TECHNISCHE UNIVERSITÄT MÜNCHEN

FACHGEBIET FÜR AGRARMARKTANALYSE UND AGRARMARKETING

Consumers' Willingness to Pay for Durable Biobased Plastic Products: Findings from an Experimental Auction

Ulla W. Kainz

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.

Vorsitzender:	**Univ.-Prof. Dr. Michael Suda**
Prüfer der Dissertation:	**1. Prof. Dr. Klaus Menrad**
	2. Univ.-Prof. Jutta Roosen, Ph.D.

Die Dissertation wurde am 30.03.2016 bei der Technischen Universität München eingereicht und
am 15.10.2016 von der Fakultät für Wirtschaftswissenschaften angenommen.

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1. Introduction and study goals

Apart from the shift towards renewable energies such as solar, biomass and wind energy, the use of renewable, biobased resources for material production plays an important role on the way towards a more sustainable and climate-friendly society and economy which was defined as goal by the United Nations in the 1992 Rio Declaration on Environment and Development (UNEP 1992). Compared to fossil resources the use of biomass for material production offers the following advantages: it conserves carbon dioxide, it is renewable and can be applied almost worldwide in one form or another, it is often less toxic, in many cases its production requires less energy and it offers new, sustainable opportunities for economically underdeveloped regions, etc. (FNR 2015). Biobased materials have always been processed – and still are – in a great variety of product categories including lubricants, construction materials, colorants, cosmetics, textiles and plastics (ibid., Beucker & Marscheider-Weidemann 2007).

In 2005, the concept of a knowledge-based bio-economy was officially presented in the European Union in order to initiate a structural change of the economic system (BMBF & BMEL 2014). The superior goal of the knowledge-based bio-economy is to achieve sustainable economic growth (ibid.). To this end, knowledge, innovation and investments should be used to find biobased, resource-efficient and economically and socially sustainable ways of production and economic activity (ibid.).

In Germany, the *Bioökonomierat* coordinates the development of the national bio-economy. Until 2015, two central strategies have been published: The *Nationale Forschungsstrategie BioÖkonomie 2030*, that offers incentives for increased research of industrial biomass use, bio refineries, sustainable agricultural production, etc. (BMBF & BMEL 2014; BMBF 2010), and the *Nationale Politikstrategie Bioökonomie*, that contains policy measures to support the implementation of the bio-economy by explicitly naming tasks for energy, industrial, agricultural, climate, environmental and other relevant policies (BMBF & BMEL 2014; BMEL 2014). Goals of the German Bio-economy Strategy are to ensure Germany's international economic competitiveness through an innovative and sustainable economy, to implement sustainable sourcing of renewable resources, to optimize process chains, to reduce conflicts between food, feed and energy use, to concentrate the use of renewable resources on ways that are most efficient, etc. (BMEL 2014, p. 44).

The development and increase of material utilization of renewable resources is named as one important field of action on the way to a bio-economy (BMEL 2014). Plastic is one of the materials that can be sourced from renewable resources and the fact that it is a multifaceted material that is applied in numerous products from automobile parts over packaging to construction materials and consumer products makes it even more promising. The manifold applications of plastic reveal that plastic has become an important "natural" part of everyday life and it is rather difficult to imagine a world without it (Philp et al. 2013; Aguado Alonso & Serrano 1999). Plastic simplifies life to a

large extent, but its conventional production from crude oil as well as the large landfills it produces and the accumulation of plastic pieces and particles in water bodies and landscapes pose a danger to environment and climate (Alvarez-Chavez et al. 2011). The production of plastics from renewable resources is, therefore, one step in the global effort to conserve fossil resources (European Bioplastics 2011; Beier 2009). Most of these so-called bioplastics or biopolymers have properties equal or similar to conventional plastics and the spectrum of applications ranges from durable engineering biopolymers for the automobile industry to biodegradable planting pots for the horticultural sector. In addition, properties such as water vapor permeability and printability can specifically be adjusted in biopolymers (Beucker & Marscheider-Weidemann 2007). However, biopolymers are usually not as sustainable as they might appear: agricultural production, the possible application of GMOs and nano-materials and their durability result in environmental pollution and health risks that need to be assessed (Alvarez-Chavez et al. 2011).

The biopolymer market has recently started a strong growth that will be described in chapter 2.2, while remaining a niche market. Recent growth of the biopolymer market was induced by the objective to reduce dependency from fossil resources and by the interest of various recipients of the plastic industry in materials with particular properties and/or suitability for cascade utilization (European Bioplastics 2015b). Furthermore, the substitution of fossil resources with plant-based resources offers potentials to reduce and compensate greenhouse gas emissions and to mitigate climate change (European Bioplastics 2015a; Beier 2009). After product use biopolymers may be remanufactured into a different product or burnt for energy use where carbon that was bound in the biomass before manufacturing it into a product is offset, thus enabling an in theory almost closed carbon cycle (European Bioplastics 2015a; Philp et al. 2013; Beucker & Marscheider-Weidemann 2007).

From a consumer perspective, the following issues may restrain awareness and acceptance of biopolymers as well as willingness to purchase biopolymer products and willingness to pay: Prices for biopolymer products can be up to three times higher than for a conventional plastic product (Carus et al. 2014, p. 4) and most biopolymers cannot be distinguished from conventional plastics because they look and feel like conventional plastics. Currently, durable, i.e. non-biodegradable, biopolymer products are available in various market segments including electronics, sports equipment, and office and household supply (European Bioplastics 2013). However, market penetration is low and according to a market research conducted by the author in 2012 (see chapter 2.2) products are available in low quantities only and in rather few specialized stores and online shops. Thus, most consumers are not confronted with biopolymer consumer products during their usual shopping (Kurka & Menrad 2009). The lack of consumer awareness of and knowledge about biopolymers and biopolymer consumer products (Kainz et al. 2013; Kurka 2012) can constitute barriers to the market success of products derived from these materials. Further barriers that might interfere with consumers' willingness to purchase biopolymer products are, for

example, a lack of interest in sustainable products, laziness, a lack of trust in quality or origin, a lack of need, a lack of financial resources and a lack of encouragement to buy biopolymers (Blake 1999). In Germany, a label to identify biopolymers does not exist and the customarily used term “bioplastic” is often misunderstood by consumers as it is associated with organic production or biodegradability of materials (Rumm et al. 2013). Adequate consumer information is, thus, necessary to remove some of the above named barriers in order to successfully place biopolymer consumer products in the market.

At first sight, the strong growth of the biopolymer market and the call for environmentally sound and climate conserving materials and products seem to go hand in hand. But plastics made from renewable resources can only outgrow their market niche if they become available in greater product varieties and quantities and if they are purchased by consumers even though prices might still be slightly higher than for the conventional product alternatives. Since existing research does not answer questions that are crucial to a permanent market implementation of biopolymer consumer products a prestudy was designed to answer the following questions:

1. What do consumers know about biopolymers?
2. What information about biopolymers is relevant to consumers?

Question 1 assesses the status quo concerning beliefs about and knowledge of biopolymers as well as lacks of information and possible misunderstandings by consumers. Research question 2 is aimed at understanding the aspects and characteristics of biopolymers that consumers find important. Once the status quo has been determined, effective information about biopolymers that might meet consumers’ needs at the point of sale can be formulated as information packages in order to be tested in the main experiment of the project. The implementation of information packages during the main experiment allows to tackle the following research questions:

3. Are consumers willing to pay more for biopolymer products than for plastic products made from fossil fuel?
4. How does information about biopolymers affect consumers’ willingness to pay?
5. Do attitudes towards sustainable consumption and prior familiarity with biopolymers affect willingness to pay?

In the course of this PhD-project, the effects of information about biopolymer production, their resource origin, their climate effects, their durability, etc., and of additional independent variables such as prior familiarity with biopolymers, attitudes towards biopolymers, and socio-demographic characteristics are tested with an experimental auction method that elicits consumers’ willingness to pay. Willingness to pay is a measure that is widely used in marketing and economics, today, to evaluate products and product characteristics (see chapter 4.1). In this study, effects on

consumers' willingness to pay for *durable* biomass-based plastic products are measured. Therefore, a computer-based laboratory experiment is performed, during which the participants are informed about biomass-based plastic, about its characteristics and about consequences of biopolymer production.

2. Biopolymers

The increased industrial use of renewable, biomass-based resources is part of the *Nationale Forschungsstrategie BioÖkonomie 2030* of the German Government that envisions a sustainable, knowledge-based bio-economy (BMBF 2010). A central goal of this strategy is to shift away from fossil resources by developing biomass-based technologies, processes and products. In the case of plastics, the desired use of biobased materials for the production of biopolymers is already underway.

2.1. Definition and material characteristics

Plastics that are either made from biogenic resources or that are biodegradable or have both of the aforementioned characteristics are termed biopolymers or bioplastics (Figure 1). Following this definition, durable biobased plastics and crude oil-based biodegradable plastics are also referred to as biopolymers or bioplastics (Endres & Siebert-Raths 2011). The terms derived in the late 1980s, when the production of biomass-based biodegradable plastics came once again into focus in order to reduce plastic waste that had become a problem in landfills and in the landscape (Iles & Martin 2013; Endres 2011).

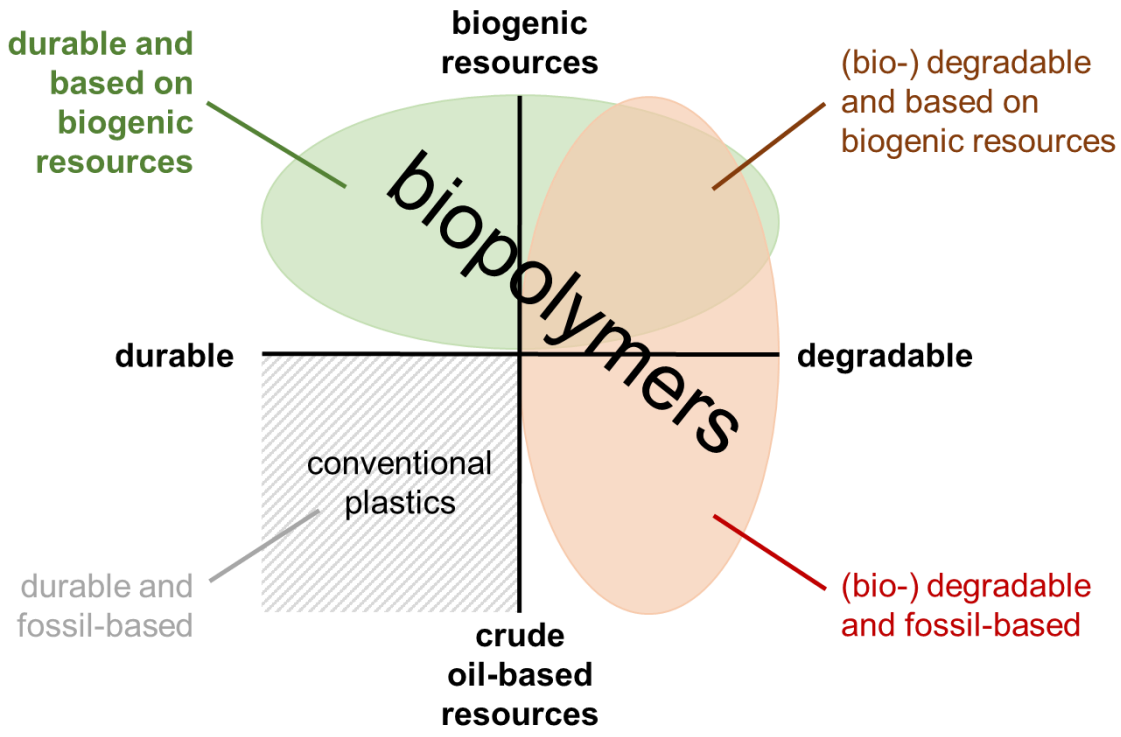


Figure 1: Definition of biopolymers
Endres et al. 2010, modified and translated

According to Iles & Martin (2013) there are three common methods of biopolymer production which result in different types of biopolymers (Table 1):

1. Modification and processing of plant-based materials
2. Direct production by micro-organisms or plants
3. Fermentation

Biomass that is used for the production of biopolymers includes

> plants, algae, crops, trees, marine organisms and biological waste from households, animals and food production (Taskforce on Bio-based Products 2007, p. 1)

as well as waste products and by-products from various industrial processes such as paper and sugar production.

Table 1: Methods of biopolymer production and corresponding market products

Current methods of biopolymer production	Biopolymers	Examples of marketed biopolymers
1. Modified natural polymers from plant material	Starch and derivatives	Starch resin Mater-Bi by Novamont
	Cellulose and derivatives	NatureFlex by Innovia Films
	Lignin	Research underway by BIOME
	Polyamide (PA)	VESTAMID terra by Evonik
2. Polymers produced directly by micro-organisms or plants	Polyhydroxicopolymers i.e. polyhydroxyalkanoate (PHA)	PHA Mirel by Metabolix
3. Polymers made from monomers obtained by fermentation	PLA	PLA by NatureWorks
	Polypropylene terephtalate (PPT)	Sorona by DuPont
	Polyethylene (PE)	Green PE by Braskem
	Ethylene derivatives	

Iles & Martin 2013, p. 41, modified and supplemented

Similar to conventional plastics, biopolymers comprise a variety of characteristics and functionalities. Biopolymers include common engineering plastics like polyamide, polyester, polyurethane and bulk plastics such as PE, polyethylene terephthalate (PET) and polyvinyl chloride (PVC) that are often produced as so-called drop-ins. Furthermore a variety of already well-known or newly developed compounds such as polylactic acid, PHA, succinic acid, butanediol and fatty acid derivatives are applied for the production of biopolymers (European Bioplastics 2011). Whereas the process routes for the new material types are often developed from scratch, many biobased engineering and bulk plastics are produced as drop-ins which have properties and chemical structures that are very similar to their crude oil-based counterparts' and therefore can use already established process and recycling routes (European Bioplastics 2012a). The only difference between biopolymer drop-ins and conventional plastics is the renewable material basis that, in the long term, enables a plastic production independent from fossil fuels (ibid.).

2.2. Areas of application and market development

Biopolymers constitute a niche of the global plastics market: In 2013, the global plastics production capacity was almost 300 million t with the production capacity in Europe accounting for about 20 % thereof (Statista 2015; PlasticsEurope 2013). The global

biopolymer production capacity amounted to less than 0.01 % of the global plastics capacity in 2013 and approximated 1.6 million t at a value of about 5.8 billion Euros (IfBB 2015). But growth rates above 10 % in the last years and expected yearly growth rates of up to 20 % indicate a good market potential (European Bioplastics 2012b). The expected capacity growth of durable biopolymers results especially from the bulk plastics PE from sugar cane ethanol and 30 %-biomass-based PET that are used for the production of all kinds of packaging and bottles (European Bioplastics et al. 2014a). The global capacity for biodegradable polymers is expected to stagnate in the coming years (Figure 2), as this market is quite satisfied. The number of products to which biodegradability constitutes an advantage for users is limited, whereas more and more industries discover the advantages of durable biopolymers (ibid.).

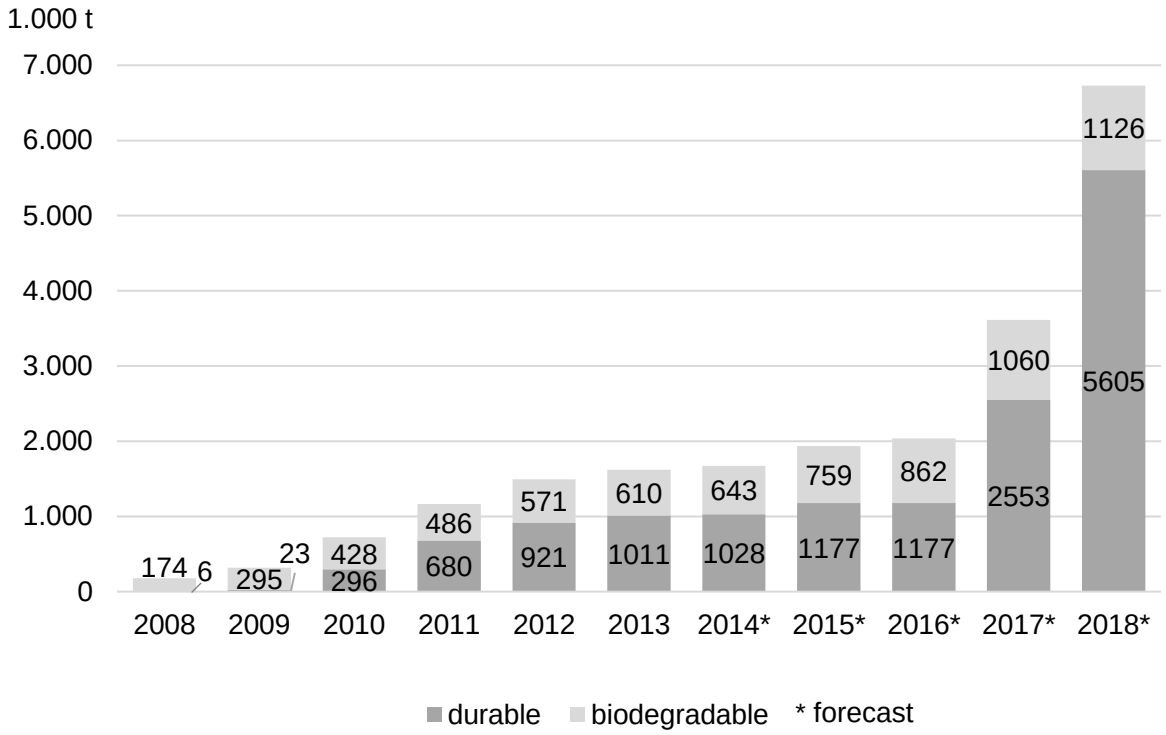


Figure 2: Development of the global biopolymer production capacity since 2008
Data from European Bioplastics et al. 2014c; European Bioplastics & IfBB 2013, 2011

In 2013, biomass for the global production of biopolymers was cultivated on an area of 608.000 ha (IfBB 2014). This area amounts to less than 0.01 % of the global agricultural area. According to Endres (2012), the biomass-based production of the complete plastics output for the year 2015 would require between four and five percent of the global agricultural area. However, this scenario does not take into account that a growing number of non-agricultural raw materials and resources such as algae or crab skin are currently explored as biopolymer sources (FNR 2014, pp. 81f; Fraunhofer IGB 2011).

Biobased products are available in various market segments, however, often in low quantities and small varieties. In 2012, packaging and bottles had the biggest shares of production capacity and value, followed by technical applications, catering supplies,

and consumer products (Figure 3). In the market segment of consumer products mostly biodegradable products for sport and outdoors as well as household and office were offered. Durable biopolymer products dominated the segments of technical applications (automobile and electronics) and bottles, and have been recently gaining importance in the consumer product segment (Endres 2011). European Bioplastics et al. (2014b) expect growing capacities for biopolymers in all segments for 2018. At the same time, the global plastics consumption is still expected to rise, especially due to economic growth in Asia (Worldwatch Institute 2015).

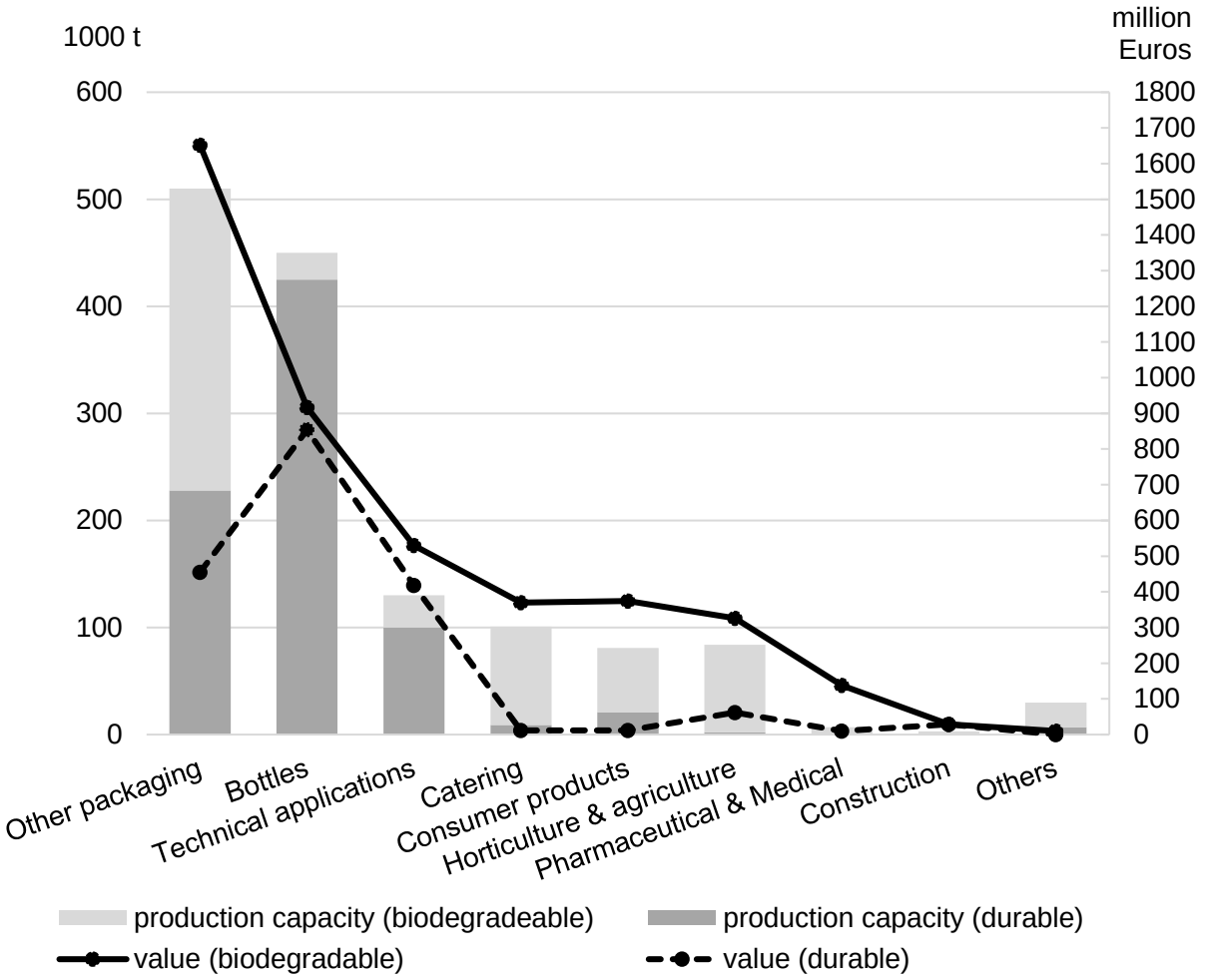


Figure 3: Global biopolymer production capacity and market value by segment 2012
Data from IfBB 2015; European Bioplastics & IfBB 2014

Prices for biopolymers vary widely depending on biopolymer type and processing grade and it seems that prices are largely dependent on the buyers and their self-conception: According to Carus et al. (2014, pp. 4–5), companies with a strong focus on sustainability or a green image are willing to pay twice as much for Bio-PE than for conventional PE. Similarly, the production of 57 %-biomass-based polyamide for a screw anchor may cost twice or thrice as much as conventional polyamide and the final product costs 20 % more than a conventional screw anchor because consumers are willing to pay for the “Green Touch” of the product (ibid.).

This PhD-study focuses on durable biomass-based polyamide products because durable biopolymers are currently gaining importance and polyamides are engineering plastics that are rather highly priced. Furthermore, biomass-based polyamides are predominantly produced from plant oil that is extracted from castor beans. Castor oil has the advantage of non-eligibility for food production and already plays a role in the chemical, pharmaceutical and other industries (Mutlu & Meier 2010) making it an accessible biomass resource for the plastic industry. Polyamide is a durable and resilient engineering plastic that is used in technical applications, especially from the automobile industry and for consumer products such as textiles and commodities. Biobased polyamide had a share of 2.4 % of the global biopolymer production capacity in 2012, which more than doubled to 4.9 % in 2013 approximating 80,000 tones (European Bioplastics et al. 2014c; European Bioplastics & IfBB 2013). For 2018, European Bioplastics et al. (2014c) expect a global biopolymer production capacity of 101,000 t. Globally, biobased polyamide was produced by around 10 companies in 2012 and is commonly based on castor oil (Table 2). Recently, scientists from the Fraunhofer Institute for Chemical Technology (ICT) and from Evonik Industries were successful in an attempt to produce polyamide from sunflower oil (Baumann & Fehrenbacher 2012). This research indicates that polyamide and other polymers can be produced from different biomass sources depending on local conditions and availability.

An online market research that was conducted by the author within the first year of working on this thesis, showed that by the end of 2012 only few consumer products that contain biobased polyamide were actually available on the market. The biomass-based shares varied widely with most products additionally containing fossil-based plastics. Available products included hard hats, glasses and sunglasses, shoe soles, socks and toothbrushes (see Table 3 and http://www.materialdatacenter.com for additional products).

Carus et al. (2014) asked plastic market experts about the expected development of biopolymer prices and consumers' willingness to pay. In their study, Carus et al. (2014) found that compared to conventional plastics, prices for biopolymers could be up to three times higher depending on the plastic type and the position in the value chain. Plastic market experts that were cited in the study, estimated that consumers would be willing to pay 15-20 % more for drop-in biopolymers within a timeframe of three years (Carus et al. 2014, p. 11). If additional criteria such as GMO-free or non-competing with food are fulfilled, consumers might be willing to pay additional surpluses of 0-100 % depending on market and region (id. p. 6). Some experts mentioned that consumers would be willing to pay surpluses of up to 100 % for biomass-based food packaging and biomass-based packaging composites (id. p. 11f).

Table 2: Companies producing biobased polyamide in 2012

Polyamide	Biomass-based raw material	Biomass-based share	Company	Product line	Product name
PA 610	castor oil	up to 70%	Akro-Plastics	AKROMID S	AKROMID S
PA 11	castor oil		Arkema	Rilsan	
PA 610	castor oil	60%	BASF	Ultramid	Ultramid Balance
PA 410	castor oil	70%	DSM	EcoPAXX	
PA 1010	castor oil	100%	DuPont	Zytel	Zytel RS
PA 610	castor oil	min. 60%	DuPont	Zytel	Zytel RS
PA 1010	castor oil	99%	EMS Grivory	Greenline	Grilamid 1S
PA 1011	castor oil	62%	EMS Grivory	Greenline	Grilamid 2S
PA 610	castor oil	53%	EMS Grivory	Greenline	Grilamid TR
PA 1010	castor oil	100%	Evonik	Vestamid	Vestamid terra DS
PA 1012	castor oil	45%	Evonik	Vestamid	Vestamid terra DD
PA 610	castor oil	62%	Evonik	Vestamid	Vestamid terra HS
PA 11	castor oil	100%	Gehr	ECOGehr	ECOGehr Nylon 11
PA 601	castor oil	60%	Gehr	ECOGehr	ECOGehr PA 6.10
PA	not specified	43%	RTP		RTP 2099 X 115387 A
PA	not specified	31%	RTP		RTP 2099 X 115387 B
PA	not specified	34%	RTP		RTP 2099 X 115387 C
PA	not specified	31%	RTP		RTP 2099 X 121825 E
PA 610	not specified		Solvay/Rhodia	Technyl eXten	

Online research by author 2012

Table 3: Marketed castor oil-based consumer products (selection)

Product	Brand	Biopolymer share / type	Market price/ piece	Availability	Origin	URL
Toothbrush	Donto Dent Nature	handle: 25% wood fiber	1.45 €	market withdraw-al due to low popularity	GER	
Toothbrush	Tom's of Maine	bristles: 50% castor oil handle: 99% castor oil-based polyamide	3.99 $	yes	USA	http://www.tomsofmaine.com/product-details/new-naturally-clean-toothbrush-medium
Toothbrush	Radius	bristles: polyamide based on castor oil handle: cellulose	7.95 $	yes	USA	http://www.radiustoothbrush.com/originaltoothbrush-right-1.aspx#
Socks	Jingo	castor oil-based polyamide "greenfil Rilsan" by Arkema	9 - 19.50 €	yes	FRA	http://www.jingo.fr/fr_greenfil/
Skiing socks	Monnet sports	Rilsan by Arkema	26 - 31.9 €	yes	FRA	http://www.ekosport.fr/monnet-greenvert-ski-alpin-12,12170042,p.html
Screw anchor	Fischer UX Green	Zytel RS by DuPont		Prototype presented on trade fairs e.g. FAKUMA Friedrichs-hafen	GER	http://www.fischer.de/de-DE/Produkte/Allgemeine-Befestigungen/Universalduebel-UX-GREEN
Sunglasses	Knock-around	53% based on castor-oil	16 $	yes	USA	http://knockaround.com/shop/sunglasses/bio-based
Hard hat	Uvex pheos blue	castor oil		?	GER	http://www.uvex-safety.com/de/produkte/schutzhelme/technologie-kopfschutz/

Online research by author 2012

3. Consumption in the context of sustainability

Nowadays, consumption of goods and services takes up a large part of everyday life that causes energy and resource use, transport and pollution. What and how much is consumed depends on habits, lifestyles, interests, beliefs, attitudes, knowledge, social norms, status, budget and external constraints amongst others (Kroeber-Riel & Gröppel-Klein 2013; Pepper et al. 2009; Trommsdorff 2009; Jackson 2005). The publication of "The Limits to Growth" by Meadows et al. (1972) is often named as starting point for a growing public awareness of environmental issues and for the search and development of more sustainable production and consumption patterns (Dobson 2007). Research on topics surrounding sustainable consumption was further sparked by the energy crisis in the 1970s, and the challenge of changing consumer behavior has been on the global agenda ever since the "Earth Summit" of 1992 that resulted in the Rio Declaration on Environment and Development (UNEP 1992) and the formulation of the United Nations Framework Convention on Climate Change (Heiskanen & Pantzar 1997; UN 1992).

- Resource depletion (Hertwich 2010),
- climate change (IPCC 2015, 2007),
- destruction of the environment (Kuckartz et al. 2007),
- social inequalities (Roberts 1996; Anderson, W. Thomas & Cunningham 1972),
- altruism and empathy (Bamberg & Möser 2007; Kollmuss & Agyeman 2002),
- social desirability and moral obligations (Mazar & Zhong 2010; Bamberg & Möser 2007),
- prestige (Amaldoss & Jain 2005),
- traceability of production processes and domestically or locally produced products (Grebitus et al. 2013; Johansson et al. 1985),
- health reasons, such as non-toxicity of ingredients (Hertwich 2010; Bamberg & Möser 2007; Kuckartz et al. 2007)

and many more (perceived) factors may induce consumers to buy products that are described as sustainable, green, environmentally friendly, climate-friendly, ecological, etc. At the same time numerous factors may inhibit sustainable behavior including

- price feeling and affordability (Trommsdorff 2009, pp. 259f.; Seyfang 2006),
- lack of (product) knowledge (Trommsdorff 2009),
- misinformation / misinterpretation (Kroeber-Riel & Gröppel-Klein 2013, p. 362),
- habits (Kroeber-Riel & Gröppel-Klein 2013; Trommsdorff 2009),
- convenience (Kroeber-Riel & Gröppel-Klein 2013; Trommsdorff 2009; Heiskanen & Pantzar 1997)
- non-availability (Kroeber-Riel & Gröppel-Klein 2013),
- opportunity costs (Siebert & Nixdorf 2008),
- social status (Kroeber-Riel & Gröppel-Klein 2013; Jackson 2005).

In this chapter, the complex construct of sustainable consumption is assessed and research on behavior towards sustainable products is summarized. Furthermore, interactive experiments that are increasingly applied to gain insight into consumers' purchase behavior towards sustainable products are outlined in this chapter. On the basis of findings from this chapter and the research questions that were formulated in chapter 1, hypotheses are formulated that are to be tested experimentally in the study at hand.

3.1. Sustainable consumption

> 'Sustainable consumption' as a discourse, a field of enquiry and a course of action, has arisen within a context of growing awareness of the ecological limitations on human activity. Sustainable consumption is a broad and contested concept that concerns the interaction of social and ecological issues […]. Its development marks an expansion of the sustainability agenda from production issues like ecological efficiency into the realm of consumption and the consumer. (Pepper et al. 2009, p. 126)

This quotation found in Pepper et al. (2009) shows that a variety of aspects and concepts are subsumed in the term sustainable consumption. Accordingly, sustainable consumption has become an umbrella term that is used for many, sometimes competing, small and large concepts about the ideal interaction between society and environment (Seyfang 2006). These concepts include green consumption (Gilg et al. 2005), green consumerism (Shrum et al. 1995), ethical consumption (Holt 2012; Harrison et al. 2005; Uusitalo & Oksanen 2004), socially conscious consumer behavior (Pepper et al. 2009; Roberts 1996; Antil 1984), social responsibility (ISO 2010), ecological and environmental citizenship (Dobson 2007; Seyfang 2006; Dobson 2003) and others. The concepts have in common that they look at "behavior undertaken with the intention of having a positive (or less negative) effect" on the environment and/or society (Pepper et al. 2009, p. 126), while using approaches from various disciplines including economics, psychology, marketing and sociology to assess and motivate sustainable consumer behavior (Pepper et al. 2009; Jackson 2005). Note, that the terms environmentally friendly and socially responsible are used interchangeably in many studies and social responsibility often includes environmentally friendly behavior, e.g. in Tully & Winer (2014) and Mazar & Zhong (2010). Research includes studies of the trade-offs consumers are willing to accept when buying sustainable products, of incentives that trigger changes in behavior, and of ways of effectively communicating environmentally friendly and sustainable behaviors and products (Heiskanen & Pantzar 1997). Research has been conducted on the role that benefits to society or the environment play during the purchase decision as well as on the effects of pricing, advertising, social norms, certification and labelling on the willingness to purchase sustainable products and the willingness to pay for them (Tully & Winer 2014; Cai & Aguilar 2013; Horne 2009). McCarty & Shrum (2001) found, for example, that value orientations (locus of control, collectivism) affect the beliefs about the importance of

recycling, whereas economic status and individualism are related to beliefs about the inconvenience of recycling resulting in an interaction of these two beliefs that affect recycling behavior. Tully & Winer's (2014) meta-analysis of about 80 studies on socially responsible WTP detected that consumers's WTP was greater for products with a positive impact on human wellbeing than for products that with a positive effect on the environment.

