Essays on International Trade, Trade Barriers, and Oligopolistic Competition

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Abstract

Empirical evidence suggests both that market power increased considerably since 1980 (e.g. De Loecker et al., 2020) and that firms differ in destination-specific trade barriers (e.g. Munch and Nguyen, 2014). Motivated by these insights, this thesis develops a trade model that allows to analyze the effects of asymmetric policies in general oligopolistic equilibrium, uses this framework to study corporate taxation, tax-motivated transfer pricing and trade policy, and provides evidence that personal characteristics of top managers like nationality and gender can give rise to firm heterogeneity in destination-specific trade barriers.

The first chapter develops a trade model with segmented markets that allows to analyze oligopolistic behavior across asymmetric countries. Firms' oligopolistic behavior has macro-level effects when countries are asymmetric. This can induce deviations from the law of one price, which gives rise to terms-of-trade based international shifts in consumption and welfare. Corporate taxation and tax-motivated transfer pricing are incorporated into this model in the second chapter. Without transfer pricing, a higher profit tax rate shifts welfare towards the taxing country. Tax-motivated transfer pricing introduces an additional incentive for all firms to export and, consequently, to expand production, such that real wages rise in both countries. As tax income shifts, consumption is relocated from the high- to the low-tax country. Import tariffs in this setting are studied in the third chapter. Their anti-competitive effect reduces labor demand as firms want to shorten supply. Unilaterally raising the import tariff increases domestic welfare at the foreign country's expense, but also favors profit incomes relative to labor incomes, as real wages fall.

The fourth chapter shows a destination-specific pro-trade effect of top managers' nationality. The effect is especially pronounced for institutionally distant destinations, which can be seen as bridging the gap between institutionally dissimilar countries. Likewise, the effect is more pronounced for destinations with less developed institutions, which indicates that manager connections help overcoming trade barriers created by low institutional quality. Finally, the fifth chapter uncovers trade-reducing effects of institutional discrimination against female managers in destination markets. This barrier exists for firm internationalization on the micro and international trade on the macro level. Importantly, it might give rise to disadvantages for female managers even in non-discriminatory countries.

Keywords: Factor income distribution; gender discrimination; general oligopolistic equilibrium; globalization; gravity; institutions; international policy transmission; international trade; labor share; oligopoly; profit shifting; strategic trade; trade barriers; trade policy; transfer pricing.

Zusammenfassung

Empirische Studien legen nahe, dass die Marktmacht vieler Firmen seit 1980 stark gestiegen ist (z.B. De Loecker et al., 2020) und dass Firmen sich in ihren ziellandspezifischen Handelsbarrieren unterscheiden (z.B. Munch und Nguyen, 2014). Basierend auf diesen Erkenntnissen entwickelt diese Dissertation ein Handelsmodell, das es erlaubt, die Effekte asymmetrischer Politikmaßnahmen im allgemeinen oligopolistischen Gleichgewicht zu analysieren. Dieser Modellrahmen wird anschließend genutzt, um die Effekte von Gewinnbesteuerung, steuermotivierter Transferpreissetzung und Handelspolitik zu untersuchen. Darüber hinaus legen die empirischen Ergebnisse dieser Dissertation nahe, dass persönliche Eigenschaften von Topmanager*innen wie Nationalität und Geschlecht zu Firmenheterogenität hinsichtlich ziellandspezifischer Handelsbarrieren führen können.

Das erste Kapitel entwickelt ein Handelsmodell mit segmentierten Märkten, welches ermöglicht oligopolistisches Verhalten zwischen asymmetrischen Ländern zu untersuchen. Dieses oligopolistische Verhalten von Firmen löst Effekte auf der Makroebene aus, wenn die Länder asymmetrisch sind. Dadurch kann das Gesetz von der Unterschiedslosigkeit der Preise verletzt werden, wodurch es zu einer terms-of-trade basierten internationalen Umverteilung von Konsum und Wohlfahrt kommt. Unternehmensbesteuerung und steuermotivierte Transferpreissetzung werden im zweiten Kapitel in dieses Modell integriert. Ohne Transferpreissetzungsspielraum führt eine höhere Gewinnsteuer zu einer Wohlfahrtsverlagerung hin zum besteuernden Land. Steuermotivierte Transferpreissetzung stellt einen zusätzlichen Exportanreiz für Firmen dar, die in der Folge ihre Produktion ausweiten möchten, was die Reallöhne in beiden Ländern steigen lässt. Durch die Steuereinnahmenverschiebung kommt es zu einer Reallokation von Konsum vom Hoch- zum Niedrigsteuerland. Importzölle in einem solchen Rahmen werden im dritten Kapitel betrachtet. Ihr wettbewerbsreduzierender Effekt hat eine sinkende Arbeitsnachfrage zur Folge, weil die Firmen ihre Angebotsmengen senken möchten. Eine einseitige Importzollerhöhung steigert die heimische Wohlfahrt auf Kosten des Auslandes, aber begünstigt auch die Gewinneinkommen im Vergleich zu den Arbeitseinkommen, da die Reallöhne fallen.

Das vierte Kapitel zeigt einen ziellandspezifischen handelsfördernden Effekt der Nationalität von Topmanager*innen. Dieser Effekt ist besonders ausgeprägt für institutionell entfernte Zielländer, was als Überwindung institutioneller Distanz zwischen unterschiedlichen Ländern interpretiert werden kann. Ebenfalls ist der Effekt stärker für Zielländer mit weniger entwickelten Institutionen, was nahelegt, dass Managerverbindungen Handelsbarrieren überwinden können, die durch eine geringe institutionelle Qualität verursacht werden. Das fünfte Kapitel weist anschließend auf einen handelsreduzierenden Effekt institutioneller Diskriminierung

gegen Managerinnen in Zielländern hin. Diese Handelsbarriere existiert auf der Mikroebene für Firmeninternationalisierung und auf der Makroebene für internationalen Handel. Dadurch kann es zu einer Benachteiligung von Managerinnen selbst in nichtdiskriminierenden Ländern kommen.

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Introduction

Recent disruptions in trade flows due to Brexit and COVID-19 have highlighted the global interconnectedness of economic activity. Due to its implications for welfare and the income distribution as well as the often active role of politics, international trade is one of the most hotly debated areas in economics. International trade is shaped strongly by the behavior of large firms with market power (e.g. Head and Spencer, 2017) and, additionally, the literature has documented the major role of firm heterogeneity (e.g. Melitz, 2003; Bernard et al., 2007). Apart from that, the pandemic has stressed that good relations with foreign firms are a valuable asset. When it comes to establishing and maintaining such firm-to-firm relationships, top managers are especially important. Hence, manager characteristics might give rise to firm heterogeneity in destination-specific trade barriers.

Likewise, the trade literature has emphasized the growing importance of large firms, which might also be related to a decline in the labor share of income (e.g. Autor et al., 2020; De Loecker et al., 2020). Driven by rising market shares of the most profitable firms within industries, aggregate markups have evolved from 21% to 61% and the average profit rate from 1% to 8% since 1980 (De Loecker et al., 2020). The largest French firm per sector on average makes up 20% of domestic sales (Gaubert and Itskhoki, 2021). In 2012, sectors in which the biggest four firms

account for more than 46% of sales produced more than half of US manufacturing output (Head and Spencer, 2017). On average, the five largest firms account for 30% of a country's exports (Freund and Pierola, 2015).

While models of perfect and monopolistic competition have dominated the theoretical literature for decades, they are increasingly challenged by empirical evidence in favor of firms' oligopolistic market power in many industries (e.g. Autor et al., 2020; De Loecker et al., 2020) that may result from high entry barriers (Head and Spencer, 2017).

> "While it is certainly possible to explain rising concentration and profit shares in a monopolistic competition model, [...] [m]any industries are dominated worldwide by a few massive firms. Furthermore, the free-entry assumption made in most monopolistic competition models is hard to reconcile with the observation of large and rising profits." - Head and Spencer (2017, p. 1423)

Additionally, oligopolists selling to multiple countries engage in price discrimination (Atkeson and Burstein, 2008). This is possible because they often hold sway over distribution channels, restrict retailers to prevent arbitrage, and only grant purchasing country specific warranties (Head and Spencer, 2017). According to Burstein et al. (2003), distribution costs account for more than 40% of consumer goods' retail prices in the United States. Based on that, Head and Spencer (2017, p. 1429) argue that the "control that large firms have over their distribution channels provides a natural support for international price discrimination and the assumption of segmented markets". Endogenous marginal costs can generate linkages between segmented markets, and a general equilibrium trade model should

comprise this interrelationship (Head and Spencer, 2017). Welfare effects from international trade along with their potential influence on inequality can be affected by the behavior of oligopolistic firms that sell in markets with differing properties. Such a behavior could alter the effects of trade or corporate tax policy as it might determine how profits are allocated across countries (Head and Spencer, 2017). The theoretical modeling of oligopolistic firms in a general equilibrium with segmented – and thus potentially asymmetric – markets requires further research.

