The Economics of Intellectual Property Protection of Geographical Indications in International Markets*

Jakob Rackl[a,1] and Luisa Menapace[b,1]

[1]Technical University of Munich, TUM School of Management and TUM School of Life Sciences, Alte Akademie 12, 85354 Freising, Germany

Abstract

This paper develops a general equilibrium model of international trade, including protection of designations of origin through Geographical Indications (GIs). The framework captures several stylised facts of GI production and protection in domestic and international markets, including high levels of craftsmanship in production, established reputation of the GI label, collective management of GIs through producer groups, and administrative protection of the GI label. We perform simulation exercises to determine the welfare-maximising domestic and international GI protection policies and describe the impact of GI protection on exporting behaviour and the allocation of market shares across the GI and non-GI sectors. We identify a novel mechanism for welfare gains in international markets driven by the interplay between domestic GI protection (i.e. organisation into producer groups) and international GI protection (i.e. administrative protection of GIs in international markets through trade agreements), which creates an inter-sectoral reallocation of market shares towards firms of higher productivity. Finally, we derive empirically testable hypotheses to be adressed once appropriate data related to the inclusion of GIs in trade agreements becomes available.

Keywords: Geographical Indications, International Trade, Intellectual Property Rights Protection, Trade Agreements.

JEL codes: F13, L22, Q13, Q17

*The study has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 861932. There are no conflicts of interest to be acknowledged for this research.

[a]Corresponding author. Email address: jakob.rackl@tum.de.

[b]Email address: luisa.menapace@tum.de.

1 Introduction

Intellectual property rights (IPR) protection is an important factor in global agreements governing the framework of international trade in goods and services. As trade is increasingly about adding value from research and development activities, “behind-the-border” measures such as international agreements on IPR protection become essential for both companies and policymakers (Gstöhl & De Bièvre, 2017). A prominent example is the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS). Signed in 1994 by all World Trade Organisation (WTO) members, it obligates the signed parties to adopt and enforce certain minimum standards of IPR protection (Saggi, 2016).

One important aspect of the TRIPS agreement is the IPR protection of Geographical Indications (GIs). A GI identifies a good as originating from a specific territory, where a given quality, reputation, or other characteristics are essentially attributable to its geographical origin (TRIPS, 1994). Well-known examples include Prosciutto di Parma, Florida oranges, and Kobe beef. As in the case of trademarks, the justification for protecting GIs results from the economics of information and reputation. Through reputation, firms can signal certain quality levels to consumers, thus alleviating potential information asymmetries (Menapace & Moschini, 2012). As Belletti (1999) notes, reputation can only improve market efficiency if it is protected through a process of “institutionalisation of reputation” through adequate legal instruments. Signing members of TRIPS thus shall provide the legal means to prevent designations meant to mislead the consumer about the true origin of a product and refuse the registration of trademarks containing a GI label.

For a producer, the possibility to signal quality and thus reputation means that a GI becomes a commercial asset for the firm and a valuable offensive marketing tool (Bramley, 2011). This is also true for trademarks (Grossman & Shapiro, 1988), meaning that GIs and trademarks can be seen as complementary instruments regarding their role in communicating reputation towards consumers. Consequently, a firm with a GI label might invest less in developing reputation through a private trademark as it benefits from the reputation of the GI label. However, unlike trademarks, GIs are a form of *collective* intellectual property whose use is restricted to producers within a demarcated area who comply with a predefined production practice. The added value or economic rent captured by GIs is then shared within the qualified producer group (Tregear et al., 2004), which provides the required scale to justify the cost of creating and marketing the differentiated product image of the GI product (Barjolle & Chappuis, 2000).

Maskus (2000) notes that efficient intellectual property management depends on the right holders’ ability to monitor and enforce their IPR. Correspondingly, actively protecting the reputation of GIs has become increasingly important in recent years, as cases of usurpation and misappropriation have increased significantly, particularly in international markets (Belletti et al., 2007). To secure the international protection of GIs by IPR law, the European Union (EU) increasingly insists on integrating GI protection into multilateral and bilateral trade agreements. Other countries, such as the United States (US), oppose the conjecture that GIs need specific protection and argue they should be protected under common trademark law (Josling, 2006).

Theoretical models of GI protection are usually restricted to a closed economy setting and are mostly concerned with issues such as alleviation of information asymmetry, reputation building, or provision of quality.[1] Further, most of these theoretical models assume products to be vertically differentiated, meaning that GI varieties possess inherent quality advantages over generic product alternatives. The present study aims to overcome both shortcomings by providing a theoretical framework of GI policy in international markets and better reflecting the current understanding of GIs as horizontally differentiated products.[2]

We base our model on the seminal paper by Melitz (2003), who developed a general equilibrium model in which heterogeneous firms produce horizontally differentiated varieties in a monopolistically competitive market. Firms differ in terms of their productivity, meaning that some of the least productive firms cannot produce profitably. Because exporting incurs additional costs, only the most productive firms can afford to sell their products in foreign countries. Within this framework, we model a market with two sectors (GI and non-GI). We construct the GI sector such that it captures the most important stylised facts associated with GIs: (i) collective reputation of the GI label, (ii) a high level of craftsmanship in the production of GI varieties, (iii) collective management of GIs through producer groups (as required by sui generis GI legislation, such as in the EU), and (iv) administrative protection of GIs (also referred to as ex officio protection), meaning that a public institution proactively takes measures to avoid misuse of the GI name and counterfeiting of GI products.

Based on these features, we define a GI policy consisting of domestic and international GI protection. *Domestic* GI protection is concerned with the institutional framework allowing firms to manage the GI collectively (e.g. advertising the label or monitoring the market for possible imitators) and the amount of public financial support the producer group receives. Domestic GI protection thus decreases production costs for all members of the GI producer group. *International* GI protection may be granted to exporting GI firms through an international agreement obliging the signing countries to protect the GI label in their markets.

[1] Studies include Lence et al. (2007), Moschini et al. (2008), Menapace & Moschini (2012), Mérel & Sexton (2012), and Menapace & Moschini (2014).

[2] See for instance Gergaud & Ginsburgh (2008), Costanigro et al. (2010), and Chandra et al. (2021).

When an agreement ensures IPR protection of a GI in international markets, a portion of the costs of protecting a GI in foreign markets is shifted from the exporting GI producers to a foreign public institution, mainly via administrative protection. International GI protection, therefore, decreases the cost of exporting for GI firms.

In the model, organisation into producer groups implies that the fixed costs arising for production in the GI sector are endogenously determined. While the domestic GI protection policy defines the structure allowing GI firms to manage the label collectively, the individual decision of GI firms to join the producer group determines how many members the costs can be shared among and how high the cost savings will be. Domestic GI protection thus inherits a positive externality because each additional member reduces the cost associated with a GI label for all incumbent GI firms. Since individual firms do not consider this effect in their decision to join, paying a subsidy to a GI producer group increases welfare by incentivising GI firms to join the producer group. The reduction in costs, both from collective management of a GI label and public support granted to a GI producer group, makes exporting relatively more expensive than domestic sales. Consequently, fewer GI firms will sell their products in foreign markets than in the absence of domestic GI protection measures. However, international GI protection decreases the cost of exporting in the GI sector, thereby fostering the entry of GI firms into foreign markets.

While domestic and international GI protection have opposing effects on the exporting behaviour of GI firms, they are complementary in terms of their effect on welfare. For instance, a higher level of domestic GI protection implies a higher degree of international GI protection at the welfare maximising optimum. The reason is that, by making domestic sales relatively more attractive than exporting, domestic GI protection creates a GI sector with few (but very productive) exporting firms. The exporting GI firms are more productive on average than the exporting non-GI firms. In turn, GI firms that exclusively operate domestically are less productive compared to domestically operating non-GI firms. By increasing the incentive to export in the GI sector, international GI protection reallocates international market shares to GI firms and domestic market shares to non-GI firms, prompting an increase in overall welfare. These results suggest that while domestic GI protection is an important policy tool, an effective GI policy should include protection mechanisms in domestic as well as international markets.

1.1 Literature Review

The effects of IPR protection in international markets have been studied from different angles, with a focus on the establishment of bilateral trade links (Campi & Dueñas, 2016;

Foster, 2014; Palangkaraya et al., 2017), market access and innovation (Chu et al., 2018; Lai et al., 2020; Santacreu, 2021), and development (Campi & Dueñas, 2019; Zheng et al., 2020). The evidence suggests that including IPR protection in free trade agreements (FTA) has a positive effect on the extensive margin of trade by easing market access and providing an incentive for firms to innovate and export their protected products; however, there is a negative impact on the intensive margin of trade. Further, the impact of IPR protection differs across countries with different development statuses, with developing countries often profiting less than developed countries.

There has been a long debate about how GIs, as a specific type of IPR, should be treated in international agreements. Josling (2006) notes that some countries see GIs as unnecessary protection of producers against competition from new entrants; others argue that GI labels provide consumers with important information and must thus be protected from imitation and misuse. The EU–US negotiations on the Transatlantic Trade and Investment Partnership (TTIP) failed (among other reasons) due to conflicting positions on GIs, with the EU advocating a system of GI-specific protection with administrative enforcement and the US favouring a trademark system, where actions against counterfeiting and misuse are left to individual firms (Mancini et al., 2017).

GI provisions are ubiquitous in newly signed trade agreements. Engelhardt (2015) looks at five bilateral and regional general trade agreements signed by the EU and finds that the EU has largely succeeded in reaching its negotiation objectives, such as securing protection for a concrete list of GIs, phasing out generic uses of GI names, and ensuring administrative protection. Detailed provisions on GI protection are also part of the US–South Korea free trade agreement (KORUS) and the Trans-Pacific Partnership (TPP) agreement, in which the protection of GIs is regulated through a trademark system (Matthews, 2016).

Different studies have aimed to quantify the effects of GIs in international markets. Raimondi et al. (2020), using data on trade margins over the 1996–2014 period, find that the presence of GIs in an exporter country exerts a positive trade effect on both the extensive and intensive margins. When registered only in the importer country, GIs seem to act weakly as a trade-reducing measure on the intensive margin. Duvaleix et al. (2021) analyse firm-product level data from French customs combined with data on Protected Designations of Origin (PDO) products from the cheese sector. They do not find evidence that PDO firms export higher volumes. However, these firms benefit from better access to countries with similar GI policies, providing an argument that including GIs in trade agreements could increase the market access for firms producing such varieties. Curzi & Huysmans (2022) look at data on cheeses from the 2004–2019 period and find that legal protection of GIs does not lead to significant additional exports beyond the general export-promoting effects of trade agreements. However, they find that GIs of higher quality and with higher market shares do benefit from stronger external legal protection. This is in line with an empirical study by Huysmans (2020), who analysed data from 11 EU trade agreements and found these trade agreements more likely to protect GIs with higher sales values and originating from southern European countries.

Theoretical papers on the effect of GI protection in international markets are scarce, except for Chambolle & Giraud-Héraud (2005), who model certifications of origin as a non-tariff barrier (NTB). In their model, firms can make investments to increase quality, and the certification of origin acts (partly) as a quality cost subsidy. The authors find that such certification can have opposing effects on consumer surplus: When the domestic firm offers the high quality good, consumer surplus is weakened (compared to free trade). If, however, the domestic firm offers the low quality good, consumer surplus is increased by GI certification.

The present article is most closely related to studies using the heterogeneous firms model suggested by Melitz (2003). Contrary to most theoretical models of GI protection, assuming horizontally differentiated varieties imposes no judgement about the inherent quality of the available varieties. The elasticity of substitution is equal among all available varieties in the market, and only the individual productivity of a firm determines if (and which quantity) it produces, the price it sets, and whether it is profitable for the firm to export. Jung (2012) uses a similar model to analyse the welfare effects of fixed cost subsidies. The author finds that only in a "small" open economy (which takes prices as given), paying a subsidy on fixed operating costs is welfare enhancing. In all other cases (all types of subsidies in the closed economy or a subsidy on fixed entry costs in the open economy), subsidies decrease welfare.

2 Basic Setup of the Model With Two Sectors

2.1 Demand

Consumers are characterised by C.E.S. preferences over a continuum of varieties of a given good:[3]

$$U = \left[\int_{\omega \in \Omega} q(\omega)^{\rho} d\omega \right]^{1/\rho},$$

with Ω the mass of all available varieties, including GI and non-GI varieties, and ω a single variety. The representative consumer distributes her income across all available varieties in

[3] The good in question could be, for example, dried ham. Its varieties are represented by firm-specific versions of the product, some of which make use of a GI label.

the market. As $0 < \rho < 1$, varieties are (imperfect) substitutes, with a constant elasticity of substitution between any two goods of $\sigma = 1/(1-\rho) > 1$. Demand for a variety ω is equal to

$$q(\omega) = p(\omega)^{-\sigma} \frac{R}{\int_{\omega} p(\omega)^{1-\sigma} d\omega} \ ,$$

with R the available income of the representative consumer (or, in other words, aggregate income of all consumers in the economy). The resulting price index is equal to

$$P = \left[\int_{\omega} p(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}} . \tag{1}$$

Demand for variety ω as a function of the aggregate price level is equal to

$$q(\omega) = p(\omega)^{-\sigma} \frac{R}{P^{1-\sigma}}.$$

Given the C.E.S. preference structure, the resulting consumption pattern is equivalent to a representative consumer using her entire income R to consume an aggregate good $Q \equiv U$ at price P (with P the aggregate price as defined above). Therefore, aggregate expenditure is given by $R = PQ$. Optimal consumption and expenditure for individual varieties are then given by

$$q(\omega) = Q \left[\frac{p(\omega)}{P} \right]^{-\sigma} , \qquad\qquad r(\omega) = R \left[\frac{p(\omega)}{P} \right]^{1-\sigma} .$$

2.2 Production

There is a continuum of firms from two sectors (GI and non-GI), where each firm produces one variety.[4] Only firms from specific regions are entitled to produce a GI variety and make use of the GI label, meaning that the division of firms into GI and non-GI sectors is exogenously determined by the geographic area in which firms produce. We define the share of land available for the production of GI varieties as $\alpha \in [0, 1]$, while $1 - \alpha$ represents the share of land available for the production of non-GI varieties. We assume that per unit of land, the number of firms that can potentially produce is fixed and equal across sectors. M_{GI} and M_T denote the number of incumbent GI and non-GI firms, respectively. The total number of incumbent firms is given by $M = M_{GI} + M_T$.

[4] Note that GI varieties are produced according to product specifications; hence, all are produced following production practices and the production technology laid down in such product specifications (European Union, 2012). Each GI-certified firm is free to differentiate its product as long as product specifications are met, giving rise to differentiated varieties of the same GI product.

