2011, pp. 51). However, the BKA (2009, p. 48) notes that some dairy COOPs in Germany act more and more like vertically integrated firms with the objective of "total profit maximization". This observation suggests that, in addition to NARP pricing, total member welfare maximization is also a suitable objective function for the analytical models in CHAPTERS 6 and 7.

In the literature, COOPs are perceived in different ways (see, e.g., the discussion in BERGMAN, 1997). Opponents of COOPs argue that COOPs display features like cartels or that they are inefficient relative to IOFs, but proponents of COOPs consider them as welfare enhancing means. While possible inefficiencies are due to different interest groups within a COOP and, thus, possibly high transaction costs, reasons for COOPs being more efficient than IOFs include possibly lower transaction costs due to vertical integration or improved information flows (PORTER AND SCULLY, 1987; SEXTON AND ISKOW, 1993). In general, public policies are rather favorable towards COOPs, e.g., in terms of taxation, subsidization, or antitrust exemptions. Reasons for such public policies may be the views that COOPs protect their members from exploitation on the part of IOFs and that COOPs are a means to indirectly regulate imperfect competition (TENNBAKK, 1995). Thus, the COOP either is able to offer farmers better terms than an IOF does (if regarded in isolation), or mitigates the market power of an IOF in a mixed market (see CHAPTER 8.3).

Based on the analytical results for the pure IOF market, CHAPTER 8.1 concludes that any possible agreement of processors on exclusive market areas is rather to the disadvantage of farmers in a pure IOF market. This conclusion, however, does not necessarily apply in a pure market of processing COOPs and is demonstrated in the analytical models in CHAPTER 6. In these models, both restricted and open membership are considered in a rather rigorous way. If COOPs are able to determine an optimal market area in a centralized manner like IOFs, it can be argued that such practice may be consistent with a restricted-membership policy (see CHAPTER 6.2). Thus, overlapping market areas of competing COOPs can be observed under the price-matching conjecture, and exclusive market areas are the result of Löschian competition. In the latter case, a COOP that maximizes total member welfare is, at the same time, a NARP-pricing COOP (i.e., it pays the highest possible UD price subject to covering costs). Therefore, under Löschian competition, total member welfare is shared among members. This result cannot be confirmed for total member welfare-maximizing COOPs under the price-matching conjecture with overlapping market areas. Due to a high UD price paid to members, the total member welfare-maximizing COOP fails to break even (i.e., the COOP's profits from processing are negative). Rather than distributing profits, the COOP needs to reclaim payments from its members as it would not be able to sustain losses in the long run. According to the literature, however, such reclaims do not occur in dairy COOPs in Germany. The results show that the UD price adjusted by per-unit profits/losses from processing is lower than that in the case of Löschian competition. Under the alternative objective of NARP pricing, the COOP necessarily breaks even under price-matching, but the UD price is also lower compared to Löschian competition. In addition, there is no feasible "competition en route"-solution if space is rather unimportant. Interestingly, only in such a COOP market the net selling price transmits to the UD price more perfectly if space becomes *more* important (i.e., if COOPs almost become spatial monopsonies). Thus, individually and as a COOP, farmers are better-off under Löschian competition: the UD price and total member welfare are highest if restricted-membership COOPs are able to achieve a market share agreement involving exclusive market areas. In addition, the pass-through of the net selling price to the UD price (i.e., price transmission) is perfect in this case. All analytical results for the pure COOP market under restricted membership show that UD prices are higher than they are in a pure IOF market. In most cases, the same applies to the price transmission.

In the models in CHAPTER 6.3, open membership is implemented by assuming that the COOP does not determine an optimal market area in a centralized manner. Rather, farmers distributed across space choose their processor by themselves. In this case, each COOP must consider the total available distance (i.e., the distance to its competitor) as its potential market area, but the actual market segmentation is the result of farmers' decisions. Thus, the open-membership COOP cannot ration supply of the raw product ("no-rationing assumption"; see also IOZZI, 2004). Given open membership, the total member welfare-maximizing COOP is, at the same time, a NARP-pricing COOP. If all farmers choose their respective nearest COOP ("efficient tie-breaking rule"), the outcome is equal to the outcome under Löschian competition. However, if all farmers in the market choose processors on a random basis, the outcome will be a total overlap of market areas ("random tie-breaking rule"). In this case, the UD price in the market is lower than in any other pure COOP market because average transportation costs are relatively high. If space is relatively important, the resulting UD price can be even lower than the monopsonistic UD price of an IOF. Nevertheless, even in this case, price transmission is perfect. The observation of overlapping market areas suggests that it may be rational for an individual farmer not to choose the nearest processor. If he does not assume (or know) that all other farmers will do the same, the farmer will not switch to the nearest processor. The perceived benefit of switching (e.g., a higher UD price) may be considered rather small, for example because switching might involve costs or because the farmer prefers the more distant processor for whatever reason. These results suggest that the enforcement of market share agreements in a pure COOP market may be beneficial for farmers. Usually, such an agreement is regarded as being detrimental because it limits the switching options for farmers. However, since processing COOPs are not expected to exercise market power over their members, exclusive rather than overlapping market areas should be encouraged in a pure COOP market.

The no-rationing assumption does not allow for spatially separated open-membership COOP monopsonies. Their existence can be established if farmers face an "outside option", i.e., an alternative to the pure COOP market. In equilibrium, the UD price of the monopsonistic COOP is equal to the level of the outside option, which, for example, represents a farmer's opportunity cost of producing the milk product. Given a certain level of the outside option, a relatively low importance of space can make the outside option obsolete. In this situation, all farmers in the market choose their respective nearest COOP because this choice makes them better off than choosing the outside option. The resulting UD price is equal to that under Löschian competition. However, if the level of this outside option is rather low and the importance of space rather high, the resulting UD price in the market can be lower than in the case of a restricted-membership COOP.

8.3 MIXED MARKETS

In some regions in Germany and Austria, the high percentage of milk processors that are COOPs suggests competition with IOFs in a "mixed market". The dominance of COOPs in milk processing and the mode of IOFs' price determination based on average prices of other processors indicate that pricing of IOFs is strongly influenced by COOPs. In the literature, the belief that COOPs can be regarded as a means to indirectly regulate imperfect competition is termed the "'yardstick of competition' hypothesis" (SEXTON, 1990, p. 709; see also COTTERILL, 1987, pp. 182) and is one of the justifications for rather favorable public policies towards COOPs. If COOPs constitute such a competitive yardstick, then the resulting mixed market should be characterized by a more competitive behavior on the part of IOFs (i.e., in terms of lower oligopsony power of IOFs towards farmers) and a higher welfare, relative to a pure IOF market.

Possibly due to some criticism towards this 'yardstick of competition' *hypothesis*, there has been an increase in analytical contributions to analyze such a pro-competitive effect of COOPs in a mixed market, in particular since the early 1990ies. DE FRAJA AND DELBONO (1990), among others, established the theory of mixed market (assuming, however, private and public firms). In a mixed oligopolistic/oligopsonistic market, objective functions of competing firms in the market are different. Results obtained from analytical mixed-market models in the literature are dependent on the following assumptions: mixed-market models either assume restricted membership (e.g., TENNBAKK, 1995; ALBAEK AND SCHULTZ, 1998), open membership (e.g., TENNBAKK, 2000 and 2004; KARANTININIS AND ZAGO, 2001; SORENSEN, 2005), or both (e.g., SEXTON, 1990). Likewise, different objective functions of COOPs are assumed in the literature. For example, TENNBAKK (1995 and 2000), HOFFMANN (2005) or AZZAM AND ANDERSSON (2008) assume total member welfare maximization, whereas ALBAEK AND SCHULTZ (1998), KARANTININIS AND ZAGO (2001), and HIGL (2003) assume NARP pricing; SEXTON (1990) and SORENSEN (2005) consider both objective functions. Another difference is the consideration of a decentralized COOP (e.g., ALBAEK AND SCHULTZ, 1998; KARANTININIS AND ZAGO, 2001) or a centralized COOP (e.g., TENNBAKK, 1995 and 2000; SEXTON, 1990; FOUSEKIS, 2010). In addition, there are differences in these models depending on whether the selling market of processors is assumed to be perfectly competitive (e.g., KARANTININIS AND ZAGO, 2001; SEXTON, 1990; FOUSEKIS,

2010) or not. Most of these analytical mixed-market models are set in a non-spatial framework with processors competing in quantities.

In general, the results of the literature confirm a competitive yardstick effect as mixed markets are more competitive due to the presence of a COOP and, thus, positive welfare effects can be expected. Total quantities produced in the mixed market are generally higher than in pure IOF markets. In addition, total welfare is higher in a mixed market (i.e., with an IOF as an alternative for farmers) than in a market, which is served by one COOP only (see, e.g., TENNBAKK, 2000; and SORENSEN, 2005). Some results indicate that IOFs are rather crowded out by COOPs in a mixed market (e.g., ALBAEK AND SCHULTZ, 1998); others confirm a stable mixed-market equilibrium (see discussions in HENDRIKSE, 1998; TENNBAKK, 2000; or SORENSEN, 2005). SORENSEN (2005) concludes that a stable equilibrium is more likely under the conditions of NARP pricing, diseconomies of scale in processing and imperfect competition in the selling market of processors. In principle, however, COOPs are able to exercise market power in the selling market, i.e., towards consumers. Theoretical results also show that market power over consumers is lower in mixed markets relative to pure IOF markets (e.g., TENNBAKK, 1995; ALBAEK AND SCHULTZ, 1998; TENNBAKK, 2004). By decomposing the effect of (COOP and IOF) concentration on price into the market power effect and the cost efficiency effect, AZZAM AND ANDERSSON (2008) empirically find for the Swedish beef-slaughter industry that the cost efficiency effect (particularly due to COOP concentration) offset the market power effect towards consumers, resulting in lower beef prices.

Contributions in the spatial economics literature to the analysis of mixed markets are rather limited. Albeit being one of the earlier mixed-market models, a seminal example is SEXTON (1990) for the case of FOB pricing. SEXTON (1990) confirms a competitive yardstick effect in terms of a relative farm-processor price spread that is lower in the mixed market relative to the pure IOF market solution. This effect is high in the case of a NARP-pricing COOP under open membership (rather than in the case of restricted membership or under the objective of total member welfare maximization) and if the COOP replaces a Löschian IOF competitor (if the NARP function is increasing). Likewise, ROGERS AND SEXTON (1994) show for the case of FOB pricing that the competitive impact of COOPs is high if transportation costs are rather low and if the COOP in the market replaces a Löschian IOF competitor. Most recently and assuming Hotelling-Smithies competition, FOUSEKIS (2010) analytically confirms the existence of a competitive yardstick effect whose extent depends on the pricing policy (UD or FOB pricing) employed by the COOP and the IOF.

The results of the spatial mixed-market models under UD pricing in CHAPTER 7 show that, first, a competitive yardstick effect can be confirmed and, second, that the outcome in the mixed market depends on the behavior of the IOF (thus, the "price-matching conjecture" as such does not seem to be applicable in these mixed-market models). Assuming the no-rationing assumption (and, therefore, an open-membership COOP), the outcome of the efficient tie-breaking rule in CHAPTER 7.2 are non-overlapping market areas. Generally, the IOF need not accept any farmer who wants to be a supplier. Whether it can control its market area or not depends on the importance of space and on the IOF's behavior in the situation of direct competition with the COOP. If space is rather important, the IOF can be in the position to operate as a spatial monopsonist without considering the presence of the COOP: the IOF can refuse a farmer beyond its market boundary and thereby pay a higher UD price than the COOP does; the latter must accept any remaining farmer in the market. As the resulting market area of the COOP is relatively large (and, thus, so are average transportation costs), its UD price is relatively low. As the importance of space decreases, the optimal market area of the IOF increases. Since the resulting lower market share of the COOP increases the COOP's UD price, the IOF must abandon its monopsonistic behavior because some of its suppliers will switch to the COOP if this becomes more beneficial to them.

At this stage of spatial competition, the IOF either has some knowledge about the COOP's pricing schedule or not. Having information about this pricing schedule makes the IOF necessarily better off (in terms of profits) since it can use this information so as to derive an optimal market area ("sequential moves game"). In the other case, an IOF lacking information about the pricing schedule of the COOP has the options to take either the UD price or the market area as given. The first option ("simultaneous moves game 1") is similar to the Hotelling-Smithies conjecture, but the common market boundary of both processors is determined by the farmer who is indifferent between processors. The resulting UD price is the highest UD price found in the mixed-market models. The second option ("simultaneous moves game 2") likewise involves an indifferent farmer at the common market boundary, but the IOF operates similarly to an open-membership COOP (though it maximizes its own profits only). In this case, the resulting market area of the COOP is largest and the UD price in this mixed market is lowest. These results indicate that, first, the quasi "closed-membership policy" of the IOF helps to prevent an open-membership COOP from getting "too large" (considered spatially), which would involve rather high average transportation costs. Second, an IOF's ignorance of the pricing schedule of the COOP can be to the benefit of farmers in the mixed market.

All three mixed-market solutions constitute a competitive yardstick effect because the corresponding UD prices in the mixed market are higher than in a pure IOF market. The strength of the competitive yardstick effect, however, is the result of both the behavior of the IOF and the respective conjecture assumed in the pure IOF market. Löschian competition in the pure IOF market yields the lowest UD price. Thus, the competitive yardstick effect is highest if, first, the COOP in the mixed market is established in place of a Löschian IOF and, second, if the IOF does not know the pricing schedule of the COOP and takes the UD price as given ("simultaneous moves game 1"). An increasing importance of space weakens the competitive yardstick effect. In the extreme case in which space becomes relatively important, the IOF can exploit its monopsonistic position and COOP members are worse off than IOF suppliers.

An empirical observation of overlapping market areas in a mixed market of milk processors may indicate that IOFs do have some information about the pricing schedule of COOPs. The reason for this presumption is the result that overlapping market areas (i.e., by invoking the random tie-breaking rule as in CHAPTER 7.3) can most likely be established if the IOF anticipates the pricing schedule of the COOP and determines an optimal market area ("sequential moves game"). Due to the high share of COOP members in the total market (which involves relatively high average transportation costs), the UD price is lower than in the case of non-overlapping market areas.

An outside option for farmers (other than selling to either processor) constrains the possibilities of IOFs. In a pure IOF market, an alternative that offers higher profits for farmers than in the case of supplying an IOF limits the range of the importance of space, in which Löschian competition is possible; the price-matching conjecture is possible within a larger range. Similar results apply for the mixed market in the presence of an outside option for farmers. In this case, only the most beneficial behavior of an IOF - from the viewpoint of farmers - is feasible for every relevant importance of space and level of the outside option: the behavior of an IOF that takes the UD price as given similarly to the Hotelling-Smithies conjecture ("simultaneous moves game 1").

These results suggest that any favorable public policy towards processing COOPs (e.g., in terms of tax allowances) seem to be justified in certain circumstances. Although such policies have not been explicitly considered in the analytical models, the results show that COOPs are able to mitigate IOFs' market power over farmers. One necessary precondition for this result is a sufficient number of processors in the market that allows for spatial interactions between processors; otherwise the IOF may benefit from a monopsonistic position. Alternatively, per-unit transportation costs must be rather low relative to the value of the processed product (i.e., the selling price of processors) to obtain such a result. Therefore, any market power of food retailers towards processors and thus a lower selling price for processors may mitigate this competitive yardstick effect. For this reason, a higher concentration of processors in the market (e.g., due to mergers among COOPs) may increase the bargaining power towards food retailers, but at the same time it may weaken the advantage that farmers expect from an organization like a COOP.

REFERENCES

AGRA-EUROPE (2011): Raiffeisen-Genossenschaften zurück in der Erfolgsspur. Deutschland - Situationsberichte; Agra-Europe 10/11 (7. März 2011), pp. 1-2.

ALBAEK, S. AND SCHULTZ, C. (1998): On the Relative Advantage of Cooperatives. Economics Letters, Vol. 59, pp. 397-401.

ALVAREZ, A.M.; FIDALGO, E.G.; SEXTON, R.J. AND ZHANG, M. (2000): Oligopsony Power with Uniform Spatial Pricing: Theory and Application to Milk Processing in Spain. European Review of Agricultural Economics, Vol. 27(3), pp. 347-364.

ANDERSON, S.P. (1989): Socially Optimal Pricing. Regional Science and Urban Economics, Vol. 19, pp. 69-86.

ANDERSON, S.P.; DE PALMA, A. AND THISSE, J.-F. (1989): Spatial Price Policies Reconsidered. The Journal of Industrial Economics, Vol. XXXVIII(1), pp. 1-18.

ANDERSON, S.P.; DE PALMA, A. AND THISSE, J.-F. (1992): Discrete Choice Theory of Product Differentiation. Cambridge, London: The MIT Press.

ANDERSON, S.P. AND ENGERS, M. (1994): Spatial Competition with Price Taking Firms. Economica, Vol. 61(242), pp. 125-136.

ANDERSON, S.P. AND NEVEN, D.J. (1991): Cournot Competition Yields Spatial Agglomeration. International Economic Review, Vol. 32(4), pp. 793-808.

AZZAM, A. AND ANDERSSON, H. (2008): Measuring Price Effects of Concentration in Mixed Oligopoly: An Application to the Swedish Beef-Slaughter Industry. Journal of Industry, Competition and Trade, Vol. 8(1), pp. 21-31; DOI: 10.1007/s10842-007-0006-x.

BATEMAN, D.I.; EDWARDS, J.R. AND LEVAY, C. (1979a): Problems of Defining a Cooperative as an Economic Organisation. Oxford Agrarian Studies, Vol. 8, pp. 53-62.

BATEMAN, D.I.; EDWARDS, J.R. AND LEVAY, C. (1979b): Agricultural Cooperatives and the Theory of the Firm. Oxford Agrarian Studies, Vol. 8, pp. 63-81.

BECKMANN, M.J. (1973): Spatial Oligopoly as a Noncooperative Game. International Journal of Game Theory, Vol. 2, pp. 263-268.

BECKMANN, M.J. (1976): Spatial Price Policies Revisited. The Bell Journal of Economics, Vol. 7, pp. 619-630.

BECKMANN, M.J. AND THISSE, J.-F. (1986): The Location of Production Activities. In: NIJKAMP, P. (ed.): Handbook of Regional and Urban Economics, Vol. I. Amsterdam: Elsevier Science Publishers BV; pp. 21-95.

BENSON, B.L. (1980): Löschian Competition Under Alternative Demand Conditions. The American Economic Review, Vol. 70(5), pp. 1098-1105.

BERGMAN, M. A. (1997): Antitrust, Marketing Cooperatives, and Market Power. European Journal of Law and Economics, Vol. 4, pp. 73-92.

BKA – BUNDESKARTELLAMT (2009): Sektoruntersuchung Milch – Zwischenbericht Dezember 2009; Bonn; www.bundeskartellamt.de (accessed March 12, 2010).

BKA – BUNDESKARTELLAMT (2012): Sektoruntersuchung Milch – Endbericht Januar 2012; Bonn; www.bundeskartellamt.de (accessed January 20, 2012).

BMLEV – BUNDESMINISTERIUM FÜR ERNÄHRUNG, LANDWIRTSCHAFT UND VERBRAUCHERSCHUTZ (2008): Die Unternehmensstruktur der Molkereiwirtschaft in Deutschland. Bonn, Deutschland; http://www.bmlev-statistik.de (accessed April 6, 2009).

BMLFUW – BUNDESMINISTERIUM FÜR LAND- UND FORSTWIRTSCHAFT, UMWELT UND WASSERWIRTSCHAFT (2007): Grüner Bericht 2007. Wien, Österreich.

BMLFUW – BUNDESMINISTERIUM FÜR LAND- UND FORSTWIRTSCHAFT, UMWELT UND WASSERWIRTSCHAFT (2008): Lebensmittelbericht Österreich. Wertschöpfungskette Agrarerzeugnisse - Lebensmittel und Getränke. Wien, Österreich.

BMLFUW – BUNDESMINISTERIUM FÜR LAND- UND FORSTWIRTSCHAFT, UMWELT UND WASSERWIRTSCHAFT (2009): Grüner Bericht 2009. Wien, Österreich.

BOYSEN, O. AND SCHRÖDER, C. (2006): Economies of Scale in der Produktion versus Diseconomies im Transport. Zum Strukturwandel im Molkereisektor. Agrarwirtschaft, Vol. 55(3), pp. 152-167.

BRAZDA, J. AND WERNER, W. (2004): Perspektiven der landwirtschaftlichen Genossenschaften in Österreich. Ländlicher Raum 4/2004, pp. 1-15; www.laendlicher-raum.at (accessed February 2, 2010).

BRESNAHAN, T.F. (1981): Duopoly Models with Consistent Conjectural Variations. American Economic Review, Vol. 71(5), pp. 934-945.

BRISCOE, R. (1971): Utopians in the Market Place. Harvard Business Review, Sept-Oct 1971, pp. 4-10.

BUSCHENDORF, H. (2007): Ermittlung und Konsequenzen einer optimierten Betriebsstättenstruktur im Molkereisektor in Deutschland. In: MEYER, H.; KULOZIK, U.; SCHERER, S; WEINDLMAIER, H. and VEREINIGUNG DER FÖRDERER DER MILCHWISSENSCHAFTLICHEN FORSCHUNG AN DER TECHNISCHEN UNIVERSITÄT MÜNCHEN IN FREISING-WEIHENSTEPHAN E.V. (eds.): Milchwissenschaftliche Forschung Weihenstephan - Jahresbericht 2006 der milchwissenschaftlichen Forschungseinheiten am

Wissenschaftszentrum Weihenstephan; Band 49; Wissenschaftszentrum Weihenstephan für Ernährung, Landnutzung und Umwelt; Technische Universität München, p. 38-43.

CAPOZZA, D.R. AND VAN ORDER, R. (1977): Pricing Under Spatial Competition and Spatial Monopoly. Econometrica, Vol. 45(6), pp. 1329-1338.