Another way to look at sustainable consumption is the examination of barriers that inhibit pro-environmental behavior including cognitive and emotional limitations such as the non-immediacy of many ecological problems, the slow pace of environmental destruction, the resistance against non-conforming information, higher prices, convenience, making excuses and free-riding, etc. (Kollmuss & Agyeman 2002, pp. 253–255; Brown & Wahlers 1998).

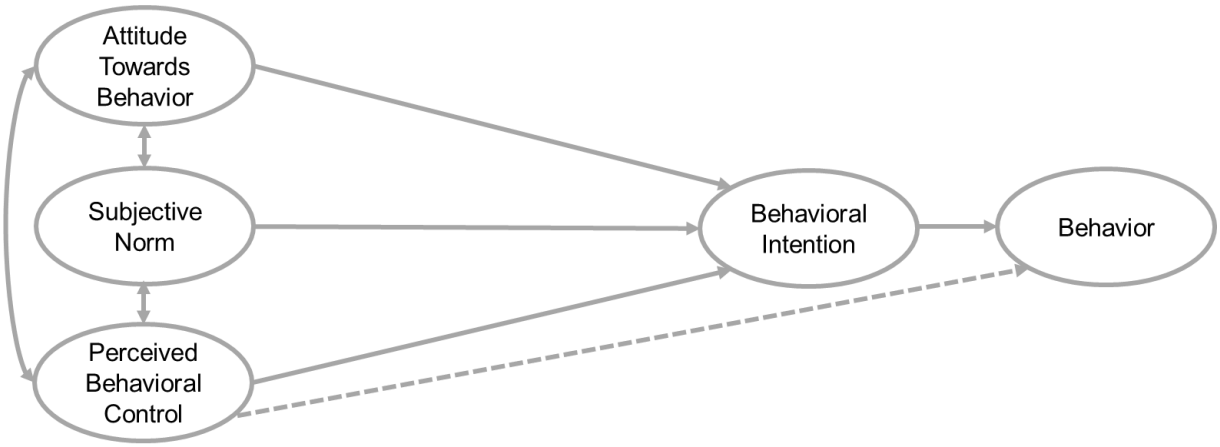


Figure 4: Theory of Planned Behavior
Figure taken from Ajzen 1991

A central issue sustainable consumption research has to deal with is the attitude-behavior gap that is also referred to as discrepancy. Various explanations and theories have been offered to reduce this gap including the Theory of Planned Behavior (TPB) (Ajzen 1985) and the Model of Responsible Environmental Behavior (Hines et al. 1987) which is based on the TPB. The mentioned theories interpose variables between attitudes and the resulting behavior in order to better predict the outcome. In the TPB, these variables include attitude towards the behavior, subjective norm, and perceived behavioral control that affect the behavioral intention which in turn affects behavior (Ajzen 1991; Figure 4). In their meta-analysis of 128 pro-environmental behavior studies Hines et al. (1987) found effects of the following variables on pro-environmental behavior: attitudes, locus of control, and individual sense of responsibility feed into the personality factor that interacts with knowledge of issues, knowledge of action strategies and action skills which affect the intention to act (Figure 5).

Ultimately, the intention to act and situational factors such as economic constraints and social pressures affect pro-environmental behavior (Kollmuss & Agyeman 2002; Hines et al. 1987). The relationships between attitudes, intentions and behavior were found

to be weak in the TPB presented by Ajzen as well as in Hines et al.'s meta-analysis (Kollmuss & Agyeman 2002). However, both frameworks offer approaches that illustrate the complexity of the relationship between attitudes and behavior.

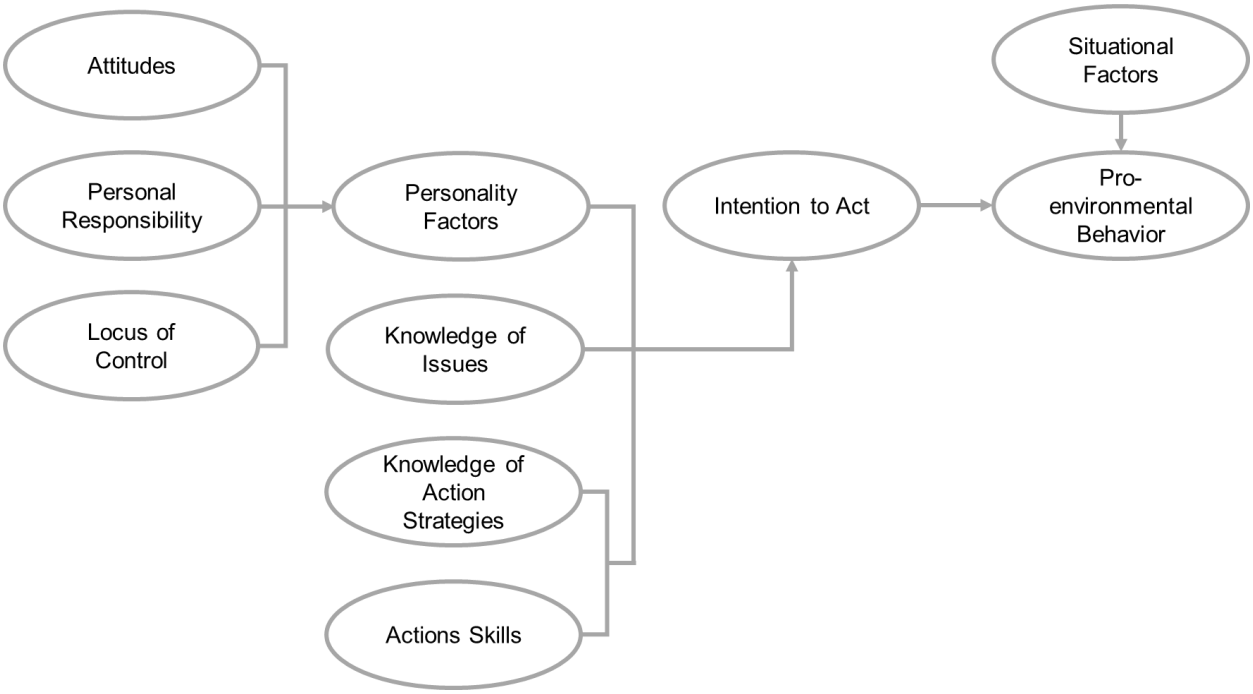


Figure 5: Hines et al.'s Model of Responsible Environmental Behavior
Figure taken from Kollmuss & Agyeman 2002; Hines et al. 1987

Blake (1999) puts the focus on barriers and constraints that may inhibit pro-environmental behavior by distinguishing three barriers that interact with each other (Figure 6): (1) The "individuality" barrier consists of attitudes, interests, characteristics such as laziness and individual desires that may overcome an individual's environmental concern and, thus, inhibit pro-environmental behaviors. (2) The second barrier "responsibility" is similar to the perceived behavioral control in the TPB or the locus of control that Hines et al. (1987) applied in their model. The responsibility barrier includes the feeling of not being responsible as well as the feeling of not being able to change something. (3) The "practicality" barrier stands for institutional and social factors such as lack of time, information, money and encouragement.

Even though the effect of attitudes on behavior was reported to be low in many studies and meta-analyses (Kollmuss & Agyeman 2002; Kaiser et al. 1999; Hines et al. 1987), attitudes are a well-researched and recurring element in the field of consumer studies (Kaiser et al. 1999): Researchers looked at the attitudes towards and the consumption of locally or regionally produced food products (Akaichi et al. 2013; Hu et al. 2010; Nurse et al. 2010; Banik et al. 2007; Henseleit et al. 2007; Wirthgen 2003). Furthermore, a number of studies report positive relationships between components of pro-environmental attitudes and (intended) behavior towards green, eco-friendly, climate-friendly and energy-saving and/or organic products as well as the willingness to pay for such products (Chen & Chai 2010; Aldrich et al. 2007; Bamberg 2003;

Laroche et al. 2001; Brown & Wahlers 1998; Minton & Rose 1997; Laroche et al. 1996; Grunert & Juhl 1995).

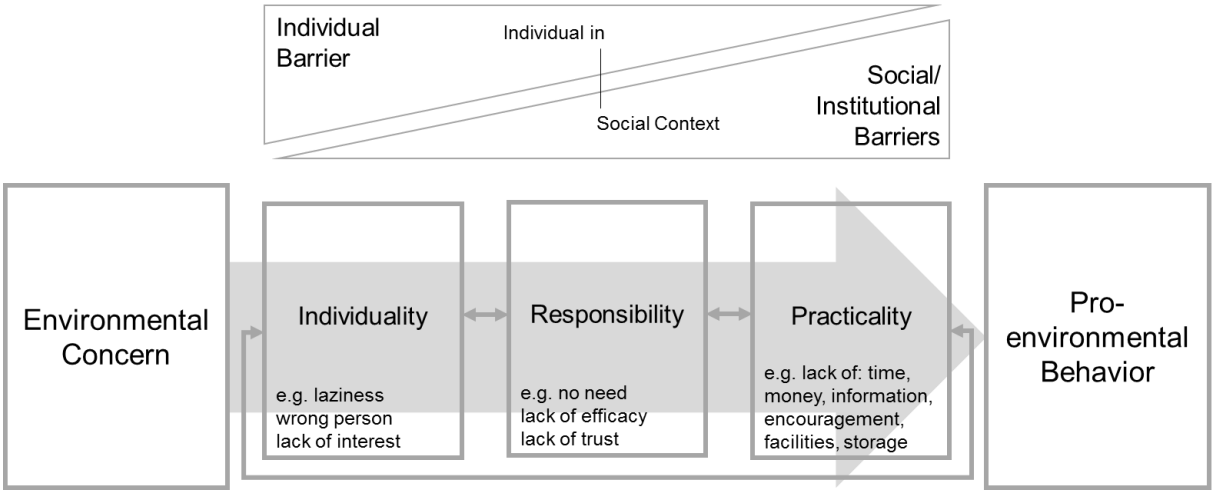


Figure 6: Blake's barriers of pro-environmental behavior
Figure taken from Kollmuss & Agyeman 2002; Blake 1999

The theoretical framework of this study consists of the following factors from the Theory of Planned Behavior by Ajzen and the Model of Responsible Environmental Behavior by Hines et al. that are applied in the context of sustainable consumption of biopolymer products:

- Attitudes: In this study, general attitudes towards biopolymers and renewable resources as well as attitudes towards environmentally friendly and regionally produced products are measured.
- Knowledge of issues: Participants' understanding of and familiarity with biopolymers are assessed.
- Knowledge of action strategies: GREEN Consumer Values (Haws et al. 2010) evaluate whether participants are familiar with the effects of their purchase behavior on the environment, where high scores on the GREEN Consumer Value scale indicate positive attitudes towards environmentally friendly behaviors.
- Pro-environmental behavior is determined with the dependent variable willingness-to-pay (see chapter 4.1).

The role of information that Blake mentions as one of the "practicality" barriers for pro-environmental behavior, is the focus of this study (see chapter 4.2).

3.2. Consumer attitudes and behavior towards biopolymer products

Until now, few scientific studies deal with consumers' familiarity with biopolymer products and their attitudes and behavior towards these products, and only Kurka (2012) assessed consumers' familiarity with biomass-based plastics. He found that

about 54 % of 289 German subjects knew something about the availability of bioplastic bags in 2009 and that about 46 % were familiar with types of plants that are used for biopolymer production (Kurka 2012, p. 63). So far, hypothetical choice experiments reported consumers' willingness to buy biodegradable biomass-based products and their willingness to pay (more) for them (Gabriel et al. 2012; Kurka 2012; Barnes et al. 2011). In these hypothetical studies, participants were not directly confronted with biomass-based products, but saw pictures and/or descriptions of the potential products. Barnes et al. (2011) found that participants of a choice experiment conducted in Hawaii, USA, were willing to pay a small premium for locally produced sugar cane-based food containers compared to conventional, fossil-based styrofoam containers. Gabriel et al. (2012) applied a hypothetical choice experiment to assess consumers' willingness to pay for biomass-based planting pots. Their findings suggest that consumers in Bavaria, Germany, are willing to pay 10 to 38 Cents more for biomass-based planting pots and consumers' willingness to pay for biodegradable planting pots was also higher than for conventional plastic pots. Yue et al. (2010) conducted two experiments with biomass-based, biodegradable planting pots that also included different shares of recycled material. A hypothetical conjoint analysis and a non-hypothetical auction experiment were performed in California and Texas, USA. Compared to the conventional plastic planting pot, participants were willing to pay a premium for biomass-based and recycled planting pots in both methods, but the actual premiums were higher in the auction experiment. The authors attribute this to the fact that auction participants could better estimate the quality of the biomass-based products because they saw and touched the real products, whereas participants of the conjoint analysis only saw pictures and received theoretical information (ibid.). Apart from the above introduced studies that dealt with packaging products, Kurka (2012) assessed consumer behavior towards a biomass-based consumer product: In a hypothetical discrete choice experiment participants from the Netherlands, Germany and Sweden stated a higher willingness to pay for a mobile phone with a biomass-based plastic case than for a fossil-based case. Differences in willingness to pay could be attributed to the participants' home country, their attitude towards the environment and their health consciousness (ibid.).

In summary, the above mentioned studies suggest that consumers are willing to pay small premiums for biomass-based and biodegradable products and packaging as well as for recycled products - often depending on the share of waste material included in the product. These findings are supported by a meta-analysis of 80 studies of willingness to pay for socially and environmentally responsible products that concludes that consumers are willing to pay a premium for such products, with a higher premium for socially responsible products than for environmentally responsible ones (Tully & Winer 2014). Casadesus-Masanell et al. (2009) found that customers of the sportswear producer Patagonia paid substantial premiums for clothing when the company switched from conventional to organic cotton informing their customers about the healthier production conditions for cotton workers amongst others. However, there is also literature suggesting that consumers will only pay a price premium for

environmentally friendly products if they are of equal or superior quality compared to the conventional product (Olson 2013) and that consumers are not willing to pay a premium at all (Barber et al. 2014). Scientific research, further suggests that the country or place of resource origin affects product perception, purchase intentions, behavior towards products, and willingness to pay (Koschate-Fischer et al. 2012; Barnes et al. 2011; Okechuku 1994; Hong & Wyer 1989). Especially in the food sector, the local or regional origin of a food product affects consumers' willingness to pay, because better product quality, freshness and support of the local economy are attributed to local origin (Akaichi et al. 2013; Grebitus et al. 2013; Banik et al. 2007).

Taking the findings from the above cited studies into account, the following hypotheses are to be tested in this work:

Hypothesis 1: *Participants' willingness to pay for a biomass-based product is significantly higher than for the conventional equivalent.*

Hypothesis 2: *Information on climate and environmental effects of biopolymer production significantly affect WTP.*

Hypothesis 3: *WTP for a product that uses resources from the region (Bavaria) exceeds WTP for a biopolymer product with unknown/distant origin.*

Hypothesis 4: *WTP is equal or higher after participants learned about quality and durability characteristics of biopolymers because of the additional utility that is provided by the biomass-based raw material.*

All mentioned studies concerning biomass-based plastic products but Yue et al. (2010), presented hypothetical products to the participants and measured their hypothetical behavior. Such an approach requires a lot of thinking and imagination from the study participants. The future product may exist on a picture, but participants of hypothetical experiments do not have the opportunity to touch, test and experience the product they are asked to evaluate. However, researchers receive a first feedback about consumers' overall impression of the product with such a hypothetical approach.

Experiments in the field or in laboratory settings in which participants are confronted with real products are a promising alternative to completely hypothetical ways of eliciting consumer behavior. In the field of agricultural economics, experimental auctions have been applied quite often since the 1980s and, today, represent an established and recognized non-hypothetical method (Corrigan et al. 2009; Lusk & Shogren 2007; Corrigan & Rousu 2006; Adler 2003). Findings from experimental auctions include the effects of preferences (Lusk et al. 2006), information (Akaichi et al. 2013; Roosen et al. 2011; Yue et al. 2010; Rousu et al. 2005; Camacho-Cuena et al. 2004; Fox et al. 2002), labels (Lusk et al. 2005; Huffman et al. 2003), prior experience (Bernard & Schulze 2005) and prior beliefs (Huffman et al. 2007) on the

willingness to pay for (food) products. Until now experimental auctions have been used especially in the field of food marketing and research (Alfnes 2007). So far, auctions with non-food products mostly served the purpose of theory testing or the study of procedures and mechanisms and were not explicitly implemented to study the willingness to pay for such products (Lusk & Shogren 2007, pp. 7–14).

4. Definition and determinants of willingness to pay

The following chapter provides the theoretical background for the elicitation of willingness to pay which is a common measure of the economic value that consumers are assumed to attribute to a product or service. Furthermore, selected determinants are listed and discussed that have been found to affect willingness to pay in the context of sustainable consumer behavior.

4.1. Willingness to pay

Willingness to pay (WTP) quantifies economic value that can be positive, zero or negative and is dependent on consumers' certainty or uncertainty about the quality of the product or service (Lusk & Shogren 2007, p. 34).

WTP is an important variable in the fields of marketing, economics and psychology. The elicitation of WTP is essential to estimate demand and to design optimal pricing schedules (Wertenbroch & Skiera 2002), to formulate competitive strategies, to conduct value audits and to develop new products (Anderson et al. 1993), to understand demand for products, services and technologies (Lusk & Shogren 2007) as well as to assess consumer preferences (Barnes et al. 2011) and to implement pricing tactics (Miller et al. 2011) among others. In this work, WTP is used according to this definition:

> The WTP denotes the maximum price a buyer is willing to pay for a given quantity of a good. It is a ratio-scaled measure of the subjective value the buyer assigns to that quantity. (Wertenbroch & Skiera 2002, p. 228)

The definition emphasizes that the value a person attributes to a product evolves from the quality one attributes to the product, and that this value is subjective or homegrown, i.e. the product value is assessed by the individual who takes their current situation and needs into account.

In the case of evaluating products consisting of renewable resources, consumers are unfamiliar with the quality of these products because it is very likely that they have not had the opportunity to use them in the past. Thus, they cannot be certain that the biomass-based product is of equal or better quality compared to the conventional, often well-known product. But according to expected utility theory each consumer knows which utility U he or she derives from a product: be it high quality $U(y, q_h)$ or low quality $U(y, q_l)$, where $U(y, q_h) > U(y, q_l)$ for all levels of income y (Lusk & Shogren 2007, p. 37). As the consumer is uncertain about the utility that he or she will derive from consuming the product the expected utility EU is calculated by means of the probability p (Lusk & Shogren 2007, p. 38):

$$EU = pU(y, q_h) + (1 - p)U(y, q_l)$$

where p is the probability of deriving high quality and $(1 - p)$ is the probability of deriving low quality from the product. WTP is the amount a person would be willing to pay to obtain the high quality product with $\mathrm{p} = 1$ or in other words it is the

> amount of money that makes a person indifferent between having the high quality good for sure and playing the gamble of consuming the [low quality] good (Lusk & Shogren 2007, p. 38).

This indifference can be described with the following equation (ibid.):

$$U(y - WTP, q_h) = pU(y, q_h) + (1 - p)U(y, q_l)$$

The preceding derivations act on the assumption that new information on the probability is added or subtracted one to one from the (expected) utility. This assumption does not take into account that people use various information sources including prior beliefs, prior experiences, advertisements and attitudes to estimate the probability of deriving high quality from a product (Lusk & Shogren 2007, p. 39). All this information summarized as prior beliefs $\tilde{p}$ affect the expected utility of a product (ibid.):

$$EU = \tilde{p}U(y, q_h) + (1 - \tilde{p})U(y, q_l) \quad (1)$$

Following Bayes Theorem the probability that a new information p' positively affects prior beliefs $\tilde{p}$ is described as (Chalmers et al. 2007, p. 142):

$$P(\tilde{p}|p') = \frac{P(p'|\tilde{p}) \cdot P(\tilde{p})}{P(p')}$$

where

- $\mathrm{P}(\tilde{\mathrm{p}}|\mathrm{p}')$ is the probability of keeping up positive prior beliefs $\tilde{p}$ under the condition of positive new information p',
- $\mathrm{P}(\mathrm{p}'|\tilde{\mathrm{p}})$ is the probability of receiving positive new information given one's prior beliefs,
- $P(\tilde{p})$ is the prior probability of having positive prior beliefs, and
- $P(\mathrm{p}')$ is the prior probability of receiving positive new information.

Taking into account that the effect of new information is contingent on the relative importance a person attributes to the new information and to their prior beliefs, a person's belief in the likelihood of a good outcome after receiving the new information is

$$\hat{p} = \frac{\alpha\tilde{p} + \beta p'}{\alpha + \beta} \quad (2)$$

where α is the weight assigned to prior beliefs and β is the weight put on the new information. (Lusk & Shogren 2007, p. 39, formula derived from Viscusi 1989, p. 239)

Incorporating equation (2) in equation (1) the expected utility under the condition of prior beliefs and new information yields (Lusk & Shogren 2007, p. 39):

$$EU = \left(\frac{\alpha\tilde{p} + \beta p'}{\alpha + \beta}\right) U(y, q_h) + \left(1 - \frac{\alpha\tilde{p} + \beta p'}{\alpha + \beta}\right) U(y, q_l) = U(y - WTP, q_h) \qquad (3)$$

At the same time, equation (3) equals the WTP of a person for deriving good quality from a product with certainty, and shows that if the new information does not affect a person's beliefs, i.e. $\beta = 0$, their WTP does not change. Apart from the uncertainty about the utility of a product, WTP is also dependent on the commitment cost that participants face. Commitment costs derive, for example, from the fact that the purchase has to be made on the day of the experiment or survey and that the participant forgoes the opportunity to collect more information about the product in the future (Zhao & Kling 2004, 2001). In such a case, WTP represents the value of the product minus a cost for information that the participant could have received in the future. Commitment costs are also present in everyday purchases as consumers always make the choice between buying a product in order to consume it, or not buying a product to have the opportunity to increase information about a product in the future and with it the perceived value of the product (Lusk & Shogren 2007; Zhao & Kling 2004, 2001).

4.2. Information effects

Information is often included as a variable in equations to determine utility, economic value and willingness to pay, as shown in the previous chapter. However, the effect of information is difficult to measure because it is dependent on various factors such as the recipient's level of involvement with a product, the level of prior information about a product and the structure of the self (Kroeber-Riel & Gröppel-Klein 2013; Cross & Madson 1997).

> What makes information effective is [therefore] not so much its accuracy and completeness as the extent to which it captures the attention of the audience, gains their involvement, and overcomes possible skepticism about its credibility and usefulness for the recipient's situation. However, even information programs that are carefully designed to achieve these objectives produce only modest short-term behavioral changes. […] In short, information alone can, if carefully designed and delivered, change certain kinds of environmentally significant consumer behaviors to a modest extent. However, little or no effect has been achieved when there are

> important barriers to action external to the individual, such as significant financial cost or inconvenience. (Stern 1999, pp. 467–468)

Nevertheless, information about a product is important for the successful market introduction and penetration of products, especially when consumers are hardly familiar with a new product. In the case of durable biopolymer consumer products, it can be assumed that consumers are better able to evaluate the products when given access to specific information. Specific information is even more relevant as biopolymer products are credence goods, i.e. they look and feel like conventional plastic products and there is no way for consumers to actually verify the biomass-based origin. Hence, consumers are dependent on trustworthy information about the product ingredients and characteristics in order to make a purchase decision that is in line with their preferences and attitudes (Verbeke 2010; Darby & Karni 1973). But information will only be effective if it addresses well-defined information needs and if the recipient is open to that information (Verbeke 2010; Wilson 2006).

A number of recent studies in the field of consumer behavior look at the various effects of information on WTP, including the information content (Hoevenagel & van der Linden 1993), the information source (Frewer et al. 1998), the personal relevance attributed to an information piece (Roosen et al. 2011; Ajzen et al. 1996), the combination of label and information (Chen et al. 2014; Huffman et al. 2003) and prior familiarity with and initial attitudes towards a product: In the field of food research, Lusk et al. (2004c) found that consumers with a negative initial attitude towards genetically modified food were less affected by positive information than consumers with positive initial attitudes. According to Maloney & Ward (1973) and Hines et al. (1987) specific attitudes towards products or behaviors are likely to manifest in behavior, whereas general pro-environmental attitudes or concerns do not necessarily translate into pro-environmental behavior. Furthermore, specific positive attitudes can act as facilitators of sustainable consumption (Tanner & Wölfing Kast 2003). Huffman et al. (2007) determined that WTP of uninformed consumers for genetically modified food was affected by information, whereas information had no significant effect on WTP of consumers who were already familiar with genetic modification.

Hypothesis 5: *Prior familiarity with biopolymers and initial attitudes towards biopolymers affect willingness to purchase and willingness to pay for biopolymer products.*

The information content is another important aspect when talking about information effects: favorable/positive information about a good results in an increase of WTP, whereas unfavorable/negative information reduces WTP and if ambiguous information is displayed, negative aspects override the positive ones and lead to a reduction of WTP (Depositario et al. 2009; Fox et al. 2002). Apart from information in form of a text, a label is an efficient way of information that easily catches the eye and is better remembered than a text (Trommsdorff 2009, p. 71). Studies in various product

categories found evidence that consumers are willing to pay more for products that are labelled eco-friendly or energy-saving (Ward et al. 2011; Bougherara & Combris 2009; Sammer 2008; Veisten 2007). However, labelling has to be seen in the context of various limitations, i.e. rebound effects, information overload, the attitude-behavior-gap as well as habits and norms that often negate the positive intentions of a label (see review by Horne 2009).

Hypothesis 6: *Participants who are confronted with a label on the biopolymer products are willing to pay more than participants who are informed about the biopolymers via a text.*

The above cited studies illustrate the variety of information effects and underline that the provided information has to meet consumers' information needs. Considering that biopolymers constitute a credence good, adequate information seems even more important. Therefore, the effects of specific, consumer-relevant information on the willingness to pay for durable biopolymer consumer products were measured and analyzed in this study.

5. Methods

Besides conducting computer-based consumer surveys in a prestudy, an experimental method was applied for data collection: An auction experiment was conducted in a computer laboratory that assessed participants' WTP for two biopolymer products after information administration over 3 consecutive auction rounds. The experimental setup allowed to measure cause and effect relationships of selected variables while experimental conditions and inputs were clearly defined and controlled. Thus, the effect of an input in form of an information package could be described and quantified because all other influencing parameters were kept constant. The reasons for the choice of an experimental method as well as the specific characteristics of this method will be explained in this chapter. Furthermore, the specific shape of the data due to the experimental method requires particular statistical analyses because bids are censored at zero.

5.1. Value elicitation method: experimental auction

Approaches to elicit WTP for products are basically divided into stated preference methods and revealed preference methods that measure WTP, both, directly or indirectly (Table 4). Stated preference methods are usually based on surveys that hypothetically elicit consumers' WTP using different types of choice experiments and hypothetical valuations to assess values of products and product attributes. Revealed preference methods analyze scanner and market data from actual product and service purchases, and gather data through (field) experiments. (Lusk & Shogren 2007; Hanley et al. 1997)

Table 4: Approaches that elicit WTP

	Hypothetical/ stated preference	**Non-hypothetical/ revealed preference**
Direct	- Open-ended questions (OE) - Payment cards - Dichotomous choice (DC) - Double-bounded referendum - Bidding game - Contingent valuation	- n^{th}-price auction - Random n^{th}-price auction - English auction - Becker-DeGroot-Marschak mechanism (BDM) - Scanner data
Indirect	- Choice-based conjoint analysis (CBC)	- Incentive-aligned choice-based conjoint Analysis (ICBC)

Summary of Miller et al. 2011, p. 173, Hanley et al. 1997, pp. 386–387, supplemented

Each approach has specific advantages and shortcomings that are listed in Table 5 and may not always allow for an accurate measure of WTP. Hypothetical methods may lead to hypothetical bias because participants may overestimate their WTP as they will not have to pay for the product, or they may underestimate the product value on purpose in an attempt to reduce future market costs (Bishop & Heberlein 1979). The fact that the purchase decision process in a survey may not represent an actual purchase decision process because participants do not usually buy the product or

because they do not have the usual time for the decision may also result in hypothetical bias (ibid.). Revealed preference methods in form of an experiment may lack market feedback and may differ from an actual purchase decision because participants are often expected to name the product prices themselves, instead of making their purchase decision based on a fixed price.

Table 5: Benefits and downsides of stated and revealed preference methods

	Stated preference	**Revealed preference**
Advantages	- Evaluation of non-existing products - Flexible scenarios/ contexts	- Real consumer choices - Evaluation of existing products - Incentive-compatible
Disadvantages	- Hypothetical evaluation - Hypothetical bias, possible manipulation - Inconsequential - Lack of budget constraints and real market feedback	- Indirect evaluation (requires simplification) - Lack of context information about budget constraints, market feedback, etc.

Summary of Lusk & Shogren 2007, pp. 2–3

Experimental auctions combine the advantages of revealed and stated preference methods and reduce their disadvantages by providing real consumer values and real consequences for decisions. However, an experimental auction has one specific disadvantage which is the unreal purchase situation: An auction experiment usually takes place in a market with a limited number of products which is a huge contrast to real purchase situations (Adler 2003). Most experimental auction methods also require an extra effort from the participants because they have to name the product value themselves. One particular advantage of auction experiments is the monetary incentive to bid one's true value (Lusk & Shogren 2007, p. 4).

This monetary incentive equals a surplus that arises from the difference between the market price and a person's bid: if the market price is lower than a person's bid she only has to pay the market price to buy the product. Participants cannot influence the size of this monetary incentive because it is decoupled from their personal bid. Only the interaction of one's bid with bids from other participants or a randomly drawn price defines the size of the surplus after the bidding. Consequently, "each bidder has a weakly dominant strategy to bid equal to their value" (Lusk & Shogren 2007, p. 19).

Bidding according to this strategy maximizes the chances of winning a product at a price one finds appropriate. Overbidding, i.e. bidding more than one's true value and underbidding, i.e. bidding less than one's true value, can have tangible and immediate effects. The consequence of overbidding may be a negative surplus: One has to pay more than their true value for a product if the market price is below one's bid but above one's true value. When underbidding, a person might not be able to buy the product even if the market price was below the person's true value because their bid was below

the market price. The consequence of underbidding may be not receiving a product although one's true product value exceeded or was equal to the market price. (Shogren et al. 2001)

Hypothetical bias that often occurs in hypothetical choice experiments is less likely in an auction experiment. Participants are less likely to overestimate their value in an auction because monetary consequences for overbidding arise immediately. In a meta-analysis List & Gallet (2001) found that on average participants in hypothetical experiments overstate their values by factor three compared to non-hypothetical settings. Cummings et al. (1995), Lusk & Schroeder (2004) and Silva et al. (2007) drew similar conclusions.

An additional factor that ensures that participants bid their true values when playing multiple rounds in one experiment or when two or more products are offered simultaneously, is the random drawing of one binding round and/or product at the end of the experiment. As bidders do not know which product from which round will actually be sold after the experiment, they are forced to always bid their true value to have the highest chance of winning (Lusk & Shogren 2007). Furthermore, this method prevents demand reduction as participants know that they would buy one unit of a product at most (ibid.).

Auction mechanisms that offer an ideal bidding strategy and that provide consequences for bidders who deviate from their true values are called incentive-compatible. Incentive-compatible experimental auctions are applied to study preferences, to test theories, to understand hypothetical bias, to further develop auction methods, to elicit homegrown values, etc. (Lusk & Shogren 2007, p. 6). The application of experimental auctions to elicit homegrown values offers marketing research a promising method to assess consumer values for new products. Dependent on the research question, experimental auctions can be applied in field or laboratory settings allowing for different levels of control through the experimenter. A field setting is appropriate to elicit values for products that consumers are familiar with (id.). For the elicitation of values for innovative products where background information is necessary a laboratory setting allows for more control of outside influences such as field prices, product substitutes, market feedback and information processing (Lusk & Shogren 2007, p. 15).