Labour is the only production factor, while firm technology is represented by a cost function with fixed costs and constant marginal costs. Labour is a linear function of output $q: \; l_i = f_i + q/\varphi$ with $i \in \{GI, T\}$, where φ measures a firm's individual productivity and f_i denotes the fixed operating costs in sector i. The higher φ, the lower the amount of labour needed per unit of output. The profit function in sector i is given by

$$\pi_i(\varphi) = [p(\varphi) - c(\varphi)]q(\varphi) - f_i.$$

The pricing rule turns out to be given by $p(\varphi) = w/\rho\varphi$, where w is the wage for workers, which we normalise to one in the following. The profit maximising markup that firms charge is thus equal to $1/\rho = \sigma/(\sigma - 1)$. Revenue as a function of productivity φ is given by $r(\varphi) = R(P\rho\varphi)^{\sigma-1}$, which holds for any firm with a productivity draw equal to φ. It follows that profits in sector i for a firm with productivity draw φ are given by

$$\pi_i(\varphi) = \frac{r(\varphi)}{\sigma} - f_i = \frac{R}{\sigma}(P\rho\varphi)^{\sigma-1} - f_i. \tag{2}$$

2.3 Aggregation

2.3.1 Aggregation Across Both Sectors

The aggregate price P as defined in (1), expressed as a function of individual firm productivity φ, can be written as

$$P = \left[\int_0^\infty p(\varphi)^{1-\sigma} M\mu(\varphi) d\varphi\right]^{\frac{1}{1-\sigma}},$$

or similarly as $P = M^{\frac{1}{1-\sigma}} p(\tilde{\varphi})$, where

$$\tilde{\varphi} = \left[\int_0^\infty \varphi^{\sigma-1}\mu(\varphi) d\varphi\right]^{\frac{1}{\sigma-1}}, \tag{3}$$

with $\mu(\varphi)$ the distribution of productivity levels over a subset of $(0, \infty)$ across all firms in the economy. $\tilde{\varphi}$ is the weighted average of firm productivity levels φ and represents aggregate productivity of all incumbent firms. All aggregate variables (aggregate price, quantity, revenue, and profits) are entirely determined by $\tilde{\varphi}$ as follows:

$$P = M^{\frac{1}{1-\sigma}} p(\tilde{\varphi}), \qquad Q = M^{\frac{\sigma}{\sigma-1}} q(\tilde{\varphi}),$$
$$R = M r(\tilde{\varphi}), \qquad \Pi = M\pi(\tilde{\varphi}).$$

This implies that an economy with M firms and a distribution of productivity levels $\mu(\varphi)$ resulting in the average productivity $\tilde{\varphi}$ yields the same aggregate outcome as an economy of M representative firms with productivity $\varphi = \tilde{\varphi}$.

2.3.2 Firm Entry and the Relation Between Sectors

To enter the market, each firm must make an initial investment in firm-specific reputation to differentiate its product in the eyes of consumers and position itself in the market. As discussed in Menapace & Moschini (2012), the use of a GI label lowers the cost of establishing a firm-specific reputation. The reason is that GIs provide a differentiation tool, thus alleviating competition from producers of similar products and improving market access for those eligible to use the designation (Bramley, 2011).[5] We capture these features in Assumption 1.

Assumption 1 (Established Reputation)
To enter the market, GI and non-GI firms have to pay a fixed entry cost $f_i^e > 0$ *with* $i \in \{GI, T\}$. *Using a GI label eases market access, thus reducing fixed entry costs for firms entitled to do so. As only GI firms are entitled to use the GI label, GI firms pay a lower fixed entry cost than non-GI firms:*

$$f_{GI}^e < f_T^e.$$

Prior to entry, firms know their type (GI or non-GI) and, therefore, the amount of fixed costs they must cover to enter the market.

After paying the fixed entry costs, firms draw their individual productivity from a distribution common within each sector but differing across them. We assume the expected value of the productivity distribution in the GI sector is lower than in the non-GI sector. This assumption reflects the fact that GIs are often found in areas where production costs are high (European Union, 2012). Higher production costs occur for several reasons that originate from geographic conditions and production methods. Geographic conditions linked, for example, to altitude, soil, and climate, occur in marginal and mountain areas where GIs are often located. While such conditions favour the development of the distinctive features of GI products, they also limit mechanisation and economies of scale. Furthermore, since GI products involve a high level of craftsmanship, production methods tend to be more specific and complex and, therefore, more costly than comparable industrialised production meth-

[5] A different way of seeing the advantage of a GI label for new producers is presented by Teuber et al. (2011), who argue that some of the fixed costs related to the implementation of the GI label in the market were borne by previous producers and are thus sunk from the view of newly entering firms.

ods (Belletti, 1999, 2021; Barjolle & Chappuis, 2000; Chilla et al., 2020). We capture these features in Assumption 2.

Assumption 2 (Craftsmanship in Production)
GI producers draw their productivity from a distribution with probability density function (PDF) $g_{GI}(\varphi)$ and cumulative density function (CDF) $G_{GI}(\varphi)$. In contrast, non-GI producers draw from a distribution with PDF $g_T(\varphi)$ and CDF $G_T(\varphi)$. The distribution from which GI firms draw their productivity has a lower expected value than the distribution from which non-GI firms draw their productivity, and so GI firms are less productive on average than non-GI firms:

$$E_{GI}(\varphi) = \int_0^\infty \varphi g_{GI}(\varphi) d\varphi < \int_0^\infty \varphi g_T(\varphi) d\varphi = E_T(\varphi).$$

It is obvious but important to note that Assumption 2 does not exclude the case in which some GI firms are more productive than some non-GI firms.

As aggregate price and aggregate productivity depend on the overall productivity distribution of incumbent firms $\mu(\varphi)$, we now explicitly derive both concepts in the context of our framework with two sectors and different productivity distributions. Any firm (independent of its sector and individual productivity draw) faces a probability δ of a shock that forces it to exit the market, and so the discounted value function for a firm from sector i with productivity φ is equal to

$$v_i(\varphi) = \max\left\{0, \sum_{t=0}^{\infty} (1-\delta)^t \pi_i(\varphi)\right\} = \max\left\{0, \frac{1}{\delta}\pi_i(\varphi)\right\}.$$

The sector-specific productivity level φ_i^*, below which firms from sector i decide not to produce and immediately exit the market, is such that $\pi_i(\varphi_i^*) = 0$. The ex ante probability of successful entry for a firm from sector i is given by $p_i^{in} = 1 - G_i(\varphi_i^*)$.

The productivity distribution per sector i conditional on successful entry is given by $\mu_i(\varphi)$ as follows:

$$\mu_i(\varphi) = \begin{cases} \frac{g_i(\varphi)}{1-G_i(\varphi_i^*)} & \text{if } \varphi \geq \varphi_i^* \\ 0 & \text{otherwise} \end{cases}.$$

The sector-specific aggregate productivity conditional on successful entry as a function of the sector-specific cutoff value φ_i^* is thus equal to

$$\tilde{\varphi}_i(\varphi_i^*) = \left[\frac{1}{1-G_i(\varphi_i^*)} \int_{\varphi_i^*}^\infty \varphi^{\sigma-1} g_i(\varphi) d\varphi\right]^{\frac{1}{\sigma-1}}. \tag{4}$$

Let the share of "surviving" GI firms (those with a productivity draw $\varphi > \varphi^*_{GI}$) be η and the share of non-GI firms who draw $\varphi > \varphi^*_T$ be $1-\eta$, so that the market is characterised by ηM incumbent GI firms and $(1-\eta)M$ incumbent non-GI firms. The overall productivity distribution $\mu(\varphi)$ is given by a mixture of the productivity distributions of the two sectors with weights equal to the share of firms from each sector:

$$\mu(\varphi) = \eta\mu_{GI}(\varphi) + (1-\eta)\mu_T(\varphi). \tag{5}$$

Using (5), aggregate productivity of all firms in the economy can be expressed as the weighted average of sector-specific aggregate productivities (see Section A.1 of the Appendix for details):

$$\tilde{\varphi}(\varphi^*_{GI}, \varphi^*_T) = \left\{\eta[\tilde{\varphi}_{GI}(\varphi^*_{GI})]^{\sigma-1} + (1-\eta)[\tilde{\varphi}_T(\varphi^*_T)]^{\sigma-1}\right\}^{\frac{1}{\sigma-1}}. \tag{6}$$

The values of the cutoff levels φ^*_i therefore determine aggregate productivity of surviving firms individually for each sector, as well as aggregate productivity of all incumbent firms in the economy. Using (5), all aggregate variables, as they depend on the distribution of productivities $\mu(\varphi)$, can be expressed as the (weighted) sum of the respective aggregate variables from the GI and non-GI sectors as follows:

$$P = \left(P_{GI}^{1-\sigma} + P_T^{1-\sigma}\right)^{\frac{1}{1-\sigma}}, \quad Q = \left(Q_{GI}^{\frac{\sigma-1}{\sigma}} + Q_T^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}},$$
$$R = R_{GI} + R_T, \qquad \Pi = \Pi_{GI} + \Pi_T.$$

Further, as individual firm revenue is given by $r = R(P\rho\varphi)^{\sigma-1}$, the ratio of the revenues of firms with different productivity levels φ_1 and φ_2 depends only on the ratio of the respective productivities:

$$\frac{r(\varphi_1)}{r(\varphi_2)} = \left(\frac{\varphi_1}{\varphi_2}\right)^{\sigma-1}.$$

As the average productivity level $\tilde{\varphi}_i$ of sector i is entirely determined by the cutoff productivity level φ^*_i, the average revenue and profit levels are also tied to this value. Average revenue $\overline{r}_i$ of sector i is thus given by

$$\overline{r}_i = r(\tilde{\varphi}_i) = \left(\frac{\tilde{\varphi}_i(\varphi^*_i)}{\varphi^*_i}\right)^{\sigma-1} r(\varphi^*_i). \tag{7}$$

2.4 Fixed Operating Costs in the Two Sectors

All firms incur fixed operating costs F for promotion and market monitoring activities. The latter activities consist, for example, of actions taken to identify and prosecute counterfeit products and potential imitators. Firms in the non-GI sector perform such activities entirely to protect and advertise their private trademark. To reflect the complementarity between a private trademark and a GI label in terms of communicating reputation to consumers, we assume that GI firms allocate the total cost F among activities related to their private trademark and their GI label. Making use of (and promoting) the reputation of the GI label, GI firms thus invest less in their private trademark than non-GI firms. Further, GI firms can take advantage of the collective nature of the GI and an institutional setup that allows for coordinating monitoring and advertising activities through a producer group, thereby sharing some of the fixed operating costs related to the GI label.

Such collective management is common to *sui generis* systems of GI protection (as in the EU), as well as GI systems based on certification markets (i.e. through marketing orders), like in the US. In the current EU GI regulations for food and agricultural products, Reg. 1151/2012 (European Union, 2012), the role of producer groups is regulated by article 45. This entitles groups to monitor the commercial use of the GI name and take actions to ensure adequate legal protection, as well as develop informational and promotional activities to enhance the value and image of the GI. However, the degree of collective management of such activities may vary in practice, ranging from loosely integrated producer organisations which collectively coordinate few activities and share limited resources to strongly integrated collective organisations (Barham & Sylvander, 2011).

We capture different levels of collective management by the share of fixed operating costs GI firms spend collectively, $\lambda \in [0, 1]$, where a higher λ indicates a stronger degree of collective action. To reflect that larger producers contribute more to the collective than smaller ones (Sautier, 2019), we let individual producers' financial contributions to the GI producer group be proportionate to the quantity they produce.

Finally, some of the costs of promoting and monitoring GIs are subsidised in various forms. The EU GI system foresees administrative protection, thereby reducing producers' costs for legal actions and litigations (Barjolle & Sylvander, 1999). Financial contributions from public institutions for protection and promotion are conditional on collective actions, meaning that financial assistance is provided to cooperatives or economic interest groups rather than individual producers to cover costs incurred by the collective (Vandecandelaere et al., 2018). We capture the subsidy paid to the producer group to cover collectively managed costs by $s \in [0, 1]$. The complete structure of fixed operating costs is pinned down by Assumption 3.

Assumption 3 (Organisation into Producer Group)
Each firm in the non-GI sector carries its operating costs individually, hence $f_T = F$*. For firms eligible to join a GI producer group, there is only one potential group in which they can participate. A share* λ *of individual fixed operating costs* F *is managed collectively by all members of the group. A firm's individual contribution to the collective is determined by its productivity, whereby a more productive firm (and therefore larger in terms of output) contributes more than a less productive firm. The GI producer group receives a subsidy* s *from the government to cover (part of) the collectively managed costs. The fixed operating costs for a GI firm with productivity* φ *are thus*

$$f_{GI}(\varphi) = \lambda(1-s)\phi(\varphi)F(M_{GI})^{-1} + (1-\lambda)F,$$

where $\phi(\varphi) = (\varphi/\tilde{\varphi}_{GI})^{\sigma-1} > 0$ *is the weight that determines the individual contribution of a GI firm according to its productivity* φ *relative to the aggregate productivity in the GI sector* $\tilde{\varphi}_{GI}$*.*

A GI firm with productivity lower (higher) than the average productivity in the GI sector therefore contributes less (more) than the average amount to the producer group. Aggregated over all GI firms, the amount paid to the collective is the same as it would be if each GI firm contributed $f_{GI}(\tilde{\varphi}_{GI}) = \lambda(1-s)F/M_{GI} + (1-\lambda)F$. All GI firms together pay fixed operating costs equal to $M_{GI}f_{GI}(\tilde{\varphi}_{GI}) = \lambda(1-s)F + M_{GI}(1-\lambda)F$. The total amount of the government subsidy is thus independent of the total number of incumbent GI firms and equal to λsF.

In expectation, a GI firm will draw a productivity equal to $\tilde{\varphi}_{GI}$ and pay fixed operating costs equal to $f_{GI}(\tilde{\varphi}_{GI}) = \lambda(1-s)F/M_{GI} + (1-\lambda)F$. The decision to join the GI producer group is made ex ante (prior to entry), and each firm eligible to use the GI label joins the group if it is at least indifferent in terms of expected fixed operating costs ($f_{GI}(\tilde{\varphi}_{GI}) \leq F$), which is the case if $(1-s)/M_{GI} \leq 1$. This holds, in the most restrictive case (i.e. when GI firms receive no subsidy, $s = 0$), as long as $M_{GI} \geq 1$, implying that a GI firm is always at least as well off when participating in the GI producer group and will thus choose to do so.

2.5 Zero Cutoff Profit Conditions

Using (2) and (7), we write average profits in the GI sector as

$$\overline{\pi}_{GI} = \pi_{GI}(\tilde{\varphi}_{GI}) = \left(\frac{\tilde{\varphi}_{GI}(\varphi^*_{GI})}{\varphi^*_{GI}}\right)^{\sigma-1} \frac{r(\varphi^*_{GI})}{\sigma} - f_{GI}(\tilde{\varphi}_{GI}),$$

where $f(\tilde{\varphi}_{GI}) = \lambda(1-s)F/M_{GI} + (1-\lambda)F$. In the non-GI sector, average profits are given by

$$\overline{\pi}_T = \pi_T(\tilde{\varphi}_T) = \left(\frac{\tilde{\varphi}_T(\varphi_T^*)}{\varphi_T^*}\right)^{\sigma-1} \frac{r(\varphi_T^*)}{\sigma} - F.$$

The zero cutoff profit conditions (ZCP) imply that a firm from sector i that drew a productivity of φ_i^* makes exactly zero profits, and so the following must hold:

$$\pi_i(\varphi_i^*) = 0$$

Therefore, revenues at the respective cutoff productivity values are equal to

$$r(\varphi_{GI}^*) = \sigma f_{GI}(\varphi_{GI}^*), \qquad\qquad r(\varphi_T^*) = \sigma F,$$

and the profit of a GI firm with aggregate productivity $\tilde{\varphi}_{GI}$ can be expressed as

$$\overline{\pi}_{GI} = \left(\frac{\tilde{\varphi}_{GI}(\varphi_{GI}^*)}{\varphi_{GI}^*}\right)^{\sigma-1} f_{GI}(\varphi_{GI}^*) - f_{GI}(\tilde{\varphi}_{GI}).$$

As $f_{GI}(\varphi_{GI}^*) = \lambda(1-s)\left(\varphi_{GI}^*/\tilde{\varphi}_{GI}\right)^{\sigma-1} F/M_{GI} + (1-\lambda)F$, the ZCP condition in the GI sector is equal to

$$\overline{\pi}_{GI} = (1-\lambda)F\left[\left(\frac{\tilde{\varphi}_{GI}(\varphi_{GI}^*)}{\varphi_{GI}^*}\right)^{\sigma-1} - 1\right]. \tag{8}$$

The ZCP for non-GI firms is equal to

$$\overline{\pi}_T = F\left[\left(\frac{\tilde{\varphi}_T(\varphi_T^*)}{\varphi_T^*}\right)^{\sigma-1} - 1\right].$$

Defining $k_i(\varphi) = \left(\frac{\tilde{\varphi}_i(\varphi)}{\varphi}\right)^{\sigma-1} - 1$, the two conditions become

$$\overline{\pi}_{GI} = (1-\lambda)F k_{GI}(\varphi_{GI}^*), \qquad\qquad \overline{\pi}_T = F k_T(\varphi_T^*).$$

2.6 Free Entry Conditions

All incumbent firms (except the firm(s) from sector i with a productivity draw of φ_i^*) make positive profits, which is the only reason firms consider paying the fixed cost f_i^e to enter the market. The present value of average profit flows of a firm in sector i is defined as $\overline{v}_i = \int_{t=0}^{\infty}(1-\delta)^t\overline{\pi}_i = (1/\delta)\overline{\pi}_i$. Also, $\overline{v}_i$ represents the average value of firms from sector i that have successfully entered: $\overline{v}_i = \int_{\varphi_i^*}^{\infty} v(\varphi)\mu_i(\varphi)d\varphi$.