CAPOZZA, D.R. AND VAN ORDER, R. (1978): A Generalized Model of Spatial Competition. American Economic Review, Vol. 68(5), pp. 896-908.

CHEUNG, F.K. AND WANG, X. (1996): Mill and Uniform Pricing: A Comparison. Journal of Regional Science, Vol. 36, pp. 129-143.

CLARK, E. (1952): Farmers Cooperatives and Economic Welfare. Journal of Farm Economics, Vol. 34, pp. 35-51.

COGECA – GENERAL COMMITTEE FOR AGRICULTURAL COOPERATION IN THE EUROPEAN UNION (2010): Agricultural Cooperatives in Europe. Main issues and trends. COGECA, Brussels; www.copa-cogeca.be (accessed July 5th, 2011).

COOK, M.L. AND ILIOPOULOS, C. (1999): Beginning to Inform the Theory of the Cooperative Firm: Emergence of the New Generation Cooperative. Liiketaloudellinen aikakauskirja (Finnish Journal of Business Economics), Vol. 48, pp. 525-535.

COTTERILL, R.W. (1987): Agricultural Cooperatives: A Unified Theory of Pricing, Finance and Investment. In: ROYER, J.S. (ed.): Cooperative Theory: New Approaches. Washington DC: U.S. Department of Agriculture, ASC Serv. Rep. No. 18, pp. 171-258.

COTTERILL, R.W. (1999): Continuing Concentration in Food Industries Globally: Strategic Challenges to an Unstable Status Quo. Research Report No. 49, Food Marketing Policy Center, University of Connecticut.

COTTERILL, R.W. (2001): Cooperative and Mempership Commiment: Discussion. American Journal of Agricultural Economics, Vol. 83(5), pp. 1280-1281.

DASGUPTA, P. AND MASKIN, E. (1986a): The Existence of Equilibrium in Discontinuous Economic Games, I: Theory. Review of Economic Studies, Vol. 53(1), pp. 1-26.

DASGUPTA, P. AND MASKIN, E. (1986b): The Existence of Equilibrium in Discontinuous Economic Games, II: Applications. Review of Economic Studies, Vol. 53(1), pp. 27-41.

DE FRAJA, G. AND DELBONO, F. (1990): Game Theoretic Models of Mixed Oligopoly. Journal of Economic Survey, Vol. 4(1), pp. 1-17.

DE FRAJA, G. AND NORMAN, G. (1993): Product Differentiation, Pricing Policy and Equilibrium. Journal of Regional Science, Vol. 33, pp. 343-363.

DE PALMA, A.; PONTES, J.P. AND THISSE, J.F. (1987): Spatial Competition under Uniform Delivered Pricing. Regional Science and Urban Economics, Vol. 17(3), pp. 441-449.

DLZ AGRARMAGAZIN (2010): Rangkämpfe – Genossenschaften mischen den Markt auf. DLZ Agrarmagazin, September 2010, pp. 20-24.

DRIVAS, K. AND GIANNAKAS, K (2007): The Effect of Marketing Cooperatives on Cost-Reducing Process Innovation Activity. Selected paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, OR, July 29–August 1, 2007.

DRIVAS, K. AND GIANNAKAS, K. (2010): The Effect of Cooperatives on Quality-Enhancing Innovation. Journal of Agricultural Economics, Vol. 61(2), pp. 295-317.

DRV – DEUTSCHER RAIFFEISENVERBAND (2010): Stellungnahme zur Sektoruntersuchung Milch – Zwischenbericht Dezember 2009 des Bundeskartellamtes. Bonn, 25. Februar 2010; http://www.raiffeisen.de/presse/pdf-aktuelles/DRV-Stellungnahme-Zwischenbericht-Sektoruntersuchung.pdf (accessed June 6, 2010).

DURHAM, C.A.; SEXTON, R.J. AND SONG, J.H. (1995): Transportation and Marketing Efficiency in the California Processing Tomato Industry. Giannini Foundation Research Report 343, Department of Agricultural and Resource Economics, University of California, Davis.

DURHAM, C.A.; SEXTON, R.J. AND SONG, J.H. (1996): Spatial Competition, Uniform Pricing and Transportation Efficiency in the California Processing Tomato Industry. American Journal of Agricultural Economics, Vol. 78(1), pp. 115-125.

EATON, B.C. AND LIPSEY, R.G. (1975): The Principle of Minimum Differentiation Reconsidered: Some New Developments in the Theory of Spatial Competition. Review of Economic Studies, Vol. 42(1), pp. 27-49.

EATON, B.C. AND LIPSEY, R.G. (1989): Product Differentiation. In: SCHMALENSEE, R. AND WILLIG, R.D. (eds.): Handbook of Industrial Organization, Vol. I. Amsterdam: Elsevier Science Publishers B.V., pp. 723-768.

EMILIANOFF, I.V. (1942): Economic Theory of Co-operation. Ann Arbor, Michigan: Edwards Bros. Inc.

ENKE, S. (1945): Consumer Cooperatives and Economic Efficiency. American Economic Review, Vol. 35, pp. 148-55.

FAHLBUSCH, M.; BAHR, A.; BRÜMMER, B. AND SPILLER, A. (2009): Der Markt für Milch und Milcherzeugnisse. Agrarwirtschaft, Vol. 58, pp. 36-52.

FOUSEKIS, P. (2010): Free-on-board and Uniform Delivery Pricing Strategies in a Mixed Duopsony. European Review of Agricultural Economics, pp. 1-21; DOI: 10.1093/erae/jbq048.

FOUSEKIS, P. (2011): Spatial Price Competition Between Cooperatives Under Hotelling-Smithies Conjectures. Agricultural Economics Review, Vol. 12(2), pp. 5-15.

FULTON, M.E. AND GIANNAKAS, K. (2001): Organizational Commitment in a Mixed Oligopoly: Agricultural Cooperatives and Investor-Owned-Firms. American Journal of Agricultural Economics, Vol. 83, pp. 1258-1265.

GALLAGHER, P.; WISNER, R. AND BRUBACKER, H. (2005): Price Relationships in Processors' Input Market Areas: Testing Theories for Corn Prices Near Ethanol Plants. Canadian Journal of Agricultural Economics, Vol. 53, pp. 117-139.

GIANNAKAS, K. AND FULTON, M. (2005): Process Innovation Activity in a Mixed Oligopoly: the Role of Cooperatives. American Journal of Agricultural Economics, Vol. 87(2), pp. 406-422.

GRAUBNER, M.; KOLLER, I.; SALHOFER, K. AND BALMANN, A. (2011a): Cooperative versus Non-cooperative Spatial Competition for Milk. European Review of Agricultural Economics, Vol. 38(1), pp. 99-118.

GRAUBNER, M.; BALMANN, A. AND SEXTON, R.J. (2011b): Spatial Price Discrimination in Agricultural Product Procurement Markets: A Computational Economics Approach. American Journal of Agricultural Economics, Vol. 93(4), pp. 949-967.

GREENHUT, J.G. AND GREENHUT, M.L. (1975): Spatial Price Discrimination, Competition and Location Effects. Economica, Vol. 42, pp. 401-419.

GREENHUT, J.; GREENHUT, M.L. AND LI, S.-Y. (1980): Spatial Pricing Patterns in the United States. Quarterly Journal of Economics, Vol. 94(2), pp. 329-350.

GREENHUT, M.L. (1981): Spatial Pricing in the U.S., West Germany and Japan. Economica, Vol. 71, pp. 79-86.

GREENHUT, M.L.; HWANG, M. AND OHTA, H. (1975): Observations on the Shape and Relevance of the Spatial Demand Function. Econometrica, Vol. 43(4), pp. 256-269.

GREENHUT, M.L.; NORMAN, G. AND HUNG, C.-S. (1987): The Economics of Imperfect Competition. A Spatial Approach. Cambridge: Cambridge University Press.

GREENHUT, M.L. AND OHTA, H. (1972): Monopoly Output Under Alternative Spatial Pricing Techniques. The American Economic Review, Vol. 62, pp. 705-713.

GREENHUT, M.L. AND OHTA, H. (1975): Discriminatory and Nondiscriminatory Spatial Prices and Outputs under Varying Market Conditions. Weltwirtschaftliches Archiv, Vol. 111(2), pp. 310-332.

GRONBERG, T. AND MEYER, J. (1981): Competitive Equilibria in Uniform Delivery Pricing. The American Economic Review, Vol. 71(4), pp. 758-763.

HANDELSBLATT (2011): Deutsches Milchkontor startet am 1. Mai. (April 29, 2011). http://www.handelsblatt.com/unternehmen/industrie/deutsches-milchkontor-startet-am-1-mai/4116840.html.

HEFFLEY, D.R. (1980): Pricing in an Urban Spatial Monopoly: Some Welfare Implications for Policies Which Alter Transportation Rates. Journal of Regional Science, Vol. 20(2), pp 207-225.

HELLBERG-BAHR, A.; PFEUFFER, M.; STEFFEN, N.; SPILLER, A. AND BRÜMMER, B. (2010): Preisbildungssysteme in der Milchwirtschaft. Ein Überblick über die Supply Chain Milch. Discussion Paper Nr. 1006; Department für Agrarökonomie und Rurale Entwicklung, Universität Göttingen.

HELMBERGER, P.G. (1964): Cooperative Enterprise as a Structural Dimension of Farm Markets. Journal of Farm Economics, Vol. 46(3), pp. 603-617.

HELMBERGER, P.G. AND HOOS, S. (1962): Co-operative Enterprise and Organization Theory. Journal of Farm Economics, Vol. 44(2), pp. 273 – 290.

HENDRIKSE, G.W.J (1998): Screening, Competition and the Choice of the Cooperative as an Organisational Form. Journal of Agricultural Economics, Vol. 49(2), pp. 202-217.

HIGL, M. (2003): Vertikale Kooperation im Oligopol: Die Gestaltung der Genossenschaftsorganisation als strategischer Zug. Volkswirtschaftliche Diskussionsreihe, Beitrag Nr. 243; Institut für Volkswirtschaftslehre, Universität Augsburg.

HOBBS, B.F. (1986): Mill Pricing Versus Spatial Price Discrimination under Betrand and Cournot Spatial Competition. The Journal of Industrial Economics, Vol. XXXV(2), pp. 173-191.

HOFFMAN, S.H. AND ROYER, J.S. (1997): Evaluating the Competitive Yardstick Effect of Cooperatives in Imperfect Markets: A Simulation Analysis. Paper presented at the Western Agricultural Economics Association 1997 Annual Meeting, July 13-16, 1997, Reno/Sparks, Nevada.

HOFFMANN, R. (2005): Ownership Structure and Endogenous Quality Choice: Cooveratives versus Investor-Owned Firms. Journal of Agricultural & Food Industrial Organization, Vol. 3(2), Article 8, pp. 1-24.

HOTELLING, H. (1929): Stability in Competition. Economic Journal, Vol. 39, pp. 41-57.

HSU, S. (1983): Pricing in an Urban Spatial Monopoly: A General Analysis. Journal of Regional Science, Vol. 23(2), pp. 165-175.

HUBER, A. (2007a): Entwicklungstendenzen in den Milcherfassungsgebieten deutscher Molkereiunternehmen. In: MEYER, H.; KULOZIK, U.; SCHERER, S; WEINDLMAIER, H. AND

VEREINIGUNG DER FÖRDERER DER MILCHWISSENSCHAFTLICHEN FORSCHUNG AN DER TECHNISCHEN UNIVERSITÄT MÜNCHEN IN FREISING-WEIHENSTEPHAN E.V. (eds.): Milchwissenschaftliche Forschung Weihenstephan - Jahresbericht 2006 der milchwissenschaftlichen Forschungseinheiten am Wissenschaftszentrum Weihenstephan; Band 49; Wissenschaftszentrum Weihenstephan für Ernährung, Landnutzung und Umwelt; Technische Universität München, p. 43-45.

HUBER, A. (2007b): Die Auswirkungen mengenmäßiger Staffelpreise für Rohmilch auf die Vergleichbarkeit der Milchpreise. In: MEYER, H.; KULOZIK, U.; SCHERER, S; WEINDLMAIER, H. AND VEREINIGUNG DER FÖRDERER DER MILCHWISSENSCHAFTLICHEN FORSCHUNG AN DER TECHNISCHEN UNIVERSITÄT MÜNCHEN IN FREISING-WEIHENSTEPHAN E.V. (eds.): Milchwissenschaftliche Forschung Weihenstephan - Jahresbericht 2006 der milchwissenschaftlichen Forschungseinheiten am Wissenschaftszentrum Weihenstephan; Band 49; Wissenschaftszentrum Weihenstephan für Ernährung, Landnutzung und Umwelt; Technische Universität München, p. 45-48.

HUBER, A. (2009): Milcherfassungsgebietskarte deutscher Molkereiunternehmen. In: MEYER, H.; KULOZIK, U.; SCHERER, S; WEINDLMAIER, H. AND VEREINIGUNG DER FÖRDERER DER MILCHWISSENSCHAFTLICHEN FORSCHUNG AN DER TECHNISCHEN UNIVERSITÄT MÜNCHEN IN FREISING-WEIHENSTEPHAN E.V. (eds.): Milchwissenschaftliche Forschung am Zentralinstitut für Ernährungs- und Lebensmittelforschung Weihenstephan (ZIEL) - Jahresbericht 2008 der milchwissenschaftlichen Forschungseinrichtungen am ZIEL; Band 51; Wissenschaftszentrum Weihenstephan für Ernährung, Landnutzung und Umwelt; Technische Universität München, p. 34-36.

HUCK, P. AND SALHOFER, K. (2005): Spatial Competition in Milk Processing Under Inelastic Raw Milk Supply. MIMEO.

HUCK, P.; SALHOFER, K. AND TRIBL, C. (2006): Spatial Competition of Milk Processing Cooperatives in Northern Germany. Contributed paper prepared for presentation at the International Association of Agricultural Economists (IAAE) Conference; August 12-18, Gold Coast, Australia.

ICA – INTERNATIONAL COOPERATIVE ALLIANCE (2011): Statement on the Co-operative Identity, http://www.ica.coop/coop/principles.html (accessed May 27, 2011).

IOZZI, A. (2004): Spatial Duopoly under Uniform Delivered Pricing when Firms Avoid Turning Customers Away. The Annals of Regional Science, Vol. 38, pp. 513-529.

JANZ, C.U. (2002): Unternehmenszusammenschlüsse in der Milch- und Zuckerindustrie unter wettbewerbsrechtlichen und ökonomischen Gesichtspunkten. Dissertation, Fakultät für Agrarwissenschaften der Georg-August-Universität Göttingen, Göttingen.

KARANTININIS, K. AND ZAGO, A. (2001): Endogenous Membership in Mixed Duopsonies. American Journal of Agricultural Economics, Vol. 83(5), pp. 1266-1272.

KATS, A. AND THISSE. J.-F. (1989): Spatial Oligopolies with Uniform Delivered Pricing. CORE Discussion Paper No. 8903; Center for Operations Research & Econometrics, Université Catholique de Louvain.

KATS, A. AND THISSE, J.-F. (1993): Spatial Oligopolies with Uniform Delivered Pricing. In: OHTA, H. AND THISSE, J.-F. (eds.): Does Economic Space Matter? Essays in Honour of Melvin L. Greenhut. New York: St Martins Press, pp. 274-302.

KOLLER, I. (2012): An Empirical Analysis of Spatial Pricing and Competition in the Raw Milk Market in Germany. Submitted doctoral thesis, Technical University of Munich, Germany.

LEDERER, P.J. AND HURTER, A.P (1986): Competition of Firms: Discriminatory Pricing and Location. Econometrica, Vol. 54(3), pp. 623-640.

LEVAY, C. (1983): Agricultural Co-operative Theory: A Review. Journal of Agricultural Economics, Vol. 34, pp. 1-44.

LÖFGREN, K.G. (1985): The Pricing of Pulpwood and Spatial Monopsony: Theory and Practice. European Review of Agricultural Economics, Vol. 12, pp. 283-293.

LÖFGREN, K.G. (1986): The Spatial Monopsonist: A Theoretical Analysis. Journal of Regional Science, Vol. 26(4), pp. 707-730.

LOPEZ, R.A. AND SPREEN, T.H. (1984): The Impact of Alternative Payment Arrangements on the Performance of Florida Sugarcane Cooperatives. Southern Journal of Agricultural Economics, Vol. 16(2), pp. 99-107.

MATSUMURA, T. AND MATSUSHIMA, N. (2003): Mixed Duopoly with Product Differentiation: Sequential Choice of Location. Australian Economic Papers, Vol. 42(1), pp. 18-34.

MATSUMURA, T. AND MATSUSHIMA, N. (2004): Endogenous cost differentials between public and private enterprises: A mixed duopoly approach. Economica, Vol. 71, pp. 671-688.

MATSUSHIMA, N. AND MATSUMURA, T. (2003): Mixed Oligopoly and Spatial Agglomeration. Canadian Journal of Economics, Vol. 36(1), pp. 62-87.

MÉREL, P.R.; SEXTON, R.J. AND SUZUKI, A. (2009): Optimal Investment in Transportation Infrastructure When Middlemen Have Market Power: A Developing-Country Analysis. Anerican Journal of Agricultural Economics, Vol. 91(2), pp. 462-476.

MURRAY, B.C. (1995): Measuring Oligopsony Power with Shadow Prices: U.S. Markets for Pulpwood and Sawlogs. The Review of Economics and Statistics, Vol. 77, pp. 486-498.

NORMAN, G. (1981): Spatial Competition and Spatial Price Discrimination. Review of Economic Studies, Vol. 48, pp. 345-372.

NOURSE, E.G. (1922): The Economic Philosophy of Co-operation. The American Economic Review, Vol. 12(4), pp. 577-597.

OGAWA, H. AND SANJO, Y. (2007): Location of Public Firm in the Presence of Multinational Firm: A Mixed Duopoly Approach. Australian Economic Papers, Vol. 46(2), pp. 191-203.

OHTA, H. (1984): On the Neutrality of Freight in Monopoly Spatial Pricing. Journal of Regional Science, Vol. 24(3), pp. 359-371.

OHTA, H. (1988): Spatial Price Theory of Imperfect Competition. Texas A&M University Press, College Station.

PAL, D. (1998): Does Cournot Competition Yield Spatial Agglomeration? Economic Letters, Vol. 60, pp. 49-53.

PHILLIPS, R. (1953): Economic Nature of the Co-operative Association. Journal of Farm Economics, Vol. 35(1), pp. 74-87.

PHLIPS, L. (1983): The Economics of Price Discrimination. Cambridge: Cambridge University Press.

PIGOU, A.C. (1950): The Economics of Welfare, 4th edition. Macmillan.

PORTER, P.K. AND SCULLY, G.W. (1987): Economic Efficiency in Cooperatives. Journal of Law and Economics, Vol. 30(1), pp. 489-512.

RHODES, V.J. (1983): The Large Agricultural Cooperative as Competitor. American Journal of Agricultural Economics, Vol. 65, pp. 1090-1095.

ROGERS, R.T. AND SEXTON, R.J. (1994): Assessing the Importance of Oligopsony power in Agricultural Markets. American Journal of Agricultural Economics, Vol. 76, pp. 1143-1150.

SALOP, S.C. (1979): Monopolistic Competition with Outside Goods. Bell Journal of Economics, Vol. 10(1), pp. 141-156.

SCHMID, E.; LARCHER, M.; SCHÖNHART, M. AND STIGLBAUER, C. (2011): Ende der Milchquote – Perspektiven und Ziele österreichischer Molkereien und MilchproduzentInnen. Forschungsendbericht. Institut für nachhaltige Wirtschaftsentwicklung, Universität für Bodenkultur, Wien.

SCHÖLER, R. (1988): Räumliche Preistheorie. Eine partialanalytische Untersuchung kontinuierlicher Wirtschaftsräume. Volkswirtschaftliche Schriften Heft 378. Berlin: Dunckner & Humblot.

SCHÖLER, K. (2001): Zweistufige Märkte bei zweidimensionaler räumlicher Verteilung der Nachfrage. Volkswirtschaftliche Diskussionsbeiträge – Diskussionsbeitrag Nr. 42; Wirtschafts- und Sozialwissenschaftliche Fakultät, Universität Potsdam.

SCHÖLER, K. AND SCHLEMPERER (1991): Räumlicher Wettbewerb bei konsistenten konjekturalen Reaktionen. Jahrbücher für Nationalökonomie und Statistik, Vol. 208(5), pp. 449-458.

SCHRAMM, M.; SPILLER, A. AND STAACK, T. (2005): Zur Brand Orientation genossenschafltícher Unternehmen der Ernährungsindustrie. Jahrbuch der Österreichischen Gesellschaft für Agrarökonomie, Vol. 14, pp. 141-152.

SCHULER, R.E. AND HOBBS, B.F. (1982): Spatial Price Duopoly Under Uniform Delivered Pricing. The Journal of Industrial Economics, Vol. 31(1/2), pp. 175-187.

SEN, A.K. (1966): Labour Allocation in a Cooperative Enterprise. Review of Economic Studies, Vol. 33, pp. 361-371.

SEXTON, R.J. (1984): Perspectives on the Development of the Economic Theory of Co-operatives. Canadian Journal of Agricultural Economics, Vol. 32, pp. 423-436.

SEXTON, R.J. (1986): The Formation of Cooperatives: A Game-Theoretic Approach with Implications for Cooperative Finance, Decision Making, and Stability. American Journal of Agricultural Economics, Vol. 68(2), pp. 214-225.

SEXTON, R.J. (1990): Imperfect Competition in Agricultural Markets and the Role of Cooperatives: A Spatial Analysis. American Journal of Agricultural Economics, Vol. 72(3), pp. 709-720.