The incentive-compatible auction mechanisms differ in the way the bids are collected, in the way the market price is determined, in the availability of market feedback, in the number of winning bidders and in the minimal number of required participants (Table 6) and are therefore applicable in different experimental settings. The BDM mechanism is very convenient in field settings because only one participant has to play and the market price can be determined quickly, whereas a random n^{th}-price auction is more appropriate in a laboratory setting because the calculation of the market price requires some time.

Table 6: Characteristics of incentive-compatible auction mechanisms

	Auction Mechanisms			
	n^{th}-price / 2^{nd}-price	Random n^{th}-price	Becker-DeGroot-Marschak (BDM)	English
Bidding procedure	Simultaneously submit sealed bid			Sequentially offer ascending bids
Market price	n^{th}-highest bid / 2^{nd}-highest bid	Randomly drawn price		Last bid offered
Market feedback	Yes, if multiple rounds are played and if desired by experimenter		No	Yes
Winning bidder(s)	Bidders with bids greater than market price / Bidder with highest bid	Bidders with bids greater than market price		Bidder of last bid
Number of winners	n-1 / 1	n-1	Individually determinded	1

Lusk et al. 2004b, p. 391, modified

Finally, the study method has to be chosen primarily according to the study goal and the sample size taking into account financial limitations, time frames and others. Since the purpose of this study was to determine the effect of information packages on WTP a controlled setting in the laboratory was preferred that enabled equal access of the participants to the information packages, especially considering that biopolymers were new to most participants. As many participants as possible should be involved in the bidding in order to receive realistic outcomes. Thus, off-margin bidders, i.e. participants who bid far from the market price as well as on-margin bidders who bid rather close to the market price had to be engaged (Lusk et al. 2004a; Shogren et al. 2001). A similar involvement of on-margin and off-margin bidders is commonly reached if participants know from the start that about half of the participants per session will win a product (Nayga [Jr.] et al. 2012), therefore an n^{th}-price auction-mechanism was chosen. To ensure the availability of the products in the run of the experiment the number of winners were determined prior to the experiment. Considering all the surrounding conditions and the study goals an 8^{th}-price auction was selected for this study.

5.2. Censored regression: Tobit model

A regression model estimates the effects of independent variables or regressors on the dependent variable. In other words: the dependent variable is explained by the independent variables. In case of this study, the independent variables “prior familiarity with biopolymers”, “prior attitudes towards biopolymers”, “attitudes towards biopolymers and renewable resources”, as well as a variety of information packages and socio-demographic characteristics are expected to affect the dependent variable “willingness to pay”. Censored regression models are necessary to correctly analyze

statistical data which is limited above and/or below a certain value. Common ordinary least squares (OLS) and linear regression models would lead to bias if applied to censored data because they do not take these limits into account (Brüderl 2000). Censored regression models are applicable to left- and right-censored data as well as to two-sided censoring from right (i.e. above) and left (i.e. below). In general, the censored regression model is written as

$$y_i^* = x_i'\beta + \varepsilon_i$$

$$y_i = \begin{cases} a & if\ y_i^* \leq a \\ y_i^*\ if\ a & > y_i^* < b \\ b & if\ y_i^* \geq b \end{cases}$$

where y_i^* is the i[th] unobserved or latent variable, x_i is the vector of independent variables, β is the vector of unknown parameters and ε_i is the disturbance, while a is the lower limit and b is the upper limit (Henningsen 2012, p. 2).

The Tobit model constitutes a special case of the censored regression model where the dependent variable y is left-censored at zero (Henningsen 2012, p. 2; Tobin 1958):

$$y_i^* = x_i'\beta + \varepsilon_i \tag{4}$$

$$y_i = \begin{cases} 0 & if\ y_i^* \leq 0 \\ y_i^* & if\ y_i^* > 0 \end{cases}$$

The log-likelihood method is typically applied to estimate censored regression and Tobit models. The log-likelihood function assumes that the disturbance ε is normally distributed with a mean equal to zero and a variance σ^2 (see Greene 2012; Henningsen 2012; Lusk & Shogren 2007). The coefficients represent the *mean* change of the latent variable for a one-unit change of each independent variable, while all other variables are kept constant. Marginal effects indicate the *expected* change of the dependent variable when the independent variable changes marginally by one unit (Henningsen 2012; Golder 2006). The data from this study is left-censored at zero because participants could not enter bids below zero[1]. Thus, a Tobit model was required to estimate the mean effects of information, attitudes and socio-demographics on the dependent variable WTP. In the case of this study, one could also speak about a corner solution model instead of a censored regression model, because all data for the dependent variable were indeed observed as strictly positive values where the ideal strategy for some participants was to bid zero (Golder 2006).

[1] A negative bid would have corresponded to the concept of willingness to accept (WTA). Contrary to WTP subjects provide the amount they want to be paid in order to accept a product. (Lusk & Shogren 2007, p. 38)

5.3. Data set structure

Another particularity of the auction data set is due to the three consecutive bids that were collected from each participant. Thus, the data set consists of three observations per participants from three points in time which correspond to three different information inputs. Data that contains two or more observations per unit over time is defined as panel data, cross-sectional time series data or longitudinal data (Dougherty 2011). Table 7 depicts a fictional example of a panel data set.

Table 7: Example structure of a panel data set

Bioplastic type (unit)	Year (time)	Production capacity [t]	Price/t [€]
Polyamide	2011	500,000	5,600
Polyamide	2012	550,000	5,200
Polyamide	2013	700,000	4,800
PE	2011	1,002,000	2,500
PE	2012	1,050,000	2,500
PE	2013	1,500,000	2,100
PET	2011	1,100,000	1,600
PET	2012	990,000	1,200
PET	2013	1,200,000	900
Corn starch-based biopolymer	2011	75,000	4,500
Corn starch-based biopolymer	2012	89,000	4,400
Corn starch-based biopolymer	2013	125,000	4,400

According to Dougherty (2011, pp. 408–409) panel data sets have the following advantages compared to cross-sectional data: Dynamics may be revealed that are difficult to determine with cross-sectional data and bias from unobserved effects may be eliminated.

Panel data regression models are commonly written as (Schmidheiny 2014, p. 1; Baltagi 2008, p. 12):

$$y_{it} = \alpha + \beta X_{it} + \gamma Z_i + \mu_i + \nu_{it} \qquad (5)$$

where the subscript $i = 1, \dots, N$ defines the individual or unit, and the time periods are defined by $t = 1, \dots, T$; α is a constant, β and γ are vectors of unknown parameters, X_i is the matrix of time-varying independent variables, Z_i is the matrix of time-invariant independent variables, μ_i represents a time-invariant individual effect and ν_{it} is the remaining disturbance also termed idiosyncratic error.

Depending on the size and structure of a data panel, complex hierarchical analysis can be necessary, but in less complex panels regression analysis is applicable. Panel data that only varies between a small number of points in time and/or units can also be

written as a regression model with dummy variables for time and/or analytical units (Cameron & Trivedi 2005, p. 700). In case of this study, only three time-varying independent variables exist. They consist of three information packages that the participants receive consecutively in the three auction rounds. Accordingly, the Tobit model to calculate this particular auction experiment can be written as

$$y_i^* = \alpha + \beta_1 t_1 + \beta_2 t_2 + \gamma Z_i + \varepsilon_i$$

$$y_i = \begin{cases} 0 & if\ y_i^* = 0 \\ y_i^* & if\ y_i^* > 0 \end{cases}$$

where α is a constant, t_1 and t_2 are (time) dummies that represent auction rounds 2 and 3, respectively, β_1 and β_2 are unknown parameters, $\gamma_1 Z_i$ represent a matrix of time-invariant individual variables and their parameters, and ε_i is the disturbance. If both dummy variables equal zero, the dependent variable for auction round 1 is calculated.

In recent literature, such a procedure has been applied repeatedly. Dummy variables have been employed to account for different points in time during auction experiments by e.g. Bieberstein et al. (2013), Akaichi et al. (2012), Roosen et al. (2011), Jaeger et al. (2004) and Huffman et al. (2003), allowing to calculate (Tobit) regressions for data sets that contain a small number of consecutive observations per individual or unit.

6. Study design

The selection of the study design is defined by the study goals and research hypotheses. Due to the lack of findings from previous studies about consumer estimations of biomass-based products the prestudy had to provide a basic assessment of consumers' knowledge of and experience with biopolymers. The prestudy was further applied to determine the content of the information packages that were to be tested in the main study. The main study constituted an auction experiment that offered considerable control to the experimenter and gave participants the opportunity to experience actual biopolymer products.

6.1. Prestudy: Online consumer survey

An online survey was conducted in May and June 2013 to gather what consumers think about biopolymers and what they want to know about them. Furthermore, information about biopolymers that consumers are interested in was determined. Participants were asked to answer the 10-minute-questionnaire via mailing lists, social media and a call in a local newspaper. The survey was programmed and conducted with the open source software LimeSurvey (www.limesurvey.com). The questionnaire consisted of different sections that were dedicated to the following questions:

- How do consumers define biopolymers?
- What information about biopolymers is relevant to consumers?
- What are consumers' attitudes towards sustainable consumption?
- What attitudes do they have towards biopolymers and renewable resources?

6.1.1. Questionnaire design

The complete questionnaire used in the survey is provided in Appendix 2a. The questionnaire started with an open question: "What are bioplastics[2]? Please name features and characteristics of bioplastics." Thus, the current understanding of biopolymers was assessed. Another open question asked participants what information about biopolymers they would like to receive. Then, a 5-point semantic differential was used to gather participants' opinion about biopolymers: participants were asked to point out what characteristic described bioplastics from antithetic word pairs such as "climate friendly – harmful to the climate", "cheap – expensive", "environmentally sound – negative impact on the environment". Subsequently, a definition of biopolymers was provided in order to ensure an equal knowledge basis of all participants for the remaining part of the survey. Participants were asked to state biopolymer products they had bought in the past 12 months, and a 5-point Likert scale (1 = "do not agree at all"; 5 = "totally agree") was used to assess consumers' attitudes towards sustainable consumption that were provided in three statement batteries. These included attitudes towards environmentally friendly and regionally produced

[2] The term bioplastics was used when communicating with participants, because the technical term biopolymers might have led to more confusion and misunderstandings.

products, attitudes towards biopolymers and renewable resources as well as GREEN Consumer Values.

Attitudes towards environmentally friendly and regionally produced products (AER) were measured with selected statements from the literature (Kurka 2012; Schoeberl 2012; Brown & Wahlers 1998), e.g. “I prefer to buy environmentally friendly products”, “I am willing to pay more for environmentally friendly products”, “I buy products made from regional resources”. Attitudes towards biopolymers and renewable resources (ABR) were measured with specifically developed statements as no scale seems to exist in the scientific literature that assesses these attitudes. Thus, statements were applied that included the impact of renewable resource use on environment and climate, the cultivation of renewable resources, the current food or fuel discussion and the climate debate. The statements included “I purposefully buy products from biogenic resources”, “The production of bioplastics induces an increase of monocultures”, “The use of biogenic resources reduces the use of fossil resources”, and “The cultivation of resources for bioplastics production reduces the area for food production”.

The GREEN Consumer Value (GCV) scale that was introduced by Haws et al. (2014; 2010) and is documented in Bearden et al. (2011, p. 171) was applied to measure consumers’ consciousness about their behavior, in particular. In order to make the scale more user friendly, the original 7-point scale was reduced to a 5-point scale. Furthermore, the two items “Instead of consuming more and more resources we should rather recycle and reuse as many materials as possible” and “When buying products, I think about the impact of their use on the environment” were added to the statement battery. At the end of the questionnaire, participants were asked to state socio-demographic characteristics such as age, gender, household size, income and education.

6.1.2. Statistical analysis

The prestudy was analyzed with SPSS software. The descriptive analysis included frequencies, medians, means and Pearson correlations. The answers to open questions were categorized in order to get an impression of participants’ understanding of biopolymers and relevant information about them. Factor analysis was conducted with the statements on attitudes towards biopolymers and renewable resources and with the extended GREEN Consumer Values. When statements loaded on the same factor, the statement with the lowest loading was deleted in order to reduce the number of similar statements and to shorten the questionnaire that was to be reused in the main study.

6.2. Main study: experimental auction

The main study was designed to answer the research questions that were developed in chapter 1. Due to consumers' lack of exposure to biopolymers, their low familiarity with biopolymers and their lack of experience with biopolymer products, a laboratory experiment seemed most appropriate. Thus, participants would build their opinion about biopolymers in a controlled environment that provided equal access to information for all participants. Outside influences were reduced to a minimum and all participants evaluated identical products after receiving identical and partly complex information. The effects of providing information about biopolymers were measured in terms of changes in participants' WTP.

6.2.1. Experimental design

Willingness to pay for the biomass-based products, sunglasses and toothbrush, was elicited with an 8th-price auction that consisted of four consecutive rounds per treatment. Overall, the design provided six treatments with 40 randomly assigned participants each. Every treatment was conducted in two sessions (20 participants each) that were evenly distributed between morning and late afternoon sessions in order to accommodate the working population. Table 8 gives an overview of the information packages assigned to the treatments and the complete information packages are provided in chapter 6.2.3. Orders of information packages varied between treatments to test possible order effects that were reported by Disdier et al. (2013) and Clark & Friesen (2008).

Table 8: Auction design

	Treatments					
Bidding Round	Control group 1	Control group 2	Text group 1	Text group 2	Label group 1	Label group 2
1	No Information		General Information		Label	
2	General Information		Climate Information	Durability Information	General Information	Climate Information
3	Climate Information	Durability Information		Climate Information		Durability Information
4	Biopolymers from biomass produced in Germany (Hypothetical WTP)					

After receiving an information package, participants simultaneously bid on both products in each round. In round 4, participants were asked to state bids for the following scenario:

Imagine the two products would have been produced with **sunflower oil from Germany**. As of today, bioplastic from sunflower oil is not available, but scientists are currently working on its development. What would you pay for the sunglasses and toothbrush, respectively that are made from **sunflower oil from Germany**?

Please note: This bidding round is excluded from the drawing of the binding round and binding product!

Bidding round 4 was excluded from the drawing of the binding round because the question was hypothetical: the offered products did not consist of sunflower oil from Germany and, thus, the offered bids could not be attributed to the sample products. After round 4, the product that was actually sold to the seven highest bidders was randomly determined. Two participants were asked to draw the binding product and the binding round from two baskets. The basket with the product lots consisted of 14 lots – seven sunglasses and seven toothbrushes lots. In each of the 12 sessions one lot was removed. Thus, the binding product was randomly drawn in each session, but the total number that would be sold of each product was predetermined and allowed an accurate calculation of the number of products that needed to be bought for the experiment. The basket of round lots consisted of three lots – one for each of the first three bidding rounds.

The experiment was programmed and conducted with the open source software Zurich Toolbox for Readymade Economic Experiments (z-Tree) that was developed at ETH Zürich (Fischbacher 2007). z-Tree can be used for a wide range of economic experiments and offers the experimenter a lot of room to maneuver. z-Tree allows interactions between participants as well as the implementation of questionnaires, videos and pictures. The software can be programmed to calculate results during an experimental session and the data from an experiment is directly written into Excel files that can be used for further analysis or converted into character-separated value (csv) files to feed into statistical analysis tools such as R or SPSS.

6.2.2. Sample products

The sample products had to meet the following requirements:

- Durable, biomass-based Polyamide/Nylon
- Product categories: lifestyle, basic commodity/low involvement
- Affordability (prices possibly below 10 Euros)
- Availability

Durable products were chosen because durable biopolymers are becoming increasingly interesting for future applications such as electronics and automobiles, and polyamide constitutes a high-quality engineering polymer. The two product categories were chosen in order to assess possible effects of the product category on WTP as suggested by Kurka (2012, pp. 116–117). Budget constraints and the fact that

participants would have to actually purchase the products are the reasons for the price limit of 10 Euros per product. An online search of products that meet these requirements showed the current limitations of the biopolymer market. Only few durable products were actually available, but were not marketed in Germany (Table 3, chapter 2.2). Finally, these two products best satisfied the requirements (Figure 7):

- Sunglasses, lifestyle product, field price 11.90 Euros
- Toothbrush, basic commodity, field price 2.90 Euros

The biomass-based share of the sunglasses is 53 %; the toothbrush handle is 99 % biomass-based and the bristles consist of 60 % biomass. Both products were ordered via internet in the United States.

Figure 7: Biomass-based sample products
Sunglasses: http://knockaround.com/shop/sunglasses/bio-based (last accessed 06/09/2015)
Toothbrush: http://www.tomsofmaine.com/oral-care/toothbrush (last accessed 12/18/2013)

6.2.3. Information packages

The setup of the experiment was based on the findings from the prestudy. The information categories that prestudy participants had requested most frequently were compiled into three information packages and one label. Basic information about biopolymers was provided through the general information package and the label, whereas the climate and durability packages contained additional information.

Package 1: General Information

Resource, share of biomass-based plastic, resource origin

Bioplastics are produced from renewable resources. They are also termed biomass-based plastics.

On the one hand, biomass-based plastics are produced from plants that are cultivated explicitly for that purpose: Biomass-based plastics are produced from

- Sugar plants (such as sugar beet, sugar cane),
- Starch plants (such as corn, potatoes),
- Oil plants (such as rape, oil palm, castor, soy bean) and
- Cellulose (wood).

On the other hand, plant-based residual products such as cane trash from sugar production and lignin - a wood residue from paper production - are used.

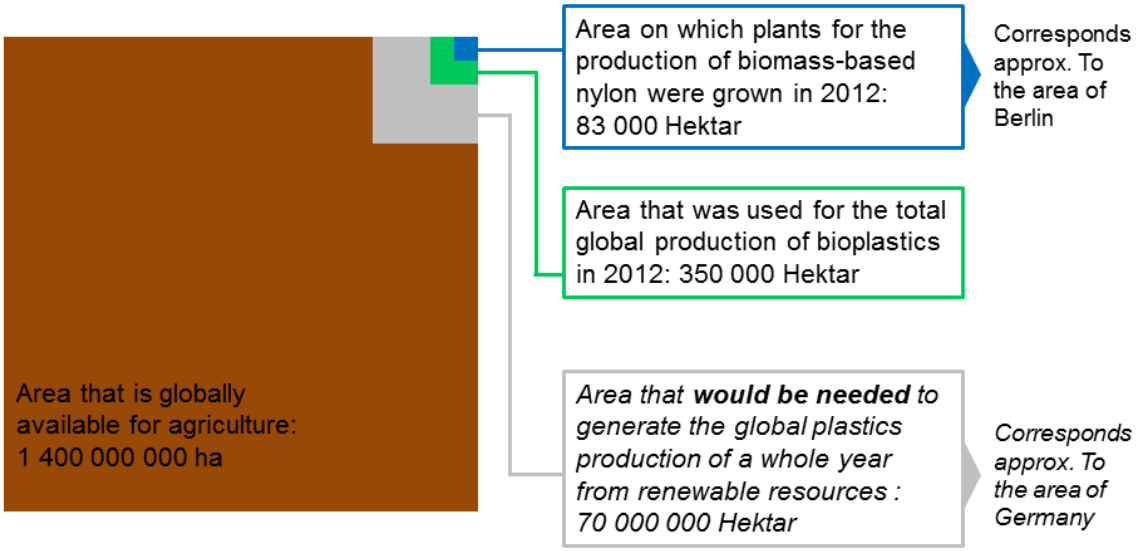
99% of the toothbrush handle consists of biomass-based plastic from castor oil and the bristles contain 60% biomass. The sunglasses contain 53% of biomass-based plastic based on castor oil.

The world's biggest cultivations of castor are located in India, China and Brazil.

Package 2: Climate Information

Climate & environmental effects, land use

Castor oil is not eligible for nutrition and is traditionally applied in medicine and cosmetics. Castor oil is applicable for the production of biomass-based nylon. The graphic shows the proportion of the agricultural area used for bioplastics production in 2012 compared to the global agricultural area:



Climate-damaging CO_2 that plants had absorbed from the atmosphere is sequestered during the production of biomass-based plastics.

Biomass-based plastics add more to the acidification and over-fertilization of soil and water than conventional fossil-based plastics because the agricultural production of renewable resources applies fertilizers (i.e. based on nitrogen and phosphate).

Biomass-based plastics reduce the use of conventional, fossil-based plastics (especially crude oil) because they are produced from annually renewable resources.
(Order of paragraphs was randomized in experiment)

Package 3: Durability Information

Durability, stability, recycling, disposal

The biomass-based toothbrush/sunglasses are as durable and stable as conventional, fossil-based toothbrushes/sunglasses.

The toothbrush/sunglasses are neither biodegradable nor compostable.

The toothbrush/sunglasses may be recycled together with conventional fossil-based plastics. The recycled plastics may be reused in form of a different product.

Another possibility is the combustion of the disposed biomass-based plastic in order to produce energy. The released amount of CO_2 through combustion equals the amount that has been absorbed by the biomass.
(Order of paragraphs was randomized in experiment)

Apart from the written information packages the experiment included one “control” package that did not provide any information at all in order to assess WTP for the conventional product and one package that consisted of a ‘Renewable Resources’ label (Figure 8).

Figure 8: Label ‘Renewable Resources’
Copyright and design by Stefanie Rumm

The label was developed from scratch by my PhD colleague Stefanie Rumm and included elements that participants of the prestudy for her PhD-thesis (that deals with labelling of biopolymer products) found important such as the wording “Renewable Resources” which was compared to “biobased” (Rumm et al. 2013). During the pre-study, labels with the wording “Renewable Resources” were chosen by more than 60 % of the participants, suggesting that the concept of renewable resources is more concrete and better comprehensible than “biobased” (ibid., p. 406). Rumm used green color and the illustration of a leaf to trigger associations to renewability and plant-based sourcing. Furthermore, a label that was unknown to participants was used in order to rule out effects due to a possible familiarity. Thus, the reaction of participants to an

unfamiliar label that lacked information about certification requirements and the certification agent could be measured. The label was applied in the auction experiment at hand, in order to compare its effect to that of similar basic information about biopolymers that was provided in form of a text.

6.2.4. Experimental procedure

To ensure comparability of the data, the experimenters followed the same procedure during all 12 sessions that were held in a computer laboratory. The participants were welcomed to the lab 15 minutes prior to the start of the experiment. Upon entry each participant drew a number which told them what computer to use. The computers were separated through walls to prevent participants from seeing their neighbors' screens.

The experiment started punctually and late arrivals were not accommodated to keep disturbances to a minimum. The experimenter welcomed the participants and asked them to fill out a consent form that ensured anonymity, explained the purpose of the experiment and the use of the acquired data and informed participants about the possibility that they would buy a maximum of two different products (see Appendix 2b). Furthermore, it informed them about the participation compensation of 35 Euros that would be handed out after the experiment.

Subsequently, participants received an instruction to the auction experiment that explained the auction mechanism, the ideal bidding strategy and how winners would be determined (see Appendix 2c). After reading the instructions participants could ask questions. Then, practice rounds were conducted in order to familiarize participants with the auction mechanism and procedure. Practice rounds are a recognized procedure in auction literature and usually products are used that consumers are familiar with such as candy bars (Akaichi et al. 2013; Corrigan & Rousu 2011; Alfnes & Rickertsen 2011; Drichoutis et al. 2008; Lusk & Shogren 2007; Huffman et al. 2003). Practice rounds are important because the strategy to bid one's true value is not a heuristic that consumers usually resort to when participating in (online) auctions, for example on eBay (Lusk & Shogren 2007, pp. 62–65). Thus, the strategy has to be carefully explained and practiced in order to ensure that participants apply it correctly in the experiment.

The practice consisted of three consecutive rounds where participants were asked to simultaneously bid on a chocolate bar and a granola bar. The candy was presented on two tables and participants were asked to get up from their seats and examine the products. Upon returning to their seats they had to enter one bid for each product into the computer program[3]. In the second and third round, participants saw additional product information on the screen and entered their bids after reading the information. After the three rounds, the computer randomly chose two participants who were asked to draw the binding round and the binding product from the respective baskets. The

[3] z-Tree programs for the described experiments are available from the author upon request.

binding product was sold for the 8th-highest price from the binding round to the seven bidders who had offered the highest bids. Participants were informed whether they had won a product, but the market price was not disclosed to them to prevent bid affiliation. The products were distributed to the winners at the very end of the experiment.

After the practice rounds, there was a last opportunity for questions and, afterwards, the main experiment started. Again, participants were asked to examine the products (sunglasses and toothbrush) on the tables. In addition, they saw pictures of the products on the screen and received information on biopolymers according to the current treatment. After each bidding of the first three bidding rounds participants had to answer the question “Did you find the information useful?” in order to control whether participants had actually read the information. After round 4, the computer randomly chose two participants who were asked to draw the binding round and binding product, respectively. Subsequently, a message on the screen informed participants about the market price and whether they had bought a product. The experimenter thanked the participants for their cooperation and asked them to fill out a questionnaire (see Appendix 2d). The questionnaire included the statement batteries about attitudes towards biopolymers and renewable resources and sustainable consumption from the prestudy, questions about the relevance and evaluation of the information they had received, and questions about the sample products as well as socio-demographics. Finally, participants were asked into the experimenter’s compartment one by one where they received the participation fee or if they had bought something they received the participation fee minus the market price of the product(s) they had bought as well as the product(s).

6.2.5. Statistical analysis

The statistical analysis of the experimental data was conducted with the open-source software R. The descriptive analysis of bids included means, standard deviations, frequencies, cumulative distributions and statistical tests such as χ^2-test and t-test. Descriptive analysis was conducted by treatment and information package. Censored regression analysis was used to determine effects of the information packages, socio-demographic characteristics and selected independent variables such as prior familiarity with biopolymers and attitudes on WTP.

7. Results

In this chapter, the samples from prestudy and main study are described and analyzed with descriptive and inductive statistical methods. First assumptions and discussion points are mentioned in this chapter if advisable, but the proper discussion of the results is provided in chapter 8.

7.1. Prestudy: Online consumer survey

The non-representative online survey was conducted in May and June 2013. As the goal was to receive an overview of consumers' information and knowledge about biopolymers the study did not require representativeness. In total, 70 questionnaires were filled in completely and 11 were completed at least half way.

7.1.1. Sample characteristics

The sample consisted predominately of young and well educated participants. More than half of the participants had a monthly net household income of 2,600 Euros or more (Table 9). 27 % of the participants had actually bought at least one item that contained biopolymers within the last 12 months. Participants had mostly bought biomass-based waste bags, packaging and cutlery.

Table 9: Socio-demographic characteristics of the prestudy

Variable	Share/ Value
n	70
Gender = female	50 %
Average age [years]	34.6
Aged between 18 and 29	51 %
University degree	70 %
Monthly net household income 2,600+ Euros	59 %

Summary of Kainz et al. 2013, p.393

7.1.2. Consumer understanding of and familiarity with biopolymers

The participants of the prestudy had a rather one-sided knowledge about biomass-based plastics. 49 participants mentioned the renewable resource basis and 37 participants mentioned biodegradability/composting of biopolymers (Figure 9). These findings are in line with Kurka (2012, p. 63) who assessed consumer knowledge about biomass-based plastics and found that about 45% of German survey participants knew what plants were mainly used to produce bioplastics and that about 53 % knew whether bioplastic bags were already available. Further, participants of the prestudy mentioned the environmentally friendly or sustainable nature of biopolymers and the possibility for recycling. All these descriptions may be connected to the term bioplastics itself. The findings also show that participants had a rather positive impression of biopolymers.

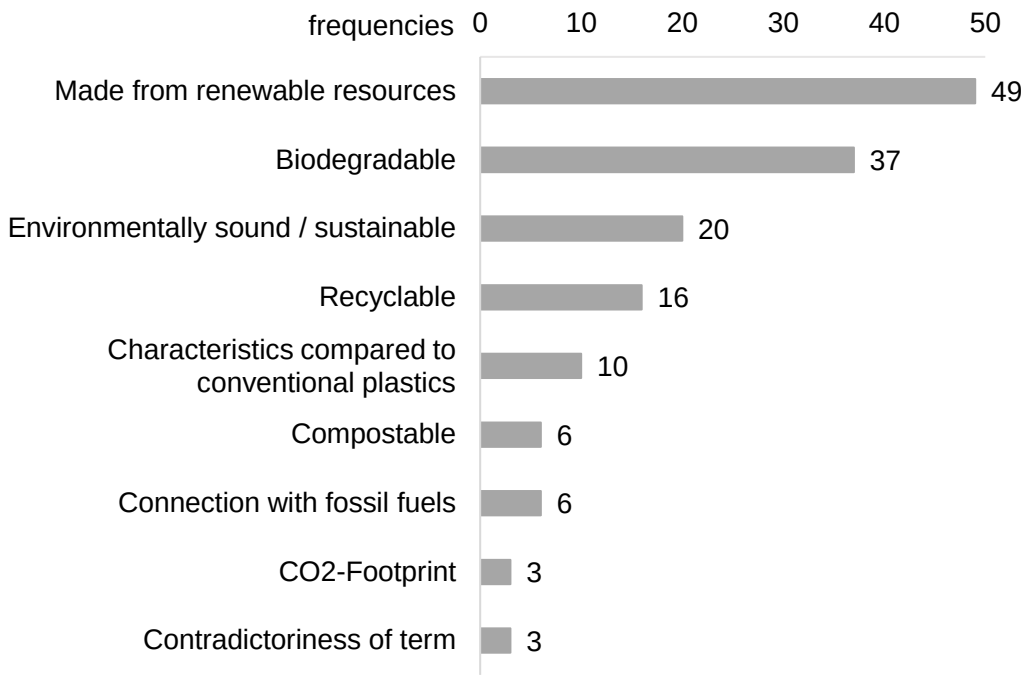


Figure 9: Consumers' understanding of biopolymers
Open question with multiple answers, n = 81

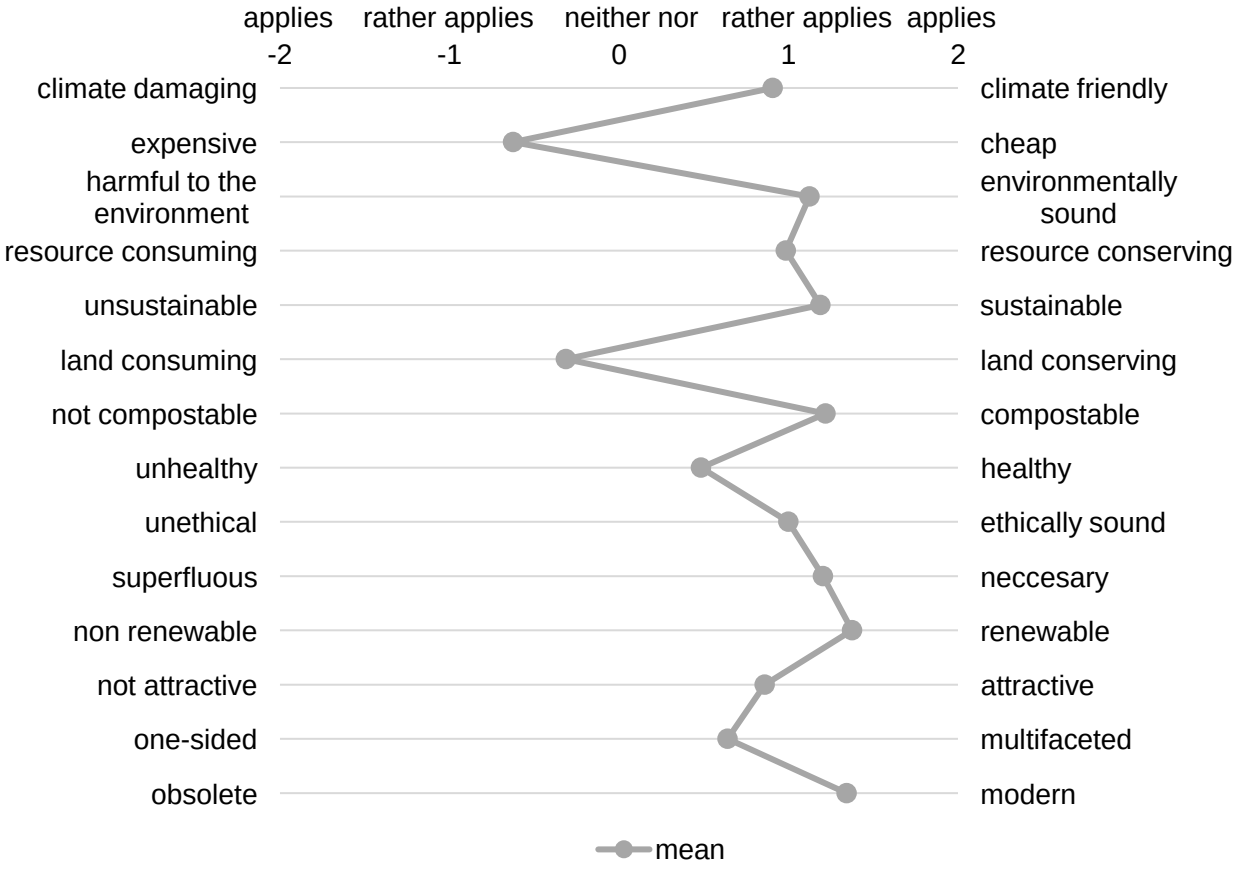


Figure 10: Consumer perception of biopolymers
Semantic differential, n = 81

This positive impression is reflected in the evaluation of biopolymer characteristics from a semantic differential (Figure 10). According to the participants, the attributes climate-friendly, environmentally sound, sustainable, compostable, renewable and modern rather apply to biopolymers. Rather negative evaluations of biopolymers concerned higher prices and land use.