Define v_i^e to be the net value of entry for sector i:

$$v_i^e = p_i^{in}\overline{v}_i - f_i^e = \frac{1 - G_i(\varphi_i^*)}{\delta}\overline{\pi}_i - f_i^e,$$

In equilibrium, the net value of entry is equal to zero, which must hold in each sector individually. If negative, no firm would want to enter the market (and some firms would exit). If positive, additional firms would enter the market until net expected profit is driven to zero. The free entry condition of sector i is thus given by

$$\overline{\pi}_i = \frac{\delta f_i^e}{p_i^{in}}. \tag{9}$$

3 Closed Economy Equilibrium

In a closed economy equilibrium, the zero cutoff profit conditions and free entry conditions define two relationships between average profits $\overline{\pi}_i$ and the cutoff productivity level φ_i^* for each sector i. Aggregated over both sectors, economy-wide average profits are determined as follows:

$$\overline{\pi} = \eta\overline{\pi}_{GI} + (1 - \eta)\overline{\pi}_T \tag{10}$$

The two conditions linking average profits $\overline{\pi}$ to cutoff productivity levels φ_{GI}^* and φ_T^* are equal to

$$\overline{\pi} = F\left[\eta(1 - \lambda)k_{GI}(\varphi_{GI}^*) + (1 - \eta)k_T(\varphi_T^*)\right], \tag{ZCP}$$

$$\overline{\pi} = \delta\left[\eta\frac{f_{GI}^e}{p_{GI}^{in}} + (1 - \eta)\frac{f_T^e}{p_T^{in}}\right]. \tag{FE}$$

In a stationary equilibrium, the aggregate variables must remain constant over time. This implies that the total mass of successful entrants M_i^e must exactly replace the mass of incumbents δM_i who exit the market following a bad shock. This must hold individually in each sector. Given the assumption that a share $\alpha \in [0, 1]$ of total land is available for GI production, the probability an entrant is from the GI sector corresponds to that same value, and the probability an entrant is from the non-GI sector is $1 - \alpha$. This implies that the mass of possible entrants from the GI sector is given by $M_{GI}^e = \alpha M^e$, while the mass of possible entrants from the non-GI sector is given by $M_T^e = (1 - \alpha)M^e$.

The process of entry and exit is as follows: Each period, a share δM_i of incumbent firms from sector i drops out of the market. From the firms in sector i who pay the fixed costs f_i^e and try to enter the market, only a share p_i^{in} draws a productivity $\varphi \geq \varphi_i^*$ and can successfully enter the market. This implies that $p_{GI}^{in}\alpha M^e$ is the mass of GI producers who successfully enter the market, while the mass of successful entrants from the non-GI sector is given by $p_T^{in}(1-\alpha)M^e$. Put together, this results in the following aggregate stability conditions for each sector:

$$p_{GI}^{in}\alpha M^e = \delta M_{GI}, \qquad\qquad p_T^{in}(1-\alpha)M^e = \delta M_T. \tag{11}$$

Using (11), the equilibrium share of incumbent GI firms is given by

$$\eta = \frac{\alpha p_{GI}^{in}}{\alpha p_{GI}^{in} + (1-\alpha)p_T^{in}}. \tag{12}$$

which likewise defines the equilibrium share of incumbent non-GI firms given by $1-\eta$. Equation (12) implies that the share of incumbent firms from each sector is determined by the relative probability of successful entry weighted by the probability of new entrants being from a certain sector. Comparing η and α reveals information about the relative entry conditions in the two sectors. For $\eta < \alpha$ ($\eta > \alpha$), entry conditions are tougher (easier) for GI firms compared to non-GI firms, meaning that a relatively lower (higher) share of possible GI entrants successfully enters the market.

To finance the subsidy for the GI producer group, the government collects a lump sum tax on labour income. Recall that as the subsidy is paid to the collective of GI producers, the total value of the subsidy is independent of the number of GI firms in the market. We assume that each period, the government collects the exact amount needed to cover the subsidy, which gives the government budget balance condition as

$$T = L - R = \lambda s F.$$

Aggregate post-tax income is thus equal to $L - \lambda s F = L^e + L^p$, where L^e is the wage paid to workers employed by entering firms from both sectors (investment workers), and so $L^e = L^e_{GI} + L^e_T$. The wage paid to workers employed in production by incumbent firms is L^p, likewise accumulated over workers in both industries ($L^p = L^p_{GI} + L^p_T$).

As labour is the only factor of production, workers' wages are the only cost firms are facing. Consequently, production workers' incomes must be equal to the difference between aggregate revenues and aggregate profits. The production workers in the GI sector receive aggregate payments equal to $L^p_{GI} = R_{GI} - \Pi_{GI}$, while production workers in the non-GI sector receive aggregate payments equal to $L^p_T = R_T - \Pi_T$. Put together, production workers in both sectors receive aggregate payments equal to $L^p = L^p_{GI} + L^p_T = R - \Pi$, which is the labour market clearing condition for production workers.

For investment workers, the labour market clearing condition is $L^e_{GI} = \alpha M^e f^e_{GI}$ in the

GI sector and $L_T^e = (1-\alpha)M^e f_T^e$ in the non-GI sector. Combining the aggregate stability conditions (11) with free entry conditions (9) yields

$$L_{GI}^e = \alpha M^e f_{GI}^e = \frac{\delta M_{GI}}{p_{GI}^{in}} f_{GI}^e = \overline{\pi}_{GI} M_{GI} = \Pi_{GI},$$

and

$$L_T^e = (1-\alpha)M^e f_T^e = \frac{\delta M_T}{p_T^{in}} f_T^e = \overline{\pi}_T M_T = \Pi_T,$$

which implies

$$L^e = L_{GI}^e + L_T^e = \Pi_{GI} + \Pi_T = \Pi.$$

Total aggregate revenue is thus equal to

$$R = L^p + \Pi = L^p + L^e = L - \lambda s F.$$

To determine the equilibrium number of all incumbent firms, recall that overall average profits are equal to the weighted sum of average profits per sector, as depicted in (10). This can be used to write overall average profits as

$$\overline{\pi} = \eta \left[\frac{\overline{r}_{GI}}{\sigma} - f_{GI}(\tilde{\varphi}_{GI}) \right] + (1-\eta) \left(\frac{\overline{r}_T}{\sigma} - F \right) = \frac{\overline{r}}{\sigma} - \eta f_{GI}(\tilde{\varphi}_{GI}) - (1-\eta)F.$$

Solving for average revenue $\overline{r}$ gives

$$\overline{r} = \sigma \left[\overline{\pi} + \eta f_{GI}(\tilde{\varphi}_{GI}) + (1-\eta)F \right]$$

The total number of firms can be derived by dividing aggregate revenue R by average revenue $\overline{r}$:

$$M = \frac{R}{\overline{r}} = \frac{L - \lambda s F}{\sigma \left\{ \overline{\pi} + \eta f_{GI}(\tilde{\varphi}_{GI}) + (1-\eta)F \right\}}. \tag{13}$$

Equation (13) determines the equilibrium price index $P = M^{\frac{1}{1-\sigma}} / \rho\tilde{\varphi}$. Finally, as aggregate utility is, per definition, equal to the aggregate quantity Q, and aggregate profits are equal to zero, total welfare is given by $W = Q$. As $Q = R/P$ and $R = L - \lambda s F$, the equilibrium expression for welfare is equal to

$$W = \frac{L - \lambda s F}{P} = (L - \lambda s F) M^{\frac{1}{\sigma-1}} \rho \tilde{\varphi}. \tag{14}$$

4 Open Economy

4.1 General Setup

In the following, all variables concerning the domestic market are indicated by a superscript d, while the superscript x denotes all variables concerning foreign markets. The subscript $i \in \{GI, T\}$ continues to denote the two sectors.

We consider a setting of $n+1$ symmetric countries in which wages are equal and normalised to one, meaning that the pricing rule for the domestic market is unchanged in the open economy and equal to $p^d(\varphi) = 1/\rho\varphi$. The trade cost τ is modelled as an "iceberg" cost, meaning that to sell one unit, an exporting firm has to ship $\tau > 1$ units to the foreign country. Therefore, exporting firms charge higher prices in foreign markets, which is represented by the pricing rule $p^x(\varphi) = \tau/\rho\varphi = \tau p^d$. Revenues in the domestic market are therefore $r^d(\varphi) = R(P\rho\varphi)^{\sigma-1}$, while revenues from export sales are $r^x(\varphi) = \tau^{1-\sigma} r^d(\varphi)$. As trade costs are the same for each country, a firm from any given country either does not export or exports to all n foreign countries. R and P denote aggregate revenue and the price index in every country, respectively. Individual firm revenue $r(\varphi)$ can be expressed as a function of a firm's exporting behaviour:

$$r(\varphi) = \begin{cases} r^d(\varphi) & \text{if the firm does not export,} \\ r^d(\varphi) + n r^x(\varphi) = (1 + n\tau^{1-\sigma}) r^d(\varphi) & \text{if the firm exports to all n countries.} \end{cases}$$

As both domestic and foreign revenue are entirely determined by the individual productivity draw φ, they are universal to both GI and non-GI producers.

4.2 GI Protection and Firm Entry into Foreign Markets

All exogenous factors affecting firm entry, exit, and productivity level remain unchanged in the open economy. As before, firms in sector i draw their productivity from a distribution $g_i(\varphi)$, and each period have a common probability $\delta \in [0, 1]$ of a shock forcing them to exit the market. After having drawn their productivity level, firms decide whether to export, which carries a fixed cost f_i^{ex}. Firms are indifferent between paying this one-time investment or the amortised portion of the cost $f_i^x = \delta f_i^{ex}$ in every period. These exporting fixed costs have to be paid for each country a firm exports to.

We focus on the fixed exporting costs firms must bear to protect intellectual property rights in foreign markets (e.g. monitoring the market for imitators and their prosecution). Such costs vary depending on the legal protection afforded to GIs in foreign markets. A minimum level of GI protection is regulated in the TRIPS agreement, but several grandfather clauses allow countries to pick and choose the GIs they want to protect (Viju et al., 2012). Higher levels of protection are achieved in international agreements, including administrative enforcement (a priority for the EU, see Moir (2016)). With administrative protection, public authorities monitor the market (and bear the related costs of doing so), an activity that otherwise would need to be conducted by GI firms individually. Hence, some export costs are shifted from individual GI firms to the public sector, making it less costly for GI firms to export. Concerning the effectiveness of public authorities providing GI protection, different arguments apply. On the one hand, producers are less likely to be informed about the judicial system of a foreign country in which they suspect infringement of their label, leading to cost savings when a public authority takes over the enforcement measures (Vittori, 2010). On the other hand, lengthy bureaucratic processes could increase the cost of enforcement of GIs when a public institution takes over. Assumption 4 captures such stylised facts of international GI protection.

Assumption 4 (International GI Protection)
International GI protection shifts a portion of the exporting costs from individual GI firms to the government, which finances a public institution to monitor the GI label and take enforcement measures when necessary. As such, a GI firm pays a lower fixed exporting cost than a non-GI firm:[6]

$$f^x_{GI} < f^x_T.$$

This shift in costs has to be financed for all exporting GI firms M^x_{GI} from all n countries. We introduce an efficiency parameter ε, which depicts the relative efficiency of the public institution in IPR protection compared to individual GI firms. For $\varepsilon > 1/\varepsilon = 1/\varepsilon < 1$, the public institution is less/equally/more efficient in protecting intellectual property rights than private firms. Put together, the total costs of international GI protection for the government are equal to $n\varepsilon M^x_{GI}(f^x_T - f^x_{GI}) \equiv nC^x$. The new government budget constraint (including the cost of subsidising fixed operating costs in the domestic market) is given by

$$T = L - R = \lambda s F + nC^x \tag{15}$$

[6]Note that a publicly financed reduction in exporting costs could be seen as an export subsidy subject to reduction commitments by all members of the WTO (WTO, 1994). This would be the case if the domestic country financed the reduction in fixed exporting costs for domestic GI producers contingent on their exporting behaviour. In the present scenario, however, it is the foreign countries financing the protection of the domestic GI (and, by symmetry, the domestic country financing the protection of the foreign GIs) in compliance with an international agreement obliging all signing members to protect IP rights of GIs in their markets.

Profits can be split into profits earned in the domestic market and profits earned from exporting:

$$\pi^d_{GI}(\varphi) = \frac{r^d(\varphi)}{\sigma} - f_{GI}(\varphi), \qquad \pi^d_T(\varphi) = \frac{r^d(\varphi)}{\sigma} - F,$$
$$\pi^x_{GI}(\varphi) = \frac{r^x(\varphi)}{\sigma} - f^x_{GI}, \qquad \pi^x_T(\varphi) = \frac{r^x(\varphi)}{\sigma} - f^x_T.$$

A firm that produces for the domestic market will also export if $\pi^x_i(\varphi) \geq 0$. Each firm's combined profits, depending on its sector i, is equal to

$$\pi_i(\varphi) = \pi^d_i(\varphi) + \max\{0, n\pi^x_i(\varphi)\}.$$

Firm value is given by $v_i(\varphi) = \max\{0, \frac{\pi_i(\varphi)}{\delta}\}$, with the corresponding cutoff value $\varphi^*_i = \inf\{\varphi : v_i(\varphi) > 0\}$. In particular, the export cutoff productivity level for firms from sector i is identified by

$$\varphi^{x*}_i = \inf\{\varphi : \varphi \geq \varphi^*_i \text{ and } \pi^x_i(\varphi) \geq 0\} \tag{16}$$

If $\varphi^{x*}_i > \varphi^*_i$, then only the firms of sector i with a productivity draw $\varphi \in [\varphi^{x*}_i, \infty)$ will export, while firms with a productivity draw $\varphi \in [\varphi^*_i, \varphi^{x*}_i)$ will produce only for the domestic market. In the following, we assume that the cost of exporting is such that partitioning of firms by export status, as described above, takes place.