SEXTON, R.J. AND ISKOW, J. (1993): What Do We Know About the Economic Efficiency of Cooperatives: An Evaluative Survey. Journal of Agricultural Co-operation, Vol. 8, pp. 15-27.

SEXTON, R.J. AND LAVOIE, N. (2001): Food Processing and Distribution: An Industrial Organization Approach. In: GARDNER, B. AND RAUSSER, G. (eds.): Handbook of Agricultural Economics, Vol. I. Amsterdam: Elsevier Science B.V., pp. 863-932.

SEXTON, R.J. AND SEXTON, T.A. (1987): Cooperatives as Entrants. RAND Journal of Economics, Vol. 18(4), pp. 581-595.

SEXTON, R.J.; WILSON, B.M. AND WANN, J.J. (1989): Some Tests of the Economic Theory of Cooperatives. Methodology and Application to Cotton Ginning. Western Journal of Agricultural Economics, Vol. 14(1), pp. 56-66.

SHAPIRO, C. (1989): Theories of Oligopoly Behaviour. In: SCHMALENSEE, R. AND WILLIG, R.D. (eds.): Handbook of Industrial Organization, Vol. I. Amsterdam: Elsevier Science Publishers B.V., pp. 329-414.

SINGER, H.W. A. (1937): Note on Special Price Discrimination. Review of Economic Studies, Vol. 5, pp. 75-77.

SORENSEN, A. (2005): Mixed Markets in the Food Processing Industry. Paper prepared for presentation at the 11th Congress of the EAAE (European Association of Agricultural Economists) in Copenhagen, Denmark, August 24-27, 2005.

STAATZ, J.M. (1987): Recent Developments in the Theory of Agricultural Cooperation. Journal of Agricultural Cooperation, Vol. 2, pp. 74-95.

STEFFEN, N.; SCHLECHT, S. AND SPILLER, A. (2009): Ausgestaltung von Milchverträgen nach der Quote. Discussion Paper Nr. 0909, Department für Agrarökonomie und Rurale Entwicklung, Universität Göttingen.

TAYLOR, R.A. (1971): The Taxation of Agricultural Cooperatives – Some Economic Implications. Canadian Journal of Agricultural Economics, Vol. 19, pp. 13-24.

TENNBAKK, B. (1992): The Case of Cooperative Mixed Duopoly. Institute of Industrial Relations Working Paper Series 044, University of California, Berkeley.

TENNBAKK, B. (1995): Marketing Cooperatives in Mixed Duopolies. Journal of Agricultural Economics, Vol. 46(1), pp. 33-45.

TENNBAKK, B. (2000): Determining the Size of an Open Marketing Cooperative in Duopoly. In: BORGEN, S. O. (ed.): Proceedings of the NJF Seminar No. 313, "The Food Sector in Transition" – Nordic Research. NILF Report 2001:2, Norwegian Agricultural Economics Research Institute, Oslo.

TENNBAKK, B. (2004): Cooperatives, Regulation and Competition in Norwegian Agriculture. Acta Agriculturae Scandinavica, Section C - Economy, Vol. 1(4), pp. 232-240.

THISSE, J.F. AND VIVES, X. (1998): Spatial Pricing Schemes. On the strategic choice of spatial price policy. In: PHLIPS, L. (ed.) Applied Industrial Economics. Cambridge: Cambridge University Press, pp. 152-173.

TIROLE, J. (1988): The Theory of Industrial Organization. Cambridge, London: The MIT Press.

TOP AGRAR ÖSTERREICH (2011): Milchpreise: Den Schwung aus 2010 mitnehmen – Milchpreisvergleich 2010. Top Agrar Österreich 3/2011, pp. 6-14.

TRIBL, C. (2009a): Spatial Competition in a Mixed Market of Food Processors – The Case of Uniform Delivered Pricing. Paper prepared for presentation at the International Workshop "Rural Cooperation in the 21st Century: Lessons for the Past, Pathways to Future", June 15-17, 2009; Rehovot, Israel.

TRIBL, C. (2009b): Spatial Competition of Food Processing Cooperatives in a Mixed Market – The Case of Uniform Delivered Pricing. Working Paper, Federal Institute of Agricultural Economics; Vienna, Austria.

VAN BEKKUM, O.F.; VAN DIJK, G.; KYRIAKOPOULUS, K. AND NILSSON, J. (2001): Introduction. In: VAN BEKKUM, O.F. AND VAN DIJK, G. (eds.): Agricultural Co-operatives in the European Union, Trends and Issues in the 21st Century. Assen, Netherlands: van Corcum.

WANN, J.J. AND SEXTON, R.J. (1992): Imperfect Competition in Multiproduct Food Industries with Application to Pear Processing. American Journal of Agricultural Economics, Vol. 74(4), pp. 980-990.

WEINDLMAIER, H. (2000): Absatz und Beschaffungsmarketing als Rahmenbedingungen für die Wettbewerbsfähigkeit des Molkereisektors in Deutschland. In: Anhang 2 zum Gutachten des Wissenschaftlichen Beirats beim Bundesministerium für Ernährung, Landwirtschaft und Forsten: Zur Wettbewerbsfähigkeit der Deutschen Milchwirtschaft; Münster-Hiltrup.

WEINDLMAIER, H. (2007): Optionen und Chancen der Milcherzeuger für eine aktive Beeinflussung der Milcherzeugerpreise. In: MEYER, H.; KULOZIK, U.; SCHERER, S; WEINDLMAIER, H. AND VEREINIGUNG DER FÖRDERER DER MILCHWISSENSCHAFTLICHEN FORSCHUNG AN DER TECHNISCHEN UNIVERSITÄT MÜNCHEN IN FREISING-WEIHENSTEPHAN E.V. (eds.): Milchwissenschaftliche Forschung Weihenstephan - Jahresbericht 2006 der milchwissenschaftlichen Forschungseinheiten am Wissenschaftszentrum Weihenstephan; Band 49; Wissenschaftszentrum Weihenstephan für Ernährung, Landnutzung und Umwelt; Technische Universität München, p. 58-63.

WEINDLMAIER, H. AND BETZ, J. (2009): Zur aktuellen Situation der Milcherfassung in Deutschland und Österreich im Jahr 2007. In: MEYER, H.; KULOZIK, U.; SCHERER, S; WEINDLMAIER, H. AND VEREINIGUNG DER FÖRDERER DER MILCHWISSENSCHAFTLICHEN FORSCHUNG AN DER TECHNISCHEN UNIVERSITÄT MÜNCHEN IN FREISING-WEIHENSTEPHAN E.V. (eds.): Milchwissenschaftliche Forschung am Zentralinstitut für Ernährungs- und Lebensmittelforschung Weihenstephan (ZIEL) - Jahresbericht 2008 der milchwissenschaftlichen Forschungseinrichtungen am ZIEL; Band 51; Wissenschaftszentrum Weihenstephan für Ernährung, Landnutzung und Umwelt; Technische Universität München, p. 43-47.

WEINDLMAIER, H. AND HUBER, A. (2001): Vor- und Nachteile des bayerischen Erzeugerorientierungspreises (EOP). Deutsche Milchwirtschaft, Vol. 52 (25), pp. 1087-1092.

WIRTSCHAFTSBLATT (2011): Fusion Berglandmilch/Tirol Milch mit Auflage genehmigt (online article, February 4, 2011). http://www.wirtschaftsblatt.at/home/oesterreich/branchen/fusion-berglandmilchtirol-milch-mit-auflage-genehmigt-457807/index.do

WOCKEN, C. AND SPILLER, A. (2009): Gestaltung von Milchlieferverträgen: Strategien für die Molkereiwirtschaft nach Auslaufen der Quote. In: THEUVSEN, L. AND SCHAPER, C. (eds.): Milchwirtschaft ohne Quote. Köln: Eul Verlag Lohmer, pp. 111-132.

YOUDE, J.G. AND HELMBERGER, P.G. (1966): Marketing Co-operatives in the U.S.: Membership policies, Market power and Antitrust policy. Journal of Farm Economics, Vol. 46(1), pp. 23-35.

ZEULI, K. AND BENTANCOR, A. (2005): The Effects of Cooperative Competition on Member Loyalty. Paper prepared at the NCERA-194 2005 Annual Meeting, November 8-9, 2005; Minneapolis, Minnesota.

ZHANG, M. (1997): Three Essays on Imperfect Competition in Agricultural Markets. Unpublished Ph.D. Dissertation, University of California, Davis, 1997.

ZHANG, M. AND SEXTON, R.J. (2001): FOB or Uniform Delivered Prices: Strategic Choice and Welfare Effects. The Journal of Industrial Economics, Vol. XLIX(2), pp. 197-221.

COOPERATIVE SOCIETIES ACTS

GENG-A (Genossenschaftsgesetz, Österreich): Gesetz vom 9. April 1873, über Erwerbs- und Wirthschaftsgenossenschaften. StF: RGBl. Nr. 70/1873; zuletzt geändert durch BGBl. I Nr. 70/2008.

GENG-D (Genossenschaftsgesetz, Deutschland): Genossenschaftsgesetz in der Fassung der Bekanntmachung vom 16. Oktober 2006 (BGBl. I S. 2230), das zuletzt durch Artikel 10 des Gesetzes vom 25. Mai 2009 (BGBl. I S. 1102) geändert worden ist.

APPENDIX

A1 PURE IOF MARKET

A1.1 THE MODEL OF ALVAREZ ET AL. (2000)

(ad CHAPTER 5.1)

TABLE A1-1. Comparative statics: *AFSZ* model

	Monopsony: $\frac{s}{\rho} \geq \frac{4}{3}$	**Competition en route:** $\frac{4}{7} < \frac{s}{\rho} < \frac{4}{3}$	**Competition in the backyard:** $0 < \frac{s}{\rho} < \frac{4}{7}$
UD price			
$\frac{\partial u_I^{AFSZ}}{\partial t}$	0	$-\frac{1}{8}d < 0$	$\frac{td^2}{\sqrt{4\rho^2 - 6t^2d^2}} > 0$
$\frac{\partial u_I^{AFSZ}}{\partial d}$	0	$-\frac{1}{8}t < 0$	$\frac{t^2d}{\sqrt{4\rho^2 - 6t^2d^2}} > 0$
$\frac{\partial u_I^{AFSZ}}{\partial \rho}$	$\frac{1}{3} > 0$	$\frac{1}{2} > 0$	$\frac{2}{3}\left[1 - \frac{\rho}{\sqrt{4\rho^2 - 6t^2d^2}}\right] > 0$
Market area (not provided by *AFSZ*)			
$\frac{\partial R_I^{AFSZ}}{\partial t}$	$-\frac{2\rho}{3t^2} < 0$	$-\frac{\rho}{2t^2} < 0$	$-\frac{\rho\left(2\rho + \sqrt{4\rho^2 - 6t^2d^2}\right)}{3t^2\sqrt{4\rho^2 - 6t^2d^2}} < 0$
$\frac{\partial R_I^{AFSZ}}{\partial d}$	0	$\frac{1}{8} > 0$	$-\frac{td}{\sqrt{4\rho^2 - 6t^2d^2}} < 0$
$\frac{\partial R_I^{AFSZ}}{\partial \rho}$	$\frac{2}{3t} > 0$	$\frac{1}{2t} > 0$	$\frac{2\rho + \sqrt{4\rho^2 - 6t^2d^2}}{3t\sqrt{4\rho^2 - 6t^2d^2}} > 0$

Note: In the circular market model under Löschian competition with $R_I = d/2$ (see CHAPTER 5.3), the optimal UD price is equal to that derived by *AFSZ* for the situation of "competition en route". Thus, the comparative statics concerning the response of the UD price are equal to those presented here in the situation of "competition en route".

A1.2 CIRCULAR MARKET: COMPETITION EN ROUTE

(ad CHAPTER 5.2.2)

TABLE A1-2. Comparative statics: competition en route

UD price for $0<\frac{s}{\rho}<\frac{4}{3}$	$\frac{\partial u_I^{er}}{\partial t}=-\frac{2\sqrt{4N^2\rho^2-8\rho Nt+10t^2}+2N\rho-5t}{3N\sqrt{4N^2\rho^2-8\rho Nt+10t^2}}<0$
	$\frac{\partial u_I^{er}}{\partial N}=\frac{t\left(2\sqrt{4N^2\rho^2-8\rho Nt+10t^2}+2N\rho-5t\right)}{3N^2\sqrt{4N^2\rho^2-8\rho Nt+10t^2}}>0$
	$\frac{\partial u_I^{er}}{\partial \rho}=\frac{2\left(\sqrt{4N^2\rho^2-8\rho Nt+10t^2}+N\rho-t\right)}{3\sqrt{4N^2\rho^2-8\rho Nt+10t^2}}>0$
Market area for $0<\frac{s}{\rho}<\frac{4}{3}$	$\frac{\partial R_I^{er}}{\partial t}=\frac{\rho\left(2N\rho-2t-\sqrt{4N^2\rho^2-8\rho Nt+10t^2}\right)}{3t^2\sqrt{4N^2\rho^2-8\rho Nt+10t^2}}<0$
	$\frac{\partial R_I^{er}}{\partial N}=-\frac{2\left(\sqrt{4N^2\rho^2-8\rho Nt+10t^2}+2N\rho-5t\right)}{3N^2\sqrt{4N^2\rho^2-8\rho Nt+10t^2}}<0$
	$\frac{\partial R_I^{er}}{\partial \rho}=-\frac{2N\rho-2t-\sqrt{4N^2\rho^2-8\rho Nt+10t^2}}{3t\sqrt{4N^2\rho^2-8\rho Nt+10t^2}}>0$

A1.3 CIRCULAR MARKET: COMPETITION IN THE BACKYARD - LOWER EXTREME CASE

(ad CHAPTER 5.2.3)

TABLE A1-3. Comparative statics: LEC of competition in the backyard

UD price for $\frac{4}{15}\le\frac{s}{\rho}<\frac{4}{7}$	$\frac{\partial u_I^{by-LEC}}{\partial t}=-\frac{4\sqrt{4N^2\rho^2-16\rho Nt+46t^2}+4N\rho-23t}{3N\sqrt{4N^2\rho^2-16\rho Nt+46t^2}}<0$
	$\frac{\partial u_I^{by-LEC}}{\partial N}=\frac{t\left(4\sqrt{4N^2\rho^2-16\rho Nt+46t^2}+4N\rho-23t\right)}{3N^2\sqrt{4N^2\rho^2-16\rho Nt+46t^2}}>0$
	$\frac{\partial u_I^{by-LEC}}{\partial \rho}=\frac{2\left(\sqrt{4N^2\rho^2-16\rho Nt+46t^2}+N\rho-2t\right)}{3\sqrt{4N^2\rho^2-16\rho Nt+46t^2}}>0$
Market area for $\frac{4}{15}\le\frac{s}{\rho}<\frac{4}{7}$	$\frac{\partial R_I^{by-LEC}}{\partial t}=\frac{\rho\left(2N\rho-4t-\sqrt{4N^2\rho^2-16\rho Nt+46t^2}\right)}{3t^2\sqrt{4N^2\rho^2-16\rho Nt+46t^2}}<0$
	$\frac{\partial R_I^{by-LEC}}{\partial N}=-\frac{4\sqrt{4N^2\rho^2-16\rho Nt+46t^2}+4N\rho-23t}{3N^2\sqrt{4N^2\rho^2-16\rho Nt+46t^2}}<0$
	$\frac{\partial R_I^{by-LEC}}{\partial \rho}=-\frac{2N\rho-4t-\sqrt{4N^2\rho^2-16\rho Nt+46t^2}}{3t\sqrt{4N^2\rho^2-16\rho Nt+46t^2}}>0$

A1.4 COMPETITION IN THE BACKYARD IN A CIRCULAR MARKET
(ad CHAPTER 5.2.3)

In the following, a general framework for the analysis of competition in the backyard in a circular market will be derived (see CHAPTER 5.2.3). In the situation of "competition in the backyard" (index *by*) processors wish to serve a market area that extends beyond the location of a competitor. If the assumed market form is a circular market, the necessary condition to analyze such a situation is that there are at least three processors ($N \geq 3$) in the market. As each processor can have more than one competitor, there are various possible situations of competition in the backyard. For example, a processor may wish to compete beyond the location of its second or third competitor. To keep the analysis as simple as possible, only two extreme cases regarding the expansion of the market area will be considered to cover the possible range of competition in the backyard. The "lower extreme case" (LEC) of competition in the backyard denotes a situation where each processor extends its market area only beyond the nearest competitor on each market side with the upper boundary of the market area being $(3d)/2$. In the "upper extreme case" (UEC) of competition in the backyard, each processor extends its market area beyond the most distant competitor on each market side. Given a circumference of 1, the largest possible length of the market area in this situation is 1/2 (in each direction). The range of the possible extensions of market areas, from the lowest (R_I^{by-LEC}) to the highest (R_I^{by-UEC}) is given by

$$\text{(A1-1)} \quad d \leq R_I^{by-LEC} < \frac{3d}{2}, \qquad \text{which is } \frac{1}{N} \leq R_I^{by-LEC} < \frac{3}{2N} \text{ for } d = \frac{1}{N}$$

$$\text{(A1-2)} \quad \frac{N-1}{2} d < R_I^{by-UEC} \leq \frac{N}{2} d, \qquad \text{which is } \frac{N-1}{2N} < R_I^{by-UEC} \leq \frac{1}{2} \text{ for } d = \frac{1}{N}.$$

In general, there are $N-2$ different profit functions that are necessary to account for all possible situations of competition in the backyard (i.e., depending on how far each processor extends its market area).[194] If $N = 3$, both extreme cases are identical: $1/3 < R_I^{by} \leq 1/2$.

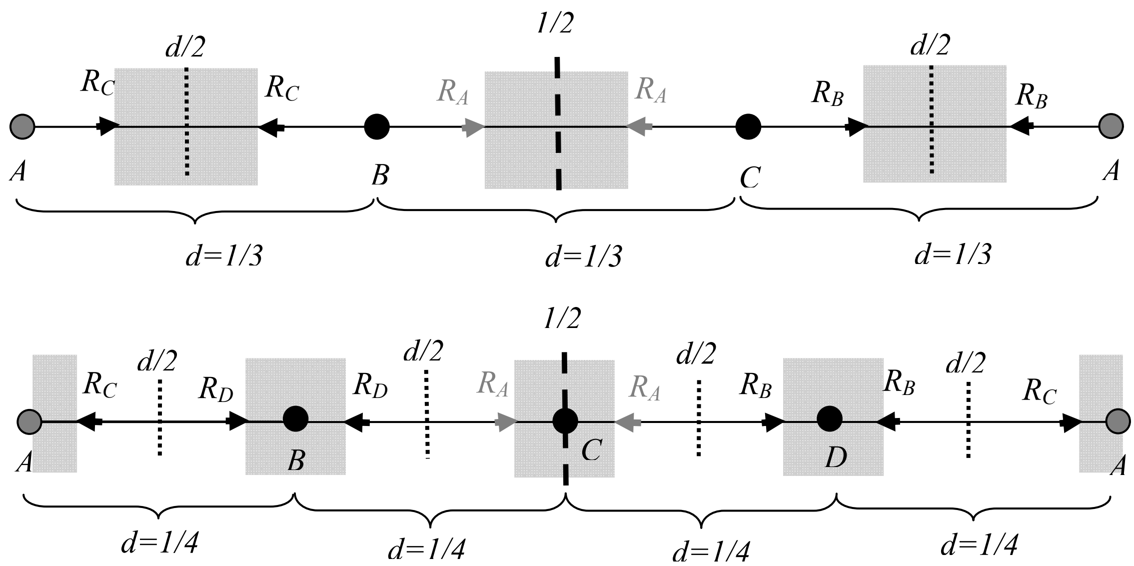
[194] There is one specific profit function for each possible situation. To consider all possibilities of overlap, the number of different profit functions for the situations of competition in the backyard is determined by the number of the distances of length *d/2* on either market side. For example, for *N=3*, there is only one profit function which applies to the situation of competition in the backyard. In this case, the nearest competitor is also the most distant competitor on each market side (the LEC, $d<R_I<(3d)/2$ is equal to the UEC, $d<R_I<1/2$). For *N=4*, the LEC ($d<R_I<(3d)/2$) is followed by the UEC ($(3d)/2< R_I <1/2$) if processors further extend their market area. Thus, there are two different profit functions for competition in the backyard. For *N=5*, there is one situation in between the LEC ($d<R_I<(3d)/2$) and the UEC ($(2d)< R_I<1/2$). Consequently, there are three different situations of competition in the backyard. This specific situation in between the two extreme cases LEC and UEC ($(3d)/2<R_I<2d$ in this case) will not be considered here.

For any $N \geq 3$, the profit function for the LEC is equal for any number of processors N (see CHAPTER 5.2.3). In the following, only the UEC will be considered. This situation demands a distinction between an even and an odd N (see FIGURE A1-1). Because of overlapping market areas, the profit function of an IOF consists of several parts (i.e., integrals) that are defined by the consecutive "sections" along the market area R_I. For example, in the case of competition en route, there is one section in which the processor serves a certain area exclusively, and there is one section with market overlap (see equation (5-15) in CHAPTER 5.2.2). In the UEC of competition in the backyard, the following number of sections along R_I for $N \geq 3$ can be defined:

(A1-3) odd N : number of sections along R_I : $\frac{3(N-1)}{2}+1$

(A1-4) even N : number of sections along R_I : $\frac{3N}{2}-1$

FIGURE A1-1. UEC of competition in the backyard



Note: For reasons of simplicity, the circular market with a circumference of length 1 is illustrated as a line market (therefore, processor *A* can be found on both ends of the line and the midpoint of this line is located at 1/2). The largest possible market area for processor *A* is given by $R_I=1/2$. In the upper figure, $N=3$ (i.e., an odd number); in the lower figure, $N=4$ (i.e., an even number). There are $N-1$ processors operating within the grey areas, and N processors in the remaining areas.