However, firms do not only differ substantially in size and profitability, but also in destination-specific trade costs. For example, firm-destination characteristics are more influential than firm-level determinants for Swedish food exports (Gullstrand, 2011). In line with that, Munch and Nguyen (2014) show that sales variation is primarily explained by firm-destination-specific heterogeneity for the majority of exports and not by general firm-specific heterogeneity. This stresses the importance of studying firm-destination-specific trade barriers. Such firm-destination-specific factors can be related to frictions in firm-to-firm matching. Matching frictions are as important as iceberg trade costs in impeding firm-level trade (Eaton et al., 2022). Similarly, the trade literature has stressed the importance of networks for international business activity (Chaney, 2014). Migrants and expatriates are of special interest in that respect (e.g. Gould, 1994; Head and Ries, 1998; Aleksynska and Peri, 2014; Andrews et al., 2017). For example, Bastos and Silva (2012) show that emigration stocks in a given destination increase firm-level exports to that destination. Békés and Muraközy (2012) find that one third of firm-destination export spells are short-lived. This indicates that characteristics influencing destination-specific firm-level exports are rather temporary in nature.

Motivated by these insights, heterogeneity in personal characteristics of top

managers like nationality and gender could give rise to differences in destination-specific firm-level trade barriers. Manager traits have the potential to alleviate or complicate firms' international business activity and matching with foreign firms depending on the institutions in foreign countries. The interrelationship between top manager characteristics and institutions in potential export destinations might cause firm heterogeneity in destination-specific trade barriers. This area requires further research.

Chapter 1 of this thesis offers a theoretical framework based on Neary (2016) to study asymmetric countries and policies in general oligopolistic equilibrium with segmented markets, which we label Asymmetric General Oligopolistic Equilibrium (AGOLE). In this model, we show how asymmetric labor market policies can affect the distribution of real income between countries and between factors of production. Likewise, profit shifting of multinational firms has been identified as an increasing challenge for national governments (Cristea and Nguyen, 2016). Chapter 2 extends the AGOLE to analyze how corporate taxation and tax-motivated transfer pricing affect market outcomes under oligopolistic competition. Additionally, recent protectionist tendencies have spurred discussions about winners and losers of trade wars (Polaski et al., 2020). Chapter 3 shows that in AGOLE a country can benefit from unilateral tariff policy in absence of foreign retaliation, but its labor incomes will always fall in this process, while profit income usually soars.

After contributing to the theoretical literature on trade and oligopoly in the first three chapters, the following two chapters leave the domain of oligopolistic competition, and turn towards micro-level determinants of trade barriers. They make empirical contributions with respect to the role of foreign top managers in overcoming and gender discriminatory institutions in creating trade barriers.

Chapter 4 presents a new data set and provides evidence of the pro-trade effect of manager connections both on the firm and on the country level as well as how this effect is moderated by institutional factors. Individual manager characteristics turn out to be influential as well. Namely, female managers face a disadvantage when the country they are connected to has gender discriminating institutions. Leaving the domain of manager connections, Chapter 5 extends and deepens this analysis of trade effects of the interrelationship between gender discriminating institutions in destination countries and top managements' female shares. The interaction between the board of directors' female share and gender-related institutions in foreign countries affects foreign sales on the micro level and bilateral trade on the macro level.

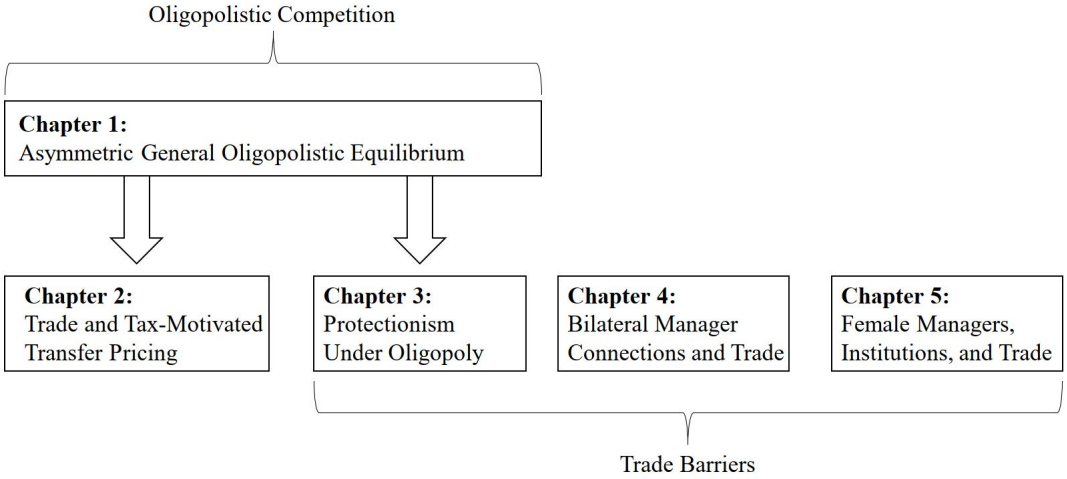

Figure 1: Overview

Figure 1 provides an overview of the five individual chapters on specific topics in the realm of international trade and how they relate to the core areas of this dissertation, namely oligopolistic competition and trade barriers. Corporate tax rate differences and transfer pricing possibilities are usually not considered as elements

of trade costs, although effectively they can influence firms' optimal supply decisions across different countries. Non-monetary factors like discrimination against female managers can hamper firms' international activities and in that sense constitute a trade barrier. The first three chapters make theoretical contributions in general oligopolistic equilibrium. Chapter 3 analyzes import tariffs in that setting and, thus, connects to the two empirical chapters that study other types of trade barriers. The following paragraphs provide a brief summary of the individual chapters of my thesis.

CHAPTER 1: ASYMMETRIC GENERAL OLIGOPOLISTIC EQUILIBRIUM. How can asymmetric and segmented markets be modeled in general oligopolistic equilibrium? Do country asymmetries affect aggregate welfare and the factor income distribution when oligopolistic firms treat markets as segmented? To explore these questions, we build a two-country general oligopolistic equilibrium model with segmented markets that allows for country asymmetries. This model opens a broad range of new applications. Firms' oligopolistic behavior in segmented markets has macro-level effects when countries' characteristics or policies are asymmetric. Due to their effect on strategic firm behavior, country asymmetries can induce deviations from the law of one price, which gives rise to terms-of-trade based international shifts in consumption and welfare. We demonstrate the procedure for solving the model and conducting comparative static analyses by studying the welfare and distributional effects of asymmetric labor market policies.

CHAPTER 2: INTERNATIONAL TRADE AND TAX-MOTIVATED TRANSFER PRICING. How does tax-motivated transfer pricing affect the strategic supply

behavior of oligopolistic firms and what are the welfare and distributional implications? We study these questions in the asymmetric general oligopolistic equilibrium framework. Asymmetric tax rates favor the high-tax country as it skims a larger proportion of global profit income. All firms react to the resulting demand increase in the high-tax country by shifting some supply from the low- to the high-tax country. Once we introduce tax-motivated transfer pricing, income and consumption shift to the low-tax country, where welfare improves on the other country's expense. Firms can further reduce their tax payments by exporting more. This incentivizes them to expand production, such that real wages rise. The labor-profit ratio increases in the low-tax country.

CHAPTER 3: HOW PROTECTIONISM HARMS WORKERS UNDER OLIGOPOLY. What are the effects of import tariffs on welfare and the factor income distribution when oligopolists strategically supply to segmented markets? What does this imply for optimal trade policy? To answer these questions, I employ the asymmetric general oligopolistic equilibrium trade model. Import tariffs have an anti-competitive effect that reduces labor demand because firms want to shorten supply. Unilaterally increasing the import tariff in that model raises domestic welfare at the foreign country's expense, but comes at the cost of favoring profit as compared to labor incomes, as real wages fall. Only if initial tariffs are low, the tariff-increasing government could use its rising tariff revenue to neutralize the distributional effect or the negative effect on labor incomes. If supporting workers is the policy objective, tariffs do not appear to be a suitable tool under oligopoly.

CHAPTER 4: BUILDING BRIDGES: BILATERAL MANAGER CONNEC-

TIONS AND INTERNATIONAL TRADE. Do top managers with personal ties to a foreign country facilitate trade with that country by overcoming bilateral trade barriers that obstruct international business relationships? We investigate that question empirically. Using individual managers' nationality, we construct a novel database of bilateral top manager connections. We analyze the trade effects of these bilateral manager connections both on the firm and on the country level. On the country level, we provide evidence for a positive effect on both bilateral exports and imports. On the firm level, we find positive effects on destination-specific foreign sales. We show that this firm-level effect is especially pronounced for institutionally distant destinations, which we interpret as bridging the gap between institutionally dissimilar countries. Furthermore, the effect is stronger for destinations with less developed institutions indicating that manager connections help overcoming trade barriers created by low institutional quality. Moreover, we show that the strength of this effect also depends on characteristics of the individual manager. Namely, the effect differs between connections of male and female managers. Gender discriminating institutions in the destination country severely downsize the pro-trade effect of female managers' connections, which could give rise to an unintended importing of gender inequality regarding management positions.