7.1.3. Attitudes towards biopolymers and sustainable consumption

The mean attitudes towards biopolymers and renewable resources of 71 participants by statement are summarized in Table 10. The means were derived from a 5-point scale, where 1 = “do not agree at all”, 2 = “rather not agree”, 4 = “rather agree” and 5 = “totally agree”, with 3 = “partly agree” representing the center. Participants especially supported statements no. 6 “The use of biogenic resources reduces the use of fossil resources” and no. 9 “Bioplastics should mainly be produced from agricultural by-products (beet leaves, bagasse)” with means of 4.1 and 4.2, respectively. Statement no. 1 “I exclusively fuel E10 because of the plant-based share” was rated negatively with the lowest mean of 1.7.

Table 10: Attitudes towards biopolymers and renewable resources

Number	Mean	Std. dev.	Statement
1[d]	1.7	0.999	I exclusively fuel E10 because of its plant-based share.
2	3.0	0.978	I purposefully buy products from biogenic resources.
3°	2.4	1.045	The production of bioplastics induces an increase of monocultures.
4°	2.8	1.019	The cultivation of resources for bioplastics production reduces the area for food production.
5°, [d]	3.2	1.124	Bioplastics should be produced from biogenic resources that are explicitly grown for this purpose (sugar beet, corn, sunflowers).
6	4.1	0.809	The use of biogenic resources reduces the use of fossil resources.
7°, [c]	3.4	1.245	The cultivation of sugar beet, corn and sunflowers for the production of bioplastics has a negative effect on the landscape.
8[c]	3.5	0.998	The use of biogenic resources reduces greenhouse gas emissions.
9[d]	4.2	0.746	Bioplastics should mainly be produced from agricultural by-products (beet leaves, bagasse).

° recoded variables
[d] statement dropped in main study
[c] formulation changed for main study
n = 71

Statements no. 3, 4, 5 and 7 had to be recoded, because low agreements signified positive attitudes and in order to compare and summarize all nine statements they all

had to point into the same direction. The statements no. 3 “The production of bioplastics induces an increase of monocultures” and no. 4 “The cultivation of resources for bioplastics production reduces the area for food production” had means below the center. Accordingly, participants see some effects of biopolymer production critically. The mean of 3.4 shows that these participants found a slightly positive effect of the cultivation of sugar beet, corn and sunflowers on the landscape (no. 7). This seems to contradict the finding from the semantic differential that biopolymers are rather land consuming. But land consumption might be associated with visible destruction of land, whereas a sunflower or corn field might be associated with a rather natural way of land use.

Participants stated mostly positive attitudes towards environmentally friendly and regionally produced products (Table 11). Only one of the six statements had a mean below the center of 3: participants found environmentally friendly products rather expensive (no. 4). Participants were willing to buy environmentally friendly products (no. 1, $\bar{x} = 3.8$) and were willing to pay more for them (no. 2, $\bar{x} = 3.9$). They were also in favor of regional products and products from regional resources (no. 5, 6), however, standard deviations were above 1 for these two statements indicating a rather wide range of attitudes. Furthermore, participants did not think that environmentally friendly products work worse than their conventional counterparts (no. 3).

Table 11: Attitudes towards environmentally friendly and regionally produced products

Number	Mean	Std. dev.	Statement
1	3.8	0.907	I prefer to buy environmentally friendly products.
2	3.9	0.866	I am willing to pay more for environmentally friendly products.
3°	3.3	0.864	Environmentally friendly products do not work as well as their conventional counterparts.
4°	2.8	0.897	Environmentally friendly products are too expensive.
5	3.6	1.299	I buy regional products because of shorter transportation routes.
6	3.3	1.061	I buy products made from regional resources.
° recoded variables n = 73			

The following results were found for the GREEN Consumer Values (GCV) of the prestudy participants (Table 12): All means were above the center with the highest means of 4.4 and 4.7 for the general statements no. 1 “It is important to me that the products I use do not harm the environment” and no. 7 “Instead of consuming more and more resources, we should rather recycle and reuse as many materials as possible”, respectively. Statements no. 3, 6 and 8 that call for personal action had slightly lower means of 3.6, 3.7 and 3.5, respectively, with standard deviations at/above 1.

Table 12: GREEN Consumer Values with additional statements

Number	Mean	Std. dev.	Statement
1	4.4	0.832	It is important to me that the products I use do not harm the environment.
2	3.9	0.930	I consider the potential environmental impact of my actions when making many of my decisions.
3	3.6	1.079	My purchase habits are affected by my concern for our environment.
4	4.3	0.959	I am concerned about wasting the resources of our planet.
5	3.8	0.898	I would describe myself as environmentally responsible.
6	3.7	1.041	I am willing to be inconvenienced in order to take actions that are more environmentally friendly.
7[d]	4.7	0.604	Instead of consuming more and more resources, we should rather recycle and reuse as many materials as possible.
8	3.5	0.998	When buying products I think about the impact of their use on the environment.
[d] statement dropped in main study due to low loading in factor analysis n = 71			

Statements 1 through 6 from Bearden et al. 2011, p. 173

Overall, prestudy participants were rather in favor of renewable resources and sustainable consumption which might partly be due to the mainly young and well-educated sample (Kuckartz et al. 2007, pp. 8–9).

7.1.4. Relevant information about biopolymers

Participants stated information on biopolymers that was of interest to them (Figure 11). The information was categorized for data analysis. Almost half of the participants requested information related to the resource basis and the origin of biopolymers. Information about environmental and climate effects of biopolymer production and use as well as information about land use conflicts was of interest to 43 % of the participants. Surprisingly, one third of the participants requested information about areas of application even though some areas had been mentioned in the definition of biopolymers provided that was provided during the survey. About 27 % asked for information about properties, recycling and disposal and 20 % were interested in the price. Other requested information included comparisons to conventional plastics, health effects, and labels.

The prestudy showed that consumers' confrontation with biopolymers prior to the prestudy was rather low resulting in a lack of comprehensive understanding of characteristics, applications and effects of biopolymer production, use and recovery. Consumers' attitudes towards biopolymers, however, were rather positive.

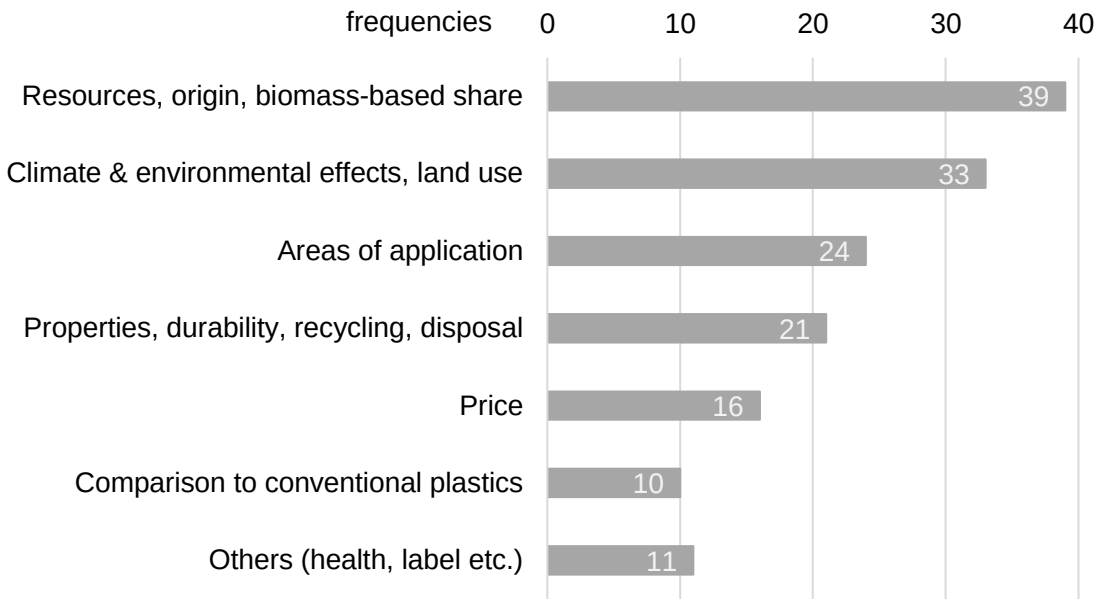


Figure 11: Requested information about biopolymers
n = 77

7.2. Main study: Experimental auction

240 consumers (plus 12 backups) were recruited by a field institute in Munich, Germany. Participants were recruited according to quotas for age and gender equivalent to the average in Bavaria (Table 13). Further, participants ought to be equally distributed over the five selected education levels that are listed in Table 13. Furthermore, filter questions were used during recruiting to sort out participants who used electrical toothbrushes and who did not plan to buy sunglasses within the next 12 months.

Table 13: Quotas for the recruitment of experiment participants

Variables	Quotas
Age*	14-29 years: 22 %; 30-49 years: 34 %; 50+ years: 44 %
Gender*	female 50 %; male: 50 %
Level of Education	no school leaving certificate: 20 %; primary school, secondary modern school, apprenticeship: 20 %; general certificate of secondary education: 20 %; high school diploma (Abitur): 20 %; university degree: 20 %

** Quotas based on Herausgebergemeinschaft Verbraucheranalyse 2012*

Participants were recruited through the online platform of the field institute and by phone. The experiment lasted about one hour and took place in the computer laboratory for experimental economic research *experimenTUM* which is operated by the TUM School of Management in Munich, Germany. The lab provided 24 computers and an extra compartment for the experimenters was staffed with the main computers and a printer to print the list of participation compensations at the end of each session.

The experiment took place on three consecutive weekdays in February 2014, with four sessions per day. The sessions started at 8:30 am, 10:30 am, 4:30 pm and 6:30 pm. Each treatment was applied in two sessions that varied in starting time. Participants were randomly assigned to a treatment and had not been informed about the purpose of the experiment during recruiting. However, they had been told that there was a possibility that they would purchase products during the session.

7.2.1. Sample characteristics

A total of 227 consumers participated at the experiment. The number of participants per treatment ranged between 32 and 42. The six treatment groups differed from each other in some socio-demographic characteristics (Table 14): t-tests confirmed that the average age of 47.1 years in label group 1 was significantly higher than in all other treatment groups. There were significantly more females in control group 2 than in text group 2 and control group 1. In all treatments the mostly occupied category of household net income was 1,700 to 3,600 Euros. Compared to the Bavarian average, the sample was slightly younger, overrepresented men and was better educated: in control group 1 and label group 1 half of the participants had earned a university degree. The household net income of the sample was slightly higher than the German average.

Table 14: Socio-demographic characteristics of main study sample

			Treatments					
Variables	Bavaria*	**Sample**	Control group 1	Control group 2	Text group 1	Text group 2	Label group 1	Label group 2
N		**227**	32	39	37	39	38	42
Age								
Mean [yrs.]	42.3[b]	**41.6**	39.1	39.3	38.7	43.3	47.1	41.8
Std. dev.		**13.4**	12.7	13.6	12.6	14.5	10.8	14.1
Gender								
Female	51%[c]	**47%**	38%	62%	43%	36%	45%	55%
Male	49%[c]	**53%**	62%	38%	57%	64%	55%	45%
Household net income [€]								
> 1,700	29%[a]	**20%**	19%	8%	8%	15%	21%	21%
1,700 -3,600	41%[a]	**44%**	34%	69%	57%	62%	40%	35%
3,600-5,000	16%[a]	**19%**	28%	8%	19%	23%	32%	29%
5,000+	14%[a]	**7%**	9%					7%
Not specified		**10%**	9%	15%	16%		8%	7%
Education								
Secondary education**	72%[c]	**27%**	19%	28%	35%	34%	29%	19%
High school (Abitur)	10%[c]	**32%**	31%	36%	38%	28%	21%	38%
University degree	12%[c]	**40%**	50%	31%	27%	38%	50%	43%
Other***	6%[c]	**1%**		5%				
1+ children living at home		**31%**	22%	36%	24%	28%	27%	38%

* household net income for Germany because data for Bavaria was not available in the applied distribution

** secondary modern school, apprenticeship, general certificate of secondary education

*** primary school, no school leaving certificate

Data from [a] Statistisches Bundesamt 2013, p. 173; [b] Bayerisches Landesamt für Statistik 2012; [c] Herausgebergemeinschaft Verbraucheranalyse 2012

About half of the participants had heard of biopolymers prior to the experiment (Table 15). Overall, participants evaluated their level of information about bioplastics *before* the experiment to be (very) low with 62-74 % participants per treatment marking these options. Around one third of participants per treatment rated their level of information to be fair or high. Comparing these percentages with the level of information participants saw themselves at *after* the experiment, participants became much more confident about their information level concerning biopolymers: In all treatments, with exception of control group 2 and label group 2, 49 % or more of the participants felt sufficiently or very well informed. The percentage of participants who did not report any difference between their level of information before and after the experiment ranged between 6 % in control group 1 and 36 % in text group 2. Additional information about biopolymer products that participants requested after the experiment during which they had received at least two information packages about the biopolymer products included costs, production and processing, durability, areas of application, comparison to conventional plastics, stability, quality, producing countries and health effects.

Table 15: Levels of information about bioplastics of the main study sample

			Treatments					
Variables	Scale	**Sample**	Control group 1	Control group 2	Text group 1	Text group 2	Label group 1	Label group 2
N		**227**	32	39	37	39	38	42
Have heard about bioplastics before experiment		**52 %**	50 %	62 %	49 %	51 %	50 %	48 %
Subjective level of information about bioplastics *before* experiment	very high						5 %	
	high/ fair	**32 %**	34 %	38 %	33 %	31 %	24 %	26 %
	(very) low	**68 %**	66 %	62 %	67 %	69 %	71 %	74 %
Description of information about bioplastics *after* experiment	very well informed	**4%**	3%		3%	3%	11%	2%
	sufficiently	**47%**	69%	44%	57%	46%	47%	26%
	not sufficiently	**25%**	22%	23%	19%	15%	29%	40%
	same as before experiment	**24%**	6%	33%	22%	36%	13%	31%

Additional variables relating to the sample products such as the number of participants wearing glasses, the assessment of the product type of sunglasses, the number of

participants using an electric toothbrush, and the number of participants needing a new toothbrush were similarly distributed over the six treatments (Table 40 in Appendix 1).

Table 16: Retrospectively elicited mean prior attitudes towards bioplastics

Scale	Sample	Control group 1	Control group 2	Text group 1	Text group 2	Label group 1	Label group 2
	227	32	39	37	39	38	42
1=negative 2=neutral 3=positive (std. dev.)	2.25 (0.51)	2.18 (0.56)	2.24 (0.49)	2.21 (0.47)	2.24 (0.49)	2.17 (0.44)	2.21 (0.49)

Participants stated slightly positive prior attitudes towards biopolymers with a sample mean of 2.25 on a scale from 1 = “negative” to 3 = “positive” with 2 = “neutral” (Table 16). Attitudes towards sustainable consumption were assessed through the three statement batteries that had already been applied in the prestudy. (1) The more general “attitudes towards bioplastics and renewable resources” scale (ABR) that focused on preferable resource production and usage. (2) “Attitudes towards environmentally friendly and regionally produced products” (AER) that were composed from different scales and concentrated on personal, explicitly environmentally friendly behavior and overall characteristics of environmentally friendly products. (3) The GREEN Consumer Value (GCV) scale that specifically assessed personal purchase behavior and its effects on the environment. Compared to the prestudy the mean attitudes of the three scales were distributed similarly, but with slightly lower means (Table 17 to Table 19) which might be due to the following reasons: In the prestudy, rather unbiased initial attitudes were measured because participants only received general information about biopolymer production before stating their attitudes, whereas auction experiment participants were asked to state their attitudes after the auction. Thus, their prior attitudes and knowledge might have been affected by the information packages they received. Furthermore, the prestudy was prone to self-selection bias meaning that there is a possibility that especially people who were interested in renewable resources and the environment participated in the survey that was clearly announced as survey about bioplastics.

Table 17: Attitudes towards environmentally friendly and regionally produced products

Number	Mean	Std. dev.	Statement
1	3.8	0.88	I prefer to buy environmentally friendly products.
2	3.5	0.95	I am willing to pay more for environmentally friendly products.
3°	2.9	0.92	Environmentally friendly products do not work as well as their conventional counterparts.
4°	2.4	0.91	Environmentally friendly products are too expensive.
5	3.5	1.21	I buy regional products because of shorter transportation routes.
6	3.3	1.11	I buy products made from regional resources.
Total	**3.2**	**0.63**	**Range: 1.50-5.00**
° recoded variables n = 224			

Table 18: Attitudes towards biopolymers and renewable resources

Number	Mean	Std. dev.	Statement
1°	2.3	0.82	The production of bioplastics induces an increase of monocultures.
2	3.1	1.68	I purposefully buy products from biogenic resources.
3°	2.6	1.09	The cultivation of resources for bioplastics production reduces the area for food production.
4	3.9	1.37	The use of biogenic resources reduces the use of fossil resources.
5°	3.1	1.21	The cultivation of sugar beet and corn for the production of bioplastics has a negative effect on the landscape.
6	3.8	1.40	The use of biogenic resources has a positive impact on environment and climate.
Total	**3.1**	**0.53**	**Range: 1.50-4.33**
° recoded variables n = 224			

Table 19: Green Consumer Values (GCV)

Number	Mean	Std. dev.	Statement
1	3.9	0.87	It is important to me that the products I use do not harm the environment.
2	3.5	0.94	I consider the potential environmental impact of my actions when making many of my decisions.
3	3.1	1.08	My purchase habits are affected by my concern for our environment.
4	4.1	0.91	I am concerned about wasting the resources of our planet.
5	3.6	0.90	I would describe myself as environmentally responsible.
6	3.4	0.93	I am willing to be inconvenienced in order to take actions that are more environmentally friendly.
7	3.1	1.00	When buying products I think about the impact of their use on the environment.
Total	**3.5**	**0.87**	**Range: 1.50-4.86**
n = 224			

The random assignment of participants to one of six auction treatments yielded rather similar groups concerning socio-demographic characteristics. About 50 % of participants across all groups had heard about biopolymers before the experiment, but more than 60 % stated a (very) low level of information about biopolymers prior to the experiment. On average, participants' attitudes towards biopolymers before the experiment were slightly positive as well as their post-auction attitudes towards sustainable consumption, biopolymers and renewable resources.

7.2.2. Willingness to pay for biopolymer products

Overall, the stated bids varied between 0 Euros and 25.70 Euros for biomass-based sunglasses and between 0 Euros and 4.50 Euros for the biomass-based toothbrush. Boxplots in Appendix 1 depict the complete distribution of WTP for sunglasses (Figure 23 to Figure 25) and toothbrush (Figure 26 to Figure 28) by treatment and bidding round. During preparation of the data for further statistical analysis cases of extreme bid values were removed from the sample. Extreme values were defined as values that occur three interquartile ranges (IQR) above the 3rd quartile and 3 x IQR below the 1st quartile of a sample (Tukey 1977). These extreme values cause bias of the sample mean and may bias regression results (Stevens 1984) and were, thus, excluded from the sample by treatment and bidding round (see Table 41 in Appendix 1). Then, mean and median WTP were calculated for the six different treatments by bidding rounds and products (Table 20 and Table 21). The tables also include the number of zero bids per treatment and the mean WTP without zero bids.

Table 20: Descriptive statistics of bids for sunglasses

Bidding round	Treatment	Information	n	Mean [Euros] (std. dev.)	Median [Euros]	Number of zero bids	Mean [Euros] excluding zero bids (std. dev.)
1	Control group 1	None	31	1.219 (1.336)	0.65	3	1.350 (1.342)
2		General	32	1.678 (1.917)	0.95	4	1.851 (1.933)
3		Climate	32	1.601 (1.806)	0.95	3	1.767 (1.818)
1	Control group 2	None	39	0.812 (0.719)	0.79	1	0.833 (0.716)
2		General	38	0.881 (0.821)	0.80	1	0.939 (0.870)
3		Durability	38	0.824 (0.787)	0.77	1	0.846 (0.786)
1	Text group 1	General	36	0.946 (0.992)	0.80	5	1.098 (0.988)
2		Climate	36	0.846 (0.939)	0.53	5	1.107 (1.167)
3		Durability	36	0.864 (0.946)	0.70	5	1.004 (0.949)
1	Text group 2	General	37	1.346 (1.613)	0.80	2	1.423 (1.625)
2		Durability	37	1.264 (1.478)	0.71	2	1.336 (1.488)
3		Climate	38	1.439 (1.790)	0.77	3	1.563 (1.814)
1	Label group 1	Label	35	0.804 (0.896)	0.50	5	0.938 (0.901)
2		General	35	0.803 (0.983)	0.50	7	1.004 (1.003)
3		Climate	35	0.807 (0.986)	0.50	7	1.009 (1.006)
1	Label group 2	Label	41	2.308 (2.853)	1.50	4	2.557 (2.896)
2		Climate	40	1.986 (2.389)	1.50	4	2.207 (2.421)
3		Durability	39	1.705 (1.725)	1.45	4	1.899 (1.746)

The overall number of zero bidders was higher for sunglasses than for toothbrush with totals of 66 zero bids and 44 zero bids, respectively. Participants who bid zero or close to zero are commonly called off-margin bidders, because their value is (far) below the

market price. Possible reasons for their low bidding are, for example, lack of involvement, a belief that they have no chance of winning or budget constraints (Lusk & Shogren 2007). Certainly, the products might have been of zero or very low value to some participants as well. The highest numbers of zero bids for sunglasses equaled 7 zero bids and occurred in label group 1 in rounds 2 and 3 (Table 20). The standard deviation of the mean bid for sunglasses was around or above 1 Euro in most treatments and medians ranged between 50 Cents (label group 1) and 1.50 Euro (label group 2).

Looking at the bids for toothbrush in Table 21, bidders of text group 1 were least engaged in the bidding: 7 bidders bid zero in rounds 2 and 3 and the median WTP decreased over the bidding rounds. Mean bids for toothbrush remained below 1 Euro for all treatments and bidding rounds.

Overall, bids remained rather low, and especially for sunglasses most bids remained far from the field price of 11.90 Euros. Possible explanations for this outcome are participants' uncertainty about the product quality and a combination of endowment effect and loss aversion which will be discussed in more detail in chapter 8.2.

In auction round 4, participants were asked to imagine that the products were made from sunflower oil that was produced in Germany, and to offer hypothetical bids for such products. Mean WTPs for the hypothetical products were significantly higher than mean WTPs across all treatments in round 3 with $p = 0.000$ for both products (t-test). On average, the 227 participants would have paid 3.30 Euros (std. dev. = 6.77) for sunglasses from German sunflower oil, and 1.02 Euros (std. dev. = 0.95) for a sunflower oil toothbrush. Participants offered on average 2.09 Euros more for sunglasses than in round 3 and 39 Cents more for the toothbrush. The share of participants who would have paid more for the products from domestically produced renewable resources amounted to 62 %; 33 % offered the same price as in round 3, and 5 % would have paid less.

Table 21: Descriptive statistics of bids for toothbrush

Bidding round	Treatment	Information	n	Mean [Euros] (std. dev.)	Median [Euros]	Number of zero bids	Mean [Euros] excluding zero bids (std. dev.)
1	Control group 1	None	32	0.495 (0.416)	0.33	2	0.528 (0.409)
2		General	32	0.662 (0.588)	0.50	1	0.683 (0.585)
3		Climate	32	0.689 (0.612)	0.50	1	0.712 (0.609)
1	Control group 2	None	39	0.316 (0.237)	0.30	0	
2		General	38	0.391 (0.308)	0.32	0	
3		Durability	38	0.388 (0.213)	0.28	0	
1	Text group 1	General	35	0.350 (0.381)	0.20	6	0.423 (0.380)
2		Climate	37	0.398 (0.470)	0.15	7	0.490 (0.477)
3		Durability	37	0.418 (0.488)	0.11	7	0.516 (0.507)
1	Text group 2	General	39	0.732 (0.698)	0.50	2	0.772 (0.694)
2		Durability	38	0.733 (0.706)	0.50	2	0.774 (0.703)
3		Climate	38	0.753 (0.725)	0.60	3	0.818 (0.719)
1	Label group 1	Label	37	0.605 (0.678)	0.49	1	0.622 (0.680)
2		General	37	0.605 (0.690)	0.50	3	0.659 (0.695)
3		Climate	36	0.576 (0.643)	0.50	3	0.628 (0.646)
1	Label group 2	Label	42	0.921 (0.768)	0.78	2	0.968 (0.758)
2		Climate	41	0.890 (0.718)	0.87	2	0.935 (0.706)
3		Durability	42	0.909 (0.764)	0.90	2	0.955 (0.754)

In round 1, the control groups did not receive any information, the text groups received general information about bioplastics, and the label groups saw the ‘Renewable Resources’ label on the products. Thus, the data of each of those two groups that had

received the same treatment could be merged in order to build a stronger data basis with more cases. Comparison of the mean WTP in round 1 between the newly formed groups provided the following results: Participants from the text group bid on average 16 % more for the biomass-based sunglasses and 39 % more for the biomass-based toothbrush than the control group which did not receive any information about the material. The label group bid on average 63 % more for the sunglasses and 95 % more for the toothbrush than participants in the control group. The percentages participants were willing to pay more for the biomass-based product were within ranges that plastic market experts expect consumers to pay more for drop-in biopolymers (15-20 %) and biomass-based packaging and composites (<100 %) within the next few years (Carus et al. 2014).

Unpaired t-tests showed that mean WTP for toothbrush was significantly higher in the label treatment ($t = 4.074$, $p = 0.000$) and in the text treatment ($t = 1.928$, $p = 0.056$) than in the control group. Mean WTP for the labelled sunglasses was significantly higher than WTP for the conventional product with $t = 2.135$ ($p = 0.035$). Within the control group mean WTP for a biopolymer toothbrush in round 2 was significantly higher than for a conventional product in round 1 (paired t-test: $t = 3.809$, $p = 0.000$).

Overall, the participants who had been randomly assigned to exactly one treatment, attributed a higher value to the biopolymer products if they received information in either form. The findings from the auction experiment that participants are willing to pay (significantly) more for the biopolymer products than for the conventional product equivalents are in line with some hypothetical and non-hypothetical studies: Gabriel et al. (2012), Kurka (2012), Barnes et al. (2011) and Yue et al. (2010) report that consumers were willing to pay premiums for biomass-based products, recycled products and biomass-based and biodegradable packaging.

Informing via a label about the renewable resources in the products had the greatest effect on WTP in round 1. This might be due to the fact that information on the label was conveyed in a simple and easily understandable way that established trust and credibility, even though participants had never seen this particular label before. This strong effect of a label on consumers' WTP is in line with Janssen & Hamm (2011) who found that consumers' WTP for organic food products that were labelled with various existent and non-existent labels was higher than for non-labelled products. The post-experiment questionnaire offered two possible explanations for the significantly higher WTP for labelled products compared to the conventional products: First of all, 60 % of the 80 participants in the label groups said the label had increased their WTP, whereas 36 % remained unimpressed by the label. There was a positive and highly significant correlation between the bids and participants saying that the label had increased their bids ($cor = 0.468$, $p = 0.000$). Second, the agreement with the statement "The label increased my trust in the offered products" correlated positively and significantly with bid size ($cor = 0.317$, $p = 0.005$). Half of the participants said that they (fully) trusted the label, and 32 % were undetermined (Figure 12). 18 % did not trust the label (at all).

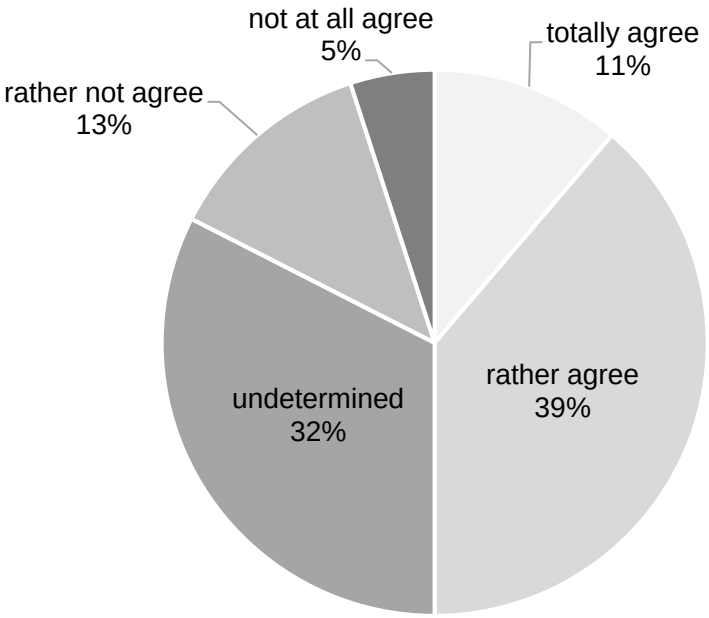


Figure 12: Influence of label 'Renewable Resources' on trust in offered products
Level of agreement with the statement "The label increased my trust in the offered products", n = 80

Differences in the distribution of bidding values between treatments in round 1 support the notion that participants were willing to pay higher prices for a biomass-based product compared to a conventional product equivalent. The relative, reverse cumulative distribution of the bids in round 1 depicts this trend (Figure 13 and Figure 14). On the y-axis, the figures show the share of bidders who offered at least a particular value, and on the x-axis this bidding value is marked. For both products, a greater share of participants in the label groups bid higher prices than in the text and control groups. Almost 60 % of the bidders in the label groups offered bids above 2 Euros for sunglasses, in the text groups about 50 % bid more than 2 Euros, and in the control groups around 20 % of the bidders offered to pay more than 2 Euros for the conventional sunglasses (Figure 13).

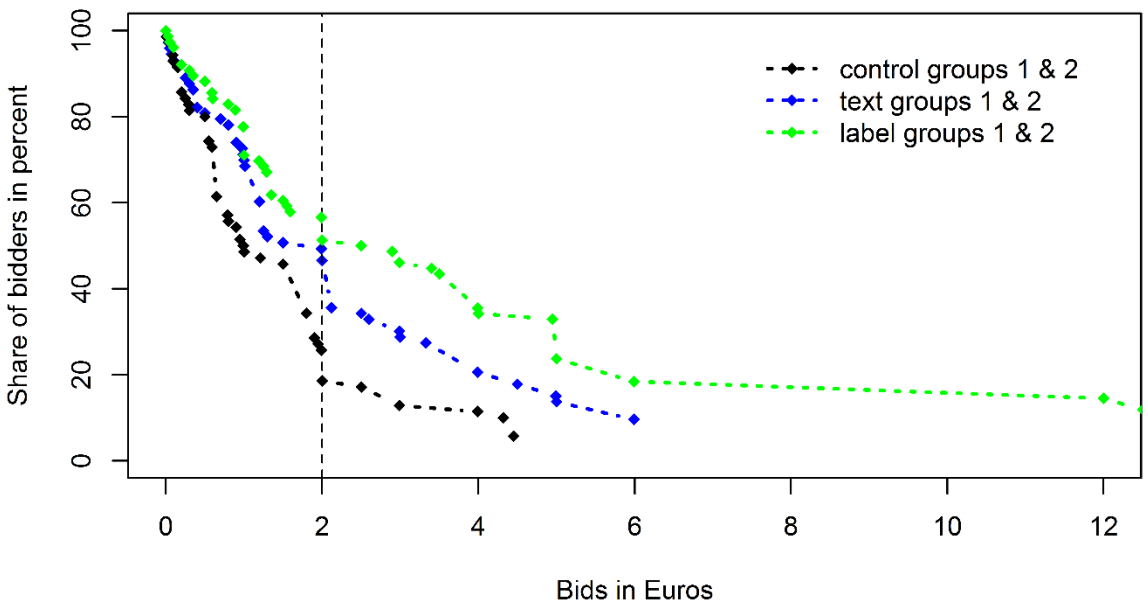


Figure 13: Reverse cumulative distribution of WTP for sunglasses in bidding round 1
Share of bidders, n = 219

Looking at the reverse cumulative distribution of the WTP for toothbrush, participants from the label groups also offered the greatest share of higher bids (Figure 14). But values were similar in all three toothbrush treatments for about 15 % of the bids, then WTP in the label treatment stayed above the WTPs in the text and control groups. About 60 % of the label group participants bid above 1 Euro, about 50 % of the text groups bid above 1 Euro, and less than 20 % of the control groups bid more than 1 Euro for the conventional toothbrush.