If $R_I^{by-UEC} = 1/2$, N processors are competing at each point in space. In the UEC of competition in the backyard (i.e., $(N-1)/2N < R_I^{by-UEC} \leq 1/2$), there are sections with N processors and sections with $N-1$ processors competing at each market point within the respective sections. More specifically:

(A1-5) odd N:

number of sections with N processors along R_I: N

number of sections with $N-1$ processors along R_I: $\frac{N-1}{2}$

(A1-6) even N:

number of sections with N processors along R_I: $\frac{N}{2}$

number of sections with $N-1$ processors along R_I: $N-1$

Irrespective of N, the distance between two processors on a circle, $d = 1/N$, always consists of three sections, which are determined by the two market boundaries of competitors (i.e., two for each market side) within d (see FIGURE A1-1).[195] FIGURE A1-1 also shows that if N is an odd number, there are always N processors competing in the first section of any distance d, $N-1$ processors (see the grey area) in the second section, and N processors in the third section. If N is an even number, the opposite is true: there are always $N-1$ processors competing in the first section of d, N processors in the second section, and $N-1$ processors in the third section.

Let the most distant competitor on each market side of any processor be the x^{th} competitor. Then, the number of processors x (i.e., the number of distances $d = 1/N$) beyond which the market area extends on each market side is

(A1-7) odd N: $x = \frac{N-1}{2}$

(A1-8) even N: $x = \frac{N}{2} - 1$

Therefore, a general profit function for the UEC of competition in the backyard for any $N \geq 3$ reads:

[195] For example, in the upper part of FIGURE A1-1, the first section within distance d is the area which extends from the location of processor A to the market boundary of competitor C, R_C. The second section is the area which extends from the market boundary R_C to the second market boundary of processor C, R_C. The third section is the area which extends from the market boundary R_C to the location of processor B.

$$\text{(A1-9)}\quad \text{odd } N: \Pi_I^{by-UEC} = 2\left[\begin{array}{l} \frac{1}{N}\int\limits_{0}^{R_I-\frac{N-1}{2}d}(...)\mathrm{d}r + \frac{1}{N-1}\int\limits_{R_I-\frac{N-1}{2}d}^{\left(\frac{N-1}{2}+1\right)d-R_I}(...)\,\mathrm{d}r + \frac{1}{N}\int\limits_{\left(\frac{N-1}{2}+1\right)d-R_I}^{d}(...)\,\mathrm{d}r + \\ \frac{1}{N}\int\limits_{d}^{R_I-\left(\frac{N-1}{2}-1\right)d}(...)\,\mathrm{d}r + \frac{1}{N-1}\int\limits_{R_I-\left(\frac{N-1}{2}-1\right)d}^{\left(\frac{N-1}{2}+2\right)d-R_I}(...)\,\mathrm{d}r + \frac{1}{N}\int\limits_{\left(\frac{N-1}{2}+2\right)d-R_I}^{2d}(...)\,\mathrm{d}r + \\ ...+ \\ \frac{1}{N}\int\limits_{\left(\frac{N-1}{2}-1\right)d}^{R_I-d}(...)\mathrm{d}r + \frac{1}{N-1}\int\limits_{R_I-d}^{(N-1)d-R_I}(...)\mathrm{d}r + \frac{1}{N}\int\limits_{(N-1)d-R_I}^{\frac{N-1}{2}d}(...)\mathrm{d}r + \\ \frac{1}{N}\int\limits_{\frac{N-1}{2}d}^{R_I}(...)\mathrm{d}r \end{array}\right]u_I$$

for $(...)=(\rho-u_I-tr)$, $R_I=\dfrac{\rho-u_I}{t}$ and $d=\dfrac{1}{N}$.

$$\text{(A1-10)}\quad \text{even } N: \Pi_I^{by-UEC} = 2\left[\begin{array}{l} \frac{1}{N-1}\int\limits_{0}^{\frac{N}{2}d-R_I}(...)\mathrm{d}r + \frac{1}{N}\int\limits_{\frac{N}{2}d-R_I}^{R_I-\left(\frac{N}{2}-1\right)d}(...)\mathrm{d}r + \frac{1}{N-1}\int\limits_{R_I-\left(\frac{N}{2}-1\right)d}^{d}(...)\mathrm{d}r + \\ \frac{1}{N-1}\int\limits_{d}^{\left(\frac{N}{2}+1\right)d-R_I}(...)\mathrm{d}r + \frac{1}{N}\int\limits_{\left(\frac{N}{2}+1\right)d-R_I}^{R_I-\left(\frac{N}{2}-2\right)d_I}(...)\mathrm{d}r + \frac{1}{N-1}\int\limits_{R_I-\left(\frac{N}{2}-2\right)d_I}^{2d}(...)\mathrm{d}r + \\ ...+ \\ \frac{1}{N-1}\int\limits_{\left(\frac{N}{2}-2\right)d}^{(N-2)d-R_I}(...)\mathrm{d}r + \frac{1}{N}\int\limits_{(N-2)d-R_I}^{R_I-d}(...)\mathrm{d}r + \frac{1}{N-1}\int\limits_{R_I-d}^{\left(\frac{N}{2}-1\right)d}(...)\mathrm{d}r + \\ \frac{1}{N-1}\int\limits_{\left(\frac{N}{2}-1\right)d}^{(N-1)d-R_I}(...)\mathrm{d}r + \frac{1}{N}\int\limits_{(N-1)d-R_I}^{R_I}(...)\mathrm{d}r \end{array}\right]u_I$$

for $(...)=(\rho-u_I-tr)$, $R_I=\dfrac{\rho-u_I}{t}$ and $d=\dfrac{1}{N}$.

In equations (A1-9) and (A1-10), each row within the term brackets $[...]$ except the last row include the three sections along d. The number of rows is determined by the number of competitors on each market side. In total, there are $x+1$ rows: the first row is the area which extends from 0 to d (i.e., the distance between processor *A* and *B*), the second row is the area which extends from d to $2d$ (i.e., the distance between processor *B* and *C*), etc. The penultimate row is the distance between the most distant competitor (i.e., the x^{th} processor) and its respective nearest competitor. The last row is the area between the location of the most distant competitor and the market boundary of the processor in question, R_I. Consequently, equation (A1-9) consists of $(N+1)/2$ rows in total and equation (A1-10) of *N/2* rows in total. Again, it is assumed that farmers are shared equally between processors within the areas of overlap. Therefore, profits derived from any section are multiplied by *1/N* if there are N processors competing in this section and by $1/(N-1)$ if there are $N-1$ processors competing in this section. Multiplying the term in brackets $[...]$ by 2 gives the profits from collecting one unit of the raw product from farmers in both directions; multiplying the result by u_I gives total profits of the processor.

To give an example, if $N=5$, processor *A* extends its market area beyond two processors on each market side (see equation (A1-7)). The profit function consists of three rows and is given by

$$\text{(A1-11)}\quad \Pi_I^{by-UEC} = 2\begin{bmatrix} \frac{1}{5}\int_0^{R_I-2d}(...)\mathrm{d}r + \frac{1}{4}\int_{R_I-2d}^{3d-R_I}(...)\mathrm{d}r + \frac{1}{5}\int_{3d-R_I}^{d}(...)\mathrm{d}r + \\ \frac{1}{5}\int_d^{R_I-d}(...)\mathrm{d}r + \frac{1}{4}\int_{R_I-d}^{4d-R_I}(...)\mathrm{d}r + \frac{1}{5}\int_{4d-R_I}^{2d}(...)\mathrm{d}r + \\ \frac{1}{5}\int_{2d}^{R_I}(...)\mathrm{d}r \end{bmatrix} u_I$$

$$\text{for } (...) = (\rho - u_I - tr),\ R_I = \frac{\rho - u_I}{t} \text{ and } d = \frac{1}{5}.$$

If $N=6$, processor *A* also extends its market area beyond two processors on each market side (see equation (A1-8)). Again, the profit function consists of three rows and is given by

$$\text{(A1-12)}\quad \Pi_I^{by-UEC} = 2\begin{bmatrix} \frac{1}{5}\int_0^{3d-R_I}(...)\mathrm{d}r + \frac{1}{6}\int_{3d-R_I}^{R_I-2d}(...)\mathrm{d}r + \frac{1}{5}\int_{R_I-2d}^{d}(...)\mathrm{d}r + \\ \frac{1}{5}\int_d^{4d-R_I}(...)\mathrm{d}r + \frac{1}{6}\int_{4d-R_I}^{R_I-d_I}(...)\mathrm{d}r + \frac{1}{5}\int_{R_I-d_I}^{2d}(...)\mathrm{d}r + \\ \frac{1}{5}\int_{2d}^{5d-R_I}(...)\mathrm{d}r + \frac{1}{6}\int_{5d-R_I}^{R_I}(...)\mathrm{d}r \end{bmatrix} u_I$$

$$\text{for } (...) = (\rho - u_I - tr),\ R_I = \frac{\rho - u_I}{t} \text{ and } d = \frac{1}{6}.$$

An application of the general profit equations (A1-9) and (A1-10) for $N = 3, ..., 10$ and the corresponding solutions of optimal UD prices and market areas are given in APPENDIX A1.5. These solutions are used for the numerical simulation, which is shown in CHAPTER 5.2.3.

A1.5 SOLUTIONS FOR THE UPPER EXTREME CASE OF COMPETITION IN THE BACKYARD

(ad CHAPTER 5.2.3)

Based on equations (A1-9) and (A1-10) (see APPENDIX A1.4), optimal UD prices and market areas for the numerical simulation of the UEC of competition in the backyard in CHAPTER 5.2.3 will be derived in the following. Since there is one specific profit function for each possible number of processors (see APPENDIX A1.4), comparative statics of UD prices with respect to changes in N ($\partial u_I / \partial N$) cannot be derived analytically but via a numerical simulation. The solutions for optimal UD prices and market areas for $N = 3, ..., 10$ may allow a sufficient range in the numerical simulation to derive general conclusions about $\partial u_I / \partial N$.

N=3:

If $N = 3$, the UEC and the LEC of competition in the backyard are the same. The profit function is given by

$$\text{(A1-13)}\quad \Pi_I^{N=3} = \max_{u_I} \left[2 \left[\begin{array}{l} \frac{1}{3}\int_0^{R_I-d}(...)\mathrm{d}r + \frac{1}{2}\int_{R_I-d}^{2d-R_I}(...)\mathrm{d}r + \frac{1}{3}\int_{2d-R_I}^{d}(...)\mathrm{d}r + \\ \frac{1}{3}\int_d^{R_I}(...)\mathrm{d}r \end{array} \right] u_I \right]$$

$$\text{for } (...) = (\rho - u_I - tr),\ R_I = \frac{\rho - u_I}{t} \text{ and } d = \frac{1}{3}$$

(see also equation (5-20) in CHAPTER 5.2.3). Maximizing $\Pi_I^{N=3}$ with respect to u_I gives the solution for the optimal UD price:

$$\text{(A1-14)}\quad u_I^{N=3} = \frac{2}{3}\rho - \frac{4}{9}t + \frac{1}{18}\sqrt{36\rho^2 - 48\rho t + 46t^2}$$

After substitution, the optimal market area is

$$\text{(A1-15)}\quad R_I^{N=3} = \frac{6\rho + 8t - \sqrt{36\rho^2 - 48\rho t + 46t^2}}{18t}$$

(see also equations (5-21), (5-22) and (5-23) in CHAPTER 5.2.3 for the LEC of competition in the backyard with $N = 3$ and *d=1/3*). For $N = 4, ..., 10$, the profit functions and the corresponding solutions for UD prices and market areas are as follows:

***N=4*:**

$$\text{(A1-16)}\quad \Pi_I^{N=4} = \max_{u_I}\left[2\left[\begin{array}{l}\frac{1}{3}\int_0^{2d-R_I}(...)\mathrm{d}r + \frac{1}{4}\int_{2d-R_I}^{R_I-d}(...)\mathrm{d}r + \frac{1}{3}\int_{R_I-d}^{d}(...)\mathrm{d}r + \\ \frac{1}{3}\int_d^{3d-R_I}(...)\mathrm{d}r + \frac{1}{4}\int_{3d-R_I}^{R_I}(...)\mathrm{d}r\end{array}\right]u_I\right]$$

for $(...) = (\rho - u_I - tr)$, $R_I = \dfrac{\rho - u_I}{t}$ and $d = \dfrac{1}{4}$

$$\text{(A1-17)}\quad u_I^{N=4} = \frac{2}{3}\rho - \frac{5}{12}t + \frac{1}{6}\sqrt{4\rho^2 - 5\rho t + 4t^2}$$

$$\text{(A1-18)}\quad R_I^{N=4} = \frac{4\rho + 5t - 2\sqrt{4\rho^2 - 5\rho t + 4t^2}}{12t}$$

***N=5*:**

$$\text{(A1-19)}\quad \Pi_I^{N=5} = \max_{u_I}\left[2\left[\begin{array}{l}\frac{1}{5}\int_0^{R_I-2d}(...)\mathrm{d}r + \frac{1}{4}\int_{R_I-2d}^{3d-R_I}(...)\mathrm{d}r + \frac{1}{5}\int_{3d-R_I}^{d}(...)\mathrm{d}r + \\ \frac{1}{5}\int_d^{R_I-d}(...)\mathrm{d}r + \frac{1}{4}\int_{R_I-d}^{4d-R_I}(...)\mathrm{d}r + \frac{1}{5}\int_{4d-R_I}^{2d}(...)\mathrm{d}r + \\ \frac{1}{5}\int_{2d}^{R_I}(...)\mathrm{d}r\end{array}\right]u_I\right]$$

for $(...) = (\rho - u_I - tr)$, $R_I = \dfrac{\rho - u_I}{t}$ and $d = \dfrac{1}{5}$

$$\text{(A1-20)}\quad u_I^{N=5} = \frac{2}{3}\rho - \frac{7}{15}t + \frac{1}{15}\sqrt{25\rho^2 - 35\rho t + 34t^2}$$

$$\text{(A1-21)}\quad R_I^{N=5} = \frac{5\rho + 7t - \sqrt{25\rho^2 - 35\rho t + 34t^2}}{15t}$$

***N*=6:**

$$\text{(A1-22)}\quad \Pi_I^{N=6}=\max_{u_I}\left[2\left[\begin{array}{l}\frac{1}{5}\int\limits_{0}^{3d-R_I}(\ldots)\mathrm{d}r+\frac{1}{6}\int\limits_{3d-R_I}^{R_I-2d}(\ldots)\mathrm{d}r+\frac{1}{5}\int\limits_{R_I-2d}^{d}(\ldots)\mathrm{d}r+\\ \frac{1}{5}\int\limits_{d}^{4d-R_I}(\ldots)\mathrm{d}r+\frac{1}{6}\int\limits_{4d-R_I}^{R_I-d_I}(\ldots)\mathrm{d}r+\frac{1}{5}\int\limits_{R_I-d_I}^{2d}(\ldots)\mathrm{d}r+\\ \frac{1}{5}\int\limits_{2d}^{5d-R_I}(\ldots)\mathrm{d}r+\frac{1}{6}\int\limits_{5d-R_I}^{R_I}(\ldots)\mathrm{d}r\end{array}\right]u_I\right]$$

for $(\ldots)=(\rho-u_I-tr)$, $R_I=\dfrac{\rho-u_I}{t}$ and $d=\dfrac{1}{6}$

$$\text{(A1-23)}\quad u_I^{N=6}=\frac{2}{3}\rho-\frac{4}{9}t+\frac{1}{36}\sqrt{144\rho^2-192\rho t+166t^2}$$

$$\text{(A1-24)}\quad R_I^{N=6}=\frac{12\rho+16t-\sqrt{144\rho^2-192\rho t+166t^2}}{36t}$$

N=7:

$$\text{(A1-25)}\quad \Pi_I^{N=7}=\max_{u_I}\left[2\left[\begin{array}{l}\frac{1}{7}\int\limits_{0}^{R_I-3d}(\ldots)\mathrm{d}r+\frac{1}{6}\int\limits_{R_I-3d}^{4d-R_I}(\ldots)\mathrm{d}r+\frac{1}{7}\int\limits_{4d-R_I}^{d}(\ldots)\mathrm{d}r+\\ \frac{1}{7}\int\limits_{d}^{R_I-2d}(\ldots)\mathrm{d}r+\frac{1}{6}\int\limits_{R_I-2d}^{5d-R_I}(\ldots)\mathrm{d}r+\frac{1}{7}\int\limits_{5d-R_I}^{2d}(\ldots)\mathrm{d}r+\\ \frac{1}{7}\int\limits_{2d}^{R_I-d}(\ldots)\mathrm{d}r+\frac{1}{6}\int\limits_{R_I-d}^{6d-R_I}(\ldots)\mathrm{d}r+\frac{1}{7}\int\limits_{6d-R_I}^{3d}(\ldots)\mathrm{d}r+\\ \frac{1}{7}\int\limits_{3d}^{R_I}(\ldots)\mathrm{d}r\end{array}\right]u_I\right]$$

for $(\ldots)=(\rho-u_I-tr)$, $R_I=\dfrac{\rho-u_I}{t}$ and $d=\dfrac{1}{7}$

$$\text{(A1-26)}\quad u_I^{N=7}=\frac{2}{3}\rho-\frac{10}{21}t+\frac{1}{42}\sqrt{196\rho^2-280\rho t+274t^2}$$

$$\text{(A1-27)}\quad R_I^{N=7}=\frac{14\rho+20t-\sqrt{196\rho^2-280\rho t+274t^2}}{42t}$$

***N=8*:**

$$\text{(A1-28)}\quad \Pi_I^{N=8} = \max_{u_I}\left[2\left[\begin{array}{l} \frac{1}{7}\int_0^{4d-R_I}(...)\mathrm{d}r + \frac{1}{8}\int_{4d-R_I}^{R_I-3d}(...)\mathrm{d}r + \frac{1}{7}\int_{R_I-3d}^{d}(...)\mathrm{d}r + \\ \frac{1}{7}\int_d^{5d-R_I}(...)\mathrm{d}r + \frac{1}{8}\int_{5d-R_I}^{R_I-2d_I}(...)\mathrm{d}r + \frac{1}{7}\int_{R_I-2d_I}^{2d}(...)\mathrm{d}r + \\ \frac{1}{7}\int_{2d}^{6d-R_I}(...)\mathrm{d}r + \frac{1}{8}\int_{6d-R_I}^{R_I-d_I}(...)\mathrm{d}r + \frac{1}{7}\int_{R_I-d_I}^{3d}(...)\mathrm{d}r + \\ \frac{1}{7}\int_{3d}^{7d-R_I}(...)\mathrm{d}r + \frac{1}{8}\int_{7d-R_I}^{R_I}(...)\mathrm{d}r \end{array}\right]u_I\right]$$

for $(...) = (\rho - u_I - tr)$, $R_I = \dfrac{\rho - u_I}{t}$ and $d = \dfrac{1}{8}$

$$\text{(A1-29)}\quad u_I^{N=8} = \frac{2}{3}\rho - \frac{11}{24}t + \frac{1}{24}\sqrt{64\rho^2 - 88\rho t + 79t^2}$$

$$\text{(A1-30)}\quad R_I^{N=8} = \frac{8\rho + 11t - \sqrt{64\rho^2 - 88\rho t + 79t^2}}{24t}$$

***N=9*:**

$$\text{(A1-31)}\quad \Pi_I^{N=9} = \max_{u_I}\left[2\left[\begin{array}{l} \frac{1}{9}\int_0^{R_I-4d}(...)\mathrm{d}r + \frac{1}{8}\int_{R_I-4d}^{5d-R_I}(...)\mathrm{d}r + \frac{1}{9}\int_{5d-R_I}^{d}(...)\mathrm{d}r + \\ \frac{1}{9}\int_d^{R_I-3d}(...)\mathrm{d}r + \frac{1}{8}\int_{R_I-3d}^{6d-R_I}(...)\mathrm{d}r + \frac{1}{9}\int_{6d-R_I}^{2d}(...)\mathrm{d}r + \\ \frac{1}{9}\int_{2d}^{R_I-2d}(...)\mathrm{d}r + \frac{1}{8}\int_{R_I-2d}^{7d-R_I}(...)\mathrm{d}r + \frac{1}{9}\int_{7d-R_I}^{3d}(...)\mathrm{d}r + \\ \frac{1}{9}\int_{3d}^{R_I-d}(...)\mathrm{d}r + \frac{1}{8}\int_{R_I-d}^{8d-R_I}(...)\mathrm{d}r + \frac{1}{9}\int_{8d-R_I}^{4d}(...)\mathrm{d}r + \\ \frac{1}{9}\int_{4d}^{R_I}(...)\mathrm{d}r \end{array}\right]u_I\right]$$

for $(...) = (\rho - u_I - tr)$, $R_I = \dfrac{\rho - u_I}{t}$ and $d = \dfrac{1}{9}$

$$\text{(A1-32)}\quad u_I^{N=9} = \frac{2}{3}\rho - \frac{13}{27}t + \frac{1}{27}\sqrt{81\rho^2 - 117\rho t + 115t^2}$$

$$\text{(A1-33)}\quad R_I^{N=9} = \frac{9\rho + 13t - \sqrt{81\rho^2 - 117\rho t + 115t^2}}{27t}$$

***N=10*:**

(A1-34) $$\Pi_I^{N=10} = \max_{u_I}\left[2\left[\begin{array}{l}\frac{1}{9}\int_0^{5d-R_I}(\ldots)\mathrm{d}r + \frac{1}{10}\int_{5d-R_I}^{R_I-4d}(\ldots)\mathrm{d}r + \frac{1}{9}\int_{R_I-4d}^{d}(\ldots)\mathrm{d}r + \\ \frac{1}{9}\int_d^{6d-R_I}(\ldots)\mathrm{d}r + \frac{1}{10}\int_{6d-R_I}^{R_I-3d_I}(\ldots)\mathrm{d}r + \frac{1}{9}\int_{R_I-3d_I}^{2d}(\ldots)\mathrm{d}r + \\ \frac{1}{9}\int_{2d}^{7d-R_I}(\ldots)\mathrm{d}r + \frac{1}{10}\int_{7d-R_I}^{R_I-2d_I}(\ldots)\mathrm{d}r + \frac{1}{9}\int_{R_I-2d_I}^{3d}(\ldots)\mathrm{d}r + \\ \frac{1}{9}\int_{3d}^{8d-R_I}(\ldots)\mathrm{d}r + \frac{1}{10}\int_{8d-R_I}^{R_I-d_I}(\ldots)\mathrm{d}r + \frac{1}{9}\int_{R_I-d_I}^{4d}(\ldots)\mathrm{d}r + \\ \frac{1}{9}\int_{4d}^{9d-R_I}(\ldots)\mathrm{d}r + \frac{1}{10}\int_{9d-R_I}^{R_I}(\ldots)\mathrm{d}r\end{array}\right]u_I\right]$$

for $(\ldots) = (\rho - u_I - tr)$, $R_I = \frac{\rho - u_I}{t}$ and $d = \frac{1}{10}$

(A1-35) $$u_I^{N=10} = \frac{2}{3}\rho - \frac{7}{15}t + \frac{1}{60}\sqrt{400\rho^2 - 560\rho t + 514t^2}$$

(A1-36) $$R_I^{N=10} = \frac{20\rho + 28t - \sqrt{400\rho^2 - 560\rho t + 514t^2}}{60t}$$

For each *N*, the corresponding ranges of s/ρ can be derived (see TABLE A1-4). The comparative statics with respect to *t* and ρ are presented in TABLE A1-5.