CHAPTER 5: INSTITUTIONAL DISCRIMINATION AGAINST FEMALE MANAGERS AS A BARRIER TO FIRM INTERNATIONALIZATION AND INTERNATIONAL TRADE. Do gender discriminating institutions in trading partner countries affect the foreign sales of female co-managed firms and bilateral trade of countries with a relatively high share of female top managers? In our empirical analysis, we show that firm internationalization is affected by the interaction between

the board of directors' female share and gender-related institutions in foreign countries. The combination of a high share of female directors and gender-discriminating institutions in a destination reduces sales in that foreign country relative to less discriminatory destinations. We deal with potential endogeneity due to omitted variable bias by including firm-year and origin-destination-year fixed effects, while an event study exploiting the appointments of new female board members addresses endogeneity due to reverse causality. This firm-level relationship transfers to the country level when using countries' aggregate share of female directors and bilateral exports in a structural gravity framework including origin-year, destination-year and origin-destination fixed effects. Our findings suggest that institutionalized discrimination against female managers is a barrier to firm internationalization on the micro level and international trade on the macro level. This might give rise to disadvantages for female managers even in non-discriminatory countries.

The remainder of this thesis is structured as follows. The next five chapters feature the self-contained essays outlined in Figure 1. The final chapter provides a succinct summary and a brief outlook on future research.

Chapter 1

Asymmetric General Oligopolistic Equilibrium*

1.1 Introduction

In the last four decades we have observed a large increase in the share of pure profits in gross value added, while the labor share has declined strongly. Industry data suggests that this could be driven by rising market concentration.[1] Accordingly, modeling strategic interactions among large firms is of growing importance. While general equilibrium models of monopolistic competition do not allow for such strategic behavior, partial equilibrium models of oligopoly cannot reflect the interactions between product and labor markets, that are highly relevant in many

*This chapter is joint work with Ansgar F. Quint and a previous version circulated as cege Discussion Paper No. 405 (Quint and Rudsinske, 2020a). We thank Udo Kreickemeier, Robert Schwager as well as participants at the Hagen Workshop on Global Economic Studies 2021 and various seminars for valuable comments.

[1] See for example Barkai (2020), De Loecker et al. (2020), Autor et al. (2020) and Shepotylo and Vakhitov (2020).

contexts. In a series of papers, J. Peter Neary proposed a trade model that allows to analyze oligopoly in general equilibrium (GOLE).[2] The key insight is that firms need to be modeled as "large in the small" sector they supply to, but "small in the large" economy.

We propose a solution strategy for a general oligopolistic equilibrium framework that combines fundamental asymmetries between countries[3] with segmented markets. The latter allow for additional strategic considerations by individual firms with respect to market-specific supply decisions. Thereby, we introduce reciprocal dumping as described by Brander and Krugman (1983) into general oligopolistic equilibrium with asymmetric countries. Demand and price asymmetries across markets have implications for the strength of firms' strategic dumping, which is mediated by market size differences. The model allows to explore the welfare and distributional effects of asymmetric policies and differing country characteristics under oligopoly. The resulting asymmetric general oligopolistic equilibrium (AGOLE) model opens a wide range of new applications without compromising the advantages of the original GOLE concept. Most importantly, this includes avoiding problems with the choice of a numéraire as individual firms cannot affect aggregate quantities.

The GOLE allows to analyze the effects of market power in a global setting. However, many classical questions in international economics are concerned with the effects of cross-country differences in endowments or aggregate productivity and with the implications of national policies in an international setting. So far, these

[2] See Neary (2007), Eckel and Neary (2010), Neary (2003b), Neary (2016), Neary (2003a) and Neary (2010).

[3] Countries are fundamentally asymmetric whenever differences in their characteristics lead to differences in their marginal utilities of income.

questions cannot be dealt with in a general oligopolistic equilibrium framework. The GOLE literature has mainly focused on fundamentally symmetric countries[4], because this keeps the countries' marginal utilities of income symmetric even when markets are allowed to be segmented. AGOLE allows for such asymmetries, which affect firms' country-specific supply decisions once we stop imposing the assumption of a fully integrated world market. As a result, asymmetric policies induce novel welfare and distributional effects due to firm-level strategic behavior, which to the best of our knowledge is a new mechanism. Our main contribution is to point out its existence, to explain its functioning and its economic implications, as well as to demonstrate how the model can be applied to analyze asymmetric policies.

We find that national policies and other country asymmetries have interesting international effects in AGOLE. These macro-level effects are shaped by firms' oligopolistic behavior in segmented markets. Country asymmetries affect firms mainly via their effects on marginal costs and marginal revenues. As oligopolists treat both markets as segmented, they can encounter different demand levels in the two countries, which manifests in marginal revenue differences for sales in the two markets. Likewise, marginal costs might be directly impacted by asymmetric policies. The revenue and the cost channel together determine the overall supply decisions, which in turn affect prices. Due to their effect on strategic firm behavior, country asymmetries can induce deviations from the law of one price, which gives rise to terms of trade based international shifts in consumption and welfare. This cannot arise in a standard GOLE framework with a world market approach.

[4] The marginal utility of income has to be identical in both countries, which is only the case when countries are fundamentally symmetric. The only asymmetries allowed are those which keep the countries' marginal utility of income equal, e.g. a sectoral productivity distribution with symmetric moments.

The solution procedure for AGOLE involves three main steps. We firstly determine supplied quantities, prices and wages that still depend on the marginal utilities of income. Secondly, we use the sum of the two countries' marginal utilities of income as numéraire and utilize the condition of an even balance of payments to solve the equilibrium. We show that there exists a unique solution. The last step involves conducting comparative static exercises. For illustration purposes, we choose a simple form of labor market policy to demonstrate this step. The basic version of the model presented here can be extended in various directions, as we show for asymmetric taxation and tax-motivated transfer pricing in Quint and Rudsinske (2020b), and for asymmetric import tariffs in Rudsinske (2020).

Looking at our labor market example, if one country's labor supply becomes larger, it starts to produce more at lower wages. This raises its real income per capita and, thus, demand, while reducing marginal costs. However, firms will find it optimal to supply a part of the additional production to the other country at reduced prices in order to inflate domestic prices artificially until marginal revenues equal marginal costs again in both markets. Therefore, oligopolistic competition shifts consumption to the other country that now benefits from the labor market liberalization abroad due to a change in the terms of trade. In this simple setting without aggregate gains from trade, the country with higher labor supply would be better off under autarky. It is important to consider such strategic incentives on the firm level when analyzing the welfare and distributional effects of asymmetries in countries' characteristics and policies.

The fundamental GOLE structure is described in Neary (2016). There is a growing literature using the GOLE model (Neary (2007), Bastos and Kreickemeier (2009), Kreickemeier and Meland (2013), H. Egger and Etzel (2012), Eckel and

Neary (2010), Fujiwara and Kamei (2018), Beladi and Chakrabarti (2019)).[5] Although some asymmetries have been introduced, countries remain fundamentally symmetric in these models. However, once we allow for fundamental asymmetries, it matters whether markets are assumed to be integrated or segmented. H. Egger and Etzel (2014) implement an asymmetric degree of labor union centralization in a general oligopolistic equilibrium model, which is a fundamental asymmetry between countries as it manifests in differing marginal utilities of income. However, due to their assumption of an integrated world market, firms have no country-specific supplies they could adjust to these differences in countries' marginal utilities of income.

If integrated markets are assumed, a single world market is solved to derive the equilibrium. This allows to consider only the world aggregate marginal utility of income, which improves tractability, but comes at the cost of reduced strategic leeway for firms in deciding on their supplies in the two countries. Additionally, in case of integrated markets it is not possible to determine total traded quantities, but only sectoral net trade flows. Unfortunately, many policy questions can only be addressed when the traded quantities of firms are known. In order to incorporate reciprocal dumping-type trade as in Brander and Krugman (1983) in general oligopolistic equilibrium, firms need to be able to discriminate between the countries they serve. Therefore, we make the assumption of segmented markets, which has been introduced to the GOLE framework by Bastos and Kreickemeier (2009) under fundamental symmetry. This also allows us to clearly determine exported quantities of individual firms and on the aggregate level.

Segmented markets allow to explain the empirical observation of pricing-to-

[5] For a detailed survey of the GOLE literature see Colacicco (2015).

market (see e.g. Fitzgerald and Haller (2014)), although in our Cournot-framework firms optimize their supplied quantities separately for different markets, which only then results in differing prices in the two countries. Head and Spencer (2017) provide anecdotal justification for segmented markets by noting that contracts often include conditions that restrict sales to other countries, such that arbitrage is not possible. Ben-Zvi and Helpman (1988) point out that the equilibrium in partial oligopoly with segmented markets coincides with a single integrated market in the absence of trade costs. Analogously, the symmetric country equilibrium in our model corresponds to an integrated world market, but country asymmetries give rise to differences in market outcomes even in the absence of trade costs. Markusen (2013) finds that in trade models with imperfect competition non-homothetic preferences can explain higher price levels in richer countries. This is in line with the empirical observation of a positive per-capita-income coefficient in gravity equations. Our model with quadratic preferences in oligopolistic competition exhibits this mechanism. Brander (1981) was the first to stress that strategic interactions can give rise to two-way trade in identical commodities. After removing a Ricardian technological comparative advantage in our model, trade functions similarly to the reciprocal dumping model in Brander and Krugman (1983), where the rivalry of oligopolistic firms is the single cause of international trade.