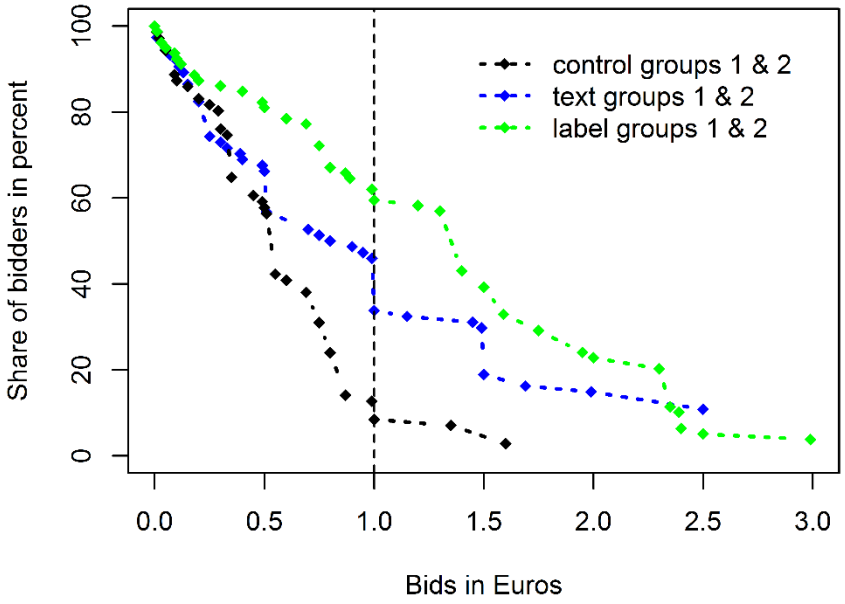


Figure 14: Reverse cumulative distribution of WTP for toothbrush in bidding round 1
Share of bidders, n = 224

The range and distribution of bids by treatment and bidding round are illustrated in boxplots with 95 % confidence intervals (Figure 15 and Figure 16). In some treatments bid ranges differed largely between bidding rounds, whereas they remained rather constant in other treatments, suggesting that participants in some groups were affected by information while other groups remained rather indifferent to information which will be assessed in more detail in chapter 7.2.3.

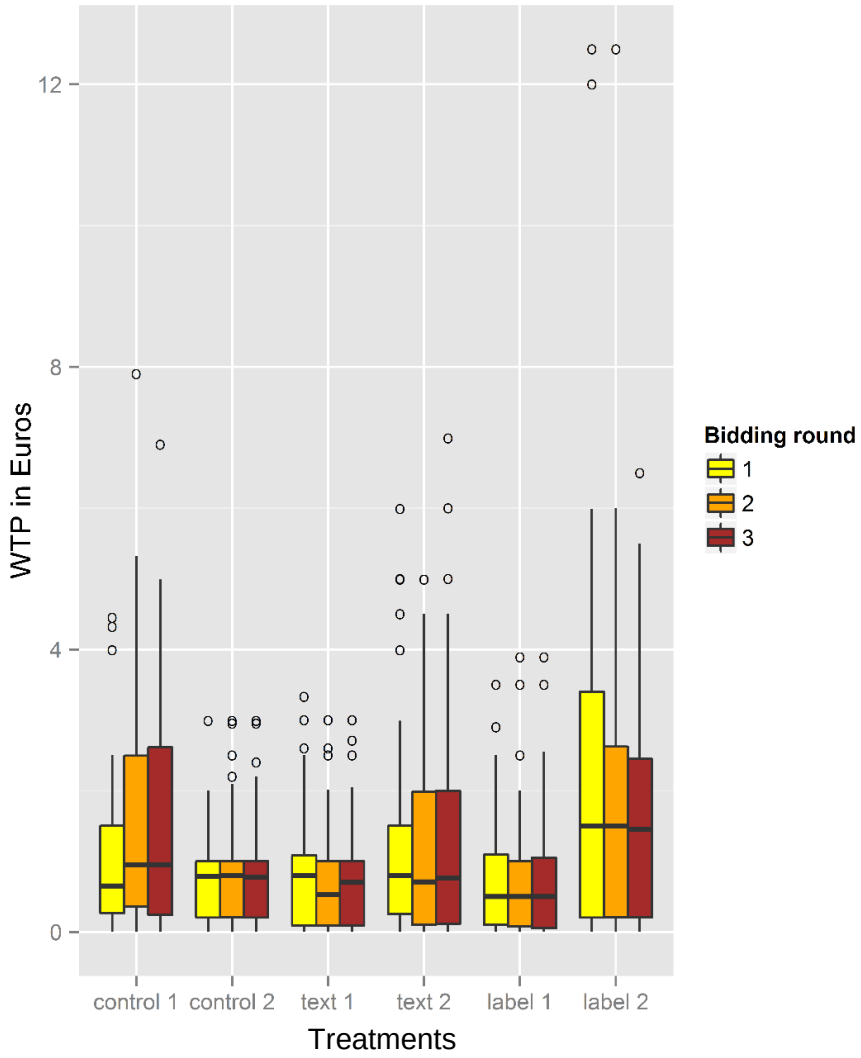


Figure 15: Heterogeneity of bids for sunglasses across treatments and bidding rounds

Bids for sunglasses vary almost double for control group 1, text group 2 and label group 2 compared to the remaining groups (Figure 15). The smallest interquartile range (IQR) occurred in control group 2 – round 2 with less than 1 Euro and the greatest IQR occurred in label group 1 – round 1 with about 3 Euros. Medians within treatments vary slightly up to approximately 30 Cents or not at all within sunglasses groups. All sunglasses and toothbrush treatments produced some outliers except for toothbrush control group 2 that also had the smallest IQR. The greatest IQR for toothbrush occurred in label group 2 (Figure 16). Toothbrush IQRs for control group 1, text group 2 and label group 2 are larger than in the remaining groups. Medians for toothbrush vary within all groups and amount up to about 25 Cents.

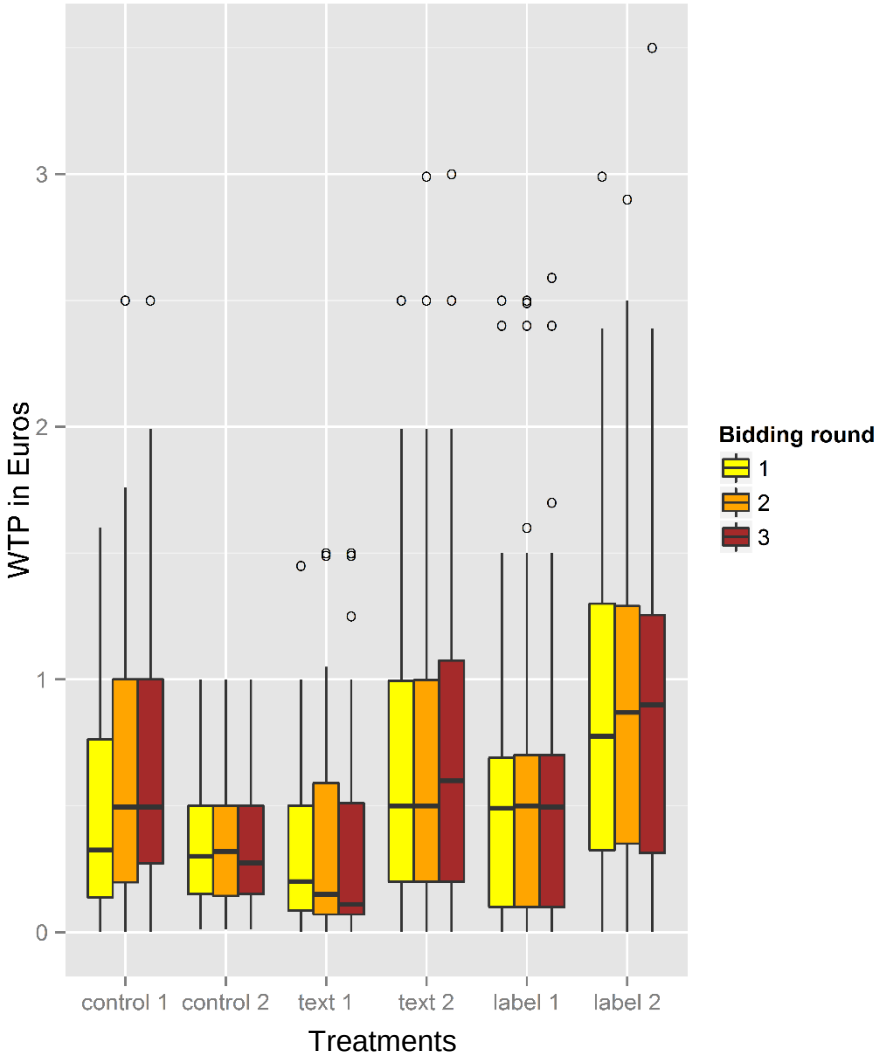


Figure 16: Heterogeneity of bids for toothbrush across treatments and bidding rounds

Altogether, mean WTP was greater for a biopolymer product than for a conventional plastic product and the label seemed to have a greater effect on WTP than the general text information.

7.2.3. Effects of information

One goal of this study was to quantify the effects of information packages that participants received during the experiment. Therefore, WTP for the products was measured in consecutive rounds. Figure 17 and Figure 18 represent the resulting data with 95 % confidence intervals by information package separated into the three bidding rounds. The bids for sunglasses comprise three or more outliers per information package (Figure 17). The boxplots show an IQR of about 1.50 Euros for no information and general information as well as for durability in round 3 compared to an IQR of approximately 2 Euros for durability in round 2 as well as for climate and label information. The medians range between about 50 Cents after climate information in

round 3, and 1 Euro after climate information in round 2. A clear pattern of information effects is not discernable for the WTP for sunglasses.

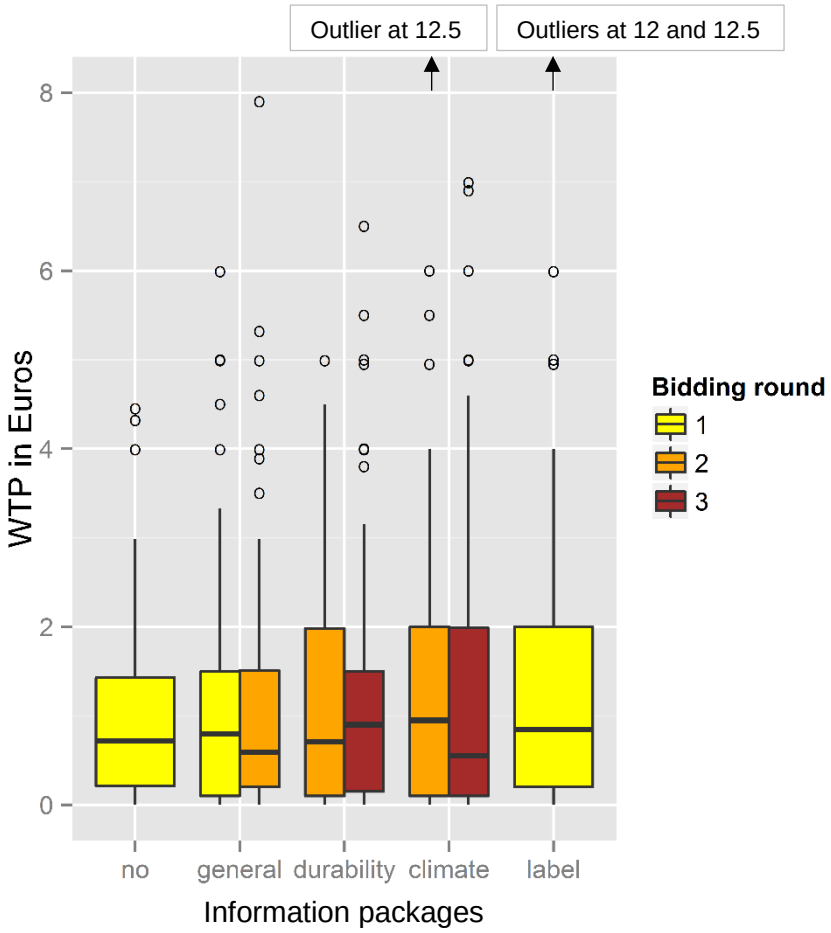


Figure 17: Heterogeneity of bids for sunglasses by information packages

There are less outlier bids in the toothbrush treatments (Figure 18) than in the sunglasses treatments. The heterogeneity boxplots for toothbrush show that bids have quite similar ranges (~ 2 Euros), IQRs (~ 80-90 Cents) and medians (~ 50 Cents) after the information packages except for general information in round 2, suggesting that additional information about biopolymers in rounds 2 and 3 did not significantly affect WTP. The range for no information equaled 1 Euro, and the IQR after general information in round 2 was about 60 Cents. The medians approximated 30 Cents after no information, and up to 50 Cents after durability, climate and label information in either round. Compared to no information, the bid ranges for toothbrush were greater after information.

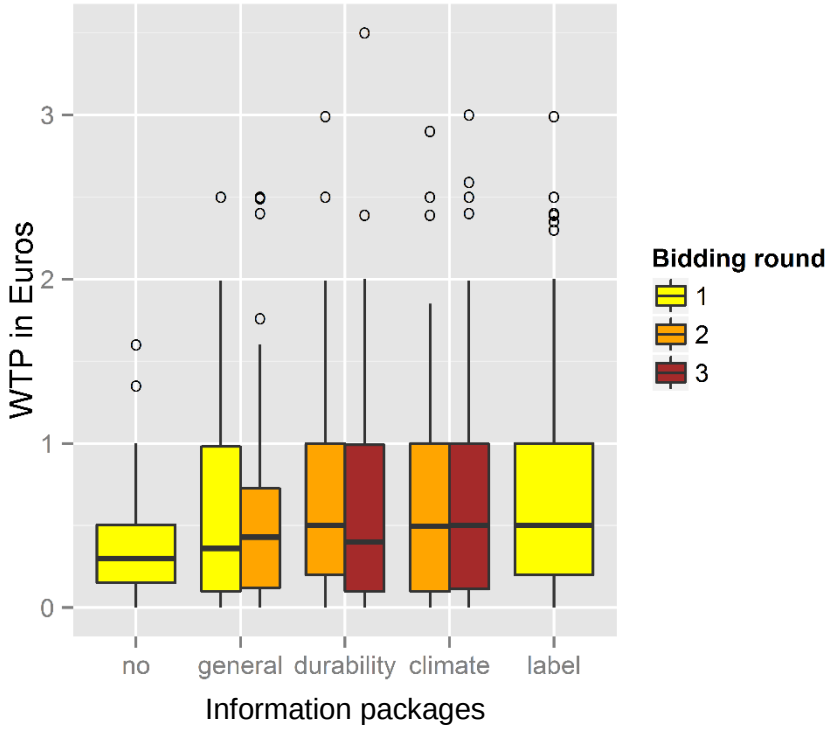


Figure 18: Heterogeneity of bids for toothbrush by information packages

Another way to look at the influence of the different information packages on participants' bidding behavior is the reduction or increase of their bid compared to the previous bidding round. Figure 19 and Figure 20 display the number of bidders per treatment who changed their bids after receiving additional information. When participants bid on toothbrush, information more often led to bid increases than when bidding on sunglasses. This difference might be attributed to the products themselves (Kurka 2012), where participants value a biomass-based toothbrush differently from biomass-based sunglasses and it seems that – in relative terms – a biomass-based toothbrush is more valuable to participants than biomass-based sunglasses. At the same time, the share of bidders who did not change their bids after additional information, i.e. who were indifferent towards information, was similar for both products.

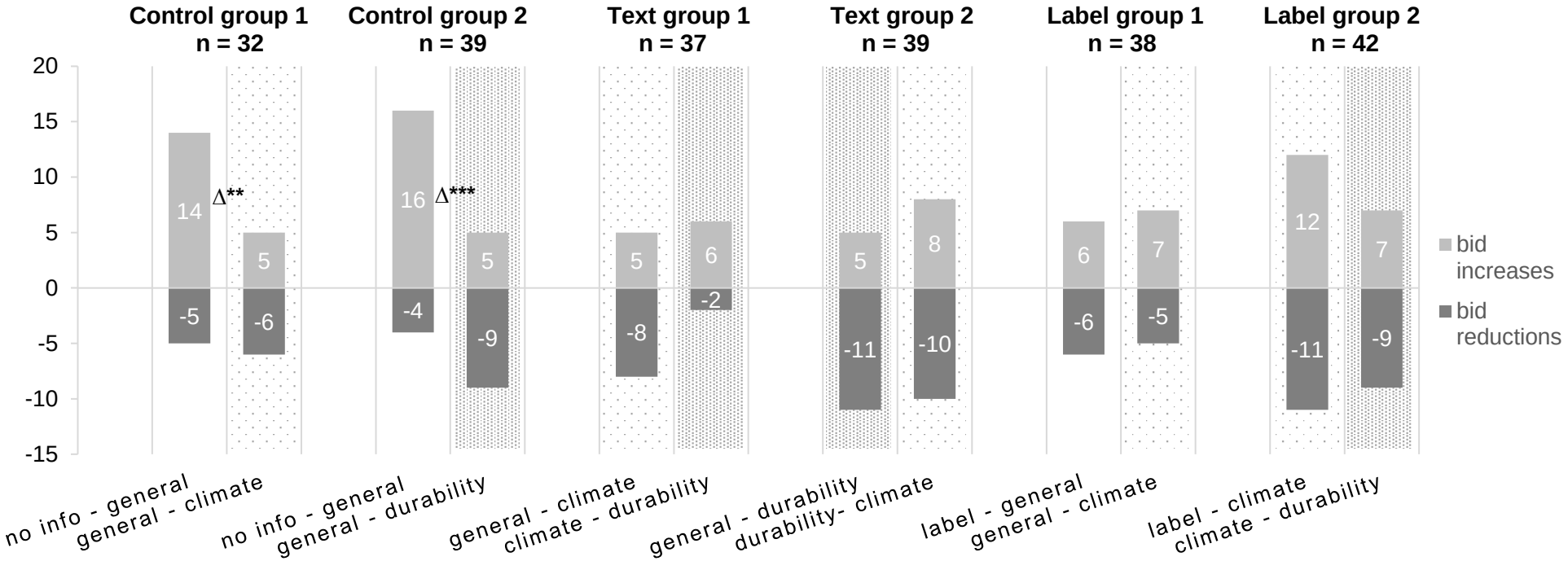


Figure 19: Bid changes by information input, sunglasses

*Frequencies of bid increases and reductions; : bid changes after climate information; : bid changes after durability information; χ^2-test of equality of fit within groups between bidding rounds 2 and 3, Δ*** sig. at 0.001, Δ** sig. at 0.01, Δ* sig. at 0.05*

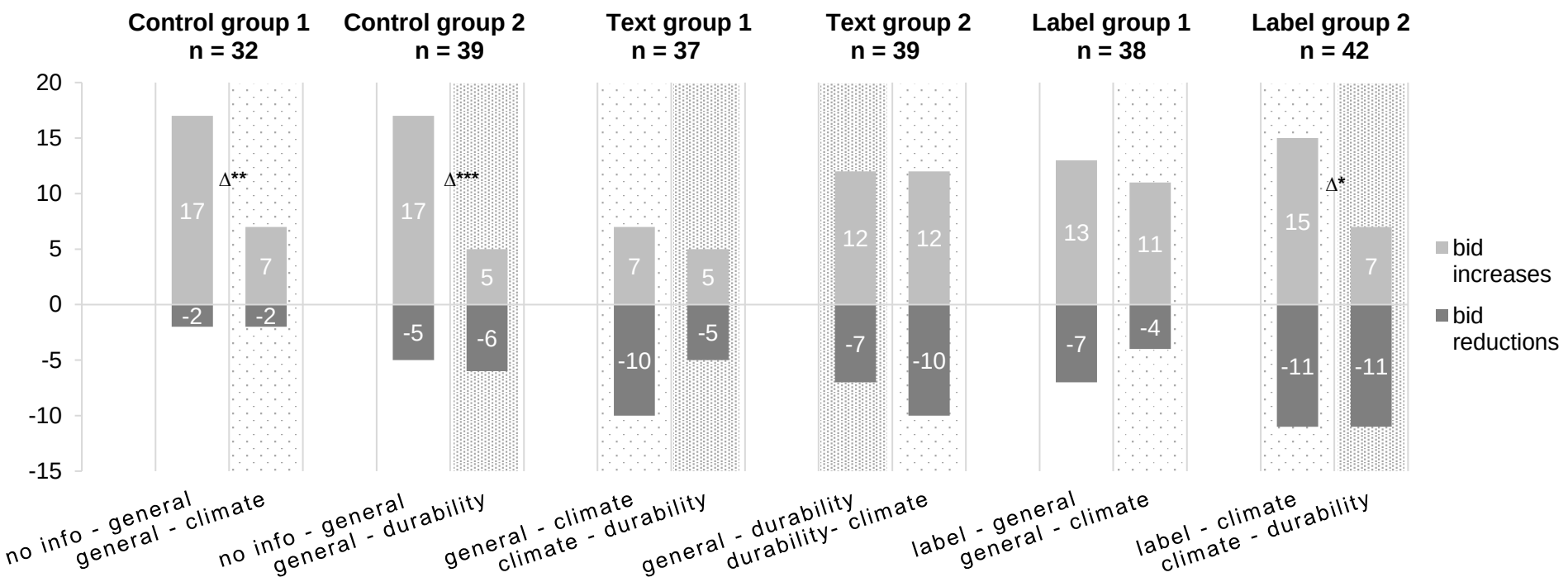


Figure 20: Bid changes by information input, toothbrush

*Frequencies of bid increases and reductions; ▭ : bid changes after climate information; ▭ : bid changes after durability information; χ^2-test of equality of fit within groups between bidding rounds 2 and 3, Δ*** sig. at 0.001, Δ** sig. at 0.01, Δ* sig. at 0.05*

For both products, the highest numbers of overall bid changes within treatment occurred in label group 2 after climate information, in the control groups after general information, and in text group 2 after climate information. General information resulted mostly in bid increases for both products, whereas a tendency towards increasing or reducing bids was not discernible for the additional information packages. After receiving climate information, participants rather reduced their bids for sunglasses, whereas they rather increased their bids for toothbrush. On average, durability information induced participants to reduce their bids for sunglasses except in text group 1. All in all, more participants changed their bid either way after climate information than after durability information, and more participants changed their bids for toothbrush than for sunglasses.

The effects of the different information packages that were applied in the run of the auction experiment were also calculated as Tobit regression models. The time variable which equals the sequence of three information packages was integrated in form of two dummy variables that were named after the corresponding information packages, thus the application of panel data model regression was not necessary. Table 22 displays the Tobit model for control group 1, where the information packages did not have significant effects on participants' mean WTP for sunglasses keeping all other variables constant. In control group 2, the intercept which represents the mean WTP for conventional sunglasses was significant (Table 23).

Table 22: Effects of information packages on WTP for sunglasses in control group 1

	Tobit model		Marginal Effects	
	Estimate	Std. Error	Estimate	Std. Error
(Intercept)	-0.001	0.533		
Gender: 0 = f, 1 = m	-0.148	0.361	-0.120	0.293
Age	0.074***	0.014	0.060***	0.011
Children	0.221	0.165	0.180	0.134
Income	-0.087	0.103	-0.071	0.083
General information	0.390	0.403	0.317	0.328
Climate information	0.312	0.403	0.253	0.328
Log Sigma	0.455***	0.077		
Log-likelihood	-168.95	8 DF		
Left-censored observations	9			
Share of zero bids	9%			

*** sig. at 0.001, ** sig. at 0.01, * sig. at 0.05
DF = degrees of freedom
n = 95
see Table 42 in Appendix 1 for correlation matrix

Table 23: Effects of information packages on WTP for sunglasses in control group 2

	Tobit model		Marginal Effects	
	Estimate	Std. Error	Estimate	Std. Error
(Intercept)	0.939***	0.262		
Gender: 0 = f, 1 = m	-0.084	0.149	-0.072	0.128
Age	0.001	0.005	0.001	0.005
Children	0.124	0.086	0.107	0.074
Income	-0.063	0.046	-0.054	0.039
General information	0.070	0.176	0.060	0.151
Durability information	0.013	0.176	0.011	0.151
Log Sigma	-0.262***	0.067		
Log-likelihood	-132.47	8 DF		
Left-censored observations	3			
Share of zero bids	3%			

*** sig. at 0.001, ** sig. at 0.01, * sig. at 0.05
DF = degrees of freedom
n = 115
see Table 43 in Appendix 1 for correlation matrix

Table 24: Effects of information packages on WTP for sunglasses in text group 1

	Tobit model		Marginal Effects	
	Estimate	Std. Error	Estimate	Std. Error
(Intercept)	1.271***	0.271		
Gender: 0 = f, 1 = m	-0.169	0.189	-0.137	0.153
Age	-0.027***	0.008	-0.022***	0.006
Children	0.549***	0.109	0.446***	0.090
Income	-0.004	0.062	-0.003	0.051
Climate information	-0.107	0.218	-0.087	0.177
Durability information	-0.088	0.218	-0.071	0.177
Log Sigma	-0.097	0.075		
Log-likelihood	1.271***	0.271		
Left-censored observations	15			
Share of zero bids	14%			

*** sig. at 0.001, ** sig. at 0.01, * sig. at 0.05
DF = degrees of freedom
n = 108
see Table 44 in Appendix 1 for correlation matrix

Table 25: Effects of information packages on WTP for sunglasses in text group 2

	Tobit model		Marginal Effects	
	Estimate	Std. Error	Estimate	Std. Error
(Intercept)	1.586***	0.435		
Gender: 0 = f, 1 = m	-1.330***	0.356	-1.055***	0.284
Age	0.027*	0.012	0.022*	0.010
Children	-0.358	0.250	-0.284	0.199
Income	0.016	0.092	0.013	0.073
Durability information	-0.083	0.370	-0.066	0.293
Climate information	0.071	0.368	0.056	0.292
Log Sigma	0.457***	0.070		
Log-likelihood	-203.45	8 DF		
Left-censored observations	7			
Share of zero bids	6%			

*** sig. at 0.001, ** sig. at 0.01, * sig. at 0.05
DF = degrees of freedom
n = 112
see Table 45 in Appendix 1 for correlation matrix

Table 26: Effects of information packages on WTP for sunglasses in label group 1

	Tobit model		Marginal Effects	
	Estimate	Std. Error	Estimate	Std. Error
(Intercept)	0.819*	0.339		
Gender: 0 = f, 1 = m	-0.053	0.210	-0.040	0.157
Age	0.003	0.010	0.002	0.008
Children	0.465***	0.129	0.347***	0.096
Income	-0.135*	0.054	-0.101*	0.041
General information	-0.040	0.250	-0.030	0.187
Climate information	-0.035	0.250	-0.026	0.187
Log Sigma	0.020	0.078		
Log-likelihood	-139.68	8 DF		
Left-censored observations	19			
Share of zero bids	18%			

*** sig. at 0.001, ** sig. at 0.01, * sig. at 0.05
DF = degrees of freedom
n = 105
see Table 46 in Appendix 1 for correlation matrix

Table 27: Effects of information packages on WTP for sunglasses in label group 2

	Tobit model		Marginal Effects	
	Estimate	Std. Error	Estimate	Std. Error
(Intercept)	3.340***	0.503		
Gender: 0 = f, 1 = m	-1.513***	0.408	-1.230***	0.335
Age	0.001	0.014	0.001	0.012
Children	1.404***	0.236	1.141***	0.194
Income	-0.526***	0.115	-0.428***	0.093
Climate information	-0.288	0.468	-0.234	0.380
Durability information	-0.505	0.472	-0.411	0.384
Log Sigma	0.726***	0.069		
Log-likelihood	-239.81	8 DF		
Left-censored observations	12			
Share of zero bids	10%			

*** sig. at 0.001, ** sig. at 0.01, * sig. at 0.05
DF = degrees of freedom
n = 120
see Table 47 in Appendix 1 for correlation matrix

The effects of the information packages on mean WTP for sunglasses in the text groups are displayed in Table 24 and Table 25. The coefficients represent the change of mean WTP for all bids > 0 for each independent variable while all other independent variables are kept constant. Again, the intercepts which in this case represent the mean WTP for the biomass-based sunglasses after general information, were significant. Information on climate and environmental effects as well as on durability and quality of the biomass-based sunglasses did not have significant effects on the mean bids. The same pattern was true for the label groups (Table 26 and Table 27): The label describing the product as renewable resource which was represented by the intercept, significantly affected mean WTP of participants, whereas general, durability or climate information did not cause significant changes in mean WTP.

Looking at the toothbrush treatments, the following effects were found: In control group 1 neither information package had a significant effect on mean WTP (Table 28), whereas the intercept, that represents the mean WTP for a conventional product, was significant in control group 2 (Table 29). General information does not have a significant effect on mean WTP in text group 1 that contained 20 zero bids (Table 30). In text group 2, the Tobit regression model calculated significant effects on mean WTP after general information (Table 31). Again, other information packages did not have a significant effect. The labelled toothbrush significantly affected mean WTP in label groups 1 and 2, respectively (Table 32 and Table 33).

In summary, clear effects of climate and durability information on WTP were not discernible and it seems probable that participants did not know how to evaluate the information.

Table 28: Effects of information packages on WTP for toothbrush in control group 1

	Tobit model		Marginal Effects	
	Estimate	Std. Error	Estimate	Std. Error
(Intercept)	0.254	0.155		
Gender: 0 = f, 1 = m	-0.253*	0.103	-0.229*	0.094
Age	0.023***	0.004	0.021***	0.003
Children	0.058	0.048	0.053	0.043
Income	-0.033	0.030	-0.030	0.027
General information	0.178	0.116	0.161	0.105
Climate information	0.206	0.116	0.187	0.105
Log Sigma	-0.779***	0.074		
Log-likelihood	61.85	8 DF		
Left-censored observations	4			
Share of zero bids	4%			

*** sig. at 0.001, ** sig. at 0.01, * sig. at 0.05
DF = degrees of freedom
n = 96
see Table 48 in Appendix 1 for correlation matrix

Table 29: Effects of information packages on WTP for toothbrush in control group 2

	Tobit model		Marginal Effects	
	Estimate	Std. Error	Estimate	Std. Error
(Intercept)	0.282**	0.094		
Gender: 0 = f, 1 = m	-0.096	0.054	-0.087	0.049
Age	0.000	0.002	0.000	0.002
Children	0.045	0.031	0.041	0.028
Income	0.011	0.016	0.010	0.015
General information	0.078	0.063	0.071	0.057
Durability information	0.076	0.063	0.069	0.057
Log Sigma	-1.285***	0.066		
Log-likelihood	-15.41	8 DF		
Left-censored observations	0			
Share of zero bids	0%			

*** sig. at 0.001, ** sig. at 0.01, * sig. at 0.05
DF = degrees of freedom
n = 115
see Table 49 in Appendix 1 for correlation matrix

Table 30: Effects of information packages on WTP for toothbrush in text group 1

	Tobit model		Marginal Effects	
	Estimate	Std. Error	Estimate	Std. Error
(Intercept)	0.268	0.147		
Gender: 0 = f, 1 = m	0.151	0.102	0.114	0.076
Age	-0.010*	0.004	-0.008*	0.003
Children	0.156*	0.064	0.117*	0.048
Income	0.040	0.033	0.030	0.025
Climate information	0.020	0.118	0.015	0.089
Durability information	0.042	0.118	0.032	0.089
Log Sigma	-0.722***	0.077		
Log-likelihood	-79.01	8 DF		
Left-censored observations	20			
Share of zero bids	18%			

*** sig. at 0.001, ** sig. at 0.01, * sig. at 0.05
DF = degrees of freedom
n = 109
see Table 50 in Appendix 1 for correlation matrix

Table 31: Effects of information packages on WTP for toothbrush in text group 2

	Tobit model		Marginal Effects	
	Estimate	Std. Error	Estimate	Std. Error
(Intercept)	0.974***	0.174		
Gender: 0 = f, 1 = m	-0.591***	0.145	-0.513**	0.126
Age	0.017***	0.005	0.014***	0.004
Children	-0.071	0.101	-0.062	0.088
Income	-0.105**	0.037	-0.092**	0.032
Durability information	0.001	0.147	0.001	0.128
Climate information	0.003	0.147	0.002	0.128
Log Sigma	-0.443***	0.069		
Log-likelihood	-112.80	8 DF		
Left-censored observations	7			
Share of zero bids	6%			

*** sig. at 0.001, ** sig. at 0.01, * sig. at 0.05
DF = degrees of freedom
n = 115
see Table 51 in Appendix 1 for correlation matrix

Table 32: Effects of information packages on WTP for toothbrush in label group 1

	Tobit model		Marginal Effects	
	Estimate	Std. Error	Estimate	Std. Error
(Intercept)	0.686**	0.210		
Gender: 0 = f, 1 = m	0.007	0.125	0.006	0.101
Age	-0.005	0.006	-0.004	0.005
Children	0.332***	0.077	0.270***	0.063
Income	-0.051	0.032	-0.042	0.026
General information	-0.021	0.150	-0.017	0.122
Climate information	-0.041	0.151	-0.033	0.123
Log Sigma	-0.445***	0.070		
Log-likelihood	-106.59	8 DF		
Left-censored observations	7			
Share of zero bids	14%			

*** sig. at 0.001, ** sig. at 0.01, * sig. at 0.05
DF = degrees of freedom
n = 110
see Table 52 in Appendix 1 for correlation matrix

Table 33: Effects of information packages on WTP for toothbrush in label group 2

	Tobit model		Marginal Effects	
	Estimate	Std. Error	Estimate	Std. Error
(Intercept)	1.262***	0.173		
Gender: 0 = f, 1 = m	-0.447***	0.135	-0.399**	0.121
Age	-0.004	0.005	-0.004	0.004
Children	0.166*	0.076	0.148*	0.068
Income	-0.062	0.036	-0.055	0.032
Climate information	-0.024	0.157	-0.021	0.141
Durability information	-0.012	0.156	-0.011	0.140
Log Sigma	-0.338***	0.065		
Log-likelihood	-134.96	8 DF		
Left-censored observations	6			
Share of zero bids	5%			

*** sig. at 0.001, ** sig. at 0.01, * sig. at 0.05
DF = degrees of freedom
n=125
see Table 53 in Appendix 1 for correlation matrix

After each bidding round participants rated the helpfulness of the information package they had just received. More than 80 % of participants who received either information package found it helpful or more or less helpful (Figure 21). About 12 % did not find the general information helpful, and about 6 % were unsatisfied with the climate information. The assessments of information differed slightly between treatments as shown in (Table 54 in Appendix 1).