The equilibrium distribution $\mu_i(\varphi)$ for incumbent firms of sector i is, as before, determined by the ex ante distribution of productivity levels conditional on successful entry $\mu_i(\varphi) = g_i(\varphi)/[1 - G_i(\varphi^*_i)]$, where the ex ante probability of successful entry is $p^{in}_i = 1 - G_i(\varphi^*_i)$. The overall equilibrium productivity distribution conditional on successful entry is still given by $\mu(\varphi) = \eta\mu_{GI}(\varphi) + (1-\eta)\mu_T(\varphi)$, where η is the share of incumbent GI firms and $1-\eta$ is the share of incumbent non-GI firms. The ex ante probability that a firm from sector i exports (conditional on successful entry into the domestic market) is equal to

$$p^{ex}_i = \frac{1 - G_i(\varphi^{x*}_i)}{1 - G_i(\varphi^*_i)}.$$

The ex post fraction of exporting firms from each sector is also represented by p^{ex}_i, and, given the number of incumbent firms from sector i is M_i, the share of exporting firms in sector i is $M^x_i = p^{ex}_i M_i$. The total number of exporting firms is given by

$$M^x = p^{ex}_{GI} M_{GI} + p^{ex}_T M_T = M\left[\eta p^x_{GI} + (1-\eta)p^x_T\right].$$

The number of firms competing in one country from sector i (or, likewise, the amount of available varieties from sector i in each country) is equal to $M_i^c = M_i + nM_i^x = (1+np_i^{ex})M_i$. The total number of competing firms in a given country is equal to $M^c = M + nM^x$.

4.3 Aggregation Within and Across Sectors

As defined in (4), $\tilde{\varphi}_i = \tilde{\varphi}_i(\varphi_i^*)$ is the aggregate productivity of all incumbent firms in sector i. As only some of the incumbent firms are sufficiently productive to export, let $\tilde{\varphi}_i{}^x = \tilde{\varphi}(\varphi_i^{x*})$ define the aggregate productivity of exporting firms in sector i. Further, define $\tilde{\varphi}_i^c$ as the weighted average productivity of sector i, which reflects the additional export shares of more productive firms and the proportion τ of units lost in the exporting process:

$$\tilde{\varphi}_i^c = \left\{ \frac{1}{M_i^c} \left[M_i \tilde{\varphi}_i^{\sigma-1} + nM_i^x (\tau^{-1}\tilde{\varphi}_i^x)^{\sigma-1} \right] \right\}^{\frac{1}{\sigma-1}}.$$

The overall average productivity of all incumbent firms can be expressed as

$$\tilde{\varphi}^c = \left\{ \frac{1}{M^c} \left[M \tilde{\varphi}^{\sigma-1} + nM^x (\tau^{-1}\tilde{\varphi}^x)^{\sigma-1} \right] \right\}^{\frac{1}{\sigma-1}}, \tag{17}$$

where $\tilde{\varphi}$ is as defined in (6) and $\tilde{\varphi}^x$ is equal to

$$\tilde{\varphi}^x = \left\{ \frac{1}{M^x} \left[M_{GI}^x \left(\tilde{\varphi}_{GI}^x\right)^{\sigma-1} + M_T^x \left(\tilde{\varphi}_T^x\right)^{\sigma-1} \right] \right\}^{\frac{1}{\sigma-1}},$$

and therefore representing aggregate productivity of all exporting firms in both sectors. Equation (17) likewise defines all aggregate variables, namely the price index P and the expenditure level R, which can be expressed as functions of the aggregate productivity level $\tilde{\varphi}^c$ and the number of available varieties M^c:

$$P = (M^c)^{\frac{1}{1-\sigma}} p(\tilde{\varphi}^c) = (M^c)^{\frac{1}{1-\sigma}} \frac{1}{\rho\tilde{\varphi}^c}, \qquad R = M^c r^d(\tilde{\varphi}^c).$$

We use aggregate productivities $\tilde{\varphi}_i$ and $\tilde{\varphi}_i^x$ to express the average revenue and profit levels of firms in sector i. $r^d(\tilde{\varphi}_i)$ and $\pi^d(\tilde{\varphi}_i)$ represent, respectively, average revenue and average profits from domestic sales for all incumbent firms of sector i. Average revenues and average profits from exporting for firms in sector i are given by $r^x(\tilde{\varphi}_i{}^x)$ and $\pi_i^x(\tilde{\varphi}_i{}^x)$, respectively. The overall average revenues and overall average profits (from domestic and exporting sales in sector i), are equal to

$$\overline{r}_i = \frac{R_i}{M_i} = r^d(\tilde{\varphi}_i) + np_i^{ex} r^x(\tilde{\varphi}_i^x), \qquad \overline{\pi}_i = \pi_i^d(\tilde{\varphi}_i) + np_i^{ex} \pi_i^x(\tilde{\varphi}_i^x)$$

The overall average revenues from domestic and exporting sales are given by

$$\bar{r} = \frac{R}{M} = \frac{M^c}{M} r^d(\tilde{\varphi}^c) = \bar{r}^d + n[\eta p^{ex}_{GI} r^x(\tilde{\varphi}^x_{GI}) + (1-\eta) p^{ex}_T r^x(\tilde{\varphi}^x_T)],$$

where $\bar{r}^d = \eta \bar{r}^d_{GI} + (1-\eta)\bar{r}^d_T$. Overall average profits are equal to

$$\bar{\pi} = \bar{\pi}^d + n[\eta p^{ex}_{GI} \pi^x_{GI}(\tilde{\varphi}^x_{GI}) + (1-\eta) p^{ex}_T \pi^x_T(\tilde{\varphi}^x_T)], \tag{18}$$

where $\bar{\pi}^d = \eta \bar{\pi}^d_{GI} + (1-\eta)\bar{\pi}^d_T$.

4.4 Equilibrium Conditions

The zero cutoff profit condition in the open economy implies four relationships linking average profits per firm $\bar{\pi}_i$ and the cutoff productivity level φ^*_i for each of the two sectors:

$$\begin{aligned}
\pi^d_{GI}(\varphi^*_{GI}) = 0 \quad &\rightarrow \quad \frac{r^d(\varphi^*_{GI})}{\sigma} = f_{GI}(\varphi^*_{GI}) \quad \rightarrow \quad \pi^d_{GI}(\tilde{\varphi}_{GI}) = (1-\lambda) F k_{GI}(\varphi^*_{GI}) \\
\pi^d_T(\varphi^*_T) = 0 \quad &\rightarrow \quad \frac{r^d(\varphi^*_T)}{\sigma} = F \quad \rightarrow \quad \pi^d_T(\tilde{\varphi}_T) = F k_T(\varphi^*_T) \\
\pi^x_{GI}(\varphi^{x*}_{GI}) = 0 \quad &\rightarrow \quad \frac{r^x(\varphi^{x*}_{GI})}{\sigma} = f^x_{GI} \quad \rightarrow \quad \pi^x_{GI}(\tilde{\varphi}^x_{GI}) = f^x_{GI} k_{GI}(\varphi^{x*}_{GI}) \\
\pi^x_T(\varphi^{x*}_T) = 0 \quad &\rightarrow \quad \frac{r^x(\varphi^{x*}_T)}{\sigma} = f^x_T \quad \rightarrow \quad \pi^x_T(\tilde{\varphi}^x_T) = f^x_T k_T(\varphi^{x*}_T)
\end{aligned}$$

with $k_i(\varphi) = \left(\frac{\tilde{\varphi}_i(\varphi)}{\varphi}\right)^{\sigma-1} - 1$. These conditions allow φ^{x*}_i to be expressed as a function of φ^*_i. That is,

$$\frac{r^x(\varphi^{x*}_{GI})}{r^d(\varphi^*_{GI})} = \tau^{1-\sigma}\left(\frac{\varphi^{x*}_{GI}}{\varphi^*_{GI}}\right)^{\sigma-1} = \frac{f^x_{GI}}{f_{GI}(\varphi^*_{GI})}, \qquad \frac{r^x(\varphi^{x*}_T)}{r^d(\varphi^*_T)} = \tau^{1-\sigma}\left(\frac{\varphi^{x*}_T}{\varphi^*_T}\right)^{\sigma-1} = \frac{f^x_T}{F},$$

for the GI and non-GI sectors, respectively. Consequently, the export cutoff productivity levels of the respective sectors are given by

$$\varphi^{x*}_{GI} = \varphi^*_{GI}\tau\left(\frac{f^x_{GI}}{f_{GI}(\varphi^*_{GI})}\right)^{\frac{1}{\sigma-1}}, \qquad \varphi^{x*}_T = \varphi^*_T\tau\left(\frac{f^x_T}{F}\right)^{\frac{1}{\sigma-1}}. \tag{19}$$

This implies that each variable dependent on φ^{x*}_i implicitly depends on φ^*_i, as depicted in the relationship above. Using (18), we can therefore express $\bar{\pi}$ as a function of φ^*_{GI} and φ^*_T:

$$\bar{\pi} = \eta\left[(1-\lambda)F k_{GI}(\varphi^*_{GI}) + n p^{ex}_{GI} f^x_{GI} k_{GI}(\varphi^{x*}_{GI})\right] + (1-\eta)\left[F k_T(\varphi^*_T) + n p^{ex}_T f^x_T k_T(\varphi^{x*}_T)\right]. \tag{ZCP}$$

As before, the present value of average profit flows is given by $\overline{v} = \sum_{t=0}^{\infty}(1-\delta)^t\overline{\pi} = (1/\delta)\overline{\pi}$. The net value of entry of a firm from sector i is still given by $v_i^e = p_i^{in}\overline{v}_i - f_i^e$, which is equal to zero if and only if $\overline{v_i} = \delta f_i^e/p_i^{in}$, and so $\overline{\pi} = \delta\left[\eta(f_{GI}^e/p_{GI}^{in}) + (1-\eta)(f_T^e/p_T^{in})\right]$ (FE) must hold.

Together with the aggregate stability conditions $p_{GI}^{in}\alpha M^e = \delta M_{GI}$ and $p_T^{in}(1-\alpha)M^e = \delta M_T$, it is implied that the aggregate payment to investment workers L^e is equal to the profit level Π. The share of domestically producing GI firms continues to be given by (12).

Aggregate revenue R is determined by the size of the labour force minus the collected tax ($R = L - \lambda sF - nC^x$). Average revenue per firm is determined by the ZCP and FE conditions as follows:

$$\overline{r} = r^d(\tilde{\varphi}) + n[\eta p_{GI}^{ex} r^x(\tilde{\varphi}_{GI}^x) + (1-\eta)p_T^{ex} r^x(\tilde{\varphi}_T^x)] = \sigma\left[\overline{\pi} + \eta f_{GI}(\tilde{\varphi}_{GI}) + (1-\eta)F + n\overline{f}^x\right],$$

where $\overline{f}^x = \eta p_{GI}^{ex} f_{GI}^x + (1-\eta)p_T^{ex} f_T^x$. The equilibrium mass of incumbent firms is thus equal to

$$M = \frac{R}{\overline{r}} = \frac{L - \lambda sF - nC^x}{\sigma\left[\overline{\pi} + \eta f_{GI}(\tilde{\varphi}_{GI}) + (1-\eta)F + n\overline{f}^x\right]}.$$

This likewise defines the total number of available varieties given by

$$M^c = M_{GI}^c + M_T^c = M\{1 + n[\eta p_{GI}^{ex} + (1-\eta)p_t^{ex}]\},$$

with their price index $P = (M^c)^{\frac{1}{1-\sigma}}/\rho\tilde{\varphi}^c$. Define η^c as the share of available GI varieties (domestically produced and imported) in the open economy:

$$\eta^c = \frac{M_{GI}^c}{M^c} = \frac{\alpha p_{GI}^{in}(1 + np_{GI}^{ex})}{\alpha p_{GI}^{in}(1 + np_{GI}^{ex}) + (1-\alpha)p_T^{in}(1 + np_T^{ex})} \tag{20}$$

This equation implies that the share of GI producers in incumbent domestic firms does not necessarily correspond to the share of available GI varieties in the open economy. For $p_{GI}^{ex} = p_T^{ex}$, we have $\eta^c = \eta$. If the probability of exporting in the GI sector relative to the non-GI sector is lower (higher), relatively fewer (more) GI firms export, leading to a lower (higher) share of available GI varieties in the market, and so $\eta^c < \eta$ ($\eta^c > \eta$). Therefore, comparing η^c and η delivers insights into the relative exporting conditions in the two sectors.

Finally, total welfare is given by

$$W = (L - \lambda sF - nC^x)(M^c)^{\frac{1}{\sigma-1}}\rho\tilde{\varphi}^c.$$

5 Results

This section aims to qualitatively and quantitatively describe the effects of GI protection policies on intra- and inter-sectoral equilibrium outcomes. To this end, we assume in the following that firms draw their productivity from a Pareto distribution. This assumption allows us to implement the equilibrium system of equations (see Section A.5 of the Appendix) in Matlab (Version R2021a 9.10.0.1669831 64-bit) and to explicitly calculate the equilibrium outcomes and their changes in response to changes in specific parameters. To proceed, we determine a baseline set of parameter values in Section 5.1.

5.1 Parameter Values

Table 1 lists all model parameters and the corresponding baseline values. Parameters are organised into three groups: GI policy parameters, structural GI parameters, and other parameters. Concerning the latter group, some can be set by harmless normalisation.

For instance, we normalise the size of the economy to be equal to $L = 1,000,000$ and set fixed operating costs F equal to 10. Following Felbermayr et al. (2012), we then set the baseline values of f_T^e and f_T^x relative to fixed operating costs F, i.e. $f_T^e/F = 5.49$ and $f_T^x/F = 1.75$. The value of the Pareto shape parameter κ, which measures the degree of heterogeneity in terms of productivity across firms, is borrowed from Eaton & Kortum (2002), who estimate its value to be equal to $\kappa = 8$. Further, we set the elasticity of substitution equal to $\sigma = 5$, which reflects the relatively high elasticity of substitution for food-related products (Oberfield & Raval, 2021). The exit rate δ is based on Fackler et al. (2013), who estimated the exit rate in the agricultural sector from 1975 to 2006 in West Germany to be 5.8%. Finally, exporting to a foreign country implies iceberg trade costs, whose value $\tau = 1.37$ is based on an empirical estimation by Felbermayr et al. (2012).

The value of φ_T^{min} is normalised to one. Therefore, setting $\varphi_{GI}^{min} = 0.9$ implies that prior to entry, the expected productivity of GI firms is 10 percent lower than that of non-GI firms, an estimate based on Hilal et al. (2021). Further, we set $f_{GI}^e = 30$ (which captures the reputation of the GI label) to ensure that $\varphi_{GI}^* \geq \varphi_{GI}^{min}$ (which has to hold by definition) and $f_{GI}^e < f_T^e$, which reflects the fact that established reputation of the GI label makes market entry to the domestic market less costly for GI firms. The share of land available for the production of GI varieties α (which corresponds to the probability that an entering firm is from the GI sector) is based on Jantyik & Török (2020). The authors reviewed different sources of literature in which the share of GI producers in France and Italy was estimated to range from about 5% to around 15%. In our simulations, we set the parameter α equal to

0.1 to reflect the relatively low share of land dedicated to the production of GI varieties.[7] We initially make the conservative assumption that there are no efficiency gains in protecting the GI label by means of a public institution ($\varepsilon = 1$). Finally, we consider the implementation of international GI protection to be based on a bilateral agreement, meaning that the number of foreign countries is equal to one ($n = 1$).

The parameters λ, s, and Δf^x_{GI} capture different dimensions of GI policy. With regard to domestic policy, we set the degree of collective management within the GI producer group λ equal to 0.4 (i.e. 40% of the fixed operating costs of GI firms is shared via the GI producer group) and the GI subsidy s equal to 0.1 (i.e. 10% of the shared costs of GI firms is covered by the government). Finally, the degree of international GI protection Δf^x_{GI} is set equal to 0.06, a value calculated endogenously as the degree of international GI protection that maximises welfare given all other parameters at their baseline values.