TABLE A1-4. Ranges of the relative importance of space: UEC of competition in the backyard

	$\frac{N-1}{2N} < R_I \leq \frac{1}{2}$		$\frac{N-1}{2N} < R_I \leq \frac{1}{2}$
$N=3$:	$\frac{4}{15} \leq \frac{s}{\rho} < \frac{4}{7}$	$N=7$:	$\frac{12}{91} \leq \frac{s}{\rho} < \frac{8}{45}$
$N=4$:	$\frac{1}{5} \leq \frac{s}{\rho} < \frac{8}{21}$	$N=8$:	$\frac{3}{26} \leq \frac{s}{\rho} < \frac{16}{105}$
$N=5$:	$\frac{8}{45} \leq \frac{s}{\rho} < \frac{3}{11}$	$N=9$:	$\frac{16}{153} \leq \frac{s}{\rho} < \frac{5}{38}$
$N=6$:	$\frac{4}{27} \leq \frac{s}{\rho} < \frac{12}{55}$	$N=10$:	$\frac{8}{85} \leq \frac{s}{\rho} < \frac{20}{171}$

TABLE A1-5. Comparative statics: UEC of competition in the backyard

	$\frac{\partial u_I^{by-UEC}}{\partial t}$	$\frac{\partial u_I^{by-UEC}}{\partial \rho}$
$N=3$:	$-\frac{4}{9}+\frac{92t-48\rho}{36\sqrt{36\rho^2-48t\rho+46t^2}}<0$	$\frac{2}{3}+\frac{72\rho-48t}{36\sqrt{36\rho^2-48t\rho+46t^2}}>0$
$N=4$:	$-\frac{5}{12}+\frac{8t-5\rho}{12\sqrt{4\rho^2-5t\rho+4t^2}}<0$	$\frac{2}{3}+\frac{8\rho-5t}{12\sqrt{4\rho^2-5t\rho+4t^2}}>0$
$N=5$:	$-\frac{7}{15}+\frac{68t-35\rho}{30\sqrt{25\rho^2-35t\rho+34t^2}}<0$	$\frac{2}{3}+\frac{50\rho-35t}{30\sqrt{25\rho^2-35t\rho+34t^2}}>0$
$N=6$:	$-\frac{4}{9}+\frac{322t-192\rho}{72\sqrt{144\rho^2-192t\rho+166t^2}}<0$	$\frac{2}{3}+\frac{288\rho-192t}{72\sqrt{144\rho^2-192t\rho+166t^2}}>0$
$N=7$	$-\frac{10}{21}+\frac{548t-280\rho}{84\sqrt{196\rho^2-280t\rho+274t^2}}<0$	$\frac{2}{3}+\frac{392\rho-280t}{84\sqrt{196\rho^2-280t\rho+274t^2}}>0$
$N=8$:	$-\frac{11}{24}+\frac{158t-88\rho}{48\sqrt{64\rho^2-88t\rho+79t^2}}<0$	$\frac{2}{3}+\frac{128\rho-88t}{48\sqrt{64\rho^2-88t\rho+79t^2}}>0$
$N=9$:	$-\frac{13}{27}+\frac{230t-117\rho}{54\sqrt{81\rho^2-117t\rho+115t^2}}<0$	$\frac{2}{3}+\frac{162\rho-117t}{54\sqrt{81\rho^2-117t\rho+115t^2}}>0$
$N=10$:	$-\frac{7}{15}+\frac{1028t-560\rho}{120\sqrt{400\rho^2-560t\rho+514t^2}}<0$	$\frac{2}{3}+\frac{800\rho-560t}{120\sqrt{400\rho^2-560t\rho+514t^2}}>0$

Regarding the optimal market area of processors, first derivatives will not be provided here. It can be shown that $\partial R_I^{by-UEC}/\partial t<0$ (see FIGURE 5-14b in CHAPTER 5.2.3) and that $\partial R_I^{by-UEC}/\partial \rho>0$. First derivatives regarding the number of processors N ($\partial u_I^{by-UEC}/\partial N$, $\partial R_I^{by-UEC}/\partial N$) cannot be derived analytically but via a numerical simulation, whereas per-unit transportation costs must be fixed at a certain level. The ranges of $s/\rho=t/(N\rho)$ in TABLE A1-4 imply that for $\rho=1$ in the numerical simulation, per-unit transportation costs vary between $4/5=0.80<t<12/7\approx 1.71$ for $N=3$ and $16/17\approx 0.94<t<200/171\approx 1.17$ for $N=10$. Thus, for $t=0.95$, for example, the comparative statics of $\partial u_I^{by-UEC}/\partial N$ and $\partial R_I^{by-UEC}/\partial N$ in the UEC of competition in the backyard can be illustrated (see FIGURES 5-16a and 5-16b in CHAPTER 5.2.3).

A2 PURE COOP MARKET

A2.1 THE TOTAL MEMBER WELFARE-MAXIMIZING COOP UNDER RESTRICTED MEMBERSHIP

A2.1.1 THE TMW-MAXIMIZING COOP: MONOPSONY AND DUOPSONY SITUATION

(ad CHAPTER 6.2.1)

TABLE A2-1. Comparative statics: the TMW-maximizing COOP I

UD price u_C	**Market area** R_C
Monopsony (u_C^M**,** R_C^M**)**	
$\frac{\partial u_C}{\partial t}=0$	$\frac{\partial R_C}{\partial t}=-\frac{2\rho}{3t^2}<0$
$\frac{\partial u_C}{\partial d}=0$	$\frac{\partial R_C}{\partial d}=0$
$\frac{\partial u_C}{\partial \rho}=\frac{2}{3}>0$	$\frac{\partial R_C}{\partial \rho}=\frac{2}{3t}>0$
Duopsony: price-matching conjecture (u_{C-TMW}^{PM}**,** R_{C-TMW}^{PM}**)**	
$\frac{\partial u_C}{\partial t}=\frac{20td^2-8\rho d}{6\sqrt{4\rho^2-8dt\rho+10d^2t^2}}-\frac{4d}{3}<0$	$\frac{\partial R_C}{\partial t}=-\frac{\rho\left(2dt+\sqrt{4\rho^2-8dt\rho+10d^2t^2}-2\rho\right)}{3t^2\sqrt{4\rho^2-8dt\rho+10d^2t^2}}<0$
$\frac{\partial u_C}{\partial d}=\frac{20dt^2-8\rho t}{6\sqrt{4\rho^2-8dt\rho+10d^2t^2}}-\frac{4t}{3}<0$	$\frac{\partial R_C}{\partial d}=-\frac{-2\sqrt{4\rho^2-8dt\rho+10d^2t^2}-2\rho+5dt}{3\sqrt{4\rho^2-8dt\rho+10d^2t^2}}>0$
$\frac{\partial u_C}{\partial \rho}=\frac{8(\rho-dt)}{6\sqrt{4\rho^2-8dt\rho+10d^2t^2}}+\frac{4}{3}>0$	$\frac{\partial R_C}{\partial \rho}=\frac{\sqrt{4\rho^2-8dt\rho+10d^2t^2}-2\rho+2dt}{3t\sqrt{4\rho^2-8dt\rho+10d^2t^2}}>0$
Duopsony:Löschian competition (u_{C-TMW}^{L}**,** R_{C-TMW}^{L}**)**	
$\frac{\partial u_C}{\partial t}=-\frac{d}{4}<0$	$\frac{\partial R_C}{\partial t}=0$
$\frac{\partial u_C}{\partial d}=-\frac{t}{4}<0$	$\frac{\partial R_C}{\partial d}=\frac{1}{2}>0$
$\frac{\partial u_C}{\partial \rho}=1>0$	$\frac{\partial R_C}{\partial \rho}=0$

Note: The comparative statics for the monopsony also apply to the NARP-pricing COOP under restricted membership (see CHAPTER 6.2.2). The comparative statics for Löschian competition also apply to the open-membership COOP under the efficient TBR (see CHAPTER 6.3.1).

A2.1.2 PRICE-MATCHING CONJECTURE: ADJUSTED UD PRICES

(ad CHAPTER 6.2.1)

The TMW-maximizing COOP makes negative profits from processing under the price-matching conjecture (see CHAPTER 6.2.1). Per-unit profits (i.e., losses) from processing, $k = \Pi_{C-TMW}^{PM-p} / Q_{C-TMW}^{PM} = \Pi_{C-TMW}^{PM-p} / \left(u_C\left(d/2\right)\right)$ (see equation (6-19)), are

$$\text{(A2-1)} \quad k = -\frac{4\rho(\rho + dt) - 14d^2t^2 - (2\rho - 5dt)\sqrt{4\rho^2 - 8dt\rho + 10d^2t^2}}{18dt}.$$

The UD price "adjusted" by per-unit profits/losses from processing (see equation (6-21)) are

$$\text{(A2-2)} \quad u_C^k = u_C + k = \frac{4\rho(5dt - \rho) - 10d^2t^2 + (2\rho + dt)\sqrt{4\rho^2 - 8dt\rho + 10d^2t^2}}{18dt}.$$

Comparative statics of equation (A2-1) and (A2-2) are presented in TABLE A2-2.

TABLE A2-2. Comparative statics: the TMW-maximizing COOP II

Per-unit profits/losses from processing k (for $k < 0$)
$\frac{\partial k}{\partial t} = -\frac{\left(-7d^2t^2 - 2\rho^2\right)\sqrt{4\rho^2 - 8dt\rho + 10d^2t^2} + 4\rho^3 - 10d^2t^2\rho - 4dt\rho^2 + 25d^3t^3}{9dt^2\sqrt{4\rho^2 - 8dt\rho + 10d^2t^2}} > 0$
$\frac{\partial k}{\partial d} = -\frac{\left(-7d^2t^2 - 2\rho^2\right)\sqrt{4\rho^2 - 8dt\rho + 10d^2t^2} + 4\rho^3 - 10d^2t^2\rho - 4dt\rho^2 + 25d^3t^3}{9d^2t\sqrt{4\rho^2 - 8dt\rho + 10d^2t^2}} > 0$
$\frac{\partial k}{\partial \rho} = \frac{2\left(\left(-2\rho - dt\right)\sqrt{4\rho^2 - 8dt\rho + 10d^2t^2} + 4\rho^2 + 10d^2t^2 - 11dt\rho\right)}{9dt\sqrt{4\rho^2 - 8dt\rho + 10d^2t^2}} < 0$
"Adjusted" UD price u_C^k
$\frac{\partial u_C^k}{\partial t} = -\frac{\left(5d^2t^2 - 2\rho^2\right)\sqrt{4\rho^2 - 8dt\rho + 10d^2t^2} + 4\rho^3 + 2d^2t^2\rho - 4dt\rho^2 - 5d^3t^3}{9dt^2\sqrt{4\rho^2 - 8dt\rho + 10d^2t^2}} < 0$
$\frac{\partial u_C^k}{\partial d} = -\frac{\left(5d^2t^2 - 2\rho^2\right)\sqrt{4\rho^2 - 8dt\rho + 10d^2t^2} + 4\rho^3 + 2d^2t^2\rho - 4dt\rho^2 - 5d^3t^3}{9d^2t\sqrt{4\rho^2 - 8dt\rho + 10d^2t^2}} < 0$
$\frac{\partial u_C^k}{\partial \rho} = \frac{2\left(\left(5dt - 2\rho\right)\sqrt{4\rho^2 - 8dt\rho + 10d^2t^2} + 4\rho^2 - 5dt\rho + 4d^2t^2\right)}{9dt\sqrt{4\rho^2 - 8dt\rho + 10d^2t^2}} > 0$

A2.2 The total member welfare-maximizing COOP using the market form of *AFSZ*

CHAPTER 6.2.1 analyzes a pure COOP market under the assumption of TMW-maximizing processing COOPs under restricted membership. In the model, the COOPs are assumed to be located at the endpoints of a line market. In the following, the analysis of spatial competition of TMW-maximizing COOPs as in HUCK ET AL. (2006) is presented and extended. HUCK ET AL. (2006) assume the same market form as in *AFSZ*), i.e., both processors are located distance d away on an unbounded line (see FIGURES 5-1, 5-2 and 5-3 in CHAPTER 5.1 for the case of IOF processors). Given this market form, each COOP faces a competitor on one market side only, and COOPs serve a large share of an exclusive market area. In addition, some farmers in the market are not served even in the situation of spatial competition. The objective function of the monopsonistic TMW-maximizing COOP is given by

$$\text{(A2-3)} \quad \Pi_C^M = \max_{R_C, u_C} \left[2\left(\int_0^{R_C} \left(\rho - \frac{u_C}{2} - tr \right) \mathrm{d}r \right) u_C \right]$$

(see also equation (6-7) in CHAPTER 6.2.1 for the monopsonistic COOP located at one endpoint of a line market). Maximizing TMW with respect to R_C gives

$$\text{(A2-4)} \quad R_C = \frac{\rho - \frac{u_C}{2}}{t} .$$

Maximizing equation (A2-3) with respect to the UD price gives

$$\text{(A2-5)} \quad u_C = \rho - \frac{tR_C}{2} .$$

After substitution, the optimal UD price and market area of the monopsonistic COOP are

$$\text{(A2-6)} \quad u_C^M = \frac{2\rho}{3}$$

$$\text{(A2-7)} \quad R_C^M = \frac{2\rho}{3t} .$$

These solutions are equal to the results of the monopsonistic COOP derived in CHAPTER 6.2.1 (i.e., with COOPs located at the endpoints of a line market). The only difference from CHAPTER 6.2.1 is that the total quantity processed and TMW of the COOP is twice as high (see equation (A2-3)). The COOP is in a monopsonistic position for $R_C \le d/2$ or

$s/\rho \geq 4/3$. Both COOPs in the market get into the situation of spatial competition as the relative importance of space decreases. Under the price-matching conjecture, each COOP is in the situation of “competition en route” for $d/2 < R_C \leq d$ (index *er*) with market overlap in between the locations of the COOPs); each COOP is in the situation of “competition in the backyard” for $R_C > d$ (index *by*), i.e., a COOP’s market area extends beyond the location of the competitor. In these situations, TMW is given by

$$\text{(A2-8)}\quad \Pi_C^{er} = \max_{u_C}\left[\left(\int_0^{R_C}\left(\rho - \frac{u_C}{2} - tr\right)\mathrm{d}r + \int_0^{d-R_C}\left(\rho - \frac{u_C}{2} - tr\right)\mathrm{d}r + \frac{1}{2}\int_{d-R_C}^{R_C}\left(\rho - \frac{u_C}{2} - tr\right)\mathrm{d}r\right)u_C\right]$$

$$\text{(A2-9)}\quad \Pi_C^{by} = \max_{u_C}\left[\left(\int_{R_C-d}^{R_C}\left(\rho - \frac{u_C}{2} - tr\right)\mathrm{d}r + \frac{1}{2}\int_0^{R_C-d}\left(\rho - \frac{u_C}{2} - tr\right)\mathrm{d}r + \frac{1}{2}\int_0^{R_C}\left(\rho - \frac{u_C}{2} - tr\right)\mathrm{d}r\right)u_C\right]$$

for $R_C = \dfrac{\rho - \frac{u_C}{2}}{t}$. Optimal UD prices and optimal market areas are

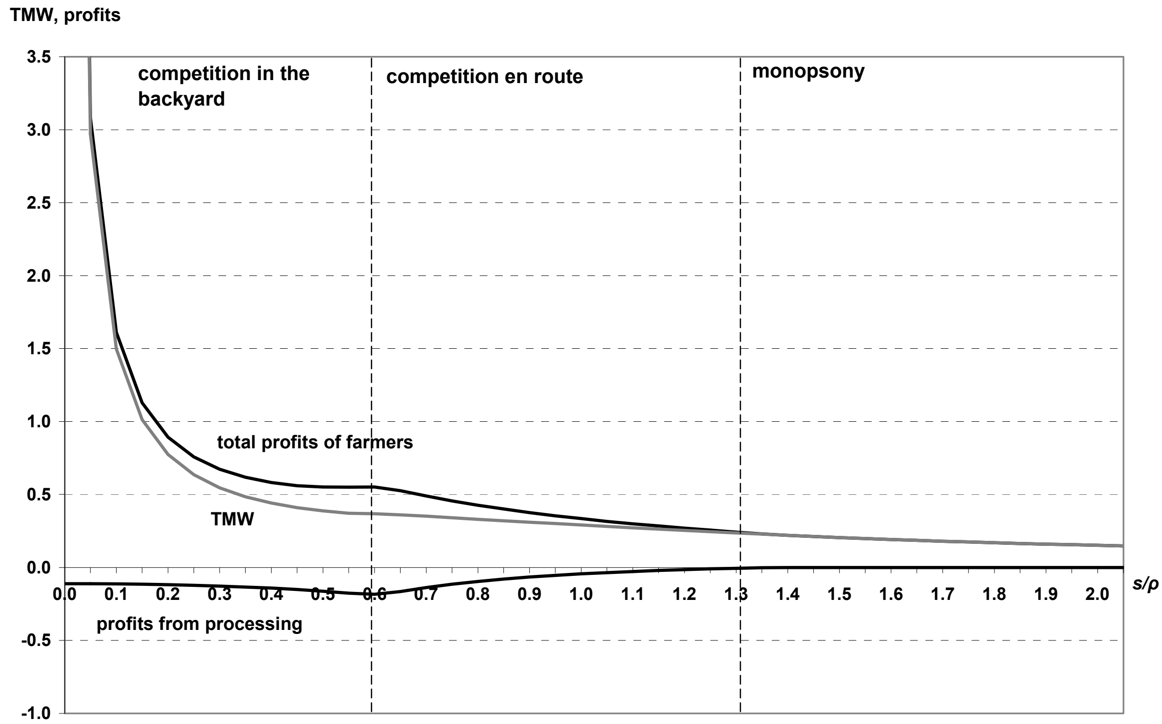
$$\text{(A2-10)}\quad u_C^{er} = \rho - \frac{td}{4} \quad \text{and} \quad R_C^{er} = \frac{4\rho + dt}{8t}$$

$$\text{(A2-11)}\quad u_C^{by} = \frac{4\rho - \sqrt{4\rho^2 - 6t^2d^2}}{3} \quad \text{and} \quad R_C^{by} = \frac{2\rho + \sqrt{4\rho^2 - 6d^2t^2}}{6t}.$$

The optimal UD price is twice as high as that in the pure IOF market by *AFSZ*; the optimal market area is equal to that in *AFSZ*. Due to the latter, the COOP is in the situation of competition en route for $4/7 \leq s/\rho < 4/3$ and in the situation of competition in the backyard for $s/\rho < 4/7$ (i.e., as in *AFSZ*).

The following is an extension to the analysis of HUCK ET AL. (2006). Similar to the situation in which COOPs are located at the endpoints of a line market (see CHAPTER 6.2.1), a COOP’s profits from processing are negative in the situation of spatial competition; i.e., the TMW-maximizing COOP fails to break even under the price-matching conjecture with overlapping market areas. Depending on the relative importance of space, s/ρ, FIGURE A2-1 illustrates the total profits of farmers, the COOP’s profits from processing and TMW.

FIGURE A2-1. Components of TMW in the pure COOP market (market form of *AFSZ*)



Note: In this figure, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. Both the net selling price *ρ* and the distance *d* between processors are normalized to *1*.