In Section 2, we introduce the basic model structure including the Cournot equilibrium. We turn to the solution strategy for the general equilibrium in Section 3. Section 4 sets out how to conduct comparative static analyses in the model with asymmetric labor market policies serving as our example. The mechanism that determines how asymmetries affect micro-level behavior and as a result macro-level outcomes is discussed in Section 5. Section 6 concludes.

1.2 Model Setup

In this section, we will describe the underlying elements of the model. We assume oligopolistic competition within each sector of the two-country economy and bring the sectors together in a general equilibrium approach. To this end, we adapt the model of international trade in general oligopolistic equilibrium developed by Neary (2016). However, we do not incorporate a world market for each sector, but distinct national markets. This follows the observation that oligopolists tend to have the market power to discriminate between markets by patenting their products' technology. Additionally, this allows to determine each firm's exports, which is a prerequisite to analyze individual firms' supply decisions. We will usually only present the expressions for the Home country. Expressions for Foreign are analogous.

1.2.1 Demand

Each country is inhabited by a representative consumer, whose preferences over the consumed goods from different sectors denoted by z are additively separable. Following Neary (2016) we use continuum-quadratic preferences:

$$U[\{y(z)\}] = \int_0^1 u[y(z)]dz \qquad \text{with} \quad \frac{\partial U}{\partial y(z)} > 0 \text{ and } \frac{\partial^2 U}{\partial y(z)^2} < 0$$
$$\text{where} \quad u[y(z)] = a\ y(z) - {}^1\!/_2\ b\ y(z)^2.$$

The consumption of a homogeneous good produced in sector $z \in [0, 1]$ is denoted by $y(z)$ and $a, b > 0$ are exogenous parameters with $a > by(z)$ to ensure non-satiation. The consumer is indifferent between domestically produced goods and imports in

each sector z.

The representative consumer inelastically supplies L units of labor to a perfectly competitive labor market. The nominal wage rate w is determined in general equilibrium and will result in a wage income of $w\ L$. Additionally, aggregate profits (Π) of all firms producing in Home are disbursed to the representative consumers. Therefore, income is given by

$$I = wL + \Pi. \tag{1.1}$$

With price $p(z)$ per unit of the good in sector z, the budget constraint is

$$\int_0^1 p(z)y(z)dz \leq I. \tag{1.2}$$

Utility function and budget constraint lead to the utility maximization problem represented by the Lagrangian:

$$\max_{y(z),\forall z} \mathcal{L} = \int_0^1 \left(ay(z) - 1/2\ by(z)^2\right) dz + \lambda \left(I - \int_0^1 p(z)y(z)dz\right).$$

The first order condition then gives

$$0 = a - by(z) - \lambda p(z) \quad \forall z$$

with λ being the Lagrange-parameter and therefore the marginal utility of income. The inverse Frisch demand in sector z follows straightforwardly and is given by

$$p(z) = \lambda^{-1} \frac{\partial u[y(z)]}{\partial y(z)} = 1/\lambda [a - by(z)]. \tag{1.3}$$

Frisch demands specify a relation between the price, the quantity demanded and

the marginal utility of income. The inverse demand functions (1.3) depend on the marginal utility of income negatively. The marginal utility of income λ acts as a demand aggregator where a higher value indicates a lower demand for goods in every sector. The inverse formulation (λ^{-1}) can be interpreted as the marginal costs or the price of utility (Browning et al., 1985). The value of λ will be determined in general equilibrium.

1.2.2 Supply

The producers aim to maximize their profits. They perceive the demand they face in the two separate markets as well as the wage rates as given. Analogously to Neary (2016), firms are assumed to have market power in their respective markets. However, they do not have direct influence on aggregate economic factors, as many sectors z exist and only jointly determine these aggregates. This especially includes the demand aggregator λ, but also the wage rate w, which all firms take as given.

As firms do not affect economy-wide variables, it is natural to assume that they maximize profits in their specific sector. Alternative objectives such as the overall welfare of their owner – the representative consumer – are not appropriate as firms are not able to influence economy-wide parameters and each sector's individual influence on the overall welfare is negligible. Gabszewicz and Vial (1972) argue that firms are myopic in such a context. Firms can collectively influence relative prices, but cannot affect them individually because they are small in the large.

We assume that n firms exist in Home in each sector z and that there are neither fixed costs of production nor trade costs.[6] The firms play a static one-stage game where they compete à la Cournot over supply in the Home and the Foreign

[6] See Rudsinske (2020) for the introduction of tariffs in an AGOLE setting.

market. Irrespective of the functional form of λ they perceive the inverse demand as linear.

Production occurs with constant returns to scale and common technology in each sector, such that costs in sector z are linear in output. Labor is the only factor of production and moves freely across sectors within a country, but not across national borders. In the general equilibrium, the wage rate will be determined at the country level by combining the inelastically supplied labor and the demand for labor that results from domestic companies' production.

The unit-cost function for sector z is then given by $c(z) = w\gamma(z)$, where $\gamma(z) > 0$ is the sector-specific unit-labor requirement. As Neary (2016) we assume that these labor inputs per unit of output are continuous in z in both countries. As in the original GOLE model, the moments of the technology distributions over the sectors in the two countries are the same with[7]

$$\alpha = \int_0^1 \gamma(z)dz = \int_0^1 \gamma^*(z)dz \quad \text{and} \quad \beta = \int_0^1 \gamma(z)^2dz = \int_0^1 \gamma^*(z)^2dz.$$

Additionally, we define

$$\Delta \equiv \int_0^1 \gamma(z) \cdot \gamma^*(z)dz.$$

Companies supply their output to both countries, where the underlying demand may differ. In general equilibrium demand differences can result from differing labor endowments or the countries' industrial structures.[8] The profit of a firm in

[7] The technology distribution in Foreign is marked with an asterisk: $\gamma^*(z)$.

[8] Additionally, other policies, implemented by governments, may also alter the countries' demands.

sector z is given by

$$\pi(z) \;=\; (p(z) - \gamma(z) \cdot w)\; y_h(z) + (p^*(z) - \gamma(z) \cdot w)\; y_f(z), \tag{1.4}$$

where $p^{(*)}(z)$ are the inverse Frisch demands defined in equation (1.3) for the Home and the Foreign market respectively. The quantity a Home firm supplies in Home is $y_h(z)$, while $y_f(z)$ gives the supply to Foreign by one Home firm.[9]

1.2.3 Cournot Equilibrium

In this subsection we determine the supplies of the firms in one of the sectors. We will therefore drop the index z in this subsection. The firms maximize their profits by choosing the amount of goods to produce and sell given the demand and the other companies' supply.

$$\begin{aligned} \max_{y_h, y_f} \pi \;&=\; [p - \gamma \cdot w]\, y_h + [p^* - \gamma \cdot w]\, y_f \\ &\qquad \text{with } p = {}^1\!/\!_\lambda [a - by] \text{ and } p^* = {}^1\!/\!_{\lambda^*} [a - by^*], \end{aligned}$$

where $y = ny_h + n^* y_h^*$ and $y^* = ny_f + n^* y_f^*$ describe the total supply of the good in Home and in Foreign respectively.

The first order conditions for Home firms' profit maximization are

$$\frac{\partial \pi}{\partial y_h} \;=\; \frac{1}{\lambda}\,(a - 2\; b\; y_h - b((n-1)\tilde{y}_h + n^* y_h^*)) - \gamma w = 0 \tag{1.5}$$

$$\frac{\partial \pi}{\partial y_f} \;=\; \frac{1}{\lambda^*}\left(a - 2\; b\; y_f - b((n-1)\tilde{y}_f + n^* y_f^*)\right) - \gamma w = 0 \tag{1.6}$$

[9] Supplies by Foreign firms are marked with an asterisk: $y_i^*(z)$ with $i \in \{h, f\}$.

where $\tilde{y}_i$ is the quantity that each of the other Home companies supplies in the respective market. As companies producing in the same country are symmetric, they will supply the same quantity, $\tilde{y}_i = y_i$, in market $i = h, f$. The first order conditions result in the well-known relation that marginal costs have to equal marginal revenues in an oligopolistic equilibrium. The first order conditions can be transformed into reaction functions depending on the supply of Foreign companies.