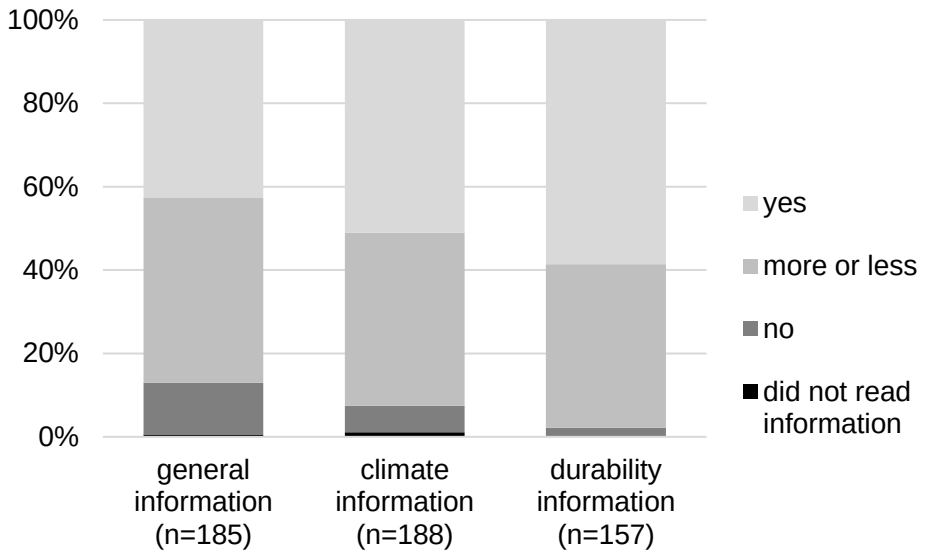


Figure 21: Assessment of information packages after each bidding round

After the auction experiment, participants were asked to evaluate the information packages according to the perceived relevance (5 = “very important” to 1 = “not important at all”) and the impression (“positive”, “neutral”, “negative”) they had of them. Calculation of Pearson’s correlation coefficient brought the following results (Table 55 in Appendix 1): Correlation between the bids for toothbrush after general information and the relevance participants put on it was slightly positive and significant (cor = 0.196, t = 2.680, p = 0.008). The correlation between bids for toothbrush and the impression participants had of the general information was also slightly positive and significant (cor = 0.164, t = 2.219, p = 0.028). Such relationships existed neither for toothbrush in the additional information packages nor for sunglasses at all. However, there was a significant correlation between the relevance participants put on the general information and their impression of the general information (cor = 0.178, t = 2.423, p = 0.016).

Overall, the effects of durability and climate information were erratic, given that they did not significantly affect WTP in neither treatment of neither product. Only, general information and the label significantly affected WTP in a few treatments of both products. Even though, more than 80 % of participants found the information packages helpful to some degree, the information did not seem to affect participants’ monetary evaluation of the products in a distinct way.

7.2.4. Effects of socio-demographics

According to existing studies socio-demographic characteristics such as gender, age, number of children living in the household, and income may have an effect on the dependent variable WTP (Torgler et al. 2008; Dupont 2004; Zelezny et al. 2000; Wiidegren 1998). The socio-demographic effects on the mean WTP for sunglasses by auction rounds were gathered in Table 34. Men bid significantly less for the sunglasses than women, and mean WTP was significantly higher if children lived in the household. Furthermore, participants with higher incomes bid significantly less for sunglasses than participants with lower income levels. Age did not significantly affect mean bids. Variables for treatment and bidding round were included in the Tobit regression to control for effects due to the different information packages, but had no significant effects on WTP.

Table 34: Effects of socio-demographics on WTP for sunglasses

	Tobit model		**Marginal Effects**	
	Estimate	Std. Error	Estimate	Std. Error
(Intercept)	1.093***	0.272		
Gender: 0 = f, 1 = m	-0.535***	0.131	-0.405***	0.099
Age	0.006	0.005	0.005	0.004
Children living at home	0.388***	0.077	0.293***	0.058
Income	-0.107*	0.046	-0.080*	0.035
Treatment	0.072	0.039	0.054	0.029
Bidding round	-0.027	0.080	-0.021	0.060
Log (scale)	0.496***	0.030		
Log-likelihood	-1189	8 DF		
Wald statistic	48.52***	6 DF		
Uncensored observations	590			
Left-censored observations	65			

*** sig. at 0.001, ** sig. at 0.01, * sig. at 0.05
DF = degrees of freedom
n = 655
see Table 56 in Appendix 1 for correlation matrix

Men bid significantly less for the toothbrush than women, whereas age did not have a significant effect on mean WTP (Table 35). When children were living in their household participants bid significantly more. Income had a negative and significant effect, and the treatment had significant effects on mean WTP, while the bidding round did not play a significant role.

In summary, men paid significantly less for the biopolymer products than women, and WTP of participants with children living in their household were

significantly higher for both products. In addition, income had a small negative, but significant effect on WTP for both products.

Table 35: Effects of socio-demographics on WTP for toothbrush

	Tobit model		Marginal Effects	
	Estimate	Std. Error	Estimate	Std. Error
(Intercept)	0.401***	0.102		
Gender: 0 = f, 1 = m	-0.165***	0.049	-0.136***	0.040
Age	0.003	0.002	0.002	0.002
Children living at home	0.105***	0.029	0.086***	0.024
Income	-0.065***	0.017	-0.053***	0.014
Treatment	0.069***	0.014	0.057***	0.012
Bidding round	0.021	0.030	0.017	0.025
Log (scale)	-0.472***	0.029		
Log-likelihood	-638	8 DF		
Wald statistic	63.02***	6 DF		
Uncensored observations	626			
Left-censored observations	44			

*** sig. at 0.001, ** sig. at 0.01, * sig. at 0.05
DF = degrees of freedom
n = 670
see Table 56 in Appendix 1 for correlation matrix

7.2.5. Influence of prior familiarity and prior attitudes

The addition of the independent categorical variables “level of information about biopolymers before experiment” and “prior attitudes towards biopolymers” to the Tobit regression model from chapter 7.2.4 tested the effect of these priors on mean WTP. The models revealed that when participants first learned about the biomass-based nature of the sunglasses these priors did not significantly affect their mean WTP (Table 36). Prior familiarity on a scale from 5 = “I was very familiar with bioplastics prior to the experiment” to 1 = “I was very unfamiliar with bioplastics prior to the experiment” (see Appendix 2, d) did not have a significant effect on participants’ mean WTP for a biomass-based toothbrush and neither did prior attitudes (Table 37).

Table 36: Effects of priors on WTP for sunglasses

	Estimate	Std. Error	Marg. Eff.	Std. Error
(Intercept)	-0.539	1.116		
Gender: 0 = f, 1 = m	-0.807**	0.249	-0.612**	0.190
Age	0.013	0.009	0.010	0.007
Children living at home	0.524***	0.143	0.398***	0.109
Income	-0.217**	0.070	-0.165**	0.053
Level of familiarity with biopolymers prior to experiment	0.106	0.142	0.080	0.108
Attitudes towards biopolymers prior to experiment	0.310	0.260	0.235	0.198
Treatment	0.237	0.126	0.180	0.096
Bidding round	0.638	0.459	0.484	0.349
Log (scale)	0.564***	0.051		
Log-likelihood	-412	10 DF		
Wald statistic	35.78***	8 DF		
Uncensored observations	199			
Left-censored observations	20			

*** sig. at 0.001, ** sig. at 0.01, * sig. at 0.05
DF = degrees of freedom
Tobit regression estimates, data from round 1 for text and label groups, data from round 2 for control groups

Table 37: Effects of priors on WTP for toothbrush

	Estimate	Std. Error	Marg. Eff.	Std. Error
(Intercept)	-0.244	0.395		
Gender: 0 = f, 1 = m	-0.195*	0.087	-0.162*	0.072
Age	0.005	0.003	0.004	0.003
Children living at home	0.072	0.051	0.060	0.043
Income	-0.061*	0.030	-0.0506*	0.025
Level of familiarity prior to experiment	0.032	0.049	0.027	0.041
Attitudes towards biopolymers prior to experiment	0.126	0.092	0.105	0.076
Treatment	0.118**	0.045	0.098**	0.037
Bidding round	0.240	0.163	0.200	0.136
Log (scale)	-0.483***	0.049		
Log-likelihood	-207.8	10 DF		
Wald statistic	26.15***	8 DF		
Uncensored observations	209			
Left-censored observations	12			

*** sig. at 0.001, ** sig. at 0.01, * sig. at 0.05
DF = degrees of freedom
Tobit regression estimates, data from round 1 for text and label groups, data from round 2 for control groups

Although, the data did not show a direct effect of prior information and attitudes related to biopolymers on the mean WTP for the biopolymer products, participants indicated in the post-experiment questionnaire that they may purchase biopolymer products in the future (Figure 22). 30 % of the sample would purchase biopolymer products if they were available or discernible as biopolymers. 28 % requested more information before purchasing biopolymer products, and 36 % would purchase them at prices similar to conventional plastic products. Only 6 % said they would (rather) not purchase biopolymer products.

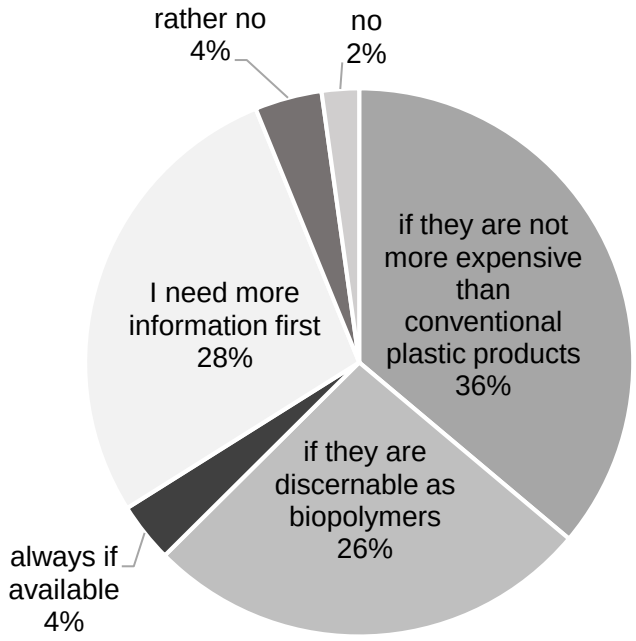


Figure 22: Prerequisites for future purchases of biopolymer products
Post-experiment questionnaire, single answers, n = 227

All in all, prior attitudes towards biopolymers as well as a prior familiarity with biopolymers did not significantly affect WTP, but a general interest in purchasing biopolymer products seems to exist.

7.2.6. Role of attitudes towards sustainable consumption

The auction experiment was also designed to test influences of attitudes towards sustainable consumption which were measured through the statement batteries for attitudes towards biopolymers and renewable resources (ABR) and GREEN Consumer Values (GCV). Table 38 and Table 39 display the relationships between ABR, GCV and the mean WTP for sunglasses and toothbrush for auction rounds 1 to 3 of all treatments. Only GCVs significantly interacted with mean WTP for sunglasses and toothbrush, whereas there were no significant interactions with ABR. Following Tanner & Wölfing Kast (2003) this finding could be attributed to the fact that the specifically formulated GCVs use statements about personal consumer behavior, whereas the ABR stated the generally desirable use of renewable resources and did not imply personal action. The interaction of GCVs and mean WTP was positive for both products and was quantified through the marginal effects: Participants could be expected to pay 22 Cents more for sunglasses per unit that they agreed more with the GCVs. For toothbrush, WTP more per unit could be expected to amount to 10 Cents.

At large, WTP was significantly affected by GREEN Consumer Values with a higher agreement with GCV statements leading to a significantly higher WTP for a biopolymer product. Attitudes towards biopolymers and renewable resources were probably too general and rudimentary to generate an effect on WTP.

Table 38: Attitudes towards sustainable consumption and WTP for sunglasses

	Estimate	Std. Error	Marg. Eff.	Std. Error
Intercept	0.227	0.515		
Gender: 0 = f, 1 = m	-0.492***	0.131	-0.373***	0.099
Age	0.001	0.005	0.001	0.004
Child at living at home	0.353***	0.073	0.267***	0.055
Treatment	0.081*	0.038	0.061*	0.029
Bidding round	-0.025	0.079	-0.019	0.060
Green Consumer Values (GCV)	0.291***	0.086	0.220***	0.066
Attitudes towards bioplastics, renewable resources (ABR)	-0.098	0.121	-0.074	0.091
Log (scale)	0.488***	0.030		
Log-likelihood	-1186	9 DF		
Wald statistic	55.26***	7 DF		
Uncensored observations	590			
Left-censored observations	65			

*** sig. at 0.001, ** sig. at 0.01, * sig. at 0.05
DF = degrees of freedom
Tobit regression estimates

Table 39: Attitudes towards sustainable consumption and WTP for toothbrush

	Estimate	Std. Error	Marg. Eff.	Std. Error
Intercept	-0.308	0.199		
Gender: 0 = f, 1 = m	-0.155**	0.049	-0.128**	0.041
Age	0.001	0.002	0.001	0.002
Child at living at home	0.078**	0.028	0.065**	0.023
Treatment	0.074***	0.014	0.061***	0.012
Bidding round	0.022	0.030	0.018	0.025
Green Consumer Values (GCV)	0.119***	0.032	0.099***	0.027
Attitudes towards bioplastics, renewable resources (ABR)	0.058	0.046	0.048	0.038
Log (scale)	-0.473***	0.029		
Log-likelihood	-637.2	9 DF		
Wald statistic	64.85***	7 DF		
Uncensored observations	626			
Left-censored observations	44			

*** sig. at 0.001, ** sig. at 0.01, * sig. at 0.05
DF = degrees of freedom
Tobit regression estimates

8. Discussion

The main purpose of this study was to assess the effects of information about biopolymer production, about their environmental and climate effects as well as their quality and durability characteristics on consumers' willingness to pay for biopolymer products. The results of this study that were presented in the preceding chapter are discussed and analyzed with regard to the research questions and hypothesis that have been developed in chapters 1, 3 and 4. In the first part of this discussion, findings are critically assessed and are compared with findings from the literature. In the second part, advantages and disadvantages of the applied study design and auction method are pointed out.

8.1. Discussion of findings

In the following, interpretations and explanations of the results are provided.

8.1.1. Low consumer understanding of bioplastics

The rather low consumer understanding of biopolymers is one main result of the prestudy. A variety of factors seem to be the basis of this finding: Participants of the prestudy did not only lack information, but sometimes the information they thought to have was also misleading. From the contradictory term bioplastic participants derived that the material was biodegradable/compostable. Or they thought that bioplastics are organic as the prefix "bio" usually stands for organic production in the German language. Such misinformation may cause unwanted consequences in the future, such as the refusal to use biopolymers for applications where durability is necessary or a contamination of organic waste, because consumers mistakenly compost durable biopolymers. Furthermore, participants seemed to have one-sided knowledge about biopolymers that was rather limited to the renewable resource basis, the biodegradability, and the sustainability of biopolymers. These findings are in line with Kurka & Menrad (2009, p. 30) who report that around 50 % of German study participants were informed about the availability of bioplastic bags and knew what raw materials are used to produce bioplastics. Following Blake's barriers of pro-environmental behavior that were presented in chapter 3.1, individual as well as social and institutional barriers seem to be in effect when it comes to biopolymers. Barriers could include the individual's lack of interest in biopolymers, as well as a lack of personal need of biopolymer products, a lack of consumer-relevant information on biopolymers and a lack of encouragement to try and use biopolymers.

The prestudy participants' impression that biopolymers are rather expensive might be derived from their experience with organic food products. At the same time, the continual growth of the organic food market (BÖLW 2015), the fact that certain groups of consumers are more likely to buy organic food products (Spiller 2006) and the discussion about lifestyle groups such as LOHAS (Wenzel & Kirig 2009) show that a market for biopolymers might exist even if they are more expensive (at first).

When prestudy participants were asked for information about biopolymers that they find important the resource basis and origin were named by almost half of the survey sample, and more than 40 % requested information that represented the ongoing discussions about climate change and land use change. The low availability of biopolymer products in the retail market, and the fact that some companies that had actually been using biopolymers in their products for some time, but only later requested a Green Premium price from their customers (Carus et al. 2014) may be reasons for the finding that one third of the participants did not know in what kinds of products biopolymers are used.

The low share of information requests relating to price (~ 20 %) in the prestudy might have been due to a social desirability bias, i.e. participants felt that they should be in favor of biopolymers because of the ongoing climate and environmental discussion and the high environmental awareness within the German society (BMU & UBA 2013). Curiosity might also have been a reason for the low interest in price that was found in the prestudy: participants became interested in the unknown material and the wish to experience it might have been of higher importance than the product price (Bernard & Schulze 2005).

8.1.2. Ambivalent effects of information on WTP

The central finding of the auction experiment is that participants offered higher bids after receiving general information about the biomass-based resource of the sample products or after seeing a product labelled ‘Renewable Resources’ than for a conventional plastic product (i.e. a product without information). The average willingness to pay more for a biopolymer product was significant between and within all treatments for toothbrush, and significant between the label and the control treatment for sunglasses. The biopolymer product was of higher value to participants no matter whether they evaluated the conventional product before learning about the biomass-based product or whether they received general or label information from the start. Thus, the raw material source itself seemed to be of value:

Hypothesis 1 that expected participants’ willingness to pay for a biomass-based sample product to be significantly higher than for the conventional equivalent can be accepted for all toothbrush treatments, and for the labelled sunglasses.

The label led to a higher WTP than general information. One central reason for this finding is the fact that images can be absorbed and processed much faster and with less effort than text, they can be remembered more easily and are better able to trigger emotions (Trommsdorff 2009, p. 71). In addition, the general information might have resulted in an ambivalent view of and conflicting emotions about biopolymers because India, Brazil and China were named as countries of origin for castor oil. As these countries are associated with environmental destruction, unsafe working conditions,

etc., a reduction of WTP could have occurred upon reading the general information[4]. According to studies by Depositario et al. (2009) and Fox et al. (2002) ambiguous information can have a negative effect on WTP. In addition, the introduction of castor beans that are a rather unknown crop as this tropical plant is not cultivated agriculturally in Germany, might have increased participants' uncertainty and/or led to confusion.

Accordingly, hypothesis 6 that expected participants who are confronted with a label on the biopolymer products are willing to pay more than participants who are informed about the biopolymers via a text can be accepted with reservation.

Additional information about climate and environmental effects of biopolymer production and about durability and disposal of biopolymers did not significantly change the initial WTP for a biopolymer product, suggesting that participants were either indifferent about the additional information, did not understand the information, were not able to properly evaluate the information or did not actively process it. Hence, effects of climate and durability information were ambivalent and unincisive. There are several possible reasons for this finding:

First, participants might have been overwhelmed by the amount and complexity of information. As most participants were not familiar with biopolymers the general information or the label might have been enough input, whereas additional information was not processed, not understood and/or could not be evaluated. Research on the effect of the so-called information overload includes findings that consumers only use a small amount of the available information to actually make decisions and that an overload of information can lead to inefficient decisions (Kroeber-Riel & Gröppel-Klein 2013, p. 468; Jacoby 1984, 1977). Since, the information packages for the auction were quite long, information overload may have occurred occasionally. As a consequence, participants might not have been able to discern their individual utility for the biopolymer-based sample products.

Second, 50 % of the participants felt either badly informed after the experiment or did not see a difference to the information they possessed before the experiment, thus the available information might not have corresponded with their information needs, they might not have understood the information completely or the information might not have been of interest to them which prevents the effective processing of information (Verbeke 2010; Wilson 2006). Findings by Roosen et al. (2011) show that information that consumers consider to be important strongly affects WTP, whereas information that is considered less relevant does lead to small or no changes of WTP. In addition, uncertainty about the accuracy of the information and the information source might have affected the information processing and might have led to rather small bids as well as rather small bid raises.

[4] One shortcoming of the study design was that the countries of origin were omitted from the label which make an absolute comparison between the WTP for general information and the WTP for the label impossible

Third, the additional information packages about climate and durability were derived as important information from the prestudy. Even if auction participants found this information important and valuable, it did not necessarily have to translate into monetary value, particularly keeping in mind that Barber et al. (2014) found that consumers might not be willing to pay a surplus for environmentally friendly products at all. Furthermore, Olson (2013) assessed that most consumers are willing to buy "green" TVs or "green" cars only if they are equal to conventional products concerning price, quality and performance. As participants were not informed about the basic functionalities of the sample products (UV-filter of sunglasses and hardness degree of toothbrush), some participants might not have considered the biomass-based products to be of the same quality as the conventional products. Additionally, environmental information was predominantly provided, which according to Tully & Winer (2014) generates a lower willingness to pay a surplus than social information. The climate information mentioned positive as well as negative effects of biopolymer production on climate and environment, and it is possible that participants' image about biopolymers became more negative because the actual effects of biopolymer production on environment and climate are greater than they had expected. The durability information that mentioned that the products are not biodegradable might as well have caused a rather negative evaluation of the sample products. Considering findings by Depositario et al. (2009) and Fox et al. (2002) that unfavorable and ambiguous information reduce WTP, such a conclusion seems plausible. Still, additional information about biopolymers might have affected participants' attitudes towards bioplastics as well as their awareness and acceptance that might affect their willingness to buy such products in the future.

In summary, the research hypothesis 2 that information on climate and environmental effects of biopolymer production significantly affects WTP must be rejected. Hypothesis 4 that WTP is equal or higher after participants learned about quality and durability characteristics of biopolymers cannot be accepted either, because of inconclusive auction results.

Fourth, information is only one factor of many that affect behavior and WTP. According to Stern (1999) information can affect short-term behaviors to a small extent when it captures attention, overcomes skepticism and triggers emotions. Additionally, usually simple behaviors which produce low costs and little inconvenience have successfully been altered by elaborate information. Climate information which was provided to the participants contained complex messages on issues like food versus non-food use of biomass, monocultures and intensive agricultural production. Information about non-biodegradability of the biopolymer products that were presented in the study, was part of the durability information. This information might have contradicted participants' expectations about biopolymers and might have affected their WTP.

Fifth, the questionnaire that was applied after the auction experiment revealed that participants were still unsure about a number of aspects relating to biopolymers that had been mentioned in the information packages such as the biomass-based

resources, the production of biopolymers, quality and durability, carbon footprint, areas of application and price. Uncertainty usually leads to careful and risk reducing behavior (Lusk & Shogren 2007; Kaas & Ruprecht 2006) which may explain the small or lacking changes of WTP after additional information. It is also possible that participants did not properly read all information, although there was no time limit for bidding and the assessment of information during the experiment suggested that usually more than 80 % of participants per treatment found the information (more or less) helpful. In summary, the effects of climate and durability information were not as substantial as the prestudy suggested. But, it turned out that basic information about the biomass-based material source appealed to consumers, caught their attention and affected WTP.

The extreme values and outliers as well as the generally higher bids for the biomass-based products might also have been caused by some kind of experimenter bias: Even though participants were randomly assigned to treatments and computers, and anonymity was imposed, participants might have wanted to please the experimenters (Lusk & Shogren 2007, p. 65). The sources of information were not disclosed to participants, thus, participants may have seen the experimenters as source of information and the amount of trust in the experimenters may have affected their assessment of the information packages and ultimately their WTP.

Comparing participants' WTP for the two products, they increased their average bid for a biomass-based toothbrush by a higher percentage than for biopolymer sunglasses. In addition, the total number of bid changes was higher for toothbrush than for sunglasses. Probably brushing one's teeth with a biomass-based toothbrush is more valuable to consumers than wearing biomass-based sunglasses. Thus, product category might play a role in the evaluation of biomass-based products as suggested by Kurka (2012). Furthermore, the purchase frequency could also affect the size of the price premium (Estelami & Maeyer 2004). In their "Meta-analysis of consumers' willingness-to-pay premiums for certified wood products" Cai & Aguilar (2013, p. 25) found that consumers pay higher premiums for frequently purchased products such as paper towels than for less frequently purchased ones such as furniture. Consequently, the basic price category could affect the size of the surplus consumers are willing to pay for sustainable products in general.

Once, participants were informed about the biomass-based material the order in which additional information was received did not seem to play a role. Furthermore. participants' reported positive or negative impressions of an information package could not be related to their bidding behavior which contradicts findings on the effects of information on WTP for food by Depositario et al. (2009) and Fox et al. (2002) that positive information leads to an increase in WTP and that negative or ambiguous information reduce WTP. However, the design of the auction experiment only allowed to measure the impression of the information packages *after* the experiment, thus participants might already have forgotten their first impression of a specific information

package. In addition, the impression was only measured on a 3-point scale (“negative”, “neutral”, “positive”) and did not assess ambiguous information.

Zero bids that occurred in all but one treatment indicate that some participants were indifferent to the provided information and/or were not interested in the products. Budget constraints should not have played a role in this auction as participants were endowed with a substantial amount of money, but loss aversion and other biases that will be discussed in chapter 8.2 might have restrained them from bidding according to the ideal strategy. Extreme values and outliers suggest that some participants either really cared for the biomass-based products, were very curious about the products and, thus, eager to possess one, or were convinced by product design and quality, etc. Another finding from this study suggests that consumers’ WTP for biomass-based products from domestic sources is likely to be higher than for renewably sourced products from unknown or distant origin. Even though WTP was only assessed hypothetically in this study, the findings are in line with analyses of WTP for locally produced goods (e.g. Koschate-Fischer et al. 2012; Okechuku 1994). A review by Banik et al. (2007) confirms that consumers accept higher prices for locally produced food products, and Barnes et al. (2011) found that consumers on Hawaii preferred food containers that contained locally grown resources. The auction results of this study put forward that this also applies to biopolymers based on domestically produced biomass in Bavaria/Germany.

Hypothesis 3 that stated that WTP for a product that uses resources from the region (Bavaria) exceeds WTP for a biopolymer product with unknown/distant origin cannot be rejected.

8.1.3. Surprising effects of socio-demographics on WTP

Above all, some differences in WTP for the biopolymer products could be attributed to socio-demographic characteristics of the participants. Overall, men offered lower bids for the biopolymer products than women. Explanations for this effect might be women’s generally higher involvement with and concern about environmental issues (Torgler et al. 2008; Zelezny et al. 2000) and women’s higher sensitivity towards ecolabels (Brécard et al. 2009). A closer look at the effects that could be ascribed to the label reveals that women offered a significantly higher WTP for both products upon being confronted with the label than men.

A significant effect of the income level appeared for both sample products with a higher income leading to a lower WTP. This is an interesting finding that adds a new aspect to the discussion whether income plays a role during the purchase of sustainable products and for sustainable behavior in general or not. While there are studies that did not find any relationship between the level of income and sustainable behaviors or that do not find these variables to be appropriate to explain such a behavior (Tanner & Wölfing Kast 2003; Laroche et al. 2001; Samdahl & Robertson 1989), Gatersleben (2001) reports a positive relationship between high income and non-sustainable

behaviors of a Dutch sample. Kurka (2012) takes a different perspective by suggesting that WTP for sustainable products is dependent on the product type and that for some products income effects might play a role, but not for others. Taking Kurka's perspective, a higher household income contributes to a small, but significant reduction of WTP for the sample products sunglasses and toothbrush that were applied in this study.

Participants who were living with one or more children had a significantly higher WTP for both products. Reasons for this finding could be an effort to protect children from substances that are harmful to health as the biomass-based origin of biopolymers may be associated with less harmful product ingredients, or a generally greater willingness to act in favor of environment and climate in order to conserve the planet for their children. A finding which corresponds with Dupont (2004) who found that parents are willing to pay more for environmental improvements of goods than non-parents, whereas Torgler et al. (2008) and Teal & Loomis (2000) did not assert a positive relationship between having children and pro-environmental tendencies or WTP for environmental programs.

8.1.4. Influences of attitudes and prior familiarity on WTP

Participants who stated to be informed about biopolymers prior to the experiment did not offer higher bids when they first received information about the biomass-based products than participants who were not informed about biopolymers prior to the experiment. These results are partly in line with Huffman et al. (2003) who found that participants who were familiar with a topic prior to the experiment did not significantly alter their WTP after additional information. A finding that corresponds with expected utility theory and Bayes Theorem yielding an unchanged WTP for a person who derives good quality from a product with certainty, but whose prior beliefs about the product are not affected by additional information (see chapter 4.1). In contrast to Huffman et al. who further found that participants who were uninformed about a product prior to the experiment significantly changed their WTP after additional product information, additional information about climate and durability did not significantly affect WTP for the biopolymer products of uninformed participants in the auction experiment. This suggests, that the additional information packages were not able to reduce participants' uncertainty about the products or did not significantly alter their prior beliefs about biopolymers.

Thus, hypothesis 5.1 that prior familiarity with biopolymers affects willingness to purchase and willingness to pay must be rejected.

As a difference in the WTP of participants who were initially informed about biopolymers and those who were not informed does not seem to exist, basic information about biopolymers on the product and at the point of sale becomes all the more important as an existing familiarity or knowledge does not seem to affect purchase behavior. Seligmann et al. (1981) found such a procedure to be successful when they confronted households with information about their energy use at the time

and place the targeted behavior occurred. Yet, the majority of auction participants claimed to be interested in buying biopolymer products in the future; as long as they could distinguish them from conventional products or as long as they were not more expensive than the conventional ones.

From the statement batteries that were summarized as indicators for sustainable consumption only GREEN Consumer Values (GCV) had a significant effect on WTP for both products. The more participants agreed with various aspects of the GCVs the higher the amount they were willing to pay for the biomass-based products. Following Tanner & Wölfing Kast (2003) that specific positive attitudes can ease sustainable consumption, it seems possible that these explicitly formulated statements that included personal behaviors of sustainable consumption supported participants' willingness to pay a surplus. The attitudes towards biopolymers and renewable resources that had been formulated in a rather general, impersonal way might therefore not have inspired participants' intention of consuming sustainably. My PhD colleague Christoph Scherer reports similar findings from a choice based conjoint analysis of biomass-based consumer products: Participants with an above average mean of GCVs and an above average mean of Perceived Consumer Effectiveness (PCE), respectively, seem less averse to higher prices for biopolymer-based products and seem to draw higher utilities from locally produced raw materials than participants with below average GCVs and PCE (unpublished findings by Scherer 2015). These findings are partly in line with Khachatryan et al. (2014) who report that participants with higher scores of environmental concern offered higher hypothetical premiums for various sustainable product attributes.

Thus, hypothesis 5.2 that attitudes towards biopolymers affect willingness to purchase and willingness to pay can partly be accepted.

Furthermore, it has to be considered that biopolymers are still new to consumers, that familiarity with biopolymers and actual experience is rather low (Kainz et al. 2013) (Kurka & Menrad 2009), and that biopolymer product characteristics might simply not play an important role for consumers (Kurka 2012, p. 94). A positive reception of biopolymers seems likely as participants stated rather positive attitudes towards biopolymers, renewable resources and green consumption in the prestudy and main experiment of this study. However, the overall positive attitudes towards biopolymers and sustainable products may also be due to a possible self-selection bias in the prestudy: people might have attended because of their positive attitudes towards the environment or an interest in biopolymers. Additionally, participants of both studies also saw some aspects of biopolymer production rather critically, e.g. a possible increase of monocultures and possible land use conflicts with food production.

8.2. Discussion of auction method

The implementation of the experimental auction method to elicit consumers' WTP for biomass-based consumer products constitutes an innovative approach. Other than the hypothetical elicitation of consumers' WTP in choice experiments and conjoint

analyses, the auction provides actual WTP for real products that is, however, formed in an artificial laboratory setting. Thus, the advantage of the auction experiment's evaluation of real products goes hand in hand with the shortcoming of an alienated purchase decision process where participants have to come up with the product price themselves. However, if participants follow the ideal bidding strategy by bidding their true value, these values are more likely to be accepted as prices in real markets, than hypothetically elicited values, where participants tend to overestimate their values (Silva et al. 2007; List & Gallet 2001).

One has to keep in mind that – even though the experimental laboratory setup imposed anonymity and allowed for considerable control of all kinds of effects – a number of biases could have occurred: Social desirability bias could have led participants to offer higher bids for the biomass-based products because, today, pro-environmental behavior plays an important role in the German society (BMU & UBA 2013). But the comparison of WTP between independent treatments indicates that social desirability was not an issue: The size of bids that participants from the text group offered for the biomass-based products in their first bidding round (i.e. the only information they had was that the products were made from biomass) was similar to the bids that participants from the control group offered for the biomass-based products in their second bidding round. However, as levels of information and attitudes were assessed after the experiment, participants might have given answers that matched their bidding behavior during the auction. A behavior that may occur unconsciously in an effort to avoid cognitive dissonance (Festinger 1962, 1957). The highly significant correlation between the WTP for a labelled product and participants saying that the label had increased their bids, and the significant correlation between WTP for a labelled product and participants' trust in the label might be attributed to participants' effort to justify the bid values to themselves.