[Insert Table 1 here]

In the following sections, we analyse how changes in the GI protection policies affect equilibrium outcomes in the GI and non-GI sectors, as well as in the overall economy. To do so, we vary the corresponding parameter(s) of interest while keeping all other parameters at their baseline, as reported in this section.

5.2 Domestic GI Protection

In this section, we focus on domestic GI protection by evaluating changes in the degree of collective management (λ) and the domestic subsidy (s).

A higher value of λ reduces the fixed operating costs for GI firms through two mechanisms. First, a larger portion of fixed operating costs is shared among all members of the GI producer group, reducing the cost that GI firms have to carry individually. Second, cost sharing lowers the productivity level sufficient for successful entry into the GI sector so that more (but less productive on average) GI firms enter the domestic market. Consequently, an increased number of incumbent GI firms can share fixed operating costs, further reducing the fixed operating cost faced by each member of the GI producer group. Ultimately, a higher value of λ leads to a larger but less productive GI sector.

[7] Note that what Jantyik & Török (2020) refer to are estimates of the share of *incumbent* GI firms. In our model, α corresponds to the share of land *available* for the production of GI varieties, while the share of incumbent GI firms η arises endogenously from the model (and can thus deviate from α, depending on the relative entry conditions in the GI and non-GI sectors). The estimates nevertheless reflect the relatively small size of the GI sector and can thus be used as a proxy for α. We explore different values of α in Section 5.6.

Domestic GI protection also influences the exporting behaviour of GI firms. Indeed, a larger GI sector (through a higher value of λ) puts pressure on the domestic factor market, where new entrants push up the real wage, increasing the cost of exporting relative to the cost of domestic sales. It follows that the cutoff productivity starting from which GI firms can afford to export increases, and so the probability that a GI firm enters foreign markets decreases. Ultimately, with a higher value of λ, fewer (but more productive on average) GI firms will export.

A similar effect through the domestic factor market also operates in the non-GI sector. The increased pressure on the domestic factor market due to a higher value of λ pushes some of the least productive non-GI firms out of the market, where exporting and non-exporting firms are symmetrically affected (meaning that the same share of non-GI firms drops out of the domestic and the international markets). However, the effect of non-GI firms dropping out of the international markets is less pronounced than in the GI sector, meaning that the international market share of non-GI firms increases.

An increase in the subsidy for GI producer groups s has the same qualitative effects on the GI sector as an increase in λ. However, note the caveat that, as the equivalence of the subsidy offered to GI producers has to be collected as a tax on labour income, the effects will be quantitatively smaller.

The foregoing implies four empirically testable hypotheses.

Increasing domestic GI protection leads to:

Hypothesis 1a: Domestic GI protection - Productivity GI sector
A decrease in aggregate productivity of the GI sector;

Hypothesis 1b: Domestic GI protection - Productivity exporting GI firms
An increase in aggregate productivity of exporting GI firms;

Hypothesis 1c: Domestic GI Protection – Domestic market shares
A reallocation of domestic market shares towards GI firms;

Hypothesis 1d: Domestic GI Protection - International market shares
A reallocation of international market shares towards non-GI firms.

Changes in the value of λ have welfare effects that align with intuition. A larger value of λ means that a larger share of costs can be shared among GI firms (i.e. resources are therefore "saved"), and consequently, welfare increases monotonically with λ. This welfare enhancing effect of domestic protection speaks in favour of GI policies in support of strong institutional frameworks that enable collective actions by GI producers and aligns with ongoing efforts of the EU to further empower GI producer groups. Indeed, the current proposal for an EU regulation on GIs provides "greater power and responsibilities to manage, promote and enforce their GI" (European Commission, 2022) and concretely expands the range of tasks that GI producer groups are entitled to conduct on behalf of their members. Note, however, that while increasing λ monotonically increases welfare, in practice, there likely exists a "natural boundary" to the cost savings possible by the collective management of promotion and IP protection. Identifying this upper bound (and hence, the feasible maximum value of λ) is beyond the scope of this paper.

Moreover, similar to Moschini et al. (2008), cost sharing in the GI sector implies that entry of any given GI firm exerts a positive externality on all other firms, as each additional entrant reduces costs for all other incumbent GI firms. However, an individual firm does not consider this effect upon its entry decision; hence, the number of GI firms entering the market is lower than socially optimal. Such positive externality can be corrected by a subsidy (the second domestic policy parameter s), which fosters entry by reducing the (expected) fixed operating costs of each GI firm. It follows that, for any given value of λ, increasing the subsidy s monotonically increases welfare, a fact that can be shown analytically for the closed economy (see Section A.2 of the Appendix). From a policy perspective, this result speaks in favour of financial support for GI firms conditional on collective organisation, meaning financial assistance is provided to the collective rather than individual producers (Barjolle & Sylvander, 1999; Vandecandelaere et al., 2018). Note, however, that the gains in welfare from increasing the degree of collective management λ are larger than the gains from increasing public support in the domestic market s, suggesting that strengthening producer groups deserves priority over increasing public support for GI producers in the domestic market.

For the range of values reported in Table 2, we have verified that the qualitative welfare effects of domestic GI protection described in this section are robust to changes in the values of the structural parameters. That is, independent of the level of established GI reputation in the domestic market f^e_{GI}, the level of craftsmanship in production φ^{min}_{GI}, or the share of land dedicated to the production of GIs α, increasing both the subsidy s and the degree of collective management λ increases welfare.

[Insert Table 2 here]

Finally, domestic GI protection also affects the optimal level of international GI protection, as we discuss more extensively in Section 5.3.

5.3 International GI Protection

In this section, we focus on international GI protection. International GI protection policy is linked to the parameter f^x_{GI}, i.e. the fixed exporting costs in the GI sector. International GI protection means the foreign country institutes administrative protection for domestic GIs (by symmetry, the domestic country protects foreign GIs), essentially covering some of the cost associated with IP protection that the exporting GI firms would otherwise cover. We let $\Delta f^x_{GI} = f^x_T - f^x_{GI}$ measure the international GI policy, where f^x_T denotes the fixed exporting costs each GI firm would have to cover in the absence of international GI protection. It is natural to assume that these coincide with the fixed exporting costs of non-GI firms. f^x_{GI} is the amount of fixed exporting costs that each GI firm effectively pays to export. A higher value of Δf^x_{GI} indicates a higher level of GI protection in international markets, as a public institution covers more of the cost associated with protecting the GI label abroad. The equivalence of the cost of this policy is collected as a tax from labour income (see Assumption 4).

International GI protection impacts equilibrium outcomes through several mechanisms. The decrease in fixed exporting costs induced by international GI protection fosters entry of GI firms into export markets, meaning the number of exporting GI firms M^x_{GI} increases. Because these additional exporting GI firms are less productive than the exporting GI firms in the absence of international GI protection, aggregate productivity of exporting GI firms $\tilde{\varphi}^x_{GI}$ decreases. The resources needed by the additional exporting GI firms induce an increase in labour demand, pushing some of the least productive GI firms out of the market. M_{GI} thus decreases, and aggregate productivity of incumbent GI firms $\tilde{\varphi}_{GI}$ increases. These effects of a reduction in fixed exporting costs are also present in the standard Melitz model with one sector. However, in the one-sector model, such a policy is welfare reducing because the associated gain is insufficient to offset the cost of a tax on labour income. In a market with two structurally different sectors, international GI protection has an additional effect that operates through the reallocation of market shares across sectors. Specifically, the combined effect of allocating higher domestic market shares to the domestically operating non-GI firms (who are relatively more productive than domestically operating GI firms) and increasing international market shares of exporting GI firms (who are relatively more productive than exporting non-GI firms), drives the welfare gains from international GI protection in the two-sector model.

The foregoing implies four empirically testable hypotheses.

An increase in international GI protection leads to:

Hypothesis 2a: International GI Protection - Productivity GI sector
An increase in aggregate productivity of the GI sector;

Hypothesis 2b: International GI Protection - Productivity exporting GI firms
A decrease in aggregate productivity of exporting GI producers;

Hypothesis 2c: International GI Protection – Domestic market shares
A reallocation of domestic market shares towards non-GI firms;

Hypothesis 2d: International GI Protection - International market shares
A reallocation of international market shares towards GI firms.

Several features of the two sectors in the present model determine the relatively lower (higher) productivity of domestically operating (exporting) GI firms. First, GI firms are less productive on average than non-GI firms by assumption, reflecting the relatively higher level of craftsmanship in production. This effect implies that all GI firms (those who operate only in the domestic market and those who also export) are less productive than their counterparts in the non-GI sector. However, collective management of the GI label reduces firm-level fixed operating costs, making domestic sales more attractive than exporting; the probability of exporting p^{ex}_{GI} and consequently the number of exporting GI firms M^{x}_{GI} decreases. Those who continue to export are the most productive GI firms; thus, the productivity of exporting GI firms $\tilde{\varphi}^{x}_{GI}$ increases.

Further, this effect on exporting GI firms' average productivity generated by collective management is reinforced by the lower fixed entry costs for GI firms f^{e}_{GI} implied by the reputation of the GI label. Indeed, a decrease in f^{e}_{GI} increases the net value of entry for GI firms, prompting more GI firms to attempt entry into the market and thereby increasing competition among GI firms. The cutoff productivity level φ^{*}_{GI} increases, and fewer GI firms can successfully enter the market. Equation (19) reveals how lower fixed entry costs f^{e}_{GI} affect the export cutoff productivity level φ^{x*}_{GI}. As a primary effect, φ^{x*}_{GI} increases proportionally with φ^{*}_{GI}. However, as a secondary effect, a higher value of φ^{*}_{GI} implies that fewer GI firms are incumbent in the market, and so the GI producer group is smaller and fixed operating costs are shared among fewer firms. Consequently, $f_{GI}(\varphi^{*}_{GI})$ increases and φ^{x*}_{GI} decreases. With the parameter values in Table 1, the former effect dominates the latter and so φ^{x*}_{GI} (and consequently $\tilde{\varphi}^{x}_{GI}$) increase with decreasing fixed entry costs f^{e}_{GI}. The two effects of collective management and reputation of the GI label determine that exporting GI firms have higher average productivity than exporting non-GI firms, and domestically operating GI firms are less productive on average than domestically operating non-GI firms. International GI protection thus becomes welfare enhancing through the reallocation of higher domestic market shares to non-GI firms and higher international market shares to GI firms.

Given the set of parameter values in Table 1, in Figure 1 we plot a stylised version of welfare over the feasible range of values Δf_{GI}^{x} and identify the welfare-maximising value of international GI protection, denoted by Δf_{GI}^{x*}. The figure depicts the inverted U shape of the welfare function, which reaches a maximum at an "intermediate" level of international GI protection, where the public institution covers part of the IP protection costs of foreign GIs. This result stems from the trade-off between the benefit of international GI protection described above and the reduction in welfare associated with the tax on labour income. As explained in the sections below, this result also holds for a variety of combinations of parameter values.

To quantify the trade and welfare effects of international GI protection, we report aggregate and sector-specific outcomes in Table 3, obtained with the baseline parameters. All percentage changes reported in Table 3 stem from the comparison between outcomes obtained with welfare-maximising international GI policy Δf_{GI}^{x*} and outcomes obtained by assuming $\Delta f_{GI}^{x} = 0$ (i.e. in the absence of international GI protection).

We find that the welfare-maximising international GI policy calls for 6.06% of the fixed exporting costs of GI firms be covered by the public hand. A policy implemented at this welfare-maximising level increases the probability that GI firms will export, exerting a positive effect on the extensive margin of trade by increasing the number of exporting GI firms M_{GI}^{x} by 13.11%. Aggregate productivity of exporting GI firms decreases by 1.53%. As GI firms make up only a small share of the market, the impact on the extensive margin of trade of all exporting firms is smaller (M^{x} increases by 0.47%). Of the domestic GI producers M_{GI}, 0.17% (the least productive) exit the market. Overall aggregate productivity of GI firms $\tilde{\varphi}_{GI}^{c}$ thus increases by 0.03%. The number of available GI varieties M_{GI}^{c} decreases by 0.05%. The non-GI sector is only marginally affected by the changes in the GI sector: the overall number of available non-GI varieties M_{T}^{c} decreases by 0.01%, while aggregate productivity in the non-GI sector $\tilde{\varphi}_{T}^{c}$ remains unaffected.

Overall, the share of domestic GI producers η decreases by 0.16% to 0.093. The share of available GI varieties η^{c} decreases less strongly by 0.04% to 0.091. Consequently, as $\eta < \alpha$, the entry conditions to the domestic market are relatively tougher in the GI sector compared to the non-GI sector. Further, as $\eta^{c} < \eta$, the probability of exporting in the GI sector is lower than in the non-GI sector (compare Equation (20)). Aggregated over both sectors, the number of available varieties M^{c} decreases by 0.006%, while overall aggregate productivity $\tilde{\varphi}^{c}$ increases by 0.002%. The absolute change in overall welfare ΔW from introducing the optimal level of international GI protection is positive but small. However, compared to the total cost of international GI protection nC^x, policy returns in terms of welfare are equal to $\Delta W/nC^x = 0.82$.

[Insert Table 3 here]

5.4 Collective Management, Reputation, and Craftsmanship in Production

To illustrate how domestic and international GI protection mechanisms are interrelated and how market structure mediates the effect of GI policy on market outcomes, we consider the interplay among the level of collective management λ, reputation of the GI label (f^e_{GI}), level of craftsmanship in production (φ^{min}_{GI}), and the optimal level of international GI protection.[8]

In Table 4, we report aggregate and sector-specific outcomes for several values of λ. We find a lower bound $\lambda = 0.23$, below which the optimal level of international GI protection is zero. For such low values of λ, the reallocation of international market shares towards GI firms induced by international GI protection does not generate sufficient welfare gains to offset the policy's cost, financed by a labour income tax.

For higher values of λ, fostering the entry of GI firms into export markets through introducing a positive level of international GI protection is welfare enhancing. In such a scenario, the optimal level Δf^{x*}_{GI} and the return to the cost of international GI protection $\Delta W/nC^x$ increase in λ. For example, for $\lambda = 0.5$, the public institution should cover 10.2% of fixed exporting costs for GI firms (up from 6.06% in the baseline scenario), increasing the return to cost ratio $\Delta W/nC^x$ to 2.35. This implies that domestic and foreign GI protection policies are complementary; stronger domestic GI protection implies a higher level of optimal international GI protection at the welfare maximising optimum. From a policy perspective, we can conclude that the positive welfare effects achieved by strengthening the role of GI producer groups in the domestic market (increasing λ) can be amplified by efforts to introduce (the optimal level of) international GI protection.

Figure 2 and Figure 3 illustrate how the optimal level of international GI protection depends on the structural features of the GI sector. The shaded areas depict the combination of parameter values for which positive international GI protection is welfare enhancing ($\Delta f^{x*}_{GI} > 0$), with a darker colour corresponding to larger optimal values of international GI protection. For a given inefficiency in production in the GI sector ($\varphi^{min}_{GI} = 0.9$), Figure 2 shows that there exist lower bounds of the values of GI reputation (f^e_{GI}) and collective

[8] A similar analysis could be conducted for the other domestic policy parameter s, which, as already seen, plays a subordinate role compared to λ.

management (λ) if a positive level of international GI protection is to be welfare enhancing. When GI firms have no advantage in reputation ($f^e_{GI} = f^e_T$), the minimum level of collective management required for international protection to enhance welfare is $\lambda = 0.582$. In the absence of collective management ($\lambda = 0$), the advantage in reputation must be such that fixed entry costs in the GI sector f^e_{GI} are no larger than 43% of fixed entry costs in the non-GI sector f^e_T.