$$y_h = \frac{a - \lambda\ \gamma\ w - b\ n^*\ y_h^*}{b(n+1)} \tag{1.7}$$

$$y_f = \frac{a - \lambda^*\ \gamma\ w - b\ n^*\ y_f^*}{b(n+1)} \tag{1.8}$$

For firms from Foreign, these reaction functions are defined analogously. We obtain the Cournot-equilibrium supply by each firm in the two countries by combining the reaction functions. The equilibrium supply of each individual company to the Home market is

$$y_h = \frac{\lambda}{b(n+n^*+1)} \left\{ \frac{a}{\lambda} - \gamma\ w + n^*(\gamma^*\ w^* - \gamma\ w) \right\} \tag{1.9}$$

$$y_h^* = \frac{\lambda}{b(n+n^*+1)} \left\{ \frac{a}{\lambda} - \gamma^*\ w^* + n(\gamma\ w - \gamma^*\ w^*) \right\}. \tag{1.10}$$

The supplied quantities in Foreign are analogous:

$$y_f = \frac{\lambda^*}{b(n+n^*+1)} \left\{ \frac{a}{\lambda^*} - \gamma\ w + n^*(\gamma^*\ w^* - \gamma\ w) \right\} \tag{1.11}$$

$$y_f^* = \frac{\lambda^*}{b(n+n^*+1)} \left\{ \frac{a}{\lambda^*} - \gamma^*\ w^* + n(\gamma\ w - \gamma^*\ w^*) \right\}. \tag{1.12}$$

The number of firms in either country has the usual competitive effects on the supplied quantities. A new entrant will lead to reduced marginal revenues resulting

in reduced supply by incumbent firms. Changes in unit costs through wage rates or the labor requirement have two effects in the Cournot equilibrium. Higher unit costs will reduce the supply by companies, which bear the rising production costs. In reaction, firms from the other country will expand their supply as they benefit from a cost-based advantage.

1.3 Asymmetric General Oligopolistic Equilibrium

In general equilibrium we need to determine the wage rates and the demand aggregators in both countries. We will first solve the labor market equilibrium before turning to our solution strategy for the marginal utilities of income in Home and Foreign.

1.3.1 Labor Market

With the Cournot-Nash-equilibrium supply derived above we now turn to the clearing of the labor market. As described, the representative consumer inelastically supplies $L^{(*)}$ units of labor. The labor demand depends on the equilibrium production in a country. Each Home company in sector z will supply

$$\bar{y}(z) \quad = \quad y_h(z) + y_f(z) = \frac{2a - \bar{\lambda}\ \gamma(z)\ w + \bar{\lambda} n^*(\gamma^*(z)\ w^* - \gamma(z)\ w)}{b(n + n^* + 1)},$$

where $\bar{\lambda} \equiv \lambda + \lambda^*$. The total labor demand is given by $L^D = \int_0^1 n\ \gamma(z)\ \bar{y}(z)\ dz$. In equilibrium, demand has to equal supply.

$$L = \int_0^1 n\ \gamma(z)\ \bar{y}(z)\ dz = \frac{n}{b(n+n^*+1)} \left\{ 2a\alpha - \bar{\lambda}(n^*+1)\beta w + \bar{\lambda} n^* \Delta w^* \right\} \quad (1.13)$$

This relation defines the nominal wage rate in Home. In combination with the analogously defined equilibrium on the Foreign labor market, wages in both countries are given by

$$w = \frac{1}{\bar{\lambda}}\ \Gamma\ \left\{ 2a\alpha \frac{n + {}^{\Delta}\!/_{\beta}\ n^* + 1}{n+n^*+1} - b\left[\frac{n+1}{n} L + \frac{\Delta}{\beta} L^* \right] \right\} \quad (1.14)$$

$$w^* = \frac{1}{\bar{\lambda}}\ \Gamma\ \left\{ 2a\alpha \frac{{}^{\Delta}\!/_{\beta}\ n + n^* + 1}{n+n^*+1} - b\left[\frac{n^*+1}{n^*} L^* + \frac{\Delta}{\beta} L \right] \right\}, \quad (1.15)$$

with

$$\Gamma = \left[\beta + \frac{nn^*}{n+n^*+1} \left(\beta - \frac{\Delta^2}{\beta} \right) \right]^{-1}.$$

Here, we can already see that for constant $\bar{\lambda}$ an increase in labor supply reduces the wage rate in both countries. Additionally, we assume that the wage rates are positive in both countries.

1.3.2 Balance of Payments Equilibrium

The model is characterized by nine equations in the general equilibrium. The Cournot equilibrium quantities determine the supply of each multinational company to each country given the wages and the marginal utilities of income. The labor market clearing in each country determines the wage rates given the produced quantities in the respective country. Lastly, the prices are given by the representative

consumers' inverse Frisch demand functions.

The last equation results from the budget constraint of the representative consumer in either country. We use the budget constraint to attain an implicit definition of the marginal utilities of income in equilibrium.[10] The budget constraint in Home is given by

$$\int_0^1 p(z) \cdot (n\ y_h(z) + n^*\ y_h^*(z))\ dz \quad = \quad w\ L + \int_0^1 n\ \pi(z)\ dz.$$

This can be rearranged using the definition of $\pi(z)$ in equation (1.4) to obtain a straightforward relationship that has to hold in equilibrium:

$$n \int_0^1 p^*(z)\ y_f(z)\ dz = n^* \int_0^1 p(z)\ y_h^*(z)\ dz \tag{1.16}$$

To close the model, we need a balance of payments equilibrium. In our simple setting, the capital balance is zero. Thus, the respective values of trade over all sectors have to be equal in general equilibrium. We have the value of exports from Home to Foreign on the left that has to be equal to the value of imports from Foreign to Home at the right. The equality of these values does not imply that the traded quantities of goods are equal. If prices or the number of firms differ, one country might import more units of a good than it exports.

To attain the general equilibrium values of the endogenous variables and to solve the system of equations, we need to determine the marginal utilities of income. The foundation of our model is given by Neary (2016), but in his case this step is less difficult. Most importantly, in his case the two countries are symmetric such

[10] Neary (2016) uses the same relationship to determine the marginal utility of income, see his footnote 13.

that $\bar{\lambda} = 2\lambda$, which significantly reduces the complexity of the equilibrium. In our case, we cannot reduce the result that way, as countries are not necessarily symmetric.

The marginal utilities of income affect firms' relative supply decisions across markets, which can have real distributional effects between countries. Thus, the difference between λ and λ^* is of high relevance in our model. As we have nine equations for the ten endogenous variables, we can normalize the aggregate marginal utility of income to one, i.e. $\bar{\lambda} = 1$. Hence, the aggregate marginal utility of income is used as numéraire. This translates into the relationship between λ and λ^* that $\lambda^* = 1 - \lambda$, which allows us to substitute all λ^*. Because both marginal utilities of income have to be positive, it follows that both will lie between zero and one, which is useful for determining the signs of derivatives later on.

As Neary (2016) notes, the model is not sensitive to the choice of numéraire. Most importantly, firms do only have an influence in their own sector, but not on the factor market or national income. If this would be different, companies would exert their monopsonistic power in the labor market and would account for their influence on income. In that case profit maximization could be an inadequate objective for the companies, while there could also result a dependency on normalization rules (Neary, 2003b). In GOLE models, this issue is solved by modeling a continuum of sectors, such that firms do not exert this influence. This inability of individual firms to influence aggregates is comparable to models with monopolistic or perfect competition (Neary, 2003c).

Remember that wages are positive and only depend on the normalized $\bar{\lambda}$ and exogenous variables. We express the remaining endogenous variables, such that they only depend on the marginal utility of income in Home. These formulations

can then be used in the balance of payments condition, where we can show that for the admissible range $\lambda \in (0,1)$ there is only one solution to this equation.

Proposition 1.1 (Existence and Uniqueness)**.** *There exists a unique solution to the condition of an even balance of payments in* $\lambda \in (0,1)$*.*

Proof. First, we reformulate the condition that the balance of payments is zero. In this paper's setting the balance of payment is equal to the balance of trade (BoT).

$$\begin{aligned} BoP \equiv BoT = 0 &= n \int_0^1 p^*(z)\ y_f(z)\ dz - n^* \int_0^1 p(z)\ y_h^*(z)\ dz \\ 0 &= x_1 + x_2\lambda + a^2 \left(\frac{n}{1-\lambda} - \frac{n^*}{\lambda} \right), \end{aligned}$$

where

$$\begin{aligned} x_1 &= a\alpha \left(wn(n - 3n^* - 1) + w^* n^* (3n - n^* + 1) \right) \\ &\quad + nn^{*2}\beta w^{*2} - n^2(n^* + 1)\beta w^2 + nn^*(n - n^* - 1)\Delta w w^*, \\ x_2 &= n^2\beta w^2 + n^{*2}\beta w^{*2} + 2nn^*\Delta w w^* > 0, \end{aligned}$$

and wages are defined by equations (1.14) and (1.15) with $\bar{\lambda} = 1$.

In the limiting cases of the admissible λ, the BoT is

$$\begin{aligned} \lim_{\lambda \to 0^+} BoT &= -\infty \\ \lim_{\lambda \to 1^-} BoT &= \infty. \end{aligned}$$

Additionally, the BoT is differentiable with respect to λ, which implies continuity of the BoT. Therefore, there has to be at least one solution of the above equation for $\lambda \in (0,1)$.