The following commitment costs could have affected bid values in the auction experiment (Lusk & Shogren 2007, pp. 43–44; Corrigan 2005; Zhao & Kling 2004, 2001): buying the product during the experiment cost participants the opportunity of receiving more information about the product in the future. As they did not know whether the products were available in the field, there was a cost of buying a product that might be cheaper in the field. Trusting the credence attribute that the products were partly biomass-based can also be seen as a commitment that might have caused a bid reduction. Consequently, it has to be assumed that participants consciously and unconsciously subtracted these and other costs from their bid.

The low bidding values that differed greatly from the actual field prices of the example products probably also have methodological reasons: information about the functionality of the products, such as UV-protection of the sunglasses and the hardness degree of the toothbrush, were not disclosed during the experiment. Participants only received information concerning the biomass-based characteristics of the products, and remained uncertain about other product features. In addition, the

bright and simple design of the sunglasses might not have been to the taste of all participants, especially, considering that the sample's average age was 41.6 years. It has to be taken into account that participants might not usually purchase the sample products, because another member of the household buys the toothbrushes and most consumers buy sunglasses rather seldom. Furthermore, price knowledge was reported to be rather low in Germany (Evanschitzky et al. 2004) and was found to be dependent on purchase frequency and exposure to advertising amongst others (Diller 2007; Estelami & Maeyer 2004).

The predominantly low bidding values for both products can also be explained theoretically by the endowment effect, the status quo bias, and loss aversion (Kahneman et al. 1991). These three effects that are strongly interlinked explain the aversion of a person to exchange a good or money that was given to them, for money or a good, because they prefer the status quo and derive more utility from it than from giving up the good or money they were endowed with. Therefore, participants of an experiment often demand a higher value to give up a good than they would give to purchase the same good. As participants of this auction experiment were endowed with a participation fee, this status quo of owning 35 Euros might have been more appealing than owning a toothbrush or sunglasses. Loureiro et al. (2003) suggest two payments in order to reduce biases due to endowment: the participation fee that compensates the participants for the time spend at the experiment should be paid sometime after the experiment, and during the experiment participants should be endowed with some money to bid. A downside of such a procedure might be that participants do not feel that they are spending their own money on the goods, but money from the experimenter that they received for exactly that purpose.

The low value of bids could also have been caused by participants' uncertainty about the actual product value (Kaas & Ruprecht 2006): the best strategy for bidders who are risk averse and uncertain about the true value of a product is to underestimate their WTP. Thus, they keep their endowment which is in line with loss aversion and the status quo bias, but at the same time they forego the opportunity to win a surplus and the product, which they might regret later (ibid.).

Despite the practice rounds and the assumption that the applied 8th-price auction is incentive-compatible, the goal of some participants might have been to take home the complete participation fee. The rather unreal purchase situation in the lab where participants were asked to come up with their own prices might also have caused mostly low bidding values, below 2 Euros for sunglasses and below 1 Euro for a toothbrush.

Participants' uncertainty about the product value can be reduced by naming the field price or a range of field prices for the product in question. A measure that might reduce underbidding, but is prone to anchoring bias, where an incidental value a subject is exposed to before bidding leads to a bid that is close to that value (Furnham & Boo

2011; Corrigan & Rousu 2006; Nunes & Boatwright 2004; Jacowitz & Kahneman 1995).
The above presented biases were considered carefully during the development of the auction design. As the main interest was to determine consumers' homegrown values for biopolymer products, ruling out anchoring was determined as the first priority. Accordingly, neither field prices nor market prices were posted during the auction experiment.

A laboratory experiment was chosen because consumers are hardly familiar with biopolymers, because biomass-based plastic consumer products cannot easily be found in the market, and because the provided information packages were quite complex. Thus, a lab setup ensured an equal access to the biopolymer products and to information for all participants, and enabled the experimenter to control for side effects. The application of several treatments allowed to compare WTP for the sample products within and between subjects. A drawback of the laboratory experiment is the relatively low number of participants which does not allow for a generalization of the findings. However, it does provide robust statistical results for the sample itself.

The use of alternative research methods such as a discrete choice experiment or a BDM-mechanism would have reduced the problem of consumers' lack of price knowledge, but would have elicited WTP hypothetically in the case of discrete choice and would have been difficult to realize in form of a BDM, because of the extensive information that was provided. Participants needed a quiet place and enough time to read and process the information about the products, a set up that is not usually provided in the BDM.

The rather unreal purchase situation that expected participants to come up with prices they found acceptable was condoned because the main goal of the study was not to assess market prices for the sample products, but to assess the relative effects of information packages on WTP. In order to keep up the involvement of on-margin and most off-margin bidders an 8^{th}-price auction was applied which combines an advantage of a Vickrey auction by engaging on-margin bidders as well as an advantage of a random n^{th}-price auction by engaging some off-margin bidders (Shogren et al. 2001). The auction design provided that, depending on the number of participants per session, one third to almost half of the participants would buy a product at the end which gave participants an additional incentive to bid truthfully on top of the ideal bidding strategy.

An improved design of the applied auction experiment should include an initial question about participants' experiences with biopolymer products and should enable the participants to experience biopolymer products, for example by letting a subsample test the products for a couple of days before the experiment or during the experiment. Additionally, less extensive information packages and the use of information that only

talks about one specific characteristic or effect of biopolymers might produce clearer results.

A further shortcoming of the study design was that the phrasing of the information packages did not directly mention personal benefits one could derive from the use of biomass-based products apart from a rather hidden appeal to altruistic motives. Recent studies on behavior towards renewable energies and on resource use show that connecting climate change with themes like health, family and security affect behavior and that residents better relate to local and visible impacts and facts such as the dry up of a local river or the lack of snow in winter than to the general, but abstract threat of climate change (Daniels 2016; Speiser 2014). The Los Angeles Solar Efficiency Report (Madrid 2014) suggests that people are more likely to start a desirable energy use behavior if they feel that they are in control of their energy use, if they see positive effects (reduction of air pollution, lower utility bills) for their family and community or if they have role-models within their peers who installed a solar panel on their roof, etc. In the Guide to Effective Climate Change Communication a total of thirteen steps for an effectful communication on climate change are described, highlighting the importance of connecting climate change with issues that matter to the audience and of describing benefits of a change in bebaviors i.e. by showing the audience behavioral ways that make them part of the solution (Markowitz et al. 2014).

9. Conclusions

This study applied a well-tested and established method from agricultural economics to the new and emerging field of biomass use for the production of consumer goods. In summary, participants of the auction experiment offered significantly higher prices for a biopolymer product than for a conventional, fossil-based plastic product. The findings suggest that consumers have a basic interest for biopolymer products and see them as a slightly positive development, but that a lot of effort is needed to raise awareness for and acceptance of such products. Information about biopolymers that was provided in the course of the main study only partly affected consumers' WTP suggesting amongst others that the information packages were too complex or that consumers were not that interested in the biopolymer products because they do not play an important part in their everyday life as does e.g. food. The lack of interest and knowledge could be addressed through opportunities for consumers to experience biomass-based plastics in form of various products. Letting people get in touch with the unknown material grade could help to reduce possible reservations and prejudices, and enable a more intensive and longer lasting experience than a newspaper article or a talk. However, durable biopolymers might not match consumers' expectations of a sustainable product as they add to environmental pollution and landfills just like conventional plastics if they are not recycled or burned for energy use. Consumers might also expect from a biomass-based plastic product that it is biodegradable.

The label proved quite powerful during the auction experiment suggesting that the implementation of a label is an effective way to inform consumers about biomass-based plastics. However, the development of specific certification schemes, an independent certification body as well as controlling systems and specific PR activities to inform consumers about the characteristics of such a label are important pre-conditions for success (Horne 2009). Also, the various limitations of labels including the rebound effect and the confusing number of labels, as well as the fact that labelled products do not necessarily reduce environmental or climate impacts have to be taken into account (ibid.). Research further suggests that the more successful labels are those that enable communication of all relevant stakeholders during the labelling process including an actor from or close to the government which seems to contribute to the simplification and concentration of such a labelling process (Iles & Martin 2013; Horne 2009).

Future willingness to purchase durable biopolymer consumer products is highly dependent on the significance consumers ascribe to biopolymers in general and the future role of biopolymers in everyday life. Willingness to pay a premium for biopolymer products is likely to be higher for specific products during a limited period of introduction, and an initially higher WTP during the market introduction of biopolymers might even be necessary to increase production quantity and visibility on the market (Carus et al. 2014). The use of locally grown raw materials for biopolymer production could be an approach to trigger consumers' interest in biopolymers.

The findings denote that the strategies that policy makers developed to build a bio-economy might not always meet society needs and interests. From the bio-economy policy point of view biopolymers might seem like an efficient and sustainable way of increasing the use of renewable resources for material purposes, but from the societal point of view the disadvantageous consequences of biopolymers such as environmental and water pollution, non-biodegradability and continued resource and energy use might weigh stronger. The example of the implementation of biopolymers into the consumer market also shows that greater efforts from the side of the policy makers and industry are necessary in order to adequately inform consumers and to include them into the development and implementation of a bio-economy.

Summary

Replacing crude-oil, natural gas or coal with biomass-based resources is one way to reduce dependency from fossil resources, to mitigate climate change, and to protect the environment. Replacing crude oil with biomass in order to produce plastics currently constitutes a growing market that offers a variety of materials and products. Most of these so-called bioplastics or biopolymers have properties equal or similar to conventional plastics, and the spectrum of applications ranges from engineering polymers to consumer products. But, small production capacities and a low market penetration are reasons for the often higher prices for biopolymers compared to conventional plastics. From the consumers' point of view, biopolymers are difficult to recognize because they look and feel like conventional plastics. In addition, familiarity with biopolymers is rather low among the public. To implement biopolymer consumer products in the market on the long term, a better understanding of consumers' present familiarity with biopolymers as well as adequate information of consumers about biomass-based products, and consumers' willingness to pay (WTP) are important factors. Accordingly, the following research questions were tackled in the course of this PhD-work:

- What do consumers know about biopolymers?
- What information about biopolymers is relevant to consumers?
- Are consumers willing to pay more for biopolymer products than for plastic products made from fossil fuel?
- How does information about biopolymers affect willingness to pay?
- Do attitudes towards sustainable consumption and prior familiarity with biopolymers affect willingness to pay?

An online consumer survey was conducted to answer the first two research questions and an auction experiment was applied to get a first insight into the remaining questions. 81 consumers participated in the online survey that was conducted in 2013. The survey showed that consumers' confrontation with biopolymers is rather low resulting in a lack of comprehensive understanding of characteristics, applications and effects of biopolymer production, use and recovery. Consumers' attitudes towards biopolymers and renewable resources, however, were rather positive. Information about bioplastics that survey participants found relevant included the raw material, the resource origin, effects on climate and environment as well as stability and quality.

An 8th-price auction was conducted to determine WTP for two durable, biomass-based consumer products (sunglasses and toothbrush) that were really sold to participants. The experiment was designed to assess effects of information inputs, attitudes towards renewable resources and sustainable consumption as well as socio-demographic characteristics on WTP. 227 consumers participated in the laboratory experiment that was conducted in Munich, Germany, in February 2014. Participants were randomly assigned to one of six experimental treatments that contained three of the five different information packages about biopolymers: (1) no information, (2) general information

about biopolymers, resource origin and resource share, (3) information about climate, environmental effects, and land use, (4) information about durability, stability, recycling and disposal of biopolymers, (5) information in form of a ‘Renewable Resources’ label. During the experiment, each participant received three information packages and was asked to state bids for both products after each information input.

A laboratory experiment was chosen because consumers are hardly familiar with biopolymers and the information packages were quite complex. Thus, a lab setup ensured an equal access to the biopolymer products and to information for all participants, and enabled the experimenter to control for side effects. Some drawbacks of this method are the rather low number of participants which does not allow for a generalization of the findings, and the somewhat unreal purchase decision process because participants have to name their own product price. A so-called incentive-compatible auction mechanism was applied that includes an ideal bidding strategy and that provides consequences for bidders who deviate from their true values. This incentive equals a surplus that arises from the difference between the market price and a person’s bid: if the market price is lower than a person’s bid she only has to pay the market price to buy the product. Participants cannot influence the size of this monetary incentive because it is decoupled from their personal bid. Only the interaction of one’s bid with bids from other participants or a randomly drawn price defines the size of the surplus after the bidding. Consequently, “each bidder has a weakly dominant strategy to bid equal to their value” (Lusk & Shogren 2007, p. 19).

The experiment was conducted with the open source software z-Tree that automatically saved the data during the experiment. Data analysis included descriptive statistics and tobit regression models.

The auction experiment provided the following findings: About 50 % of participants had heard about biopolymers before the experiment, but more than 60 % stated a (very) low level of information about biopolymers prior to the experiment. Men paid significantly less for the biopolymer products than women, and WTP of participants with children living in their household was significantly higher for both products. Interestingly, income had a small negative, but significant effect on WTP for both products. WTP was significantly affected by GREEN Consumer Values that measured specific attitudes towards pro-environmental consumer behavior. Hypothetically, participants offered significantly higher WTPs for products based on sunflower oil from Germany than for products that were made from biomass imported from India, China or Brazil.

The central finding of the auction experiment is that participants offered higher bids after receiving general information about the biomass-based resource of the sample products or after seeing a product labelled ‘Renewable Resources’ than for a conventional plastic product. The biopolymer product was of higher value to participants no matter whether they evaluated the conventional product before learning

about the biomass-based product or whether they received general or label information from the start. One reason for the finding that the label led to a higher WTP than general information is that images are processed much faster than text. In addition, the general information might have resulted in an ambivalent view of biopolymers because India, Brazil and China were named as countries of origin for castor oil. In addition, the introduction of castor beans that are a rather unknown agricultural crop in Germany, might have increased participants' uncertainty and/or led to confusion. Additional information about climate and environmental effects of biopolymer production and about durability and disposal of biopolymers did not significantly change the initial WTP for a biopolymer product, suggesting that participants were either indifferent about the additional information, did not understand the information or did not actively process it.

Comparing participants' WTP for the two products, they increased their average bid for a biomass-based toothbrush by a higher percentage than for biopolymer sunglasses. In addition, the total number of bid changes was higher for toothbrush than for sunglasses. Probably brushing one's teeth with a biomass-based toothbrush is more valuable to consumers than wearing biomass-based sunglasses. Thus, product category might play a role in the evaluation of biomass-based products as suggested by Kurka (2012). Furthermore, the purchase frequency could also affect the size of the price premium (Estelami & Maeyer 2004). In their "Meta-analysis of consumers' willingness-to-pay premiums for certified wood products" Cai & Aguilar (2013, p. 25) found that consumers pay higher premiums for frequently purchased products such as paper towels than for less frequently purchased ones such as furniture. Consequently, the basic price category could affect the size of the surplus consumers are willing to pay for sustainable products in general.

Overall, the findings suggest that consumers have a basic interest in biopolymer products, but as they are not part of everyday consumer behavior biopolymers seem somewhat meaningless and rather far away from consumers. The experiment showed that given the information that was provided, consumers find it difficult to evaluate the benefits and values of biopolymers. In addition, biopolymers might not meet consumers' expectations of a sustainable, climate-friendly, environmentally friendly material.

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Appendix 1

Table 40: Additional sample characteristics relating to sample products

	Treatment						
	Control group 1	**Control group 2**	**Text group 1**	**Text group 2**	**Label group 1**	**Label group 2**	**Sample**
Spectacle wearers							
always	34%	15%	23%	15%	32%	21%	24%
sometimes	19%	33%	37%	44%	43%	36%	35%
no	47%	51%	40%	41%	24%	43%	41%
Product type of sunglasses							
lifestyle product	34%	44%	40%	36%	38%	43%	39%
basic commodity	50%	51%	57%	46%	49%	43%	49%
sports equipment	16%	5%	3%	18%	14%	14%	12%
Number of sunglasses							
0-1	44%	33%	37%	18%	43%	33%	35%
2-3	25%	44%	34%	51%	38%	55%	41%
4+	31%	23%	29%	31%	19%	12%	24%
Electric toothbrush user							
yes	31%	33%	17%	18%	14%	26%	23%
no	69%	67%	83%	82%	86%	74%	77%
Need new toothbrush							
yes	38%	23%	26%	23%	41%	33%	31%
no	63%	77%	74%	77%	59%	67%	69%

Table 41: Occurrence of outliers and extreme bid values

Round	Treatment	Information	Sunglasses		Toothbrush	
			Outliers [€] (above 1.5 IQR)	Extreme values [€] (above 3 IQR)	Outliers [€] (above 1.5 IQR)	Extreme values [€] (above 3 IQR)
1	Control group 1	None	3.99 4.32 4.45	8.50		
2		General	7.90		2.50	
3		Climate	6.90		2.50	
1	Control group 2	None	2.99			
2		General	2.50 2.95 2.99	5.00		2.00
3		Durability	2.40 2.95 2.99	6.00		2.00
1	Text group 1	General	3.33	4.99	1.45	2.00 2.22
2		Climate	2.50 2.60 3.00	4.99	1.49 1.50	
3		Durability	2.50 2.71 3.00	4.99	1.25 1.49 1.50	
1	Text group 2	General	4.99 5.00 5.99	7.50 25.70	2.50	
2		Durability	4.99	7.00 20.70	1.99 2.50 2.99	3.50
3		Climate	5.00 6.00 6.99	20.70	3.00	3.99
1	Label group 1	Label		6.00 7.00 15.00	2.40 2.50	3.20
2		General	3.89	6.00 7.00 19.00	1.60 2.40 2.49 2.50	3.90
3		Climate	3.50 3.89	7.0 7.50 19.00	2.40 2.59	3.50 3.90
1	Label group 2	Label	12.00 12.50	19.99	2.99	
2		Climate	12.50	20.59 22.00	2.90	4.50
3		Durability		11.95 14.00 20.59	3.5	

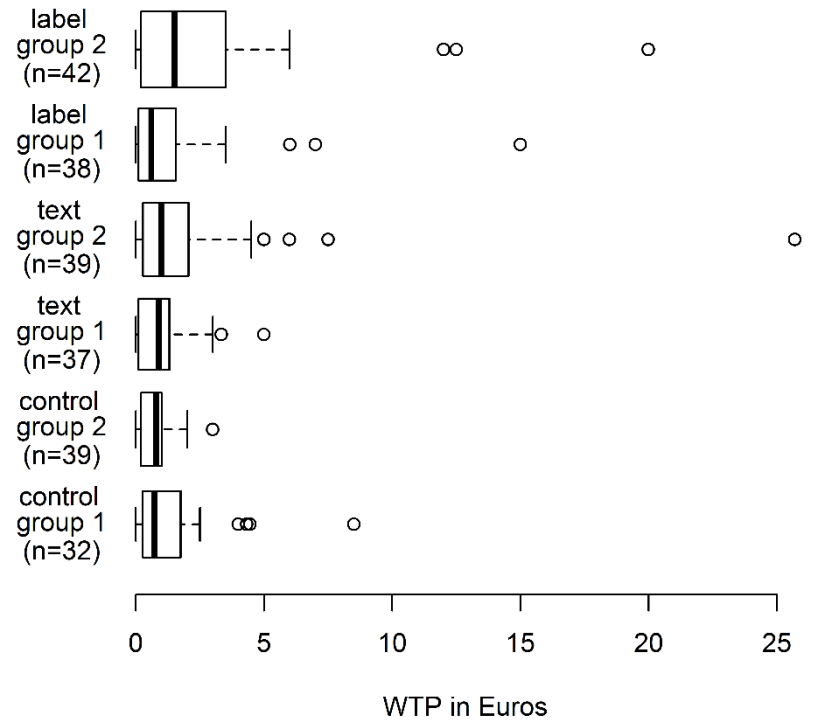

Figure 23: Boxplots depicting WTP for sunglasses by treatment in bidding round 1

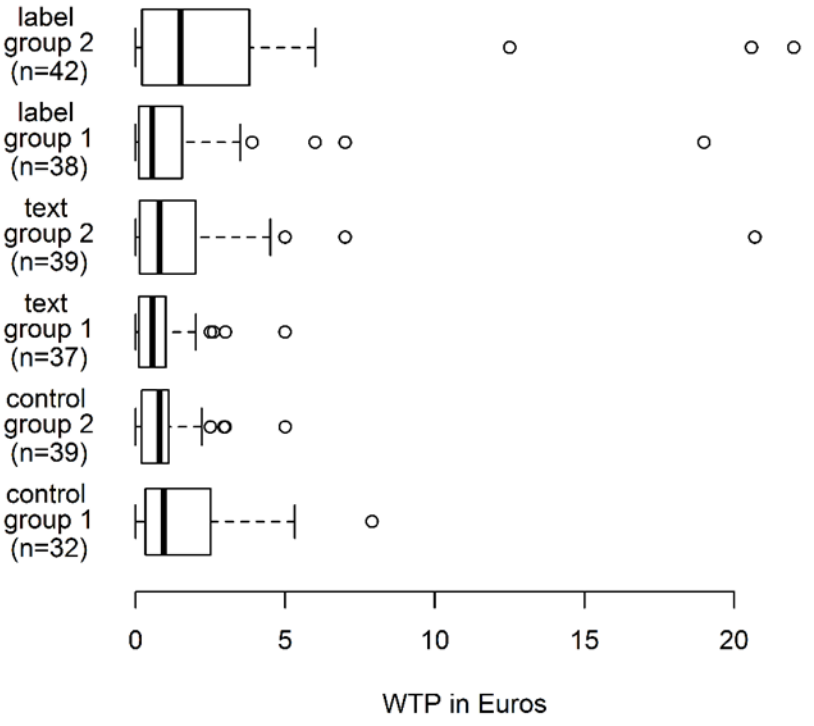

Figure 24: Boxplots depicting WTP for sunglasses by treatment in bidding round 2

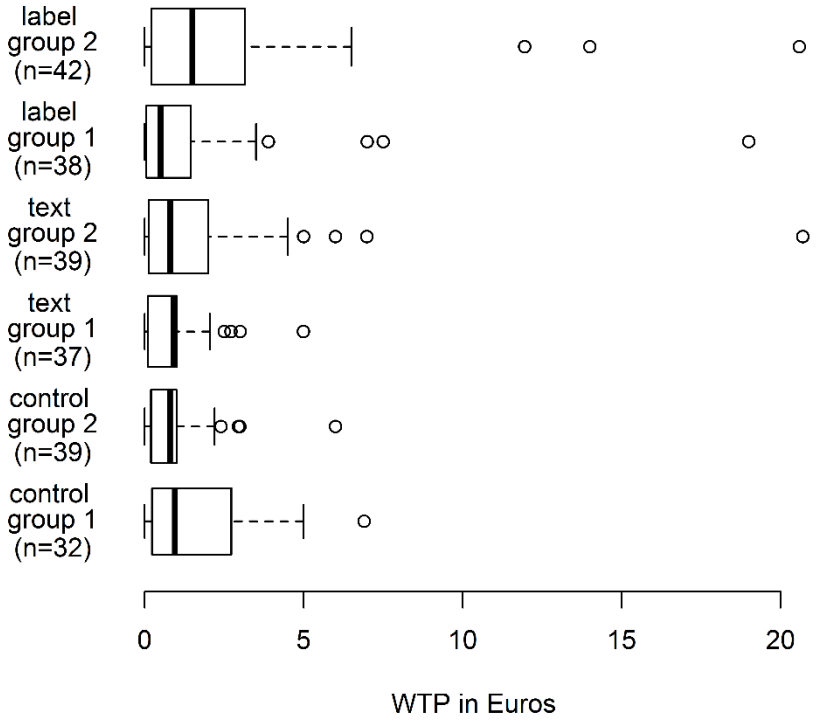

Figure 25: Boxplots depicting WTP for sunglasses by treatment in bidding round 3

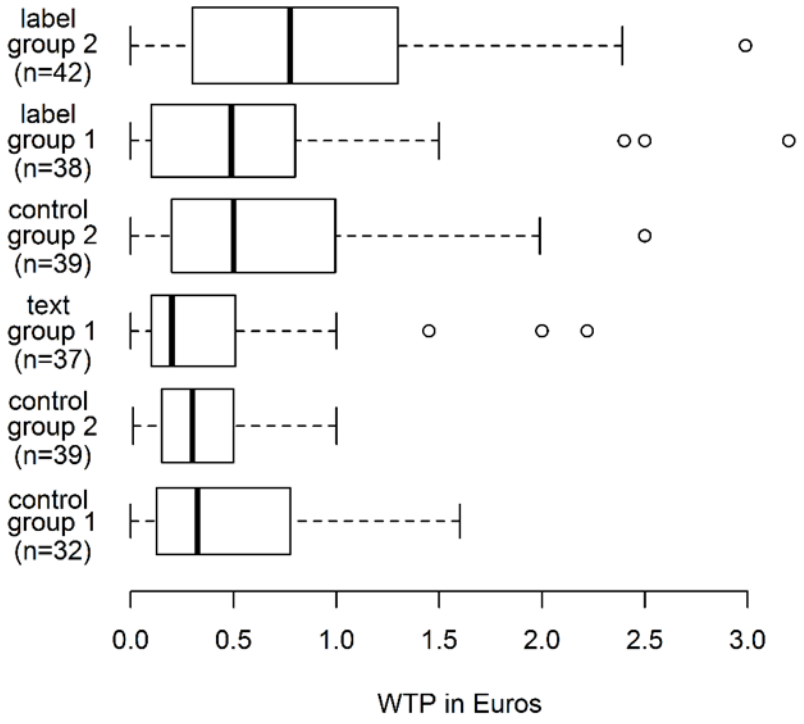

Figure 26: Boxplots depicting WTP for toothbrush by treatment in bidding round 1

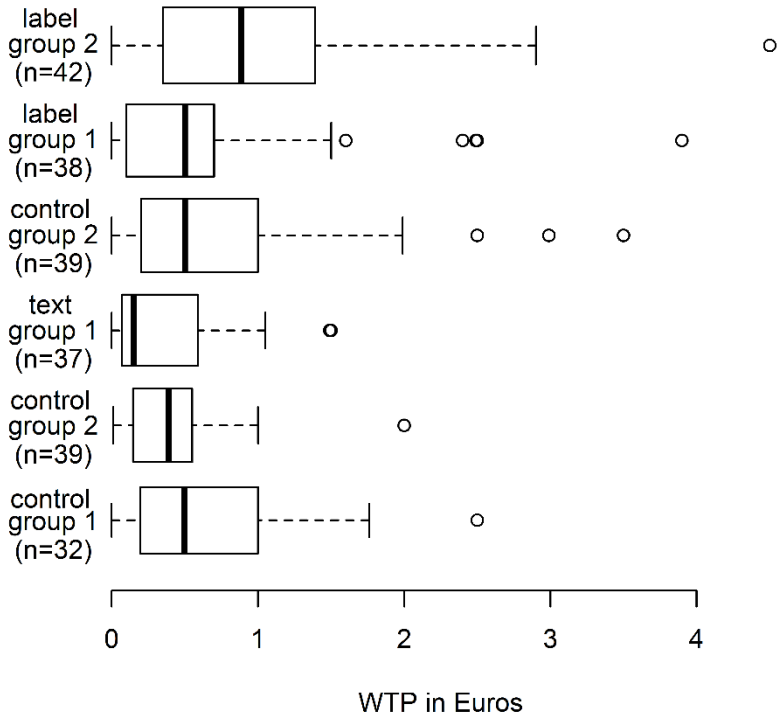

Figure 27: Boxplots depicting WTP for toothbrush by treatment in bidding round 2

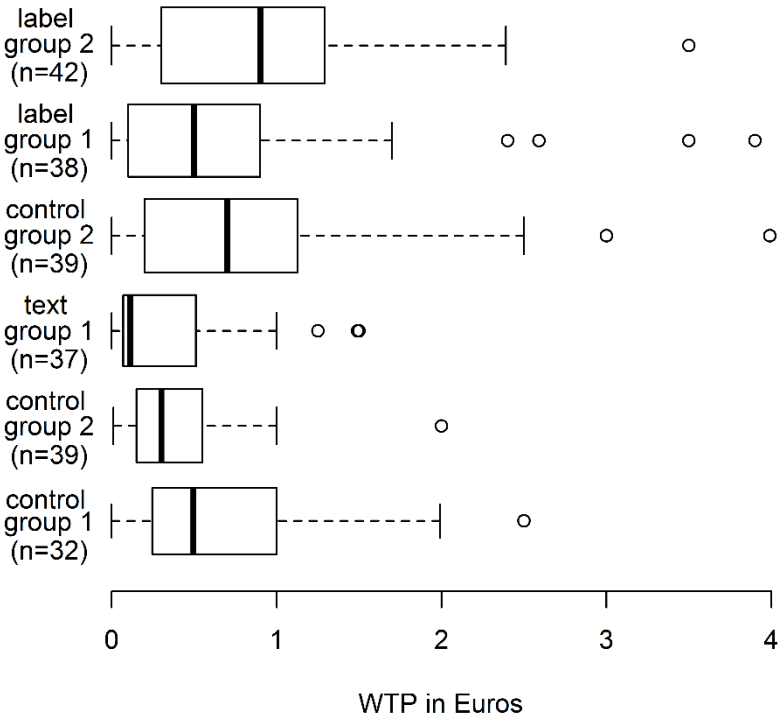

Figure 28: Boxplots depicting WTP for toothbrush by treatment in bidding round 3

Table 42: Correlation matrix, sunglasses control group 1

Tobit Model	Intercept	Gender	Age	Children	Income	General Information	Climate Information	log Sigma
Intercept	1							
Gender	-0.521	1						
Age	-0.475	0.025	1					
Children	0.096	-0.306	0.177	1				
Income	-0.533	0.252	-0.065	-0.408	1			
General Information	-0.378	0.015	-0.035	-0.006	0.008	1		
Climate information	-0.378	0.015	-0.035	-0.006	0.009	0.510	1	
log Sigma	0.006	-0.059	0.038	0.058	-0.048	-0.001	-0.001	1

Table 43: Correlation matrix, sunglasses control group 2

Tobit Model	Intercept	Gender	Age	Children	Income	General Information	Durability information	log Sigma
Intercept	1							
Gender	-0.174	1						
Age	-0.671	0.036	1					
Children	-0.273	0.041	0.181	1				
Income	-0.605	-0.127	0.177	-0.048	1			
General Information	-0.349	-0.010	0.011	0.018	0.021	1		
Durability information	-0.349	-0.010	0.011	0.018	0.021	0.494	1	
log Sigma	0.005	-0.014	0.008	0.012	-0.023	0.000	0.000	1

Table 44: Correlation matrix, sunglasses text group 1

Tobit Model	Intercept	Gender	Age	Children	Income	Climate Information	Durability information	log Sigma
Intercept	1							
Gender	-0.572	1						
Age	-0.465	0.210	1					
Children	0.055	-0.024	-0.012	1				
Income	-0.335	0.110	-0.349	-0.397	1			
Climate Information	-0.401	-0.007	0.006	-0.001	-0.004	1		
Durability information	-0.401	-0.007	0.006	-0.001	-0.004	0.499	1	
log Sigma	-0.037	0.043	-0.072	0.032	0.050	-0.002	-0.002	1

Table 45: Correlation matrix, sunglasses text group 2

Tobit Model	Intercept	Gender	Age	Children	Income	Climate Information	Durability information	log Sigma
Intercept	1							
Gender	-0.174	1						
Age	-0.468	-0.489	1					
Children	0.030	0.033	-0.068	1				
Income	-0.480	-0.024	0.127	-0.461	1			
Climate Information	-0.425	0.000	0.000	0.000	0.000	1		
Durability information	-0.420	-0.002	-0.008	0.007	-0.004	0.503	1	
log Sigma	-0.014	-0.032	0.017	0.014	0.009	0.000	-0.005	1

Table 46: Correlation matrix, sunglasses label group 1

Tobit Model	Intercept	Gender	Age	Children	Income	General Information	Climate Information	log Sigma
Intercept	1.000							
Gender	-0.231	1.000						
Age	-0.587	-0.198	1.000					
Children	-0.121	0.067	-0.060	1.000				
Income	-0.342	0.061	-0.194	-0.166	1.000			
General Information	-0.365	0.000	0.003	-0.006	-0.002	1.000		
Climate Information	-0.365	0.000	0.003	-0.006	-0.002	0.496	1.000	
log Sigma	-0.024	-0.002	-0.011	0.091	-0.030	-0.016	-0.016	1.000

Table 47: Correlation matrix, sunglasses label group 2

Tobit Model	Intercept	Gender	Age	Children	Income	Climate Information	Durability information	log Sigma
Intercept	1							
Gender	-0.136	1						
Age	-0.440	-0.293	1					
Children	0.007	0.089	-0.177	1				
Income	-0.401	-0.134	-0.038	-0.418	1			
Climate Information	-0.458	-0.008	-0.008	0.012	0.005	1		
Durability information	-0.458	-0.021	0.007	0.027	-0.004	0.489	1	
log Sigma	-0.002	0.000	0.038	0.062	-0.106	-0.001	0.000	1