Holding the level of reputation constant at its baseline value (f^e_{GI} equal to 55% of f^e_T), Figure 3 shows the lower bounds in relative productivity of GI firms $\varphi^{min}_{GI}/\varphi^{min}_T$ and collective management λ needed for positive levels of international GI protection to be welfare enhancing. For example, for $\lambda = 0.5$, the GI sector can be up to 14.7% less productive than the non-GI sector. In general, these two variables tend to compensate each other: the higher the level of collective management, the lower the level of productivity in the GI sector (relative to the non-GI sector), for which a positive level of international GI policy is still welfare enhancing.

In summary, our analysis shows that the lower the reputation of the GI and the higher the level of craftsmanship in GI production, the lower the optimal level of international GI protection is. Strengthening collective management helps GI producers "make up" for a certain disadvantage in terms of productivity (or lower advantage in terms of reputation), thus justifying the protection of the GI label in international markets.

Hypothesis 3: International GI Protection - Collective Management, Reputation, and Productivity
The welfare gains from introducing international GI protection are higher, the higher the level of domestic protection λ (and s), the lower the fixed entry costs f^e_{GI} (the closer to one is f^e_{GI}/f^e_T), and the lower the level of craftsmanship in production (the closer to one is $\varphi^{min}_{GI}/\varphi^{min}_T$). GIs with stronger collective management, with higher reputation among consumers, and who are relatively more productive should thus be more likely to be protected in international agreements.

[Insert Table 4 here]

5.5 Government Efficiency

We turn our analysis to government efficiency in international GI protection, ε. It could be argued that public institutions enjoy economies of scale in market monitoring and infringement prosecution activities as compared to individual firms. Therefore, by reducing the value of ε, we relax the assumption that the cost of protecting the GI label translates one to one from individual GI firms to the public institution. For example, setting $\varepsilon = 0.75$ implies that for each unit of costs spent by any exporting GI firm to monitor the market abroad, 0.75 units of costs emerge for the foreign government.

Table 5 shows aggregate and sector-specific market outcomes for several values of ε. Overall, the higher the efficiency ε, the higher the optimal level of international GI protection Δf_{GI}^{x*}, and the greater the gain in terms of welfare relative to the cost of the tax on labour income $\Delta W/nC^x$. For example, with $\varepsilon = 0.75$, the optimal international GI protection covers 20.46% of fixed exporting costs of GI firms; the gain to cost ratio is 2.77. Also, the positive effect on the extensive margin of trade from implementing the optimal international GI policy increases with ε. With $\varepsilon = 0.75$, implementing the optimal level of GI protection increases the number of exporting firms M_{GI}^x by 56.960%. Aggregate productivity of exporting GI firms $\tilde{\varphi}_{GI}^x$ decreases by 5.480%. With $\varepsilon = 0.5$, the number of exporting GI firms increases more strongly (by 167.358%), while the aggregate productivity of exporting GI firms decreases by 11.568%.

Finally, Table 5 shows that if public institutions surpass a certain level of inefficiency in GI protection ($\varepsilon > 1.12$), the cost of protecting GI firms in international markets outweighs the associated gain in welfare. Building efficient public institutions that protect the GI label effectively plays an essential role in providing welfare-enhancing (international) GI policy.

Hypothesis 4: International GI Protection - Government Efficiency
The welfare gains from introducing international GI protection are higher the more efficiently a government can provide protection to GI firms. Countries that established institutions with an efficient system of GI protection should thus be more likely to protect GIs in international agreements.

[Insert Table 5 here]

5.6 Number of Foreign Countries and Size of GI Land

We finally consider the scenario of a multilateral (instead of bilateral) trade agreement, where all signing parties provide GI protection to foreign GIs. Results are shown in Table 6.

Keeping other parameters at their baseline values, increasing the number of foreign countries from $n = 1$ to $n = 2$ decreases the optimal level of international GI protection. This result is driven by the fact that the cost of international GI protection, nC^x, increases linearly with the number of foreign countries n.

For $n = 2$, the optimal level of international GI protection corresponds to 5.77% of fixed exporting costs, and the ratio of welfare gains relative to the cost of implementing such protection decreases to 0.77. The positive impact on the extensive margin of trade from implementing optimal GI protection likewise decreases compared to the baseline scenario (the number of exporting firms M^x increases by 0.444%). For $n = 10$, the optimal level of international GI protection decreases to 3.83%, while the ratio of welfare gains relative to cost decreases to 0.46; the impact of international GI protection on the extensive margin of trade decreases further.

Conversely, if the public institution is more efficient than individual GI firms in protecting the GI label (e.g. $\varepsilon = 0.5$), then increasing the number of foreign countries n increases the cost of international GI protection nC^x less sharply than the associated welfare gains. The optimal level of international GI protection thus increases with the number of foreign countries n (from 39.89% for $n = 2$ to 43.66% for $n = 10$). The effect of optimal GI protection on the extensive margin of trade likewise increases with the number of countries involved in an international agreement n. This result implies that for countries with efficient public institutions (in terms of GI protection), multilateral agreements present an advantage over bilateral agreements from a welfare perspective in securing a high level of protection for GIs.

Hypothesis 5: International GI Protection - Number of Foreign Countries
The welfare gains from introducing international GI protection are increasing in the number of countries only for countries with a sufficiently efficient system of GI protection. Countries that established such a system of GI protection should thus be more likely to protect GIs in multilateral agreements. In contrast, countries with less efficient systems of GI protection should be more likely to not rely on international GI protection or protect GIs via bilateral agreements.

[Insert Table 6 here]

In anticipation of a potential expansion of the GI sector, we consider an increase in the share of land dedicated to the production of GI varieties α shown in Table 7. Here, we note that an increase in the size of the GI sector mainly affects the cost of GI protection, which increases more strongly than its benefit; hence, optimal international GI protection decreases.

Hypothesis 6: International GI Protection - Size of Land available for GI Production
The welfare gains from introducing international GI protection are decreasing in the size of land available for the production of GI varieties. GI sectors with a larger production area should thus be less likely to be protected in international agreements.

[Insert Table 7 here]

6 Conclusion

In this article, we develop a first general-equilibrium model of international trade to incorporate a GI sector alongside a non-GI sector in the context of heterogeneous firms who produce horizontally differentiated varieties. The model reflects a number of stylised facts about GI production: collective reputation of the GI label, high levels of craftsmanship in the production of GI varieties, collective management of GI producer groups, and administrative protection of GIs in international markets.

We analyse the effects of implementing GI protection policies in domestic and international markets on the allocation of market shares among GI and non-GI producers, exporting behaviour, and overall welfare. We find that domestic GI protection (strengthening collective management and subsidising collective efforts of the GI producer group) increases the number of available GI varieties and, through a reduction in operating costs for all members of the producer group, monotonically increases welfare. On a global level, the trade-off between the costs and benefits of international GI protection means that, for GI policy to be welfare maximising, an intermediate level of IPR protection is needed. The exact value depends positively on the level of reputation of the GI label and negatively on the level of craftsmanship in production of the GI. International GI protection reallocates domestic market shares towards non-GI firms and international market shares towards GI firms.

Further, we find that domestic and international GI protections are complementary: stronger domestic GI protection necessitates a higher level of international GI protection to be welfare maximising. Performing several simulation exercises, we could derive the welfare-maximising GI policy under different parameter constellations and quantify the reallocation effects of GI policy. The present study thus provides a theoretical framework that sheds light on the impact of GI protection policies in the context of open markets, an issue salient in the negotiations of many international agreements. Through the conceptualisation of organisation into producer groups and administrative enforcement, we further contribute to the discussion on the impacts of GI-specific protection compared to protection through a trademark system.

We identified two potential ways in which the present model could be extended. First, the effects of GI policy in open markets could be analysed within a framework of asymmetric countries, such as in Demidova (2008) or Falvey et al. (2006), allowing for a theoretical analysis of varying strengths of GI protection across different countries. Second, the effects of GI policy in international markets could be re-examined within a framework in which consumer preferences are adapted to match empirical investigations regarding the consumption of GI and non-GI products (see, for instance, Stasi et al. (2011) or Sorgho & Larue (2018)). Both represent interesting paths for further research.

A Appendix

A.1 Aggregate Productivity in each Sector and the Economy

Economy-wide aggregate productivity is given by

$$\tilde{\varphi} = \left[\int_0^\infty \varphi^{\sigma-1} \mu(\varphi) d\varphi \right]^{\frac{1}{\sigma-1}},$$

where $\mu(\varphi)$ is defined as a mixture of productivity distributions from the two sectors

$$\mu(\varphi) = \eta \mu_{GI}(\varphi) + (1-\eta)\mu_T(\varphi),$$

which allows us to write the economy-wide aggregate productivity as

$$\tilde{\varphi} = \left[\int_0^\infty \varphi^{\sigma-1} [\eta \mu_{GI}(\varphi) + (1-\eta)\mu_T(\varphi)] d\varphi \right]^{\frac{1}{\sigma-1}} = \left[\eta \int_0^\infty \varphi^{\sigma-1} \mu_{GI}(\varphi) d\varphi + (1-\eta) \int_0^\infty \varphi^{\sigma-1} \mu_T(\varphi)] d\varphi \right]^{\frac{1}{\sigma-1}}.$$

As sector-specific aggregate productivity is given by

$$\tilde{\varphi}_i = \left[\int_0^\infty \varphi^{\sigma-1} \mu_i(\varphi) d\varphi \right]^{\frac{1}{\sigma-1}},$$

economy-wide aggregate productivity can finally be expressed as

$$\tilde{\varphi} = \left[\eta (\tilde{\varphi}_{GI})^{\sigma-1} + (1-\eta)(\tilde{\varphi}_{GI})^{\sigma-1} \right]^{\frac{1}{\sigma-1}}.$$

A.2 Welfare and Optimal Level of the Subsidy

In the closed economy, increasing the subsidy s leaves the cutoff productivity levels in each sector (and therefore aggregate productivities and average profits in both sectors andas well as the share of GI firms) unaffected:

$$\frac{\partial \varphi_i^*}{\partial s} = \frac{\partial \tilde{\varphi}_i}{\partial s} = \frac{\partial \tilde{\varphi}}{\partial s} = \frac{\partial \overline{\pi}_i^*}{\partial s} = \frac{\partial \eta}{\partial s} = 0 \tag{21}$$

Using (13) and (21), the change in available varieties induced by a change in the subsidy s is given by

$$\frac{\partial M}{\partial s} = \frac{\lambda F(\sigma-1)}{\sigma[\overline{\pi} + F(1-\lambda\eta)]} > 0, \tag{22}$$

Increasing the subsidy s monotonically increases the number of incumbent firms (and thus the number of available varieties for consumers) in the closed economy. Using (14) and (22), the overall effect of marginally increasing the subsidy s on welfare can be determined as follows:

$$\frac{\partial W}{\partial s} = \rho\tilde{\varphi}\left[-\lambda F M^{\frac{1}{\sigma-1}} + (L-\lambda sF)\frac{1}{\sigma-1}M^{\frac{2-\sigma}{\sigma-1}}\frac{\partial M}{\partial s}\right] = \rho\tilde{\varphi}M^{\frac{1}{\sigma-1}}\left[-\lambda F + (L-\lambda sF)\frac{1}{\sigma-1}M^{-1}\frac{\partial M}{\partial s}\right].$$

This expression is greater than or equal to zero if

$$\lambda F \leq (L-\lambda sF)\frac{1}{\sigma-1}\left[\frac{L-\lambda F[s+\sigma(1-s)]}{\sigma\left[\overline{\pi}+F\left(1-\lambda\eta\right)\right]}\right]^{-1}\frac{\lambda F(\sigma-1)}{\sigma[\overline{\pi}+F(1-\lambda\eta)]},$$

which can be simplified to give

$$s \leq 1,$$

which implies that welfare in the closed economy is maximised when the subsidy is at its highest level of $s = 1$. In the open economy, changing the subsidy s affects the probability of exporting p^{ex}_{GI}, meaning that (21) does not hold anymore. We thus rely on simulation exercises to determine the impact of a change in s on equilibrium outcomes.

A.3 Equilibrium Outcomes with Pareto Distribution

To being able to explicitly derive the equilibrium values of the model, we assume that firms draw their productivity from a Pareto distribution. The PDF of the Pareto distribution is equal to

$$g_i(\varphi) = \frac{\kappa(\varphi_i^{min})^\kappa}{\varphi^{\kappa+1}},$$

with the CDF equal to

$$G_i(\varphi) = 1 - \left(\frac{\varphi_i^{min}}{\varphi}\right)^\kappa,$$

where $i \in \{GI, T\}$. To satisfy the assumption that the productivity distribution of the GI sector has a lower expected value, we assume $\varphi_{GI}^{min} < \varphi_T^{min}$.

Aggregate productivity of sector i is given by $\tilde{\varphi}_i = \left[\frac{1}{1-G_i(\varphi_i^*)}\int_{\varphi_i^*}^{\infty}\varphi^{\sigma-1}g_i(\varphi)d\varphi\right]^{\frac{1}{\sigma-1}}$, which, using the two definitions above, is equal to

$$\tilde{\varphi}_i = \left[\frac{\kappa}{\kappa+1-\sigma}\right]^{\frac{1}{\sigma-1}}\varphi_i^*.$$

The ZCP conditions in the closed economy become

$$\overline{\pi}_{GI} = (1-\lambda)F\frac{\sigma-1}{\kappa+1-\sigma}, \qquad \overline{\pi}_{T} = F\frac{\sigma-1}{\kappa+1-\sigma}.$$

The FE conditions in the closed economy are equal to

$$\overline{\pi}_{GI} = \delta f^e_{GI}\left(\frac{\varphi^*_{GI}}{\varphi^{min}_{GI}}\right)^{\kappa}, \qquad \overline{\pi}_{T} = \delta f^e_{T}\left(\frac{\varphi^*_{T}}{\varphi^{min}_{T}}\right)^{\kappa}.$$

Putting these two conditions together, the equilibrium expressions for φ^*_{GI} and φ^*_T in the closed economy are given by

$$\varphi^*_{GI} = \left[\frac{(1-\lambda)F(\sigma-1)}{\delta f^e_{GI}(\kappa+1-\sigma)}\right]^{\frac{1}{\kappa}}\varphi^{min}_{GI}, \qquad \varphi^*_{T} = \left[\frac{F(\sigma-1)}{\delta f^e_{T}(\kappa+1-\sigma)}\right]^{\frac{1}{\kappa}}\varphi^{min}_{T}.$$

The probability of entry for a firm from sector i is equal to $p^{in}_i = 1 - G_i(\varphi^*_i)$, which, for the GI sector, is equal to

$$1 - G_{GI}(\varphi^*_{GI}) = \left(\frac{\varphi^{min}_{GI}}{\varphi^*_{GI}}\right)^{\kappa} = \left(\frac{\varphi^{min}_{GI}}{\left[\frac{(1-\lambda)F(\sigma-1)}{\delta f^e_{GI}(\kappa+1-\sigma)}\right]^{\frac{1}{\kappa}}\varphi^{min}_{GI}}\right)^{\kappa},$$

Therefore, the probabilities of entry for the respective sectors are equal to

$$p^{in}_{GI} = \frac{\delta f^e_{GI}(\kappa+1-\sigma)}{(1-\lambda)F(\sigma-1)}, \qquad p^{in}_{T} = \frac{\delta f^e_{T}(\kappa+1-\sigma)}{F(\sigma-1)}.$$

A.4 Equilibrium conditions: Closed Economy

$$\overline{\pi}_{GI} = (1-\lambda)F\frac{\sigma-1}{\kappa+1-\sigma} \tag{23}$$

$$\overline{\pi}_{T} = F\frac{\sigma-1}{\kappa+1-\sigma} \tag{24}$$

$$\overline{\pi}_{GI} = \delta f^e_{GI}\left(\frac{\varphi^*_{GI}}{\varphi^{min}_{GI}}\right)^{\kappa} \tag{25}$$

$$\overline{\pi}_{T} = \delta f^e_{T}\left(\frac{\varphi^*_{T}}{\varphi^{min}_{T}}\right)^{\kappa} \tag{26}$$

$$\left(\frac{\varphi^{min}_{GI}}{\varphi^*_{GI}}\right)^{\kappa}\alpha M^e = \delta\eta M \tag{27}$$

$$\left(\frac{\varphi_T^{min}}{\varphi_T^*}\right)^\kappa (1-\alpha)M^e = \delta(1-\eta)M \tag{28}$$

$$M = \frac{L - \lambda s F}{\sigma\left\{\eta\overline{\pi}_{GI} + (1-\eta)\overline{\pi}_T + \eta\left[\lambda(1-s)\frac{F}{\eta M} + (1-\lambda)F\right] + (1-\eta)F\right\}} \tag{29}$$

This gives a system of seven equations with seven unknowns, where the endogenous variables are: $\overline{\pi}_{GI}$, $\overline{\pi}_T$, η, M, φ_{GI}^*, φ_T^*, and M^e.