Under both competition en route and competition in the backyard, total supply to a COOP is given by

$$\text{(A2-12)}\quad Q_C = u_C\left(R_C + \frac{d}{2}\right)$$

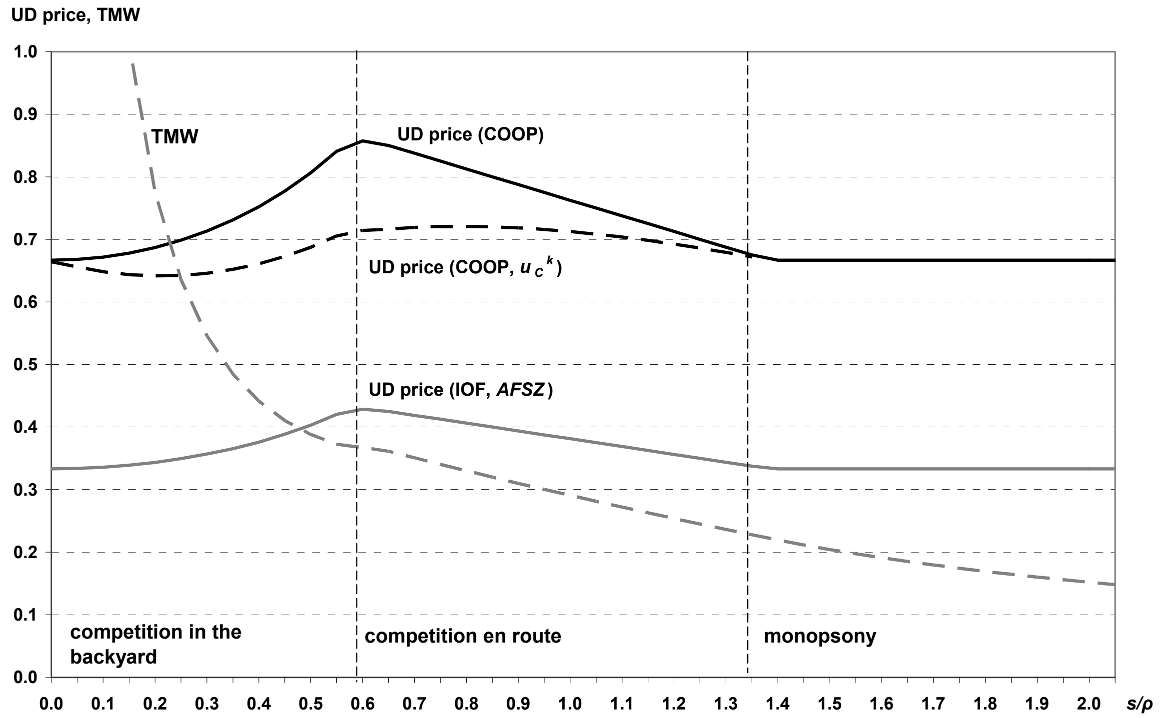
where $R_C + d/2$ is the share of farmers that patronizes one specific COOP. Consequently, per-unit profits/losses from processing are given by $k = \Pi_C^p / Q_C$, or

$$\text{(A2-13)}\quad k^{er} = -\frac{(4\rho - dt)(4\rho - 3dt)}{8(5dt + 4\rho)}$$

$$\text{(A2-14)}\quad k^{by} = -\frac{dt\left(4\rho - \sqrt{4\rho^2 - 6d^2t^2}\right)}{2\left(3dt + 2\rho + \sqrt{4\rho^2 - 6d^2t^2}\right)}.$$

The "adjusted" UD price (i.e., the UD price after allocation of per-unit profits/losses from processing) is $u_C^k = u_C + k$. FIGURE A2-2 illustrates the results depending on the relative importance of space.

FIGURE A2-2. UD price and TMW in the pure COOP market (market form of *AFSZ*)



Note: In this figure, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. Both the net selling price *ρ* and the distance *d* between processors are normalized to *1*.

In FIGURE A2-2, (negative) per-unit profits from processing k are given by the vertical distance between the UD price (u_C) and the adjusted UD price (u_C^k). Contrary to a situation in which processors are located at the endpoints of a line market (see CHAPTER 6.2.1), the UD price does not increase beyond the level of ρ (in FIGURE A2-2, ρ is normalized to 1). FIGURE A2-2 shows that the adjusted UD price u_C^k is an inverted U-shaped function of the relative importance of space in the situation of competition en route and a U-shaped function in the situation of competition in the backyard. In addition, the adjusted UD price u_C^k is lower in the situation of competition in the backyard relative to the monopsony situation. TMW is increasing if space becomes less important. In the situation of competition in the backyard, the TMW-maximizing COOP has a relatively large market area and, at the same time, sets a relatively low UD price; the former (a large market area) outweighs the latter (a low UD price) so that TMW is relatively high. However, the adjusted UD price is still higher than the UD price derived by *AFSZ* for the pure IOF market. Comparative statics for the model are given in TABLES A2-3, A2-4a and A2-4b.

TABLE A2-3. Comparative statics: the TMW-maximizing COOP I (market form of *AFSZ*)

	Monopsony: $\frac{s}{\rho} \geq \frac{4}{3}$	**Competition en route:** $\frac{4}{7} < \frac{s}{\rho} < \frac{4}{3}$	**Competition in the backyard:** $0 < \frac{s}{\rho} < \frac{4}{7}$
UD price			
$\frac{\partial u_C}{\partial t}$	0	$-\frac{1}{4}d < 0$	$\frac{2td^2}{\sqrt{4\rho^2 - 6t^2d^2}} > 0$
$\frac{\partial u_C}{\partial d}$	0	$-\frac{1}{4}t < 0$	$\frac{2t^2d}{\sqrt{4\rho^2 - 6t^2d^2}} > 0$
$\frac{\partial u_C}{\partial \rho}$	$\frac{2}{3} > 0$	$1 > 0$	$\frac{4}{3}\left[1 - \frac{\rho}{\sqrt{4\rho^2 - 6t^2d^2}}\right] > 0$
Market area			
$\frac{\partial R_C}{\partial t}$	$-\frac{2\rho}{3t^2} < 0$	$-\frac{\rho}{2t^2} < 0$	$-\frac{\rho\left(2\rho + \sqrt{4\rho^2 - 6t^2d^2}\right)}{3t^2\sqrt{4\rho^2 - 6t^2d^2}} < 0$
$\frac{\partial R_C}{\partial d}$	0	$\frac{1}{8} > 0$	$-\frac{td}{\sqrt{4\rho^2 - 6t^2d^2}} < 0$
$\frac{\partial R_C}{\partial \rho}$	$\frac{2}{3t} > 0$	$\frac{1}{2t} > 0$	$\frac{2\rho + \sqrt{4\rho^2 - 6t^2d^2}}{3t\sqrt{4\rho^2 - 6t^2d^2}} > 0$

TABLE A2-4a. Comparative statics: the TMW-maximizing COOP IIa (market form of *AFSZ*)

Competition en route:
Per-unit profits/losses from processing k (for $k < 0$)
$\frac{\partial k}{\partial t} = \frac{3d\left(48\rho^2 - 8dt\rho - 5d^2t^2\right)}{8(4\rho + 5dt)^2} > 0$
$\frac{\partial k}{\partial d} = \frac{3t\left(48\rho^2 - 8dt\rho - 5d^2t^2\right)}{8(4\rho + 5dt)^2} > 0$
$\frac{\partial k}{\partial \rho} = -\frac{16\rho^2 + 40dt\rho - 23d^2t^2}{2(4\rho + 5dt)^2} < 0$
"adjusted" UD price u_C^k
$\frac{\partial u_C^k}{\partial t} = -\frac{d\left(104dt\rho - 112\rho^2 + 65d^2t^2\right)}{8(5dt + 4\rho)^2}$ (max)
$\frac{\partial u_C^k}{\partial d} = -\frac{t\left(104dt\rho - 112\rho^2 + 65d^2t^2\right)}{8(5dt + 4\rho)^2}$ (max)
$\frac{\partial u_C^k}{\partial \rho} = \frac{16\rho^2 + 40dt\rho + 73d^2t^2}{2(5dt + 4\rho)^2} > 0$

Note: min/max indicates that first derivatives have a minimum/maximum within the relevant range of exogenous variables.

TABLE A2-4b. Comparative statics: the TMW-maximizing COOP IIb (market form of *AFSZ*)

Competition in the backyard:
Per-unit profits/losses from processing k (for $k<0$)
$\frac{\partial k}{\partial t}=-\frac{d\left(\left(2\rho^2+3d^2t^2\right)\sqrt{4\rho^2-6d^2t^2}+4\rho^3+12\rho d^2t^2+9d^3t^3\right)}{\left(2\rho+3dt+\sqrt{4\rho^2-6d^2t^2}\right)^2\sqrt{4\rho^2-6d^2t^2}}<0$
$\frac{\partial k}{\partial d}=-\frac{t\left(\left(2\rho^2+3d^2t^2\right)\sqrt{4\rho^2-6d^2t^2}+4\rho^3+12\rho d^2t^2+9d^3t^3\right)}{\left(2\rho+3dt+\sqrt{4\rho^2-6d^2t^2}\right)^2\sqrt{4\rho^2-6d^2t^2}}<0$
$\frac{\partial k}{\partial \rho}=-\frac{6d^2t^2\left(\rho+3dt-\sqrt{4\rho^2-6d^2t^2}\right)}{\left(2\rho+3dt+\sqrt{4\rho^2-6d^2t^2}\right)^2\sqrt{4\rho^2-6d^2t^2}}$ (max)
"adjusted" UD price u_C^k
$\frac{\partial u_C^k}{\partial t}=-\frac{d\left(\left(2\rho^2-8dt\rho-9d^2t^2\right)\sqrt{4\rho^2-6d^2t^2}+4\rho^3-12\rho d^2t^2-16dt\rho^2+3d^3t^3\right)}{\left(2\rho+3dt+\sqrt{4\rho^2-6d^2t^2}\right)^2\sqrt{4\rho^2-6d^2t^2}}$ (min)
$\frac{\partial u_C^k}{\partial d}=-\frac{t\left(\left(2\rho^2-8dt\rho-9d^2t^2\right)\sqrt{4\rho^2-6d^2t^2}+4\rho^3-12\rho d^2t^2-16dt\rho^2+3d^3t^3\right)}{\left(2\rho+3dt+\sqrt{4\rho^2-6d^2t^2}\right)^2\sqrt{4\rho^2-6d^2t^2}}>0$
$\frac{\partial u_C^k}{\partial \rho}=\frac{2\left(\left(8\rho^2+12dt\rho-3d^2t^2\right)\sqrt{4\rho^2-6d^2t^2}+16\rho^3-45\rho d^2t^2+24dt\rho^2-45d^3t^3\right)}{3\left(2\rho+3dt+\sqrt{4\rho^2-6d^2t^2}\right)^2\sqrt{4\rho^2-6d^2t^2}}>0$

Note: min/max indicates that first derivatives have a minimum/maximum within the relevant range of exogenous variables.

A2.3 THE NARP-PRICING COOP UNDER RESTRICTED MEMBERSHIP

A2.3.1 THE NARP-PRICING COOP WITH POSITIVE FIXED COSTS

(ad CHAPTER 6.2.2).

Assume a monopsonistic NARP-pricing COOP under restricted-membership with positive fixed costs *F*. TMW of the COOP is the sum of profits of COOP members (i.e., farmers) from producing the raw product and the profits from processing of the COOP. If the COOP is located at the endpoint of a line market, TMW is given by

$$\text{(A2-15)}\quad \begin{aligned} \Pi_C^M &= \Pi_C^f + \Pi_C^p = \left(\int_0^{R_C}\left(\frac{u_C}{2}\right)\mathrm{d}r\right)u_C + \left(\int_0^{R_C}(\rho - u_C - tr)\mathrm{d}r\right)u_C - F \\ &= \left(\int_0^{R_C}\left(\rho - \frac{u_C}{2} - tr\right)\mathrm{d}r\right)u_C - F = \left(\rho - \frac{u_C}{2} - \frac{tR_C}{2}\right)u_C R_C - F \end{aligned}.$$

The monopsonistic COOP's profits from processing are

$$\text{(A2-16)}\quad \Pi_C^{M-p} = \left(\rho - u_C - \frac{tR_C}{2}\right)u_C R_C - F$$

and the net revenue product (NRP) is given by

$$\text{(A2-17)}\quad NRP = \left(\rho - \frac{tR_C}{2}\right)u_C R_C - F\ .$$

NRP is the revenue net of costs (except for the costs of the raw product). Net average revenue product (NARP) is the net revenue per unit of the processed product, i.e.,

$$\text{(A2-18)}\quad NARP = \frac{NRP}{Q_C} = \frac{NRP}{u_C R_C} = \left(\rho - \frac{tR_C}{2}\right) - \frac{F}{u_C R_C}\ .$$

Under NARP pricing, the COOP pays a UD price equal to NARP, i.e., $u_C \overset{!}{=} NARP$. Setting equation (A2-18) equal to u_C and solving the equation for u_C gives the NARP function, i.e., the UD price u_C as a function of the market area R_C:

$$\text{(A2-19)}\quad u_C = \frac{2\rho R_C - tR_C^2 + \sqrt{4\rho^2 R_C^2 - 4\rho R_C^3 t + t^2 R_C^4 - 16 R_C F}}{4R_C}$$

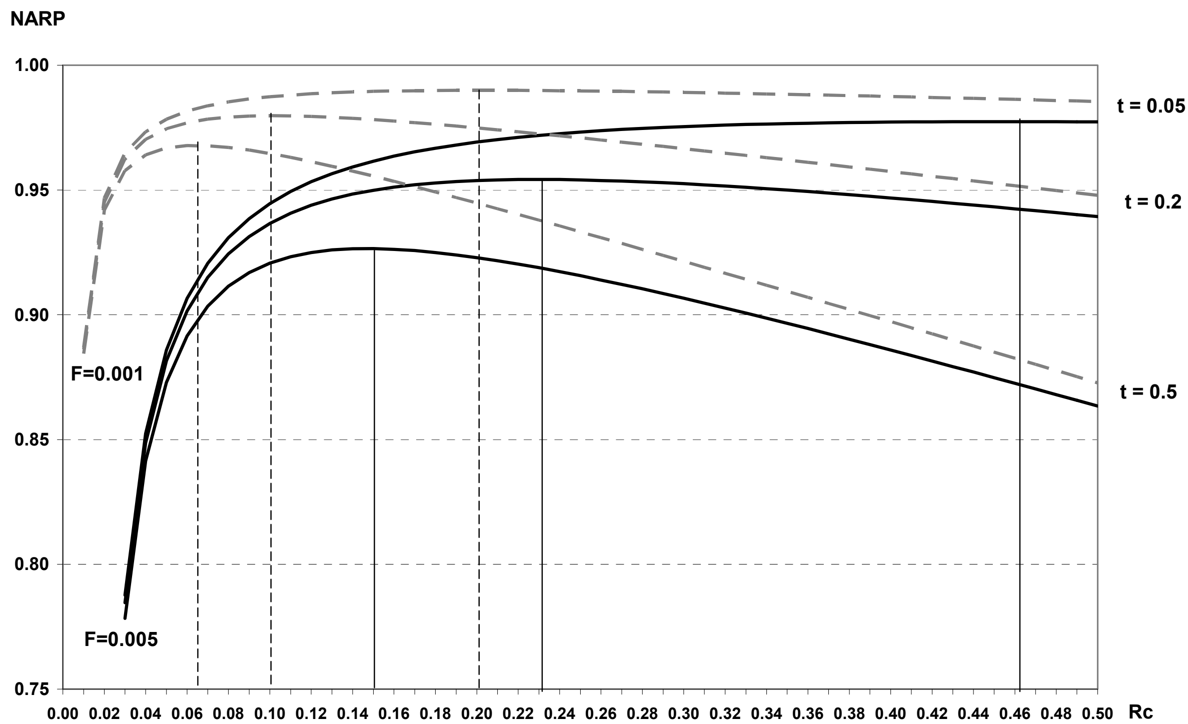
Now it can be assumed that the monopsonistic COOP sets a UD price by determining the market area that maximizes this NARP function (see, e.g., CLARK, 1952; taken from SEXTON

ET AL., 1989, regarding the restricted-membership optimum). Maximizing equation (A2-19) with respect to R_C gives the following solution for the optimal market area:

$$R_C^* = \frac{\rho^2 + \left(\rho^3 - 27Ft + 3t\sqrt{3}\sqrt{\frac{F\left(27Ft - 2\rho^3\right)}{t}}\right)^{\frac{2}{3}}}{3t\left(\rho^3 - 27Ft + 3t\sqrt{3}\sqrt{\frac{F\left(27Ft - 2\rho^3\right)}{t}}\right)^{\frac{1}{3}}} + \frac{\rho\left(\rho^3 - 27Ft + 3t\sqrt{3}\sqrt{\frac{F\left(27Ft - 2\rho^3\right)}{t}}\right)^{\frac{1}{3}}}{3t\left(\rho^3 - 27Ft + 3t\sqrt{3}\sqrt{\frac{F\left(27Ft - 2\rho^3\right)}{t}}\right)^{\frac{1}{3}}} \quad \text{(A2-20)}$$

The reason for the assumption of restricted-membership COOPs with fixed costs equal to zero in CHAPTER 6.2 (and also in other COOP models in this thesis) is the complexity of the solution in equation (A2-20). Moreover, this analytical solution does not yield a computable numerical result. Therefore, FIGURE A2-3 presents a numerical simulation of the NARP function, equation (A2-19), for different levels of *t* and *F*.

FIGURE A2-3. Simulation of the NARP function with positive fixed costs *F*



Note: In this figure, both the net selling price ρ and the distance d between processors are normalized to *1*.

In FIGURE A2-3, NARP is a function of the market area R_C; ρ and *d* are normalized to 1. The COOP is in a monopsonistic position if its market area R_C is smaller than 1/2 (i.e., *d/2*). Assuming different levels of *t* and *F*, the numerical simulation shows the following expected results: For a given level of *F*, the market area that maximizes the NARP function (and thus the UD price) is decreasing in per-unit transportation costs *t*. The lower *t* is, the higher the UD price will be. For a given level of *t*, a lower level of fixed costs *F* implies a smaller market area and a higher UD price. Consequently, a NARP-pricing COOP is in a monopsonistic position ($R_C \le d/2$) if per-unit transportation costs *t* are relatively high or if fixed costs *F* are relatively low.

To conclude, due to the mathematical complexity of the solutions in the presence of fixed costs and to simplify matters, no fixed costs are assumed in the COOP models. Therefore, only the portion of the NARP function that is decreasing in space is considered in the models.

A2.3.2 THE NARP-PRICING COOP: PRICE-MATCHING CONJECTURE

(ad CHAPTER 6.2.2)

TABLE A2-5. Comparative statics: the NARP-pricing COOP under price matching

UD price u_{C-NARP}^{PM}	**Market area** R_{C-NARP}^{PM}
$\frac{\partial u_C}{\partial t} = -3d + \frac{14d^2t - 4d\rho}{2\sqrt{7d^2t^2 - 4dt\rho}}$ (max)	$\frac{\partial R_C}{\partial t} = -\frac{d\rho}{t\sqrt{7d^2t^2 - 4dt\rho}} < 0$
$\frac{\partial u_C}{\partial d} = -3t + \frac{14t^2d - 4t\rho}{2\sqrt{7d^2t^2 - 4dt\rho}}$ (max)	$\frac{\partial R_C}{\partial d} = \frac{3\sqrt{7d^2t^2 - 4dt\rho} + 2\rho - 7dt}{2\sqrt{7d^2t^2 - 4dt\rho}}$ (min)
$\frac{\partial u_C}{\partial \rho} = 2 - \frac{2dt}{\sqrt{7d^2t^2 - 4dt\rho}}$ (max)	$\frac{\partial R_C}{\partial \rho} = \frac{d}{\sqrt{7d^2t^2 - 4dt\rho}}$ (min)

Note: min/max indicates that first derivatives have a minimum/maximum within the relevant range of exogenous variables.

Under Löschian competition and due to the absence of fixed costs, the UD price of the NARP-pricing COOP is equal to the UD price of the TMW-maximizing COOP. Comparative statics are given in APPENDIX A2.1.1.

A2.4 THE OPEN-MEMBERSHIP COOP

A2.4.1 THE NO-RATIONING ASSUMPTION

(ad CHAPTER 6.3.1)

TABLE A2-6. Comparative statics: the pure COOP market under the no-rationing assumption

	UD price u_C^{eTBR} **efficient TBR,** $R_C = d/2$	**UD price** u_C^{rTBR} **random TBR,** $R_C = d$
$\frac{\partial u_C}{\partial t}$	$-\frac{d}{4} < 0$	$-\frac{d}{2} < 0$
$\frac{\partial u_C}{\partial d}$	$-\frac{t}{4} < 0$	$-\frac{t}{2} < 0$
$\frac{\partial u_C}{\partial \rho}$	1	1

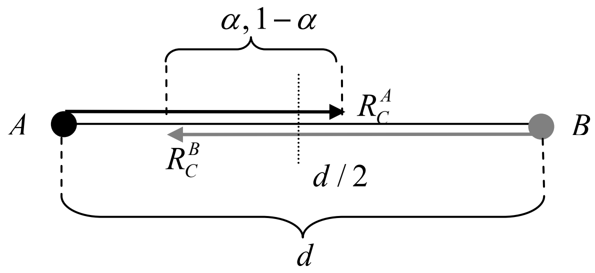
A2.4.2 A SIMULATION OF OVERLAPPING MARKET AREAS IN A PURE COOP MARKET

Under the random TBR in a pure COOP market and according to an open-membership policy, both COOPs in the market consider the total distance *d* as their market area. Any farmer along *d* might wish to patronize either COOP with equal probability. The duopsony model in CHAPTER 6.3.1 can be extended to account for overlapping market areas due to contractual relationships between processors and farmers. According to the review in CHAPTER 2.5, farmers are tied to processors via supply contracts for several years. Therefore, overlapping market areas of competing processors may also be the case if there are farmers with existing supply contracts as well as farmers who are free to choose between processors.

As before, both COOPs *A* and *B* are located at the endpoints of a line market. Under the random TBR as in CHAPTER 6.3.1, the market area of each COOP is $R_C = d$. In the following, let the market area of a COOP be determined by the most distant member patronizing this COOP by assuming a two-period game (see also FIGURE A2-4)

In period 1, farmers along distance *d* sign (long-run) supply contracts with a respective (open-membership) COOP. These supply contracts imply that these COOP members are tied to their respective processor and cannot switch to an alternative processor in the short run. Given these supply contracts, assume that the farmer located at $r = R_C^A$ and all farmers within distance $d - R_C^B$ patronize COOP *A*. The farmer located at $r = R_C^B$ and all farmers within distance $d - R_C^A$ patronize COOP *B*. Therefore, the market area for each COOP is determined by the most distant farmer tied to this COOP via supply contracts in period 1. Given this setup, farmers located within $r = R_C^A$ and $r = R_C^B$ are free to choose any COOP under open membership in period 2.