At the same time the balance of trade has a strictly positive derivative with respect to λ in $\lambda \in (0, 1)$.

$$\frac{\partial BoT}{\partial \lambda} = x_2 + a^2 \left(\frac{n}{(1-\lambda)^2} + \frac{n^*}{\lambda^2} \right) > 0.$$

Therefore, there exists a unique solution. □

The equilibrium marginal utility of income $\hat{\lambda}$ is defined as a root of a cubic polynomial with a positive discriminant. Therefore, in this setting it is possible to obtain the expression of $\hat{\lambda}$ in closed form and all solutions to the polynomial are real-valued. Only one of the roots is within the interval $(0, 1)$.[11]

However, in many cases it is not necessary to determine the exact value of $\hat{\lambda}$. Firstly, the derivative of the marginal utility of income in general equilibrium with respect to a parameter of interest can be derived from the balance of payments condition using implicit differentiation. Secondly, we know that $\hat{\lambda} \in (0, 1)$. Newton's method allows to determine stricter borders for $\hat{\lambda}$. This often suffices to determine signs of endogenous variables' derivatives with respect to a parameter of interest, given the sign of the derivative of $\hat{\lambda}$ with respect to that parameter. Hence, qualitative results can often be shown even in extensions of the model that are too complex to derive $\hat{\lambda}$ in closed form.

1.3.3 Graphical Representation

A defining feature of the model are the supply decisions by the oligopolists. To give the reader some intuition about the mechanisms that determine the supply in

[11] However, two of the three roots are complex. For the proof of Proposition 1.2 below a derivation is needed and provided in the supplement with mathematical software.

general equilibrium, we develop a graphical representation of their supply decisions. For these representations we set $\gamma(z) = \gamma^*(z) = 1$ in all sectors, thus precluding Ricardian gains from trade. Trade now only occurs due to strategic interactions. This allows us to drop the z, as well as the labor input requirement.

We can reduce the system down into two fundamental conditions. This way we can focus on the firms' strategic considerations. The consumption indifference condition (CI) states that for utility maximization the origin of the product is inconsequential. The representative consumer is indifferent between products in the same sector that are produced in Home and in Foreign. The market indifference condition (MI) states that in equilibrium all firms have to be indifferent between selling the marginal unit in Home or in Foreign. The MI line represents all Cournot-equilibria for all possible demands firms face. We can plot these two conditions in a box diagram in Figure 1.1.

In the box diagram, the supply decision of one firm from Home and of one firm from Foreign are depicted. As all firms producing in the same country are symmetric, this still provides useful insights not only into each firm's decision, but also the overall supply.

The CI line is easily derived from the budget constraint.

$$CI: \qquad y_h = \frac{I/p}{n} - \frac{n^*}{n} y_h^*$$

It gives us a function with perfect substitutability between the goods of a Home and a Foreign firm from the consumer's perspective, for whom real income I/p is exogenous. The slope of the CI line is $-n^*/n$. If all Foreign firms increase their supply, Home firms need to reduce theirs such that the overall consumption is

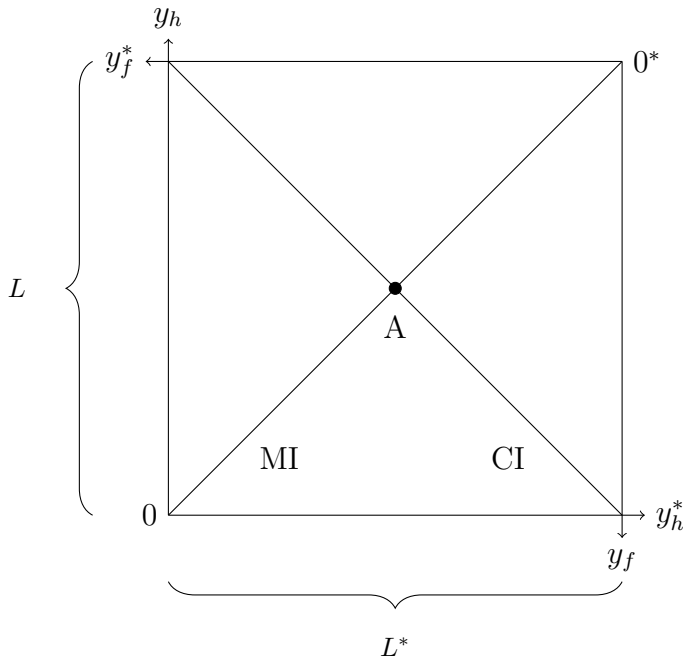

Figure 1.1: General Equilibrium with Symmetric Countries ($L = L^*$ and $n = n^* = 1$)

unchanged. An increase in real income in Home shifts the CI line towards the upper-right corner. In symmetric equilibrium ($L = L^*$), the intercept is exactly in the upper left corner of the graph. In this case both countries consume the same quantities. The same can analogously be done for the Foreign representative consumer giving us exactly the same line in the graph.

The MI line follows straightforwardly from the profit maximization in equations (1.5) and (1.6) as marginal revenues need to be equal across countries in equilibrium. The same relation needs to hold for Foreign firms.

$$\begin{aligned} \frac{1}{\lambda}\left(a - b((n+1)y_h + n^* y_h^*)\right) &= w = \frac{1}{\lambda^*}\left(a - b((n+1)y_f + n^* y_f^*)\right) \\ \frac{1}{\lambda}\left(a - b(y_h + (n^*+1)y_h^*)\right) &= w^* = \frac{1}{\lambda^*}\left(a - b(y_f + (n^*+1)y_f^*)\right) \end{aligned}$$

As both relations need to hold in the Cournot-equilibrium, they can be combined to attain

$$\begin{aligned} p - p^* &= \frac{1}{\lambda}\left(a - b(ny_h + n^* y_h^*)\right) - \frac{1}{\lambda^*}\left(a - b(ny_f + n^* y_f^*)\right) \\ &= b\left(\frac{y_h}{\lambda} - \frac{y_f}{\lambda^*}\right) = b\left(\frac{y_h^*}{\lambda} - \frac{y_f^*}{\lambda^*}\right). \end{aligned}$$

This gives us a direct link between the cross-country price difference and the firms' supply to the two markets – weighted with the respective marginal utilities of income. As $y_h^{(*)} + y_f^{(*)} = {}^{L^{(*)}}/_{n^{(*)}}$, we obtain a relation between the supply to Home by one Home firm and one Foreign firm, which has to hold in the Cournot-equilibrium.

$$MI: \qquad y_h = \lambda\left(\frac{L}{n} - \frac{L^*}{n^*}\right) + y_h^*. \tag{1.17}$$

This results in a line with the slope +1. The intercept consists of two parts. Firstly, within the brackets we have the Home production per firm minus the Foreign production per firm. If this is positive, Home firms have a larger quantity to supply than Foreign firms. Secondly, the marginal utility of income λ gives the share of this excess production that is allocated to the Home market, whereas $1 - \lambda = \lambda^*$ is the share allocated to Foreign. Figure 1.1 shows how the equilibrium supplies are determined at the intersection of MI line and CI line.

1.4 Comparative Static Application

The AGOLE model allows to analyze a wide variety of economic aspects, for example asymmetries in market concentration[12], trade policies or taxation.[13] Such analyses can be structured into three main steps. Firstly, the other endogenous variables need to be determined depending on λ and λ^*. Secondly, existence and uniqueness – or the conditions thereof – need to be established. Both of these steps have been described above.

In this section we illustrate a procedure for the third step of conducting comparative static analyses in AGOLE models. The aim is to obtain meaningful results for endogenous variables such as exports or consumption, but also interesting insights into distributional effects. In most cases, the exact value of the marginal utility of income in equilibrium is not necessary to derive qualitative effects resulting from changes in exogenous variables. In these cases, we first narrow the possible range of $\hat{\lambda}$, before determining its derivative with respect to the exogenous variable of interest as well as the derivative's sign. These elements often suffice to determine the sign of other derivatives of interest. Sometimes the equilibrium value of $\hat{\lambda}$, although not particularly illuminating by itself, is needed to determine certain comparative static results. It can be obtained with mathematical software as we show in the supplement.

To present this procedure, we analyze a straightforward change in the labor market regime in one of the countries in the AGOLE model. Changes in labor

[12] For $L = L^*$, it is easy to show the effects of changes in n. The domestic labor share falls with rising concentration in a country, while the other country is unaffected. With $L \neq L^*$ this becomes computationally more demanding.

[13] See Rudsinske (2020) for an analysis of asymmetric tariffs and Quint and Rudsinske (2020b) for an analysis of asymmetric taxation and tax-motivated transfer pricing.

endowment L in our setting may be interpreted as labor market policies that alter the average working hours in a country, such as changes in vacation entitlements or reductions in the workdays per week. Such changes in L do not increase the population as given by the number of consumers, which are characterized by the representative consumer. This follows from the structure of the utility function of a country's representative consumer, which does not change with L. An increase in the population would increase the labor endowment and the number of consumers equally, such that it should not affect consumption per capita and the marginal utility of consumption. In our application, only working hours per capita are rising, while the number of consumers is unaffected, so consumption per capita rises and the marginal utility of consumption falls. Such differences in labor endowment are not comparable to the technology differences in Neary (2016), where labor measured in efficiency units can only be different within the sectors, but not on the aggregate level due to the symmetry assumptions on the technology distributions in the two countries. We will focus on changes in L in the Home country.