Table 48: Correlation matrix, toothbrush control group 1

Tobit Model	Intercept	Gender	Age	Children	Income	General Information	Climate Information	log Sigma
Intercept	1							
Gender	-0.521	1						
Age	-0.509	0.066	1					
Children	0.091	-0.293	0.165	1				
Income	-0.531	0.240	-0.045	-0.402	1			
General Information	-0.376	-0.005	0.005	0.005	-0.002	1		
Climate information	-0.376	-0.005	0.005	0.005	-0.003	0.503	1	
log Sigma	-0.002	-0.027	0.032	0.033	-0.035	0.008	0.008	1

Table 49: Correlation matrix, toothbrush control group 2

Tobit Model	Intercept	Gender	Age	Children	Income	General Information	Durability information	log Sigma
Intercept	1							
Gender	-0.172	1						
Age	-0.673	0.039	1					
Children	-0.276	0.047	0.179	1				
Income	-0.607	-0.139	0.184	-0.039	1			
General Information	-0.426	0.002	0.009	-0.009	0.008	1		
Durability information	-0.426	0.009	-0.001	-0.015	0.018	0.493	1	
log Sigma	-0.013	-0.031	0.019	0.014	0.007	0.000	-0.007	1

Table 50: Correlation matrix, toothbrush text group 1

Tobit Model	Intercept	Gender	Age	Children	Income	Climate Information	Durability information	log Sigma
Intercept	1							
Gender	-0.578	1						
Age	-0.459	0.224	1					
Children	0.089	0.019	-0.025	1				
Income	-0.353	0.086	-0.328	-0.403	1			
Climate Information	-0.410	-0.009	0.011	-0.067	0.017	1		
Durability information	-0.411	-0.009	0.010	-0.067	0.017	0.514	1	
log Sigma	-0.045	0.050	-0.057	0.036	0.029	-0.009	-0.009	1

Table 51: Correlation matrix, toothbrush text group 2

Tobit Model	Intercept	Gender	Age	Children	Income	Climate Information	Durability information	log Sigma
Intercept	1							
Gender	-0.188	1						
Age	-0.449	-0.504	1					
Children	0.015	0.023	-0.020	1				
Income	-0.475	-0.010	0.084	-0.454	1			
Climate Information	-0.426	0.002	0.009	-0.009	0.008	1		
Durability information	-0.426	0.009	-0.001	-0.015	0.018	0.493	1	
log Sigma	-0.013	-0.031	0.019	0.014	0.007	0.000	-0.007	1

Table 52: Correlation matrix, toothbrush label group 1

Tobit Model	Intercept	Gender	Age	Children	Income	General Information	Climate Information	log Sigma
Intercept	1							
Gender	-0.238	1						
Age	-0.642	-0.124	1					
Children	-0.104	0.020	-0.038	1				
Income	-0.357	0.006	-0.106	-0.198	1			
General Information	-0.354	0.000	0.002	-0.004	-0.001	1		
Climate Information	-0.361	0.010	0.003	0.015	-0.001	0.493	1	
log Sigma	-0.001	0.021	-0.018	0.029	-0.008	-0.013	-0.013	1

Table 53: Correlation matrix, toothbrush label group 2

Tobit Model	Intercept	Gender	Age	Children	Income	Climate Information	Durability information	log Sigma
Intercept	1							
Gender	-0.155	1						
Age	-0.450	-0.284	1					
Children	0.000	0.076	-0.195	1				
Income	-0.448	-0.074	-0.015	-0.340	1			
Climate Information	-0.432	-0.004	-0.012	0.000	-0.012	1		
Durability information	-0.451	0.000	0.000	0.000	0.000	0.497	1	
log Sigma	0.004	-0.004	0.016	0.017	-0.047	0.000	0.000	1

Table 54: Participants' assessment of information packages during the experiment

Was the information you received about information package X helpful?	General information (n = 185)					
	control group 1	control group 2	text group 1	text group 2	label group 1	label group 2
yes	41%	36%	54%	28%	55%	
more or less	50%	51%	35%	56%	29%	
no	9%	13%	11%	15%	13%	
did not read information					3%	
	Climate information (n = 188)					
yes	53%		54%	49%	66%	36%
more or less	44%		43%	44%	29%	48%
no			3%	8%	5%	14%
did not read information	3%					2%
	Durability information (n = 157)					
yes		49%	70%	51%		40%
more or less		28%	19%	38%		52%
no		23%	11%	10%		7%
did not read information						

Table 55: Pearson correlations of relevance and impression of information and WTP

Variable 1	Variable 2	Correlation	t	p	95%-conf. interval	
Sunglasses						
Relevance of General Information	WTP for General Information	0.128	1.714	0.088	-0.019	0.270
Relevance of Climate Information	WTP for Climate Information	0.116	1.568	0.119	-0.030	0.258
Relevance of Durability Information	WTP for Durability Information	-0.029	-0.349	0.727	-0.188	0.132
Impression of General Information	WTP for General Information	0.018	0.240	0.811	-0.129	0.165
Impression of Climate Information	WTP for Climate Information	0.077	1.027	0.306	-0.070	0.220
Impression of Durability Information	WTP for Durability Information	0.052	0.634	0.527	-0.109	0.211
Toothbrush						
Relevance of General Information	WTP for General Information	**0.196**	**2.680**	**0.008**	**0.052**	**0.333**
Relevance of Climate Information	WTP for Climate Information	0.077	1.048	0.296	-0.068	0.220
Relevance of Durability Information	WTP for Durability Information	0.007	0.087	0.931	-0.151	0.165
Impression of General Information	WTP for General Information	**0.164**	**2.219**	**0.028**	**0.018**	**0.302**
Impression of Climate Information	WTP for Climate Information	0.072	0.967	0.335	-0.074	0.214
Impression of Durability Information	WTP for Durability Information	0.063	0.787	0.433	-0.095	0.219
Correlation of Relevance and Impression						
Relevance of General Information	Impression of General Information	**0.178**	**2.423**	**0.016**	**0.033**	**0.316**
Relevance of Climate Information	Impression of Climate Information	0.015	0.204	0.839	-0.130	0.159
Relevance of Durability Information	Impression of Durability Information	0.088	1.088	0.279	-0.071	0.242

Table 56: Correlation matrix of full sample

	Intercept	Gender: 0 = f, 1 = m	Age	Children living at home	Income	Treatment	Bidding round	Log sigma
Intercept	1							
Gender: 0 = f, 1 = m	-0.219	1						
Age	-0.350	-0.114	1					
Children living at home	-0.014	-0.020	0.025	1				
Income	-0.330	0.028	-0.128	-0.303	1			
Treatment	-0.464	0.033	-0.145	-0.057	0.064	1		
Bidding round	-0.585	-0.006	-0.003	0.010	-0.001	0.007	1	
Log sigma	-0.002	-0.013	0.005	0.037	-0.019	-0.015	-0.003	1

Appendix 2

a. Online survey questionnaire

Online-Befragung zu Produkten aus Biokunststoffen

Liebe Teilnehmerin, lieber Teilnehmer,

vielen Dank für Ihre Unterstützung und max. 10 Minuten Ihrer Zeit.

Diese Umfrage wird im Rahmen eines wissenschaftlichen Forschungsprojekts und einer Doktorarbeit an der Hochschule Weihenstephan-Triesdorf durchgeführt.

Alle Ihre Antworten werden anonym ausgewertet und nur im Zusammenhang mit dem Forschungsprojekt verwendet. Bitte antworten Sie ehrlich. Es gibt keine falschen Antworten.

Bei Fragen dürfen Sie sich gerne an Ulla Glaser wenden.

Mit freundlichen Grüßen

Prof. Dr. Klaus Menrad M.Sc. Ulla Glaser

Diese Umfrage enthält 19 Fragen.

Einstieg

Meinungen zu Biokunststoffen Kaufverhalten

Was verstehen Sie unter Biokunststoff?

Bitte nennen Sie Eigenschaften und Merkmale von Biokunststoffen.

Bitte geben Sie Ihre Antwort hier ein:

Welche Informationen zu Biokunststoffen interessieren Sie?

Bitte geben Sie Ihre Antwort hier ein:

Bitte ergänzen Sie: Biokunststoffe sind...

Wählen Sie die zutreffende Antwort für jedes Wortpaar aus.

*

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	trifft zu	trifft eher zu	weder noch	trifft eher zu	trifft zu	
klimaschonend	○	○	○	○	○	klimaschädlich
billig	○	○	○	○	○	teuer
umweltschonend	○	○	○	○	○	umweltbelastend
ressourcenschonend	○	○	○	○	○	ressourcenverbrauchend
nachhaltig	○	○	○	○	○	nicht nachhaltig
flächensparend	○	○	○	○	○	flächenverbrauchend
kompostierbar	○	○	○	○	○	nicht kompostierbar
gesund	○	○	○	○	○	gesundheitsschädlich
ethisch vertretbar	○	○	○	○	○	nicht ethisch vertretbar
notwendig	○	○	○	○	○	überflüssig
erneuerbar	○	○	○	○	○	nicht erneuerbar
attraktiv	○	○	○	○	○	nicht attraktiv
vielfältig	○	○	○	○	○	einseitig
modern	○	○	○	○	○	veraltet

Definition/ Info BK

Definition "Biokunststoff"

Bitte berücksichtigen Sie bei den übrigen Fragen dieser Umfrage ausschließlich diese Art von Biokunststoff:

o hergestellt aus nachwachsenden pflanzlichen Rohstoffen, z.B. Zuckerrüben, Sonnenblumenöl, Maisstärke

oder pflanzlichen Reststoffen, z.B. Rübenblätter, Bagasse

o dauerhafte Biokunststoffe für langlebige Konsumgüter, die nur in Ausnahmefällen kompostierbar sind.

z.B. Plastikbesteck, Lebensmitteldosen, Spielzeug, Kleidung, Sportschuhe, Büroartikel.

Diese Produkte werden mittlerweile auch aus Biokunststoff hergestellt.





Quellen: www.bioeinwegartikel.de, http://ajaa.de, www.biofactur.de, www2.dupont.com/biosciences, www.designroom.com, www.kms-fra.com

Beantworten Sie die nun folgenden Fragen bitte im Hinblick auf die genannten Produkte.

*

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ Ich habe die Informationen gelesen.

Haben Sie in den letzten 12 Monaten Produkte aus Biokunststoff gekauft? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ Ja
- ○ Nein

Nennen Sie Produkte aus Biokunststoff, die Sie in den letzten 12 Monaten gekauft haben.

Beantworten Sie diese Frage nur, wenn folgende Bedingungen erfüllt sind:
Antwort war 'Ja' bei Frage '5 [Kauf_BK]' (Haben Sie in den letzten 12 Monaten Produkte aus Biokunststoff gekauft?)

Bitte geben Sie Ihre Antwort(en) hier ein:

Inwiefern stimmen Sie den folgenden Aussagen zu?

Auch diese Frage bezieht sich auf Produkte aus langlebigen Biokunststoffen auf Basis nachwachsender Rohstoffe und NICHT auf Lebensmittel!

*

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	stimme voll und ganz zu	stimme eher zu	teils teils	stimme eher nicht zu	stimme überhaupt nicht zu
Beim Einkauf bevorzuge ich umweltschonende Produkte.	○	○	○	○	○
Ich bin bereit für umweltschonende Produkte mehr zu zahlen.	○	○	○	○	○
Umweltschonende Alternativen vieler Produkte funktionieren nicht so gut.	○	○	○	○	○
Umweltschonende Produkte sind zu teuer.	○	○	○	○	○
Ich kaufe regionale Produkte wegen der kürzeren Transportwege.	○	○	○	○	○
Ich kaufe Produkte, die aus regionalen Rohstoffen hergestellt sind.	○	○	○	○	○

Inwiefern stimmen Sie folgenden Aussagen zu? *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	stimme voll und ganz zu	stimme eher zu	teils teils	stimme eher nicht zu	stimme überhaupt nicht zu
Qualität ist mir wichtiger als ein günstiger Preis.	○	○	○	○	○
Produkte sollen vor allem billig sein.	○	○	○	○	○
Ich kaufe meistens beim Discounter und in günstigen Geschäften ein.	○	○	○	○	○

Bitte geben Sie den Grad Ihrer Zustimmung zu folgenden Aussagen an: *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	stimme voll und ganz zu	stimme eher zu	teils teils	stimme eher nicht zu	stimme überhaupt nicht zu
Ich tanke E10 ausschließlich wegen des Anteils an pflanzlichen Rohstoffen.	○	○	○	○	○
Ich kaufe gezielt Produkte aus nachwachsenden Rohstoffen.	○	○	○	○	○
Die Produktion von Biokunststoff führt zu einem zunehmenden Anbau von landwirtschaftlichen Monokulturen.	○	○	○	○	○
Durch den Anbau von Rohstoffen für die Biokunststoffproduktion gehen der Nahrungsmittelerzeugung erhebliche Flächen verloren.	○	○	○	○	○
Biokunststoff sollte aus eigens dafür angebauten nachwachsenden Rohstoffen (Zuckerrüben, Mais, Sonnenblumen etc.) hergestellt werden.	○	○	○	○	○
Durch den Einsatz von nachwachsenden Rohstoffen wird der Verbrauch von nicht erneuerbaren (fossilen) Ressourcen verringert.	○	○	○	○	○
Der Anbau von Zuckerrüben, Mais und Sonnenblumen für die Produktion von Biokunststoff hat einen negativen Einfluss auf das Landschaftsbild.	○	○	○	○	○
Durch die Verwendung nachwachsender Rohstoffe wird der CO_2-Ausstoß verringert.	○	○	○	○	○
Biokunststoff sollte überwiegend aus landwirtschaftlichen Reststoffen (Rübenblätter, Bagasse etc.) hergestellt werden.	○	○	○	○	○

Inwiefern stimmen Sie folgenden Aussagen zu? *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	stimme voll und ganz zu	stimme eher zu	teils teils	stimme eher nicht zu	stimme überhaupt nicht zu
Es ist mir wichtig Produkte zu verwenden, die der Umwelt nicht schaden.	○	○	○	○	○
Ich bedenke die möglichen Umweltfolgen meines Handelns, wenn ich Entscheidungen treffe.	○	○	○	○	○
Meine Einkaufsgewohnheiten sind durch meine Sorge um unsere Umwelt beeinflusst.	○	○	○	○	○
Ich bin besorgt um die Ressourcenverschwendung auf unserer Erde.	○	○	○	○	○
Ich würde mich selbst als umweltbewusst handelnden Menschen bezeichnen.	○	○	○	○	○
Ich bin bereit Unannehmlichkeiten und Einschränkungen in Kauf zu nehmen, um mich umweltschonender zu verhalten.	○	○	○	○	○
Anstatt immer mehr Rohstoffe zu verbrauchen, sollten wir möglichst viele Materialien recyceln und wiederverwenden.	○	○	○	○	○
Wenn ich Produkte kaufe, überlege ich mir, welchen Einfluss deren Nutzung auf die Umwelt hat.	○	○	○	○	○

Ich bin... *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ weiblich
- ○ männlich

In welchem Jahr sind Sie geboren? *

Bitte geben Sie Ihre Antwort hier ein:

Ihr Familienstand: *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ Ledig
- ○ Verheiratet / In Partnerschaft lebend
- ○ Geschieden / Verwitwet

Wie viele Personen leben insgesamt in Ihrem Haushalt? *

Bitte geben Sie Ihre Antwort hier ein:

Wie viele Kinder leben ständig in Ihrem Haushalt?

Bitte geben Sie Ihre Antwort(en) hier ein:

Anzahl der Kinder:

Kinder unter 18 Jahren:

Was ist Ihr höchster Bildungsabschluss? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ Kein Abschluss
- ○ Schulabschluss (z.B. Haupt-/Mittel- oder Realschule)
- ○ Beruflicher Abschluss (z.B. Geselle, Meister, Techniker)
- ○ Schulabschluss mit Studienberechtigung (z.B. Fachabitur, Abitur)
- ○ Hochschulabschluss
- ○ Anderer

Was machen Sie beruflich? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ Angestellte/r, Arbeiter/in, Beamter/in
- ○ In Ausbildung/Studium
- ○ Selbstständige/r
- ○ Leitende/r Angestellte/r
- ○ Landwirt/in
- ○ Hausfrau/-mann
- ○ In Rente/Pension
- ○ Arbeitssuchend
- ○ Sonstige Tätigkeit

In welchem Bereich liegt das Nettoeinkommen Ihres gesamten Haushalts? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ unter 1300 Euro
- ○ 1300 bis unter 1700 Euro
- ○ 1700 bis unter 2600 Euro
- ○ 2600 bis unter 3600 Euro
- ○ 3600 bis unter 5000 Euro
- ○ 5000 Euro und mehr
- ○ keine Antwort

b. Consent form for auction participants

Experiment zum Verhalten von Verbrauchern bei Konsumprodukten
geleitet von: Ulla Kainz, M.Sc., Hochschule Weihenstephan-Triesdorf, Wissenschaftszentrum Straubing

Beschreibung: In der Studie wird das Verhalten von Verbrauchern im Rahmen eines computergestützten Experiments untersucht. Eine Sitzung besteht aus mehreren Runden und dauert ca. eine Stunde. Es nehmen etwa 20 zufällig ausgewählte Teilnehmer an der Sitzung teil. Das Ergebnis hängt von den Entscheidungen aller Teilnehmer ab. Sieben Teilnehmer, die in einer zufällig ausgelosten Runde am meisten für ein Produkt geboten haben, kaufen dieses Produkt tatsächlich. Der Produktpreis wird dabei von der Aufwandsentschädigung abgezogen. Am Ende der Sitzung werden alle Teilnehmer gebeten, einen Fragebogen auszufüllen.

Risiken und Vorteile: Die Teilnahme am Laborexperiment ist mit keinen unmittelbaren Risiken oder direkten Vorteilen verbunden.

Kosten und Aufwandsentschädigung: Ihnen entstehen keine Kosten. Wenn Sie ein Produkt erwerben, wird der Kaufpreis von Ihrer Aufwandsentschädigung von 35 Euro abgezogen und Sie erhalten das Produkt. Wenn ein/e Teilnehmer/in sich dafür entscheidet, die Sitzung vorzeitig zu verlassen, verzichtet er/sie auf die komplette Aufwandsentschädigung.

Vertraulichkeit: Bei der Durchführung der Studie werden durch die Entscheidungen aller Teilnehmer Daten generiert. Diese Daten liegen anonymisiert vor und können keiner Person zugeordnet werden. Die anonymisierten Daten werden für die Erstellung von wissenschaftlichen Forschungsarbeiten und Vorträgen verwendet, die veröffentlicht werden.

Das Experiment abbrechen: Ihre Teilnahme am Experiment ist freiwillig. Sie können das Experiment jederzeit verlassen. Ein/e Teilnehmer/in kann vom Experiment ausgeschlossen werden, wenn er/sie während der Sitzung nicht die Anweisungen der Experimentatorin befolgt. Die Versuchsleitung kann auch entscheiden, die Sitzung wegen Software-Fehler oder aus einem anderen Grund abzubrechen. Sie erhalten dann eine angemessene Entschädigung, die sich danach richtet, wie viel Zeit Sie bereits im Labor verbracht haben.

Freiwilliges Einverständnis:

Ich,_____(Bitte Vor- und Nachnamen leserlich eintragen!) erkläre mich mit den beschriebenen Regeln und Datenschutzbedingungen einverstanden. Alle meine Fragen wurden geklärt. Ich bestätige, dass ich am oben genannten Experiment teilnehmen möchte.

München,_____
Datum und Unterschrift

c. Instructions for auction participants

Ablauf

Bitte lesen Sie sich die Anleitung für das Experiment **sorgfältig** und **vollständig** durch. Sollten Sie im Anschluss noch Fragen haben, machen Sie bitte per Handzeichen auf sich aufmerksam.

Das Experiment besteht aus **mehreren** Runden, die immer folgendermaßen ablaufen:

- In jeder Runde werden Ihnen zwei verschiedene Produkte angeboten, die wir hier im Labor vorrätig haben.
- Sie werden gebeten, Ihr Gebot für jedes Produkt in das entsprechende Feld am Computerbildschirm einzutippen.
- Der Computer ordnet dann die Gebote für jedes Produkt vom höchsten zum niedrigsten Gebot.
- Das acht-höchste Gebot ergibt den **Kaufpreis** für das Produkt.
- Die sieben Teilnehmer, die die höchsten Gebote abgegeben haben, kaufen das Produkt zum Kaufpreis und zahlen somit weniger für das Produkt, als sie geboten haben.

Am Ende der Sitzung wird zufällig **ein** Produkt aus **einer** Runde ausgelost. Die Gebote für dieses Produkt sind damit verbindlich, d.h. die sieben Teilnehmer, die am meisten geboten haben, kaufen das ausgeloste Produkt. Wurden gleiche Gebote abgegeben, so werden die sieben verfügbaren Produkte unter den Meistbietenden ausgelost. Der Kaufpreis wird von der Aufwandsentschädigung dieser sieben Teilnehmer abgezogen. Dafür wird das Produkt ausgehändigt.

Bitte beachten: Abgegebene Gebote sind in Euro. Das Computer-Programm erkennt **kein** Komma. Bitte stattdessen Punkte verwenden. Sollten Sie trotzdem einmal ein Komma verwenden, werden Sie vom Programm um Korrektur Ihrer Eingabe gebeten. Bitte geben Sie die Beträge auf einen Cent genau ein.

Bitte wenden!

Da Sie während des Experiments nicht wissen, welches Produkt am Ende ausgelost wird, ist es die **beste Strategie** immer genau den Betrag einzugeben, den Sie **tatsächlich** für das angebotene Produkt bezahlen möchten. Halten Sie sich nicht an diese Strategie, so gibt es genau zwei mögliche Konsequenzen:

1. Wenn Sie ein Gebot abgeben, das **höher** ist als der Betrag, der Ihnen das Produkt tatsächlich wert ist, dann kann es sein, dass Sie am Ende mehr für das Produkt bezahlen müssen, als es Ihnen tatsächlich wert ist.

2. Wenn Sie ein Gebot abgeben, das **unter** dem Betrag liegt, der Ihnen das Produkt tatsächlich wert ist, können Sie das Produkt möglicherweise nicht kaufen, obwohl der Kaufpreis geringer ist als der Betrag, den Sie zu zahlen bereit gewesen wären.

Trainingsrunde: Bevor das eigentliche Experiment beginnt, werden wir eine Trainingsrunde durchführen, damit Sie sich an den Mechanismus gewöhnen können. Am Ende der Trainingsrunde wird ein Produkt ausgelost, welches an die sieben meistbietenden Teilnehmer verkauft wird.

Wichtig: Sie können maximal zwei verschiedene Produkte erwerben: Ein Produkt aus der Trainingsrunde und ein Produkt aus dem Experiment. Sie erhalten am Ende der Sitzung Ihre Aufwandsentschädigung im Wert von 35 Euro. Der Kaufpreis für erworbene Produkte wird von der Aufwandsentschädigung abgezogen. Erworbene Produkte werden am Ende ausgehändigt.

Vielen Dank für Ihre Teilnahme!

d. Auction experiment questionnaire

Unmittelbar nach jeder Gebotsabgabe mit Information

Fanden Sie die Informationen zu X hilfreich?

ja
teilweise
nein
Ich habe keine Informationen gelesen

Nach Auktionsende

1. Haben Sie vor dem heutigen Experiment schon einmal von Biokunststoffen gehört?

   ja
   nein

2. Wie gut wussten Sie vor dem Experiment über Biokunststoffe Bescheid?

   sehr gut
   gut
   mittelmäßig
   schlecht
   sehr schlecht

3. Welche weiteren Informationen zu den Produkten aus Biokunststoff hätten Sie sich während des Experiments gewünscht?

4. Wie fühlen Sie sich jetzt, nach der Teilnahme am Experiment, über Biokunststoffe informiert?

   Ich fühle mich sehr gut informiert.
   Ich fühle mich ausreichend informiert.
   Ich fühle mich genauso informiert wie vor dem Experiment.
   Ich fühle mich nicht ausreichend informiert.
   Ich fühle mich schlecht informiert.

5. Bitte geben Sie an, wie wichtig Ihnen die Informationen jeweils waren.

   sehr wichtig
   wichtig
   neutral
   weniger wichtig
   überhaupt nicht wichtig

   a. Information zu **Pflanzen/Rohstoffen**, welche zur Produktion von Biokunststoff verwendet werden
   b. Information zur **geographischen Herkunft** der Pflanzen/Rohstoffe
   c. Information zum prozentualen **Anteil von Biokunststoff** am gesamten Produkt
   d. Auswirkungen der Produktion und Verwendung von Biokunststoffen auf **Umwelt und Klima**
   e. Information zur **Fläche**, die für den Anbau von nachwachsenden Rohstoffen für die Biokunststoffproduktion benötigt wird (Landnutzung)
   f. Information zu **Stabilität und Haltbarkeit** der vorliegenden Biokunststoff-Produkte
   g. Information zur **Kompostierbarkeit** der vorliegenden Biokunststoffprodukte
   h. Information zur **Entsorgung** der vorliegenden Biokunststoffprodukte

6. Wie haben Sie die verschiedenen Informationen empfunden?
   positiv
   neutral
   negativ

   a. Information zu Rohstoffen
   b. Information zur Herkunft der Rohstoffe
   c. Information zu Biokunststoff-Anteil
   d. Information zu Umwelt- und Klimaeinflüssen
   e. Information zur Landnutzung
   f. Information zu Haltbarkeit und Stabilität
   g. Information zur Kompostierbarkeit
   h. Information zur Entsorgung

7. Wie war Ihre Einstellung zu Biokunststoffen vor dem Experiment?
   positiv
   neutral
   negativ

8. Hat sich Ihre Einstellung zu Biokunststoffen im Laufe des Experiments verändert?
   Meine Einstellung hat sich nicht verändert.
   Meine Einstellung ist viel positiver.
   Meine Einstellung ist etwas positiver.
   Meine Einstellung ist neutral.
   Meine Einstellung ist etwas negativer.
   Meine Einstellung ist viel negativer.

9. [Einstellungen zu regionalen und umweltschonenden Produkten:] Inwiefern treffen die folgenden Aussagen auf Sie persönlich zu?
   stimme voll und ganz zu
   stimme eher zu
   teils teils
   stimme eher nicht zu
   stimme überhaupt nicht zu

   a. Beim Einkauf bevorzuge ich umweltschonende Produkte.
   b. Ich bin bereit für umweltschonende Produkte mehr zu bezahlen
   c. Umweltschonende Alternativen vieler Produkte funktionieren nicht so gut.
   d. Umweltschonende Produkte sind zu teuer.
   e. Ich kaufe regionale Produkte wegen der kürzeren Transportwege.
   f. Ich kauf vorzugsweise Produkte, die aus regionalen Rohstoffen hergestellt sind.

10. [Einstellungen zu Nachwachsenden Rohstoffen und Biokunststoff:] Bitte geben Sie den Grad Ihrer Zustimmung zu folgenden Aussagen an.
    stimme voll und ganz zu
    stimme eher zu
    teils teils
    stimme eher nicht zu
    stimme überhaupt nicht zu

    a. Die Produktion von Biokunststoffen führt zu einem zunehmenden Anbau von landwirtschaftlichen Monokulturen.
    b. Ich kaufe gezielt Produkte aus nachwachsenden Rohstoffen.

c. Durch den Anbau von Rohstoffen für die Biokunststoffproduktion gehen der Nahrungsmittelerzeugung erhebliche Flächen verloren.
d. Durch den Einsatz von nachwachsenden Rohstoffen wird der Verbrauch von nicht erneuerbaren (fossilen) Ressourcen verringert.
e. Der Anbau von Zuckerrüben oder Mais für die Produktion von Biokunststoff hat einen negativen Einfluss auf das Landschaftsbild.
f. Die Verwendung nachwachsender Rohstoffe hat eine positive Wirkung auf Umwelt und Klima.

11. Sind Sie Brillenträger/in?

ja, ich trage immer eine Brille
ja, ich trage gelegentlich eine Brille
nein

12. Wie viele Sonnenbrillen besitzen Sie?

13. [Green Consumer Values] Bitte geben Sie an inwiefern Sie den folgenden Aussagen zustimmen.

stimme voll und ganz zu
stimme eher zu
teils teils
stimme eher nicht zu
stimme überhaupt nicht zu

a. Es ist mir wichtig Produkte zu verwenden, die der Umwelt nicht schaden.
b. Ich bedenke die möglichen Umweltfolgen meines Handelns, wenn ich Entscheidungen treffe.
c. Meine Einkaufsgewohnheiten sind durch meine Sorge um unsere Umwelt beeinflusst.
d. Ich bin besorgt um die Ressourcenverschwendung auf unserer Erde.
e. Ich würde mich selbst als umweltbewusst handelnden Menschen bezeichnen.
f. Ich bin bereit Unannehmlichkeiten und Einschränkungen in Kauf zu nehmen, um mich umweltschonender zu verhalten.
g. Wenn ich Produkte kaufe, überlege ich mir, welchen Einfluss deren Nutzung auf die Umwelt hat.

14. Was für eine Art von Produkt ist eine Sonnenbrille für Sie persönlich?

Gebrauchsgegenstand
Accessoire/Lifestyle-Produkt
Sportgerät (Ski- und Bergsport, Radfahren, etc.)

15. Benötigen Sie zurzeit eine neue Zahnbürste?

ja
nein

16. Nutzen Sie normalerweise eine elektrische Zahnbürste?

ja
nein

17. Werden Sie in Zukunft Produkte aus Biokunststoffen kaufen?

Ja, immer wenn diese verfügbar sind.
Ja, wenn ich diese erkennen kann.
Ja, wenn sie nicht teurer sind als vergleichbare Kunststoffprodukte.

Ich benötige zuerst noch mehr Informationen zu Biokunststoffen.
eher nicht
nein

18. Inwiefern spielte das Siegel „Nachwachsende Rohstoffe“ eine Rolle bei Ihrer Gebotsabgabe?
    Es hat meine Zahlungsbereitschaft erhöht.
    Es hat meine Zahlungsbereitschaft verringert.
    Das Siegel war mir egal.

19. Inwiefern stimmen Sie der folgenden Aussage zu? Das Siegel „Nachwachsende Rohstoffe“ hat mein Vertrauern in die angebotenen Produkte erhöht.
    stimme voll und ganz zu
    stimme eher zu
    teils teils
    stimme eher nicht zu
    stimme überhaupt nicht zu

20. Haben Sie im Verlauf der Auktion einmal oder öfter 0 Euro geboten?
    ja
    nein

21. Wenn ja,
    a. bei welchem Produkt haben Sie 0 Euro geboten?
        Sonnenbrille
        Zahnbürste
        Schokoriegel
        Müsliriegel

    b. aus welchen Gründen haben Sie 0 Euro geboten?

22. Bitte beantworten Sie zum Abschluss noch einige Fragen zu Ihrer Person.
    a. Ich bin...
        männlich
        weiblich

    b. Bitte geben Sie Ihr Alter an:

    c. Wie viele Personen leben insgesamt in Ihrem Haushalt?

    d. Wie viele Kinder leben ständig in Ihrem Haushalt?

    e. davon Kinder unter 18 Jahren:

    f. Was ist Ihr höchster Bildungsabschluss?
        (noch) kein allgemeiner Schulabschluss
        Hauptschule, Lehre
        Mittlere Reife, weiterführende Schule ohne Abitur
        Abitur/Hochschulreife ohne Studium
        Studium (Uni, Hochschule, FH, Akademie, etc.

    g. Was ist oder war Ihr Beruf?
        Selbstständig, Freiberufler, Landwirt
        Leitende Angestellte, Beamte

Sonstige Angestellte, Beamte
Facharbeiter
Sonstige Arbeiter
Nie berufstätig gewesen

h. In welchem Bereich liegt das monatliche Nettoeinkommen Ihres gesamten Haushalts?

unter 1300 Euro
1300 bis unter 1700 Euro
1700 bis unter 2600 Euro
2600 bis unter 3600 Euro
3600 bis unter 5000 Euro
5000 Euro und mehr
keine Antwort

Danke

Mein besonderer Dank gilt Herrn Prof. Dr. Klaus Menrad für die Überlassung dieses spannenden Projekts und die fachliche Unterstützung.

Ich danke meiner Zweitgutachterin Frau Prof. Jutta Roosen, Ph.D. und Herrn Prof. Dr. Michael Suda für die Übernahme des Vorsitzes.

Danke an das Team des Labors für experimentelle Wirtschaftsforschung experimenTUM, der TUM School of Management für die Möglichkeit das Computerlabor zu nutzen sowie für die technische Betreuung.

Ein großes Dankeschön an meine Kolleginnen und Kollegen am Fachgebiet für Marketing und Management Nachwachsender Rohstoffe, die immer ein offenes Ohr bei inhaltlichen, methodischen und sonstigen Fragen hatten.

Ein besonderer Dank an meine Familie für die kontinuierliche Unterstützung.

Dieses Projekt wurde im Rahmen des Graduiertenkollegs BayReChem 2050 vom Bayerischen Staatsministerium für Ernährung, Landwirtschaft und Forsten gefördert.