FIGURE A2-4. Overlapping market areas in a pure COOP market



In period 2, there is a two-stage game. In stage 1, farmers that are not tied to either COOP via supply contracts make their choice of which COOP to patronize. In the model, this choice is given by α (for $0 < \alpha < 1$), which is the endogenously determined share of farmers within the area of overlap patronizing COOP *A*. Therefore, $1-\alpha$ is the share of farmers patronizing COOP *B*. In stage 2 of the game, both COOPs determine their UD price, given the choice of farmers within the area of overlap.

The two-stage game of period 2 is solved by backward induction. In stage 2, each COOP determines an optimal UD price, taking the COOP affiliation of the farmers within the area of overlap, α and $1-\alpha$, as given. The problems of the (NARP-pricing) COOPs *A* and *B* paying UD prices u_C^A and u_C^B, respectively, to its members are given by

$$\text{(A2-21)} \quad \frac{\Pi_C^A}{d - R_C^B + \alpha\left(R_C^A - \left(d - R_C^B\right)\right)} \overset{!}{=} \frac{\left(u_C^A\right)^2}{2} \quad \text{for}$$

$$\Pi_C^A = \left(\int_0^{d-R_C^B} \left(\rho - \frac{u_C^A}{2} - tr \right) \mathrm{d}r + \alpha \int_{d-R_C^B}^{R_C^A} \left(\rho - \frac{u_C^A}{2} - tr \right) \mathrm{d}r \right) u_C^A$$

$$\text{(A2-22)} \quad \frac{\Pi_C^B}{d - R_C^A + (1-\alpha)\left(R_C^B - \left(d - R_C^A\right)\right)} \overset{!}{=} \frac{\left(u_C^B\right)^2}{2} \quad \text{for}$$

$$\Pi_C^B = \left(\int_0^{d-R_C^A} \left(\rho - \frac{u_C^B}{2} - tr \right) \mathrm{d}r + (1-\alpha) \int_{d-R_C^A}^{R_C^B} \left(\rho - \frac{u_C^B}{2} - tr \right) \mathrm{d}r \right) u_C^B .$$

where Π_C^A and Π_C^B are the TMW functions of the COOPs. The solutions to these problems give the UD price for each COOP:

$$\text{(A2-23)}\quad u_C^A = \frac{2\left(\alpha\rho\left(d - R_C^A - R_C^B\right) + \rho\left(R_C^B - d\right) + tdR_C^B(\alpha - 1)\right)}{2\left(R_C^B - d + \alpha\left(d - R_C^A - R_C^B\right)\right)} + \frac{t\left(\alpha\left(\left(R_C^A\right)^2 - d^2 - \left(R_C^B\right)^2\right) + d^2 + \left(R_C^B\right)^2\right)}{2\left(R_C^B - d + \alpha\left(d - R_C^A - R_C^B\right)\right)}$$

$$\text{(A2-24)}\quad u_C^B = \frac{2\left(\alpha\rho\left(d - R_C^A - R_C^B\right) + \rho R_C^B - td\alpha R_C^A\right) + t\left(\alpha\left(\left(R_C^B\right)^2 - d^2 - \left(R_C^A\right)^2\right) - \left(R_C^B\right)^2\right)}{2\left(\alpha\left(d - R_C^A - R_C^B\right) + R_C^B\right)}$$

It can be shown that the COOP objective of maximizing TMW with respect to the UD price yields the same results. In stage 1 of the game, farmers within the area of overlap choose a processor whose UD price maximizes their individual profits.[196] In equilibrium, UD prices between both COOPs (see equation (A2-23) for COOP *A* and equation (A2-24) for COOP *B*) must be equal. This is the case for the following share of COOP members patronizing COOP *A* within the area of overlap:[197]

$$\text{(A2-25)}\quad \alpha = \frac{d - 2R_C^B}{2\left(d - R_C^B - R_C^A\right)}$$

The optimal share of members α patronizing COOP *A* within the area of overlap is independent from per-unit transportation costs *t*. In addition, if $R_C^{A,B} > d/2$, then $0 < \alpha < 1$. If $R_C^A = R_C^B$, then the optimal share is $\alpha = 1/2$. The larger the market area of a COOP is, the lower the share of COOP members patronizing this COOP within the area of overlap will be: $\alpha \le 1/2$ for $R_C^A \ge R_C^B$. Substituting equation (A2-25) into equation (A2-23) or equation (A2-24), gives the optimal UD price

$$\text{(A2-26)}\quad u_C = \rho - \frac{t\left(d - R_C^B - R_C^A\right)}{2} - \frac{R_C^A R_C^B t}{d}.$$

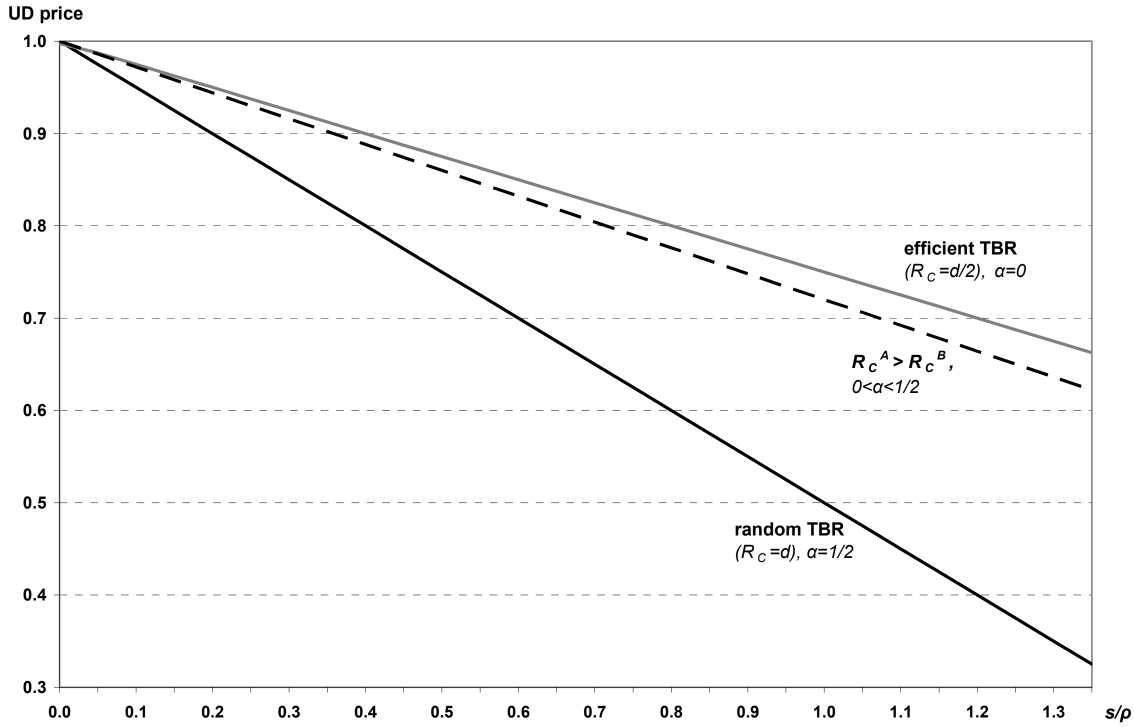
As in CHAPTER 6.3.1, price transmission in this COOP market is perfect: $\partial u_C / \partial \rho = 1$. In effect, irrespective of the actual market area of either COOP, half of the farmers along *d* patronize any of the respective COOPs. For example, the number of members patronizing COOP *A* is given by $d - R_C^B + \alpha\left(R_C^A + R_C^B - d\right)$. Substituting for the optimal α (see equation (A2-25)), gives the total share of members patronizing COOP *A*: *d/2*.

[196] Given that profits of a single farmer are only dependent on the UD price (see equation (6-4) in CHAPTER 6.2), comparing profits by choosing one of the respective COOPs is equivalent to comparing UD prices between the two COOPs.

[197] This result still assumes that the spatial distribution of farmers patronizing a specific COOP is arbitrary because it is independent from the actual location of a farmer patronizing a specific COOP.

The results are illustrated in FIGURE A2-5. If the exogenously given market area is $R_C^A = R_C^B = d$ (i.e., there is a total overlap of market areas), then $\alpha = 1/2$ and the UD price is lowest: $u_C = \rho - (td)/2$ (see equation (6-44) in CHAPTER 6.3.1). If the market area of COOP *B* is reduced (relative to COOP *A*), then α will decrease and the optimal UD price will increase (see FIGURE A2-5 for $R_C^A = (4d)/5$ and $R_C^B = (3d)/5$, which implies $\alpha = 1/4$). The UD price is highest if there is no overlap of market areas, i.e., if $R_C^A = R_C^B = d/2$ (efficient TBR) and, consequently, $\alpha = 0$: $u_C = \rho - (td)/4$ (see equation (6-47) in CHAPTER 6.3.1).

FIGURE A2-5. Simulation of UD prices in a pure COOP market



Note: In this figure, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. Both the net selling price *ρ* and the distance *d* between processors are normalized to *1*.

In equilibrium, no farmer within the area of overlap will switch between the COOPs. Assume that farmers patronizing COOP *B* within the area of overlap decide to switch to COOP *A* so that α increases. This decreases the UD price of COOP *A* and increases the UD price of COOP *B*, relative to the optimal solution. Consequently, no farmer will switch. Comparative statics of the optimal share of farmers within the area of overlap patronizing COOP A, α, (equation (A2-25)) and of the optimal UD price (equation (A2-26)) are given in TABLE A2-7:

TABLE A2-7. Comparative statics: simulation under the no-rationing assumption

share of farmers α	**UD price** u_C
$\frac{\partial \alpha}{\partial t} = 0$	$\frac{\partial u_C}{\partial t} = -\frac{d^2 - d\left(R_C^A + R_C^B\right) + 2R_C^A R_C^B}{2d} < 0$
$\frac{\partial \alpha}{\partial d} = \frac{R_C^B - R_C^A}{2\left(d - R_C^B - R_C^A\right)^2} < 0$	$\frac{\partial u_C}{\partial d} = -\frac{t\left(d^2 - 2R_C^B R_C^A\right)}{2d^2}$ (max)
$\frac{\partial \alpha}{\partial \rho} = 0$	$\frac{\partial u_C}{\partial \rho} = 1 > 0$
$\frac{\partial \alpha}{\partial R_C^A} = \frac{d - 2R_C^B}{2\left(d - R_C^B - R_C^A\right)^2} < 0$	$\frac{\partial u_C}{\partial R_C^A} = -\frac{2tR_C^B - td}{2d} < 0$
$\frac{\partial \alpha}{\partial R_C^B} = -\frac{d - 2R_C^A}{2\left(d - R_C^B - R_C^A\right)^2} > 0$	$\frac{\partial u_C}{\partial R_C^B} = -\frac{2tR_C^A - td}{2d} < 0$

Note: The direction of the change that occurs in the endogenous variable was derived by assuming $R_C^{A,B} > d/2$; max indicates that the first derivative has a maximum within the relevant range of the exogenous variable.

A3 MIXED MARKET

A3.1 THE NO-RATIONING ASSUMPTION OF THE COOP IN A MIXED MARKET

(ad CHAPTERS 7.1 and 7.2)

Assume a line market of length d where processors (an open-membership COOP and an IOF) are located at the endpoints of the line. The COOP offers its pricing schedule, i.e., it takes the market area as given. Under the no-rationing assumption, the COOP is constrained to consider the total distance d as its market area because any farmer along d might wish to join the COOP. Given no rationing of the COOP, two different outcomes are possible. First, under the random TBR, the COOP serves distance d and the area of market overlap is determined by the market area of the IOF. Second, under the efficient TBR, there is no market overlap and the COOP serves farmers that are not served by the IOF ($R_C < d$).

In the mixed market, the pricing schedule offered by the COOP is a function of the market area of the IOF. Under the random TBR, TMW of the COOP is given by

$$\text{(A3-1)}\quad \Pi_C^{rTBR} = \left(\int_0^{d-R_I} \left(\rho - \frac{u_C}{2} - tr \right) \mathrm{d}r + \alpha \int_{d-R_I}^{d} \left(\rho - \frac{u_C}{2} - tr \right) \mathrm{d}r \right) u_C .$$

The first term in equation (A3-1) gives the area in which the COOP serves farmers exclusively; the second term gives the area of overlap (see equation (7-27) in CHAPTER 7.2). Assume that $\alpha = 1/2$, i.e., farmers within the area of overlap are equally shared between processors. Assuming that TMW is shared among members (i.e., $\Pi_C^{rTBR} / \left(d - R_I/2\right) \stackrel{!}{=} u_C^2 / 2$) and thus a NARP-pricing COOP, the pricing schedule under the random TBR (u_C^{rTBR}) is given by

$$\text{(A3-2)}\quad u_C^{rTBR} = \rho - \frac{t\left(2d^2 - 2dR_I + R_I^2\right)}{2\left(2d - R_I\right)}$$

(see equation (7-28) in CHAPTER 7.2). The solution in equation (A3-2) can also be derived by either determining the UD price such that profits from processing, i.e.,

$$\text{(A3-3)}\quad \Pi_C^{p-rTBR} = \left(\int_0^{d-R_I} \left(\rho - u_C - tr \right) \mathrm{d}r + \alpha \int_{d-R_I}^{d} \left(\rho - u_C - tr \right) \mathrm{d}r \right) u_C$$

are equal to zero; or by assuming a TMW-maximizing COOP that maximizes TMW with respect to the UD price; i.e.,

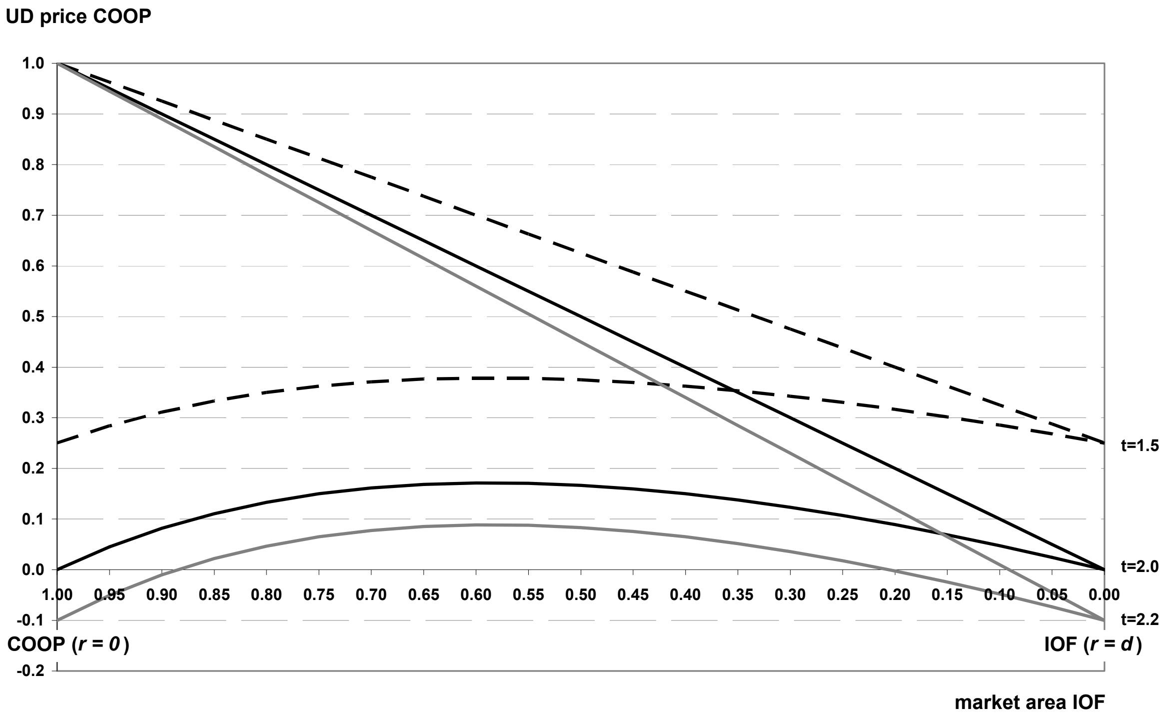
$$\text{(A3-4)}\quad \Pi_C^{rTBR} = \max_{u_C}\left[\left(\int_0^{d-R_I}\left(\rho - \frac{u_C}{2} - tr\right)\mathrm{d}r + \alpha\int_{d-R_I}^{d}\left(\rho - \frac{u_C}{2} - tr\right)\mathrm{d}r\right)u_C\right].$$

Therefore, this COOP is both a NARP-pricing COOP and a TMW-maximizing COOP. Under the efficient TBR, no farmer within the market area of the IOF will supply the COOP, i.e., $\alpha = 0$. Thus, the second term in equation (A3-1) is equal to zero and the pricing schedule under the efficient TBR (u_C^{eTBR}) is given by

$$\text{(A3-5)}\quad u_C^{eTBR} = \rho - \frac{t(d - R_I)}{2}.$$

(see equation (7-2) in CHAPTER 7.1). The pricing schedules under the random TBR and under the efficient TBR are illustrated in FIGURE A3-1.

FIGURE A3-1. Pricing schedule of the COOP (efficient/random TBR)



Note: In this figure, both the net selling price ρ and the distance d between processors are normalized to 1.

In FIGURE A3-1, the COOP is located at endpoint on the the left-hand side of the line market; the IOF is located distance d away on the right-hand side. The pricing schedules of the COOP (equation (7-28) and (A3-5)) are illustrated for three specific levels of the transportation rate t. Given any market area of the IOF (see the horizontal axis), these pricing schedule show the level of UD prices of the COOP. Under the efficient TBR, the pricing schedule is linear; under the random TBR, the pricing schedule is an inverted U-shaped curve.

For example, consider the case *t=2* (i.e., $s/\rho = 2$). If the market area R_I of the IOF is equal to zero, UD prices of the COOP are zero (both under the random TBR and under the efficient TBR). As R_I increases, the UD price of the COOP increases under the efficient TBR (i.e., in the case of non-overlapping market areas) and is equal to $\rho = 1$ for $R_I = d = 1$. Under the random TBR (i.e., in the case of overlapping market areas), the UD price is highest if $R_I \sim 0.6$. FIGURE A3-1 shows that the UD price of the COOP under the random TBR is lowest (and equal to zero) if $R_I = 0$ and if $R_I = d = 1$.

For *t>2*, FIGURE A3-1 shows that UD prices are negative if $R_I = 0$ and if $R_C = d = 1$ under both TBRs. Therefore, if the behavior of the IOF is not known by the COOP (i.e., any R_I is possible), it can be argued that the no-rationing assumption is limited to the case of $s/\rho < 2$. In this case, UD prices are strictly positive for any behavior of the IOF and the COOP's constraint to consider distance *d* as its market area is always binding.

However, if the COOP knows the behavior of the IOF, it can be argued that even a situation like $s/\rho \geq 2$ qualifies for the no-rationing assumption, provided that the behavior of the IOF results in a strictly positive UD price. In this case, the constraint for the COOP to consider distance *d* as its market area is non-binding under the efficient TBR: the UD price of the COOP is equal to zero for $R_C < d$. The behavior of the IOF in the mixed market is analyzed in CHAPTER 7.1 (efficient TBR) and CHAPTER 7.2 (random TBR). Under the efficient TBR, the UD price of the COOP is equal to zero for $s/\rho = 8/3 \sim 2.6$ if the COOP faces a monopsonistic IOF (see equation (7-9) in CHAPTER 7.1). Under the random TBR, the UD price in the mixed market is equal to zero for $s/\rho \sim 2.37$ (see CHAPTER 7.2). Therefore, it can be argued that any $s/\rho < 2.37$ qualifies for the no-rationing assumption.