In order to focus solely on the effect of strategic interactions, we disregard technological differences across countries in this section. By setting $\gamma(z) = \gamma^*(z) = 1\ \forall z$ we only consider the case of identical technology across sectors and countries so we can drop z throughout. However, we retain the assumption of a continuum of sectors even though they will be symmetrical. Thus, the model does not capture a Ricardian-style technological comparative advantage anymore. The reasons for trade in this setting are the strategic considerations among firms in Cournot competition as in Brander and Krugman (1983). As companies remain small in the large, they still do not take their effect on wages into account when maximizing their profits. For simplicity, we set $n = n^* = 1$. Additionally, we assume $b(L + L^*) < a$

to ensure a positive marginal utility of consumption in any case. This also assures positive wage rates in both countries.[14]

Firms in a substantially smaller country possibly supply to the larger country only, but nothing to the country in which they produce, as demand and hence the marginal revenues are smaller there. To ensure an interior solution we assume that the countries' labor endowments are sufficiently similar to obtain positive supplies to all countries by all firms. The larger country may only have just under a 2.5 times larger endowment, i.e. $2/5 < L/L^* < 5/2$.[15] These restrictions reduce the possible values, $\hat{\lambda}$ may take. In full symmetry with $L = L^*$, the marginal utility of income will be one half in equilibrium in both countries. Using Newton's method we can show that $1/4 < \hat{\lambda} < 3/4$.[16]

To analyze the changes in general equilibrium, we need the reaction of $\hat{\lambda}$ to changes in the exogenous parameter of interest (L). Firstly, we can determine the expression for this derivative depending on $\hat{\lambda}$. Secondly, we show the sign of this derivative, which remains the same for all possible values of the marginal utility of income in general equilibrium.

Lemma 1.1 (Effect of L on $\hat{\lambda}$)**.** *An increase in L will reduce the marginal utility of income in Home in general equilibrium ($\hat{\lambda}$).*

Proof. In the equilibrium condition in equation (1.16), $\hat{\lambda}$ is implicitly defined. The

[14] See Appendix A.1 for supplied quantities, prices and wages depending on exogenous parameters and λ.

[15] This is not an overly restrictive assumption. According to OECD (2021), the ratios of average weekly working hours per full-time employee clearly lie within our allowed space.

[16] See Appendix A.2 for the derivations.

derivative of $\hat{\lambda}$ with respect to L is then given by

$$\frac{\partial \hat{\lambda}}{\partial L} = -\frac{\partial BoT/\partial L}{\partial BoT/\partial \lambda}.$$

The derivative of the balance of trade with regard to λ is positive as shown in the proof of uniqueness. Additionally, the derivative of the balance of trade with respect to L is given under our assumptions by

$$\frac{\partial BoT}{\partial L} = (2\lambda - 1) \underbrace{\left[b(L + L^*) - \frac{4}{3}a \right]}_{<0} + \underbrace{a - bL}_{>0}, \tag{1.18}$$

where the signs follow from the assumption that $b(L + L^*) < a$. As we show in Appendix A.2, $\hat{\lambda} = 1/2$ for $L = L^*$. Therefore,

$$\left.\frac{\partial BoT}{\partial L}\right|_{L=L^*} = a - bL > 0.$$

This implies a decreasing $\hat{\lambda}$ for a marginally increasing L at $L = L^*$. If now L is increased further, we have $\hat{\lambda} < 1/2$. In this case

$$\left.\frac{\partial BoT}{\partial L}\right|_{L>L^*} = \underbrace{(2\lambda - 1)}_{<0} \underbrace{\left[b(L + L^*) - \frac{4}{3}a \right]}_{<0} + \underbrace{a - bL}_{>0} > 0,$$

which assures a declining $\hat{\lambda}$ when L rises in equilibrium for $L > L^*$. It follows that $\hat{\lambda} < 1/2$, if $L > L^*$.

We know that $\hat{\lambda} \in (1/4, 3/4)$. In equation (1.18) the term in parentheses becomes largest if λ takes the largest possible value and therefore, the equation as a whole may become negative. However, for the largest value $\lambda = 3/4$ the derivative is still

positive for

$$\begin{aligned} 0 &< \frac{\partial BoT}{\partial L} = \frac{1}{2}\left[b(L+L^*) - \frac{4}{3}a\right] + a - bL \\ b(L-L^*) &< \frac{2}{3}a. \end{aligned}$$

This condition is fulfilled for all $L^* > L$, as a is positive. Therefore, the derivative of the BoT with respect to L will be positive for all $L^* > L$.

It follows that the derivative $\partial\hat{\lambda}/\partial L$ is negative, as the derivative $\partial BoT/\partial L > 0$. □

From this proof follows:

$$\hat{\lambda} \begin{cases} \in \left(\frac{1}{4}, \frac{1}{2}\right) & \text{for } L > L^* \\ = \frac{1}{2} & \text{for } L = L^* \\ \in \left(\frac{1}{2}, \frac{3}{4}\right) & \text{for } L < L^* \end{cases}$$

When average working hours L increase, Home production rises. Home firms maximize their profits and thus set marginal revenues equal to marginal costs, which are identical for supplies to both markets. As a consequence, it is not optimal for Home firms to supply all newly produced goods to Home. They can increase their average mark-ups by supplying more to both markets. Thus, they will not only increase their domestic supply, but also increase their exports. Consequently, as long as prices do not react, Home will run a trade balance surplus. This is impossible in equilibrium. Therefore, the balance of trade needs to adjust. On the one hand, the price ratio p/p^*, which is also the Foreign terms of trade, increases. On the other hand, supply decisions adjust, but this does not reverse the initial impetus. Because both the traded quantity $y_f + y_h^*$ and the Foreign terms of trade

increase, it follows that Foreign consumption rises as well. Therefore, Home's production increase after liberalization is not fully consumed there. This implies that Home loses from international trade if $L > L^*$ and would prefer autarky in this case, where consumption is equal to production.

Proposition 1.2 (Consumption and Trade)**.** *Liberalizing the labor market, i.e. increasing the average working hours, in one of the countries increases consumption in both countries and raises the total traded quantity. International trade under oligopoly causes the more liberal country to be worse off compared to autarky.*

Proof. Changes in consumption in Home and Foreign are given by

$$\begin{aligned}\frac{\partial}{\partial L}(y_h + y_h^*) &= \hat{\lambda} + \frac{\partial \hat{\lambda}}{\partial L}\left(L + L^* - \frac{4}{3}\frac{a}{b}\right), \\ \frac{\partial}{\partial L}(y_f + y_f^*) &= (1 - \hat{\lambda}) + \frac{\partial \hat{\lambda}}{\partial L}\left(\frac{4}{3}\frac{a}{b} - (L + L^*)\right).\end{aligned}$$

The increase of consumption in Home is straightforward as $\frac{\partial \hat{\lambda}}{\partial L} < 0$ and $L + L^* < {}^{4a}/_{3b}$ under our assumption of $b(L + L^*) < a$. For consumption in Foreign, we show with mathematical software in the supplement that the derivative is positive in equilibrium.

The sum of exports will be affected by an increase in L according to

$$\frac{\partial}{\partial L}(y_f + y_h^*) = 1 - \hat{\lambda} + \frac{\partial \hat{\lambda}}{\partial L}(L^* - L).$$

For $L \geq L^*$ it follows immediately that the derivative is positive, but also for $L < L^*$ we show with mathematical software in the supplement that the derivative remains positive.

Without loss of generality we now assume that Home is the more liberal country

with $L > L^*$. Consumption in Home is smaller than its production if

$$\begin{aligned} y_h + y_h^* &< L \\ \hat{\lambda}\left(L + L^* - \frac{4a}{3b}\right) &< L - \frac{2a}{3b} \end{aligned}$$

We show with mathematical software in the supplement that this is given in equilibrium, such that Home's consumption is lower under free trade than under autarky, where $y_h = L$. □

We obtain these results by taking the derivative of the endogenous variables with respect to the parameter of interest while taking the change of $\hat{\lambda}$ into account. Although the signs of these derivatives are straightforward in some cases or at least under certain conditions, we need the value of $\hat{\lambda}$ for the remaining cases. As we show in Appendix A.2, a cubic polynomial implicitly defines the marginal utility of income in equilibrium. The three roots are distinct and real and mathematical software can be used to determine the root that lies within the allowed range. In the supplement we provide the Mathematica code for determining the relevant root as well as the ensuing analysis of the effect on endogenous variables.