A.5 Equilibrium Conditions: Open Economy

$$\overline{\pi}_{GI} = \left[(1-\lambda)F + np_{GI}^{ex} f_{GI}^x\right] \frac{\sigma - 1}{\kappa + 1 - \sigma} \tag{30}$$

where $p_{GI}^{ex} = \frac{1-G_{GI}(\varphi_{GI}^{*x})}{1-G_{GI}(\varphi_{GI}^{*})} = \left(\frac{\varphi_{GI}^*}{\varphi_{GI}^{*x}}\right)^\kappa = \tau^{-\kappa}\left(\frac{f_{GI}^x}{\frac{\lambda(1-s)(\kappa+1-\sigma)}{\kappa}\frac{F}{\eta M} + (1-\lambda)F}\right)^{\frac{\kappa}{1-\sigma}}$

$$\overline{\pi}_T = (F + np_T^{ex} f_T^x) \frac{\sigma - 1}{\kappa + 1 - \sigma} \tag{31}$$

where $p_T^{ex} = \tau^{-\kappa}\left(\frac{f_T^x}{F}\right)^{\frac{\kappa}{1-\sigma}}$

$$\overline{\pi}_{GI} = \delta f_{GI}^e \left(\frac{\varphi_{GI}^*}{\varphi_{GI}^{min}}\right)^\kappa \tag{32}$$

$$\overline{\pi}_T = \delta f_T^e \left(\frac{\varphi_T^*}{\varphi_T^{min}}\right)^\kappa \tag{33}$$

$$\left(\frac{\varphi_{GI}^{min}}{\varphi_{GI}^*}\right)^\kappa \alpha M^e = \delta\eta M \tag{34}$$

$$\left(\frac{\varphi_T^{min}}{\varphi_T^*}\right)^\kappa (1-\alpha)M^e = \delta(1-\eta)M \tag{35}$$

$$M = \tag{36}$$
$$\frac{L - \lambda s F - n\varepsilon p_{GI}^{ex}\eta M(f_T^x - f_{GI}^x)}{\sigma\left\{\eta\overline{\pi}_{GI} + (1-\eta)\overline{\pi}_T + \eta\left[\lambda(1-s)\frac{F}{\eta M} + (1-\lambda)F\right] + (1-\eta)F + n[\eta p_{GI}^{ex} f_{GI}^x + (1-\eta)p_T^{ex} f_T^x]\right\}}$$

List of endogenous variables: $\overline{\pi}_{GI}$, $\overline{\pi}_T$, η, M, φ_{GI}^*, φ_T^*, and M^e

A.6 Firm Productivity and Use of Labour

To determine the baseline value of φ_{GI}^{min} for our simulation exercises, we follow Bouamra-Mechemache & Chaaban (2010), who state that variable production costs are, on average, 40% higher for PDO compared to non-PDO producers. As labour is the only production factor, define the production costs per unit of output vc_i in sector i as

$$vc_i = \frac{L_i^c}{Q_i^c} \tag{37}$$

To reflect the result of Bouamra-Mechemache & Chaaban (2010), we need $vc_{GI}/vc_T = 1.4$, meaning that GI firms use 40% more labour per unit of output than non-GI firms. Using $L_i^c = M_i^c[r_i(\tilde{\varphi}_i^c) - \pi_i(\tilde{\varphi}_i^c)]$ and $Q_i^c = (M_i^c)^{\frac{\sigma}{\sigma-1}} q(\tilde{\varphi}_i^c) = (M_i^c)^{\frac{\sigma}{\sigma-1}} RP^{1-\sigma}(\rho\tilde{\varphi}_i^c)^{\sigma}$ with $P = (M^c)^{\frac{1}{1-\sigma}}(\rho\tilde{\varphi}^c)^{-1}$ and $R = L - \lambda sF - nC^x$, the baseline parameters defined in Table 1, and the equilibrium conditions defined in Section A.5, we are able to derive that for $\varphi_{GI}^{min} = 0.9314$, we have $vc_{GI}/vc_T = 1.4$. We thus use this value as a baseline parameter to reflect that GI firms use, on average, more labour per unit of output than non-GI firms.

A.7 Tables

Table 1: Parameter values

Type	Parameter	Value	Description
	λ	0.4	Domestic GI protection (Degree of collective management)
GI policy parameters	s	0.1	Domestic GI protection (Share of collective operating costs covered by government)
	$\Delta f_{GI}^{x*}/f_T^x$	0.06	International GI protection (Share of fixed exporting costs covered by government)
	φ_{GI}^{min}	0.9	Degree of craftsmanship in GI production (Hilal et al., 2021) (Minimum value of GI productivity distribution),
Structural parameters	f_{GI}^e	30	Reputation of GI label (Fixed entry costs GI firms)
	α	0.1	Share of land dedicated to GI production (Jantyik & Török, 2020) (Probability that entrant is from GI sector)
	ε	1	Government efficiency in international protection
	n	1	Bilateral agreement (Number of foreign countries)
	L	1,000,000	Size of the economy
	φ_T^{min}	1	Minimum value of non-GI productivity distribution
	F	10	Fixed operating costs
	f_T^e	54.9	Fixed entry cost non-GI firms Felbermayr et al. (2012) ($f_T^e/F = 5.49$)
Other parameters	f_T^x	17.5	Fixed exporting costs in the absence of international protection Felbermayr et al. (2012) ($f_T^x/F = 1.75$)
	κ	8	Pareto shape parameter (Eaton & Kortum, 2002)
	σ	5	Elasticity of substitution (Zhai, 2008)
	δ	0.058	Exit rate (Fackler et al., 2013)
	τ	1.37	Iceberg trade cost (Felbermayr et al., 2012)

Table 2: Range of parameter values considered in analysis of different policies

Parameter	Range	Description
λ	$[0, 1)$	Different levels of collective management from no coll. management to full coll. management
s	$[0, 1]$	Different levels of public support for domestic GIs from none to all of shared fixed operating costs covered
$\Delta f^x_{GI}/f^x_T$	$[0, 1]$	Different levels of international GI protection from no protection to full protection
f^e_{GI}	$[f^e_{GI} = 0.1 f^e_T, f^e_{GI} = f^e_T]$	From strong reputational advantage of GI label to no reputational advantage
φ^{min}_{GI}	$[\varphi^{min}_{GI} = 0.1\varphi^{min}_T,\ \varphi^{min}_{GI} = \varphi^{min}_T]$	From high level of craftsmanship in production to low level of craftsmanship in production
ε	[0.1, 1.5]	Different levels of government efficiency from very efficient to very inefficient
n	[1, 10]	From bilateral agreement (one foreign country) to multilateral agreement with ten foreign countries
α	[0.01, 0.5]	Different sizes of GI sector from 1% to 50% of land available for GI production

Table 3: **CHECK VALUES!** Baseline simulation. Changes in aggregate outcomes (per sector) by introducing the optimal level of international GI protection Δf_{GI}^{x*} relative to $f_{GI}^{x*} = 0$.

Aggregate outcomes										
$\Delta f_{GI}^{x*}/f_T^x$	$\Delta W/nC^x$	η	η^c	ΔM	ΔM^c	$\Delta\tilde{\varphi}^c$	$\Delta\eta$	$\Delta\eta^c$	ΔM^x	$\Delta\tilde{\varphi}^x$
6.06%	0.82	0.093	0.091	−0.017%	−0.006%	0.003%	−0.157%	−0.044%	0.468%	−0.053%

GI sector						non-GI sector				
ΔM_{GI}^c	$\Delta\tilde{\varphi}_{GI}^c$	ΔM_{GI}	ΔM_{GI}^x	$\Delta\tilde{\varphi}_{GI}^x$		ΔM_T^c	$\Delta\tilde{\varphi}_T^c$	ΔM_T	ΔM_T^x	$\Delta\tilde{\varphi}_T^x$
−0.049%	0.034%	−0.174%	13.114%	−1.529%		−0.001%	–	−0.001%	−0.001%	–

Table 4: Changes in aggregate outcomes (per sector) by introducing the optimal level of international GI protection Δf_{GI}^{x*} relative to $f_{GI}^{x*} = 0$ for different levels of collective management λ.

Aggregate outomes:									
	$\Delta f_{GI}^{x*}/f_T^x$	$\Delta W/nC^x$	$\Delta\eta^c$	ΔM^c	$\Delta\tilde{\varphi}^c$	$\Delta\eta$	ΔM	ΔM^x	$\Delta\tilde{\varphi}^x$
$\lambda < 0.23$	0	–	–	–	–	–	–	–	–
$\lambda = 0.3$	2.51%	0.14	−0.013%	−0.002%	0.001%	−0.074%	−0.007%	0.212%	−0.026%
$\lambda = 0.5$	10.23%	2.35	−0.088%	−0.012%	0.005%	−0.228%	−0.030%	0.715%	−0.074%

Outomes per sector:										
	ΔM_{GI}^c	ΔM_T^c	ΔM_{GI}	ΔM_T	ΔM_{GI}^x	ΔM_T^x	$\Delta\tilde{\varphi}_{GI}^c$	$\Delta\tilde{\varphi}_T^c$	$\Delta\tilde{\varphi}_{GI}^x$	$\Delta\tilde{\varphi}_T^x$
$\lambda < 0.23$	0	–	–	–	–	–	–	–	–	–
$\lambda = 0.3$	−0.015%	−0.0005%	−0.081%	−0.0005%	5.140%	−0.0005%	0.014%	–	−0.625%	–
$\lambda = 0.5$	−0.101%	−0.002%	−0.258%	−0.002%	23.767%	−0.002%	0.057%	–	−2.630%	–

Table 5: Changes in aggregate outcomes (per sector) by introducing the optimal level of international GI protection Δf_{GI}^{x*} relative to $f_{GI}^{x*} = 0$ for different levels of government efficiency ε.

Aggregate outcomes:									
	$\Delta f_{GI}^{x*}/f_T^x$	$\Delta W/nC^x$	$\Delta\eta^c$	ΔM^c	$\Delta\tilde{\varphi}^c$	$\Delta\eta$	ΔM	ΔM^x	$\Delta\tilde{\varphi}^x$
$\varepsilon > 1.12$	0	–	–	–	–	–	–	–	–
$\varepsilon = 0.75$	20.46%	2.77	−0.132%	−0.017%	0.009%	−0.623%	−0.068%	2.034%	−0.250%
$\varepsilon = 0.5$	39.37%	5.30	−0.117%	−0.020%	0.017%	−1.559%	−0.168%	5.980%	−0.817%

Outcomes per sector:										
	ΔM_{GI}^c	ΔM_T^c	ΔM_{GI}	ΔM_T	ΔM_{GI}^x	ΔM_T^x	$\Delta\tilde{\varphi}_{GI}^c$	$\Delta\tilde{\varphi}_T^c$	$\Delta\tilde{\varphi}_{GI}^x$	$\Delta\tilde{\varphi}_T^x$
$\varepsilon > 1.12$	0	–	–	–	–	–	–	–	–	–
$\varepsilon = 0.75$	−0.150%	−0.004%	−0.691%	−0.004%	56.960%	−0.004%	0.123%	–	−5.480%	–
$\varepsilon = 0.5$	−0.137%	−0.008%	−1.725%	−0.008%	167.358%	−0.008%	0.249%	–	−11.568%	–

Table 6: Changes in aggregate outcomes (per sector) by introducing the optimal level of international GI protection Δf_{GI}^{x*} relative to $f_{GI}^{x*} = 0$ for different numbers of foreign countries n.

Aggregate outcomes:

	$\Delta f_{GI}^{x*}/f_T^x$	$\Delta W/C^x$	$\Delta\eta^c$	ΔM^c	$\Delta\tilde{\varphi}^c$	$\Delta\eta$	ΔM	ΔM^x	$\Delta\tilde{\varphi}^x$
For $\varepsilon = 1$:									
$n = 2$	5.77%	0.77	−0.078%	−0.010%	0.005%	−0.290%	−0.032%	0.444%	−0.051%
$n = 10$	3.83%	0.46	−0.144%	−0.020%	0.010%	−0.767%	−0.094%	0.283%	−0.034%
For $\varepsilon = 0.5$:									
$n = 2$	39.89%	5.25	−0.166%	−0.033%	0.032%	−3.051%	−0.334%	6.070%	−0.835%
$n = 10$	43.66%	4.98	1.424%	0.070%	0.087%	−13.079%	−1.564%	6.720%	−0.962%

Outcomes per sector:

	ΔM_{GI}^c	ΔM_T^c	ΔM_{GI}	ΔM_T	ΔM_{GI}^x	ΔM_T^x	$\Delta\tilde{\varphi}_{GI}^c$	$\Delta\tilde{\varphi}_T^c$	$\Delta\tilde{\varphi}_{GI}^x$	$\Delta\tilde{\varphi}_T^x$
For $\varepsilon = 1$:										
$n = 2$	−0.088%	−0.002%	−0.322%	−0.002%	12.263%	−0.002%	0.062%	–	−1.436%	–
$n = 10$	−0.163%	−0.005%	−0.860%	−0.005%	7.191%	−0.005%	0.147%	–	−0.865%	–
For $\varepsilon = 0.5$:										
$n = 2$	−0.198%	−0.016%	−3.375%	−0.016%	167.389%	−0.016%	0.474%	–	−11.570%	–
$n = 10$	1.500%	−0.073	−14.438%	−0.073%	169.564%	−0.073%	1.561%	–	−11.667%	–

Table 7: Changes in aggregate outcomes (per sector) by introducing the optimal level of international GI protection Δf_{GI}^{x*} relative to $f_{GI}^{x*} = 0$ for different shares of land available for GI production α.