A3.2 The mixed market under the efficient TBR
(ad Chapter 7.1)

Table A3-1. Comparative statics: sequential moves game

Sequential moves game (ad Chapter 7.1.1):	
UD price	$\frac{\partial u^{seq}}{\partial t} = -\frac{d\left(\sqrt{3t^2d^2 - 12dt\rho + 16\rho^2} - td + 2\rho\right)}{4\sqrt{3t^2d^2 - 12dt\rho + 16\rho^2}} < 0$
	$\frac{\partial u^{seq}}{\partial d} = -\frac{t\left(\sqrt{3t^2d^2 - 12dt\rho + 16\rho^2} - td + 2\rho\right)}{4\sqrt{3t^2d^2 - 12dt\rho + 16\rho^2}} < 0$
	$\frac{\partial u^{seq}}{\partial \rho} = \frac{4\sqrt{3t^2d^2 - 12dt\rho + 16\rho^2} - 3td + 8\rho}{6\sqrt{3t^2d^2 - 12dt\rho + 16\rho^2}} > 0$
Market area (IOF)	$\frac{\partial R_I^{seq}}{\partial t} = -\frac{\rho\left(-3td - 2\sqrt{3t^2d^2 - 12dt\rho + 16\rho^2} + 8\rho\right)}{3t^2\sqrt{3t^2d^2 - 12dt\rho + 16\rho^2}} > 0$
	$\frac{\partial R_I^{seq}}{\partial d} = -\frac{-\sqrt{3t^2d^2 - 12dt\rho + 16\rho^2} - td + 2\rho}{2\sqrt{3t^2d^2 - 12dt\rho + 16\rho^2}} > 0$
	$\frac{\partial R_I^{seq}}{\partial \rho} = \frac{8\rho - 3td - 2\sqrt{3t^2d^2 - 12dt\rho + 16\rho^2}}{3t\sqrt{3t^2d^2 - 12dt\rho + 16\rho^2}} < 0$
Market area (COOP)	$\frac{\partial R_C^{seq}}{\partial t} = \frac{\rho\left(-3td - 2\sqrt{3t^2d^2 - 12dt\rho + 16\rho^2} + 8\rho\right)}{3t^2\sqrt{3t^2d^2 - 12dt\rho + 16\rho^2}} < 0$
	$\frac{\partial R_C^{seq}}{\partial d} = \frac{\sqrt{3t^2d^2 - 12dt\rho + 16\rho^2} - td + 2\rho}{2\sqrt{3t^2d^2 - 12dt\rho + 16\rho^2}} > 0$
	$\frac{\partial R_C^{seq}}{\partial \rho} = -\frac{8\rho - 3td - 2\sqrt{3t^2d^2 - 12dt\rho + 16\rho^2}}{3t\sqrt{3t^2d^2 - 12dt\rho + 16\rho^2}} > 0$

Table A3-2. Comparative statics: simultaneous moves game 1

Simultaneous moves game 1 (ad Chapter 7.1.2):		
UD price	**Market area (IOF)**	**Market area (COOP)**
$\frac{\partial u^{sim1}}{\partial t} = -\frac{d}{3} < 0$	$\frac{\partial R_I^{sim1}}{\partial t} = 0$	$\frac{\partial R_C^{sim1}}{\partial t} = 0$
$\frac{\partial u^{sim1}}{\partial d} = -\frac{t}{3} < 0$	$\frac{\partial R_I^{sim1}}{\partial d} = \frac{1}{3} > 0$	$\frac{\partial R_C^{sim1}}{\partial d} = \frac{2}{3} > 0$
$\frac{\partial u^{sim1}}{\partial \rho} = 1$	$\frac{\partial R_I^{sim1}}{\partial \rho} = 0$	$\frac{\partial R_C^{sim1}}{\partial \rho} = 0$

TABLE A3-3. Comparative statics: simultaneous moves game 2

Simultaneous moves game 2 (ad CHAPTER 7.1.3)**:**		
UD price	**Market area (IOF)**	**Market area (COOP)**
$\frac{\partial u^{sim2}}{\partial t} = -\frac{d}{6} < 0$	$\frac{\partial R_I^{sim2}}{\partial t} = \frac{2\rho}{3t^2} > 0$	$\frac{\partial R_C^{sim2}}{\partial t} = -\frac{2\rho}{3t^2} < 0$
$\frac{\partial u^{sim2}}{\partial d} = -\frac{t}{6} < 0$	$\frac{\partial R_I^{sim2}}{\partial d} = \frac{2}{3}$	$\frac{\partial R_C^{sim2}}{\partial d} = \frac{1}{3}$
$\frac{\partial u^{sim2}}{\partial \rho} = \frac{2}{3}$	$\frac{\partial R_I^{sim2}}{\partial \rho} = -\frac{2}{3t} < 0$	$\frac{\partial R_C^{sim2}}{\partial \rho} = \frac{2}{3t} > 0$

A3.3 THE MIXED MARKET UNDER THE RANDOM TBR: SIMULTANEOUS MOVES GAMES (ad CHAPTER 7.2)

Under the random TBR, the COOP offers its pricing schedule according to equation (7-28) as in CHAPTER 7.2. Given a simultaneous moves game of type 1, the IOF takes the UD price as given and maximizes profits with respect to its market area:

$$\text{(A3-6)} \quad \Pi_I^{sim1} = \max_{R_I} \left[\frac{1}{2} \left(\int_0^{R_I} (\rho - u_I - tr) \mathrm{d}r \right) u_I \right]$$

Farmers within the area of overlap randomly choose their processor, i.e., farmers are shared equally between processors within the market area of the IOF (see FIGURE 7-11 in CHAPTER 7.2). The solution to the problem in equation (A3-6) gives the optimal market area of the IOF:

$$\text{(A3-7)} \quad R_I = \frac{\rho - u_I}{t}$$

The inverse of equation (A3-7) gives the “market area schedule” of the IOF:

$$\text{(A3-8)} \quad u_I = \rho - tR_I$$

In equilibrium, UD prices of the COOP and the IOF must be equal. Setting this “market area schedule” equal to the pricing schedule of the COOP, equation (7-28) in CHAPTER 7.2, gives the resulting market area of the IOF:

$$\text{(A3-9)} \quad R_I^{sim1} = d - \frac{d\sqrt{3}}{3}$$

Thus, $r = R_I^{sim1}$ is the location of the most distant IOF supplier. Substituting equation (A3-9) into the pricing schedule of either processor gives the UD price in such a mixed market:

$$\text{(A3-10)}\quad u^{sim1} = \rho - dt + \frac{\sqrt{3}dt}{3}$$

Given the simultaneous moves game of type 2, the IOF takes the market area as given and maximizes profits with respect to the UD price:

$$\text{(A3-11)}\quad \Pi_I^{sim2} = \max_{u_I}\left[\frac{1}{2}\left(\int_0^{R_I}(\rho - u_I - tr)\mathrm{d}r\right)u_I\right]$$

The solution of equation (A3-11) gives the pricing schedule of the IOF:

$$\text{(A3-12)}\quad u_I = \frac{\rho}{2} - \frac{tR_I}{4}$$

Setting this pricing schedule equal to the pricing schedule of the COOP (equation (7-28) in CHAPTER 7.2), gives the resulting market area of the IOF (and, thus, the location of the most distant IOF supplier):

$$\text{(A3-13)}\quad R_I^{sim2} = \frac{3td - \rho - \sqrt{\rho^2 + 6td\rho - 3t^2d^2}}{3t}$$

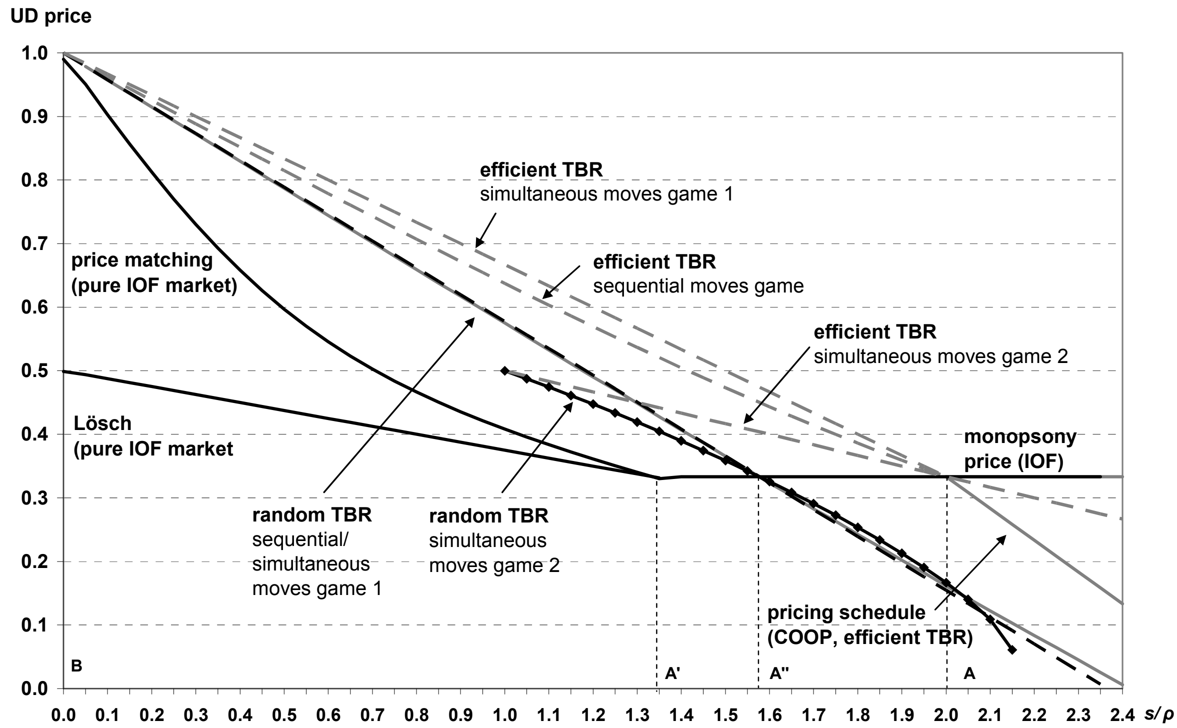
Substituting the IOF's market area into either processor's pricing schedule yields the optimal UD price in this mixed market:

$$\text{(A3-14)}\quad u_I^{sim2} = \frac{7\rho - 3td + \sqrt{\rho^2 + 6td\rho - 3t^2d^2}}{12}$$

The UD prices in the mixed market under the random TBR[198] are illustrated in FIGURE A3-2. Comparative statics of UD prices and of the IOF's market area are given in TABLE A3-4.

[198] The UD price under the sequential moves game was not derived analytically but via a numerical simulation; see CHAPTER 7.2.1. For a low relative importance of space, the UD price is slightly lower in the sequential moves game than in the simultaneous moves game of type 1 (see FIGURE A3-2). For any *s/ρ> ~1.6*, the UD price in the sequential moves game is slightly higher.

FIGURE A3-2. UD prices in the mixed market (random TBR)



Note: In this figure, *s/ρ* is increasing due to increases in per-unit transportation costs *t*. Both the net selling price *ρ* and the distance *d* between processors are normalized to *1*.

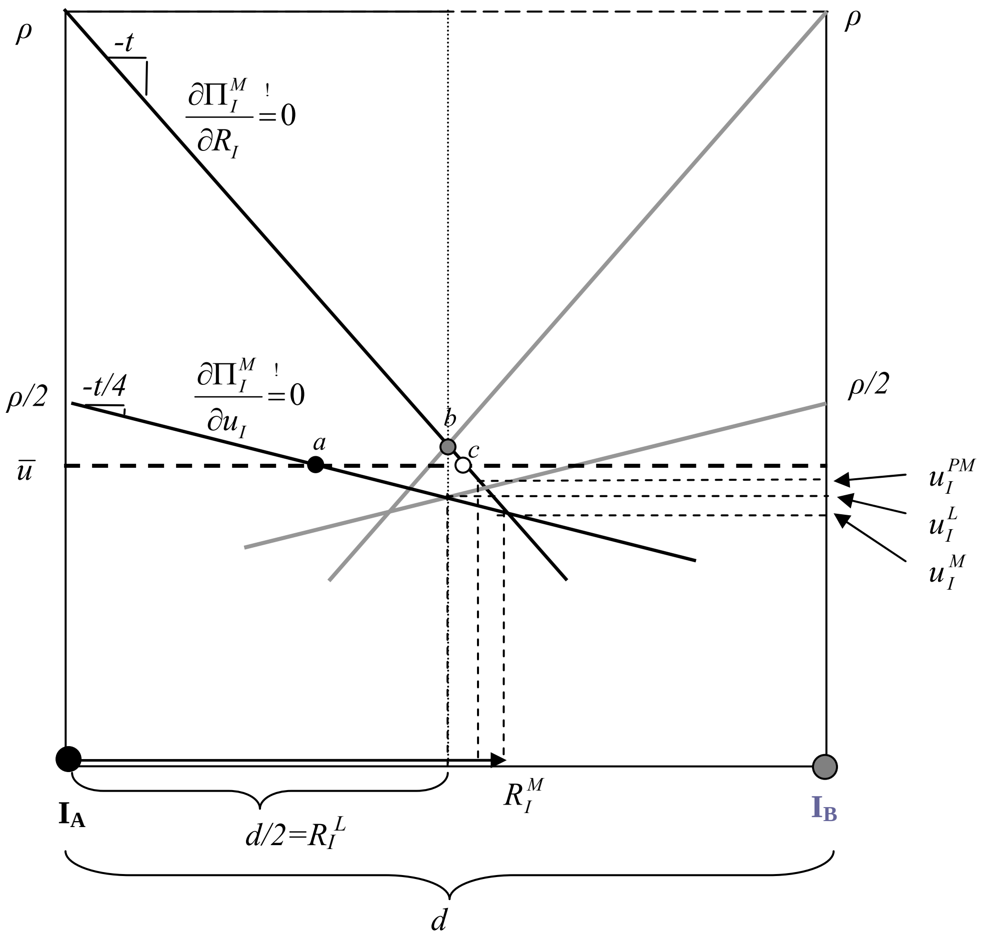
TABLE A3-4. Comparative statics: simultaneous moves games 1 and 2 (random TBR)

UD price	**Market area (IOF)**
Simultaneous moves game 1	
$\frac{\partial u^{sim1}}{\partial t} = -d + \frac{\sqrt{3}d}{3} < 0$	$\frac{\partial R_I^{sim1}}{\partial t} = 0$
$\frac{\partial u^{sim1}}{\partial d} = -t + \frac{\sqrt{3}t}{3} < 0$	$\frac{\partial R_I^{sim1}}{\partial d} = 1 - \frac{\sqrt{3}}{3} > 0$
$\frac{\partial u^{sim1}}{\partial \rho} = 1$	$\frac{\partial R_I^{sim1}}{\partial \rho} = 0$
Simultaneous moves game 2	
$\frac{\partial u^{sim2}}{\partial t} = -\frac{d}{4} + \frac{6\rho d - 6td^2}{24\sqrt{\rho^2 + 6td\rho - 3t^2d^2}} < 0$	$\frac{\partial R_I^{sim2}}{\partial t} = \frac{\rho\left(3td + \rho + \sqrt{\rho^2 + 6td\rho - 3t^2d^2}\right)}{3t^2\sqrt{\rho^2 + 6td\rho - 3t^2d^2}} > 0$
$\frac{\partial u^{sim2}}{\partial d} = -\frac{t}{4} + \frac{6t\rho - 6t^2 d}{24\sqrt{\rho^2 + 6td\rho - 3t^2d^2}} < 0$	$\frac{\partial R_I^{sim2}}{\partial d} = -\frac{\rho - td - \sqrt{\rho^2 + 6td\rho - 3t^2d^2}}{\sqrt{\rho^2 + 6td\rho - 3t^2d^2}} > 0$
$\frac{\partial u^{sim2}}{\partial \rho} = \frac{7}{12} + \frac{2\rho + 6td}{24\sqrt{\rho^2 + 6td\rho - 3t^2d^2}} > 0$	$\frac{\partial R_I^{sim2}}{\partial \rho} = -\frac{3td + \rho + \sqrt{\rho^2 + 6td\rho - 3t^2d^2}}{3t\sqrt{\rho^2 + 6td\rho - 3t^2d^2}} < 0$

A3.4 BEHAVIOR OF THE IOF IN A PURE IOF MARKET GIVEN AN OUTSIDE OPTION (ad CHAPTER 7.3.1)

Given any outside option $\bar{u} > \rho/3$, there is a certain range of the relative importance of space, where IOFs are in the situation of spatial competition but optimal UD prices under Löschian competition (u_I^L) and under the price-matching conjecture (u_I^{PM}) are lower than the outside option (see CHAPTER 7.3.1). However, IOFs must pay UD prices, which are at least equal to the outside option: $u_I^{L,PM} \geq \bar{u}$. The upper boundary of this range of the relative importance of space is determined by the monopsony situation, i.e., $s/\rho = 2-(2\bar{u})/\rho$ (see equation (7-38) in CHAPTER 7.3.1); the lower boundary of this range is determined by the level of the relative importance of space where $u_I^{L,PM} = \bar{u}$ (see equations (7-39) and (7-40)). Within this range, IOFs have three options (see FIGURE A3-3):

FIGURE A3-3. Pure IOF market given an outside option



In FIGURE A3-3, the steeper downward-sloping black line represents the “market area schedule” of IOF I_A. In this case, the IOF takes the UD price as given and maximizes profits with respect to the market area; the inverse of this schedule is $u_I = \rho - tR_I$, which is the maximum UD price the IOF is willing to pay at point $r = R_I$ (see also equation (7-5)). The flatter downward-sloping black line represents the pricing schedule of IOF I_A. In this case, the IOF takes the market area as given and maximizes profits with respect to UD prices, $u_I = \rho/2 - (tR_I)/4$ (see also equation (7-6)). In FIGURE A3-3, the IOFs are in the situation of spatial competition, i.e., $s/\rho > 4/3$. In the absence of an outside option, UD prices are u_I^L under Löschian competition and u_I^{PM} under the price-matching conjecture.[199] Given the level of the outside option $\bar{u}$ in FIGURE A3-3 $(\bar{u} = 0.4)$, these optimal UD prices would be lower than the outside option. In this situation, IOFs have three options. Option (a) involves a decision according to the pricing schedule, and option (b) and (c) involves a decision according to the "market area schedule".

(a) IOFs may only offer a pricing schedule, like an open-membership COOP. Then, the market area R_I is determined by the farmer who is indifferent between supplying the IOF or choosing the outside option (see point *a* in FIGURE A3-3). In this situation, UD prices are equal to the outside option: $u_I^a = \bar{u}$. Solving the pricing schedule of the IOF $u_I = \rho/2 - (tR_I)/4$ for R_I gives the respective market area of the IOF:

$$\text{(A3-15)} \quad R_I^a = \frac{2\rho - 4\bar{u}}{t}$$

This option is only possible if $\bar{u} < \rho/2$ and $R_I^a \le d/2$ (i.e., this option involves an indifferent farmer and thus there is no market overlap). Given the latter condition, the lower boundary of the relative importance of space is $s/\rho \ge 4 - 8\bar{u}/\rho$ (see also equation (7-40)).

(b) IOFs may collude regarding market areas by setting $R_I^b = d/2$ (i.e., there is no market overlap). Then, IOFs can price according to their "market area schedule" (see point *b* in FIGURE A3-3). After substitution of $R_I^b = d/2$ into this schedule, the resulting UD prices are

$$\text{(A3-16)} \quad u_I^b = \rho - \frac{td}{2}.$$

[199] In FIGURE A3-3, $\rho=1$, $d=1$, and $t=1.15$. Therefore, FIGURE A3-3 illustrates the situation of $s/\rho=1.15$. In this situation (and assuming the absence of IOF I_B), IOF I_A would pay its monopsonistic UD price $u_I^M=0.33$ and operate within its monopsonistic market area $R_I^M=0.58$ (i.e., $R_I^M>d/2$). Under Löschian competition, the IOF prices according to its pricing schedule, i.e., the flatter downward-sloping line ($u_I^L=0.36$). Under the price-matching conjecture with overlapping market areas, the IOF prices according to its "market area schedule" (i.e., the steeper downward-sloping line), which shows the resulting market area, given any UD price ($R_I=(\rho-u_I)/t$). The IOF maximizes profits with respect to the UD price, i.e., it determines the UD price – market area combination on this schedule that maximizes profits. This combination is given by $u_I^{PM}=0.37$, $R_I^{PM}=0.55$.

Equation (A3-16) gives the maximum UD price the IOF is willing to pay at the point $r = d/2$. Such a behavior is only possible if $u_I^b \geq \bar{u}$, which is the case for any $s/\rho \leq 2-(2\bar{u})/\rho$ (i.e., this behavior is possible for any relative importance of space that is lower than the level of the relative importance of space where IOFs are spatially separated monopsonists; see also equation (7-34)). Given this behavior, the resulting UD price within range of the relative importance of space in question is higher than the level of the outside option. In FIGURE 7-15 in CHAPTER 7.3.1, this UD price is given by the dashed downward-sloping line.

(c) Similar to the behavior in the monopsony situation for $\bar{u} > \rho/3$, IOFs may set UD prices equal to the outside option ($u_I^c = \bar{u}$) and determine their market area according to their "market area schedule" (see point *c* in FIGURE A3-3).[200] Then, the market area of either IOF is given by

(A3-17) $$R_I^c = \frac{\rho - \bar{u}}{t}.$$

In this situation, the market areas of the competing IOFs overlap: $d/2 < R_I^c \leq d$. Given this condition, such a behavior is possible for any $1-\bar{u}/\rho < s/\rho \leq 2-(2\bar{u})/\rho$.

As noted above, the lower boundary of the range of the relative importance of space for these three possibilities is determined by the level of s/ρ, where $u_I^L = \bar{u}$ and $u_I^{PM} = \bar{u}$, respectively. First, assume Löschian competition in the pure IOF market such that any outside option $\rho/3 < \bar{u} < \rho/2$ is relevant (see also FIGURE A3-3). The lower boundary is given by $s/\rho = 4-(8\bar{u})/\rho$ for the three options. However, under option (c), the market area must be smaller than *d*: $s/\rho = 1-\bar{u}/\rho$. These two boundaries are equal for $\bar{u} = (3\rho)/7$. Consequently, for option (c) and provided that $\rho/3 < \bar{u} < (3\rho)/7$, the lower boundary is $s/\rho = 4-(8\bar{u})/\rho$ (i.e., $u_I^L = \bar{u}$); for $(3\rho)/7 < \bar{u} < \rho/2$, the lower boundary is $s/\rho = 1-\bar{u}/\rho$ (i.e., $R_I = d$).[201]

Second, assume price matching in the pure IOF market so that any outside option $\rho/3 < \bar{u} < \rho$ is relevant; however, option (a) is only possible for $\rho/3 < \bar{u} < \rho/2$. For any of

[200] Analytically, IOF I_A considers market overlap in its profit function, which is a function of R_I^A and R_I^B. In this case, IOF I_A maximizes profits with respect to R_I^A (i.e., it takes R_I^B and the UD price as given). The resulting market area is given in equation (A3-15).

[201] At this lower boundary, u_I^L is still lower than the outside option. Thus, IOFs must choose either option (a) or option (b) as the relative importance of space further decreases.

the three options, the lower boundary is given by $s/\rho = \left(2\rho - 4\bar{u} + \sqrt{2\rho^2 - 8\rho\bar{u} + 10\bar{u}^2}\right)/\rho$ (see equation (7-39)). For option (c), the boundary involving $R_I = d$ is obsolete.

To conclude, these three options of the IOF either result in UD prices equal to the outside option (under option (a), IOFs are spatially separated monopsonists; under option (c), IOFs have overlapping market areas) or UD prices which are higher than the outside option (under option (b), IOFs set their market areas equal to *d/2*).