Aggregate outcomes:

	$\Delta f_{GI}^{x*}/f_T^x$	$\Delta W/nC^x$	$\Delta\eta^c$	ΔM^c	$\Delta\tilde{\varphi}^c$	$\Delta\eta$	ΔM	ΔM^x	$\Delta\tilde{\varphi}^x$
$\alpha = 0.2$	5.66%	0.76	−0.037%	−0.011%	0.005%	−0.131%	−0.032%	0.936%	−0.106%
$\alpha = 0.5$	4.11%	0.56	−0.017%	−0.020%	0.010%	−0.060%	−0.060%	2.158%	−0.245%

Outcomes per sector:

	ΔM_{GI}^c	ΔM_T^c	ΔM_{GI}	ΔM_T	ΔM_{GI}^x	ΔM_T^x	$\Delta\tilde{\varphi}_{GI}^c$	$\Delta\tilde{\varphi}_T^c$	$\Delta\tilde{\varphi}_{GI}^x$	$\Delta\tilde{\varphi}_T^x$
$\alpha = 0.2$	−0.047%	−0.002	−0.163%	−0.002%	12.169%	−0.002%	0.032%	–	−1.426%	–
$\alpha = 0.5$	−0.038%	−0.004%	−0.120%	−0.004%	8.636%	−0.004%	0.023%	–	−1.031%	–

A.8 Figures

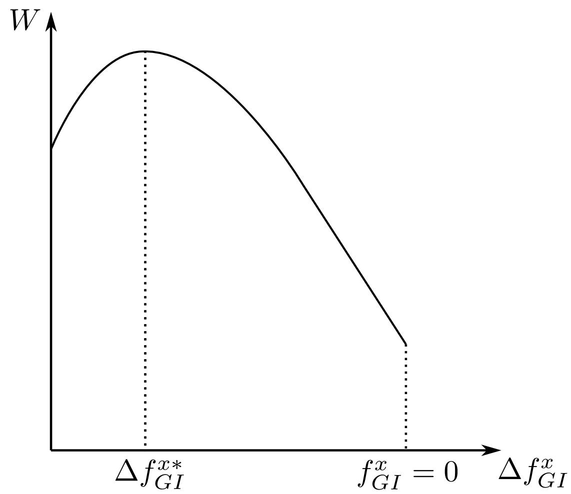

Figure 1: *Welfare and optimal level of international GI protection.*
The figure depicts a stylised version of welfare W as a function of the level of international GI protection Δf_{GI}^{x}, where the optimal level of international GI protection is denoted by Δf_{GI}^{x*}.

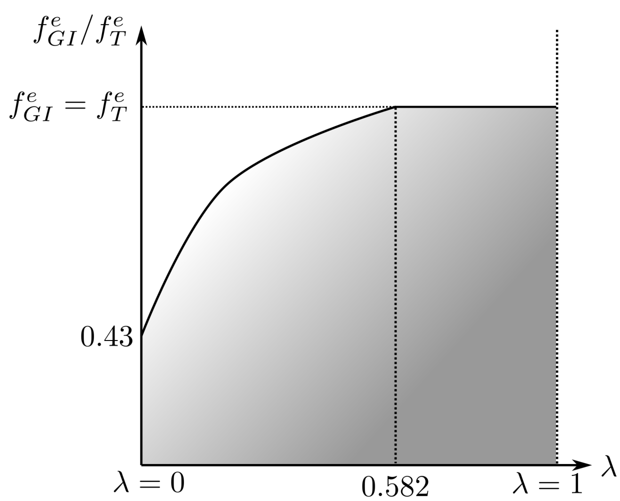

Figure 2: *International GI protection, domestic GI policy, and reputation.*
Holding constant the degree of craftsmanship in production of GI firms ($\varphi_{GI}^{min} = 0.9$), the shaded area in the figure depicts the combinations of parameter values concerning advantage in terms of reputation in the GI sector (f_{GI}^{e}/f_{T}^{e}) and the degree of collective management (λ), for which the optimal level of international GI protection is positive. The darker the shaded area, the larger is the optimal level of international GI protection.

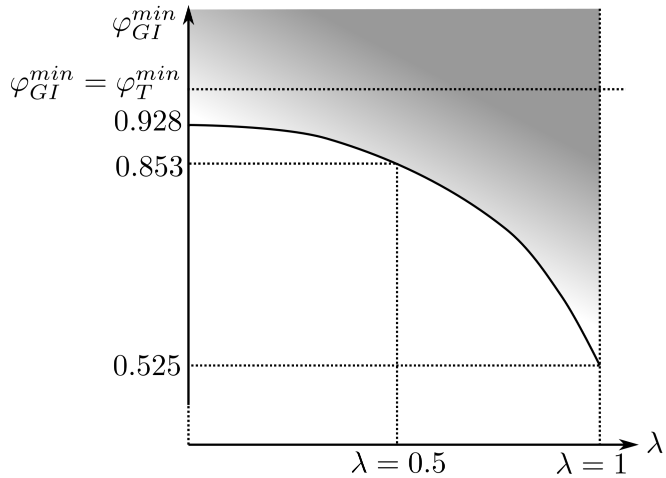

Figure 3: *International GI protection, domestic GI policy, and relative productivity.* Holding constant the advantage in terms of reputation in the GI sector ($f_{GI}^{e}/f_{T}^{e} = 0.55$), the shaded area in the figure depicts the combinations of parameter values concerning the degree of craftsmanship in production of GI firms (φ_{GI}^{min}) and the degree of collective management (λ), for which the optimal level of international GI protection is positive. The darker the shaded area, the larger is the optimal level of international GI protection.

References

Barham, E., & Sylvander, B. (2011). *Labels of origin for food: Local development, global recognition*. Cabi.

Barjolle, D., & Chappuis, J.-M. (2000). Transaction costs and artisanal food products. *Actas de la*, *1*, 1–17.

Barjolle, D., & Sylvander, B. (1999). Some factors of success for origin labelled products in agri-food supply chains in Europe: Market, internal resources and institutions. *No. 730-2016-50586*, 45-71.

Belletti, G. (1999). *Origin labelled products, reputation and heterogeneity of firms* (Tech. Rep.).

Belletti, G. (2021). *Evaluating Geographical Indications: Guide to tailor evaluations for the development and improvement of Geographical Indications*. Food & Agriculture Organization of the United Nations.

Belletti, G., Burgassi, T., Manco, E., Marescotti, A., Pacciani, A., & Scaramuzzi, S. (2007). *The roles of geographical indications (pdo and pgi) on the internationalisation process of agro-food products* (Tech. Rep.).

Bouamra-Mechemache, Z., & Chaaban, J. (2010). Determinants of adoption of protected designation of origin label: Evidence from the french brie cheese industry. *Journal of Agricultural Economics*, *61*(2), 225–239.

Bramley, C. (2011). A review of the socio-economic impact of geographical indications: considerations for the developing world. In *Wipo worldwide symposium on geographical indications* (Vol. 22, pp. 1–22).

Campi, M., & Dueñas, M. (2016). Intellectual property rights and international trade of agricultural products. *World Development*, *80*, 1–18.

Campi, M., & Dueñas, M. (2019). Intellectual property rights, trade agreements, and international trade. *Research Policy*, *48*(3), 531–545.

Chambolle, C., & Giraud-Héraud, E. (2005). Certification of origin as a non-tariff barrier. *Review of International Economics*, *13*(3), 461–471.

Chandra, R., Moschini, G., Lade, G. E., & Moschini, G. (2021). Geographical indications and welfare: Evidence from the us wine market.

Chilla, T., Fink, B., Balling, R., Reitmeier, S., & Schober, K. (2020). The EU food label 'Protected Geographical Indication': Economic implications and their spatial dimension. *Sustainability*, *12*(14), 5503.

Chu, A. C., Fan, H., Shen, G., & Zhang, X. (2018). Effects of international trade and intellectual property rights on innovation in china. *Journal of Macroeconomics*, *57*, 110–121.

Costanigro, M., McCluskey, J. J., & Goemans, C. (2010). The economics of nested names: name specificity, reputations, and price premia. *American Journal of Agricultural Economics*, *92*(5), 1339–1350.

Curzi, D., & Huysmans, M. (2022). The impact of protecting eu geographical indications in trade agreements. *American Journal of Agricultural Economics*, *104*(1), 364–384.

Demidova, S. (2008). Productivity improvements and falling trade costs: boon or bane? *International Economic Review*, *49*(4), 1437–1462.

Duvaleix, S., Emlinger, C., Gaigné, C., & Latouche, K. (2021). Geographical Indications and trade: Firm-level evidence from the French cheese industry. *Food Policy*, *102*, 102118.

Eaton, J., & Kortum, S. (2002). Technology, geography, and trade. *Econometrica*, *70*(5), 1741–1779.

Engelhardt, T. (2015). Geographical Indications under recent EU trade agreements. *IIC - International Review of Intellectual Property and Competition Law*, *46*(7), 781–818.

European Commission. (2022). Proposal for a regulation of the European Parliament and of the Council on European Union Geographical Indications for wine, spirit drinks and agricultural products, and quality schemes for agricultural products, amending regulations (EU) no 1308/2013, (EU) 2017/1001 and (EU) 2019/787 and repealing regulation (EU) no 1151/2012. *2022/0089 (COD)*.

European Union. (2012). Regulation (EU) no. 1151/2012 of the European Parliament and of the council of 21 november 2012 on quality schemes for agricultural products and foodstuffs. *Official Journal of the European Union*, *343*, 1–29.

Fackler, D., Schnabel, C., & Wagner, J. (2013). Establishment exits in germany: the role of size and age. *Small Business Economics*, *41*(3), 683–700.

Falvey, R., Greenaway, D., & Yu, Z. (2006). Extending the melitz model to asymmetric countries. *University of Nottingham research paper*(2006/07).

Felbermayr, G., Jung, B., & Larch, M. (2012). *Tariffs and welfare in new trade theory models* (Tech. Rep.). University of Tübingen Working Papers in Economics and Finance.

Foster, N. (2014). Intellectual property rights and the margins of international trade. *The Journal of International Trade & Economic Development*, *23*(1), 1–30.

Gergaud, O., & Ginsburgh, V. (2008). Natural endowments, production technologies and the quality of wines in bordeaux. does terroir matter? *The Economic Journal*, *118*(529), F142–F157.

Grossman, G. M., & Shapiro, C. (1988). Counterfeit-product trade. *The American Economic Review*, *78*(1), 59–75.

Gstöhl, S., & De Bièvre, D. (2017). *The trade policy of the European Union.* Macmillan International Higher Education.

Hilal, M., Leedon, G., de Labarre, M. D., Antonioli, F., Boehm, M., Péter, C., … Gauvrit, L. a. o. (2021). Organic and geographical indication certifications' contributions to employment and education. *Journal of Agricultural & Food Industrial Organization*, *19*(2), 161–176.

Huysmans, M. (2020). Exporting protection: EU trade agreements, Geographical Indications, and gastronationalism. *Review of International Political Economy*, 1–28.

Jantyik, L., & Török, Á. (2020). Estimating the market share and price premium of GI foods — The case of the Hungarian food discounters. *Sustainability*, *12*(3), 1094.

Josling, T. (2006). The war on terroir: Geographical Indications as a transatlantic trade conflict. *Journal of Agricultural Economics*, *57*(3), 337–363.

Jung, B. (2012). Optimal fixed cost subsidies in Melitz-type models. *Empirica*, *39*(1), 87–108.

Lai, H., Maskus, K. E., & Yang, L. (2020). Intellectual property enforcement, exports and productivity of heterogeneous firms in developing countries: Evidence from china. *European Economic Review*, *123*, 103373.

Lence, S. H., Marette, S., Hayes, D. J., & Foster, W. (2007). Collective marketing arrangements for geographically differentiated agricultural products: Welfare impacts and policy implications. *American Journal of Agricultural Economics*, *89*(4), 947–963.

Mancini, M. C., Arfini, F., Veneziani, M., & Thévenod-Mottet, E. (2017). Geographical indications and transatlantic trade negotiations: Different US and EU perspectives. *EuroChoices*, *16*(2), 34–40.

Maskus, K. E. (2000). *Intellectual property rights in the global economy.* Peterson Institute.

Matthews, A. (2016). What Outcome To Expect On Geographical Indications in the TTIP Free Trade Agreement Negotiations With The United States? *Intellectual Property Rights for Geographical Indications: What is at Stake in the TTIP?*, 2.

Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, *71*(6), 1695–1725.

Menapace, L., & Moschini, G. (2012). Quality certification by Geographical Indications, trademarks and firm reputation. *European Review of Agricultural Economics*, *39*(4), 539–566.

Menapace, L., & Moschini, G. C. (2014). Strength of protection for Geographical Indications: Promotion incentives and welfare effects. *American Journal of Agricultural Economics*, *96*(4), 1030–1048.

Mérel, P., & Sexton, R. J. (2012). Will Geographical Indications supply excessive quality? *European Review of Agricultural Economics*, *39*(4), 567–587.

Moir, H. V. (2016). Geographical Indications: EU policy at home and abroad. In *IP statistics for decision makers (IPSDM) conference Sydney, Australia.*

Moschini, G., Menapace, L., & Pick, D. (2008). Geographical Indications and the competitive provision of quality in agricultural markets. *American Journal of Agricultural Economics*, *90*(3), 794–812.

Oberfield, E., & Raval, D. (2021). Micro data and macro technology. *Econometrica*, *89*(2), 703–732.

Palangkaraya, A., Jensen, P. H., & Webster, E. (2017). The effect of patents on trade. *Journal of International Economics*, *105*, 1–9.

Raimondi, V., Falco, C., Curzi, D., & Olper, A. (2020). Trade effects of Geographical Indication policy: The EU case. *Journal of Agricultural Economics*, *71*(2), 330–356.

Saggi, K. (2016). Trade, intellectual property rights, and the World Trade Organization. *Handbook of Commercial Policy*, *1*, 433–512.

Santacreu, A. M. (2021). Intellectual property rights, technology transfer and international trade. *Technology Transfer and International Trade (July 12, 2021)*.

Sautier, D. (2019). *Seminar on Geographical Indications*. European Union Intellectual Property Office.

Sorgho, Z., & Larue, B. (2018). Do Geographical Indications really increase trade? A conceptual framework and empirics. *Journal of Agricultural & Food Industrial Organization*, *16*(1).

Stasi, A., Nardone, G., Viscecchia, R., & Seccia, A. (2011). Italian wine demand and differentiation effect of geographical indications. *International Journal of Wine Business Research*.

Teuber, R., Anders, S. M., & Langinier, C. (2011). *The economics of Geographical Indications: Welfare implications* (Tech. Rep.).

Tregear, A., Arfini, F., Belletti, G., & Marescotti, A. (2004). The impact of territorial product qualification processes on the rural development potential of small-scale food productions. In *XI World Congress of Rural Sociology. Trondheim (Norway)*.

TRIPS. (1994). Agreement on trade-related aspects of intellectual property rights. *Marrakesh Agreement Establishing the World Trade Organization*, *Annex 1C, 1869 U.N.T.S. 299, 33 I.L.M. 1197*.

Vandecandelaere, E., Teyssier, C., Barjolle, D., Jeanneaux, P., Fournier, S., & Beucherie, O. (2018). *Strengthening sustainable food systems through Geographical Indications: An analysis of economic impacts*. European Bank for Reconstruction and Development (EBRD).

Viju, C., Yeung, M. T., & Kerr, W. A. (2012). *Geographical Indications, barriers to market access and preferential trade agreements* (Tech. Rep.).

Vittori, M. (2010). The international debate on Geographical Indications (GIs): The point of view of the global coalition of GI producers—oriGIn. *The Journal of World Intellectual Property*, *13*(2), 304–314.

WTO. (1994). Agreement on agriculture. *Apr. 15, 1994. Marrakesh Agreement Establishing the World Trade Organization, Annex 1A, 1867 U.N.T.S. 410*.

Zhai, F. (2008). Armington meets Melitz: Introducing firm heterogeneity in a global CGE model of trade. *Journal of Economic Integration*, 575–604.

Zheng, Z., Huang, C.-Y., & Yang, Y. (2020). Patent protection, innovation, and technology transfer in a schumpeterian economy. *European Economic Review*, *129*, 103531.