Figure 1.2 graphically illustrates the effects. Both the CI and the MI lines shift upwards. The rise of consumption in Foreign can be described as a spillover effect. In consequence, the CI line shifts less than the initial rise in the labor endowment. This captures that less than 100 percent of the additional production is consumed in Home. Under autarky, the additional production would be fully consumed in Home, such that we would arrive at point C on $\mathrm{CI_A}$. Also the MI line shifts less than the rise in labor supply, because all firms have an incentive to increase exports. However, which curve shifts more is ambiguous. We depict the case where the CI

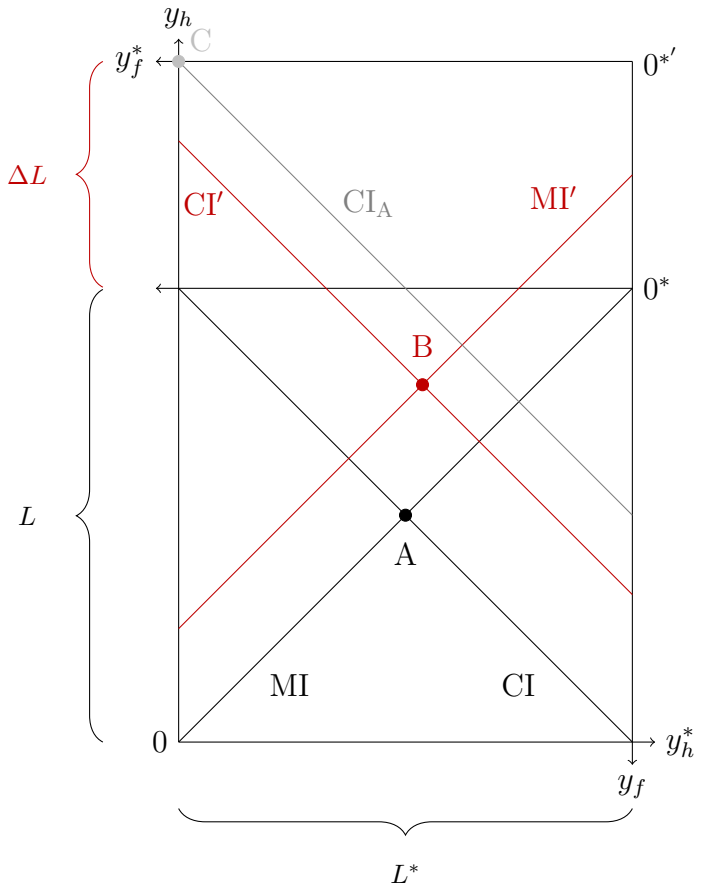

Figure 1.2: Home Labor Market Liberalization ($n = n^* = 1$)

shifts more, which is always true if $L^* \leq 2L$ and depends on the parameters a and b otherwise.

Additionally, the general equilibrium makes distributional effects of labor market policies visible. In Home, real wages will decreases, whereas in Foreign the real wage change is ambiguous with declining nominal wages and decreasing prices. If Home labor market policies were more liberal already ($L > L^*$), further liberalization will reduce the labor share in Foreign.

Proposition 1.3 (Income and Distribution)**.** *Liberalizing the labor market, i.e.*

increasing the average working hours, in one country causes its real wages to fall. Whenever that country's labor market has been more liberal already, i.e. the average working hours have been larger, real profits rise and the labor share declines in the other country.

Proof. The changes in nominal wages and prices in Home, where L is increased, are given by

$$\begin{aligned} \frac{\partial w}{\partial L} &= -2b \\ \frac{\partial p}{\partial L} &= -\frac{1}{3}\frac{a}{\hat{\lambda}^2}\frac{\partial \hat{\lambda}}{\partial L} - b \end{aligned}$$

The change in real wages is accordingly

$$\frac{\partial}{\partial L}\left(\frac{w}{p}\right) = \frac{1}{p^2}\left(\frac{\partial w}{\partial L}p - w\frac{\partial p}{\partial L}\right),$$

where the expression in parentheses determines the sign of the derivative. This expression is negative in general equilibrium as

$$\begin{aligned} \frac{\partial w}{\partial L}p - w\frac{\partial p}{\partial L} &= -2b\ p - w\left(-\frac{1}{3}\frac{a}{\hat{\lambda}^2}\frac{\partial \hat{\lambda}}{\partial L} - b\right) \\ &= \underbrace{\frac{1}{3}\frac{a}{\hat{\lambda}^2}\frac{\partial \hat{\lambda}}{\partial L}w}_{<0} - b\left(\underbrace{\frac{2}{3}a\frac{1-\hat{\lambda}}{\hat{\lambda}}}_{>0} + \underbrace{\frac{4}{3}a - bL^*}_{>0}\right) < 0, \end{aligned}$$

where the sign of the last two summands follows from $b(L + L^*) < a$.

If Foreign's labor endowment is smaller and L increases, wage payments in

Foreign (w^*L^*) will decrease, as

$$\frac{\partial w^* L^*}{\partial L} = -bL^*.$$

The profits in Foreign will change according to

$$\frac{\partial \pi^*}{\partial L} = \frac{1}{9}\frac{a^2}{b}\frac{2\hat{\lambda}-1}{\hat{\lambda}^2(1-\hat{\lambda})^2}\frac{\partial \hat{\lambda}}{\partial L}.$$

As for $L > L^*$ we know that $\hat{\lambda} < 1/2$, this derivative is positive. Therefore the labor share will decrease. The price in foreign changes according to

$$\frac{\partial p^*}{\partial L} = \frac{1}{3}\frac{a}{(1-\hat{\lambda})^2}\frac{\partial \hat{\lambda}}{\partial L} - b < 0$$

if L increases. As this is negative, real profits will increase whenever nominal profits increase. □

With the growing labor supply on a perfect labor market and oligopolistic product markets, nominal wages will fall in Home. At the same time, Home firms expand their production and supplies in both countries. These competitive pressure let Foreign firms reduce their supply, thereby reducing their labor demand. As the labor supply is fixed at L^* the decline in labor demand leads to a reduction in the nominal wage rate in Foreign. With declining prices, however, the real wage effect in Foreign is ambiguous.[17] By contrast, the real wage rate unambiguously decreases in Home. Nominal wages decline due to the higher labor supply, while prices increase with the higher demand.

[17] At least for $L = L^*$ Foreign real wages increase.

In equilibrium, Home firms' unit costs, i.e. the nominal wages, decline more strongly than those of Foreign firms. Home firms can improve their nominal profits, while the real profit reaction is ambiguous.[18] Foreign firms' nominal profits will increase, if Home already had a more liberal labor market. Most importantly, their unit costs go down, which even outweighs potential revenue losses. Overall, the decline in nominal wages shifts Foreign income from workers to firms leading to the decrease in the labor share.

1.5 From Micro Behavior to Macro Effects

Proposition 1.2 implies that country asymmetries induce a consumption spillover effect. One country can consume more than it produces, while the other country produces more than it consumes. The simplified model with identical technology in all sectors does not include aggregate gains from trade. Accordingly, international trade under oligopoly causes a shift of consumption, and thus welfare, from one country to the other. This is a somewhat surprising result that requires further explanation.

The optimization behavior of individual firms with respect to supply decisions on asymmetric segmented markets is the core micro-level element of the AGOLE. Each firm sets its supplies such that marginal revenues equal marginal costs in each market. Thus, country asymmetries can affect firms' decision-making via their impact on marginal costs and marginal revenues. This micro-level adjustment to country asymmetries has macro-level effects. This section aims to clarify the cost and the revenue channel for the case of asymmetric labor market policies.

[18] At least for the initial increase at $L = L^*$ Home real profits increase.

A shift of consumption between the two countries requires differences in the amount of exported goods, i.e. the net export quantity of Home NXQ is not zero ($NXQ \equiv y_f - y_h^* \neq 0$). With an equalized balance of trade in our general equilibrium model, this condition cannot be fulfilled without market segmentation, because a uniform world market price would imply that exported quantities are identical for both countries. Although in general equilibrium this results endogenously from asymmetric policies, the underlying transmission channels are already present in a simple partial equilibrium model with oligopolistic competition and segmented markets like in Brander and Krugman (1983). Therefore, we first present the two channels in partial equilibrium, before turning to their interplay in general equilibrium.

For the partial equilibrium analysis, we stick to our previous notation but consider the demand aggregators $\lambda^{(*)}$ and the wages $w^{(*)}$ to be exogenously given for a single oligopolistic sector. In partial equilibrium, the oligopolistic sector's trade can be imbalanced. We can combine the Cournot supplies in equations (1.10) and (1.11) to obtain

$$NXQ \equiv y_f - y_h^* = \frac{1}{3b}\left\{-\lambda^*(2w - w^*) + \lambda(2w^* - w)\right\},$$

such that we arrive at

$$NXQ \begin{cases} > 0 & \text{if } w^* \geq 2w \\ \gtrless 0 & \text{if } \frac{w^*}{2} < w < 2w^* \ \wedge \ \frac{\lambda}{\lambda^*} \gtrless \frac{2w - w^*}{2w^* - w} \\ < 0 & \text{if } w \geq 2w^*. \end{cases} \tag{1.19}$$

This shows that wage differences matter. When wages are not too different, as

in the second case of equation (1.19), we have to compare countries' relative wages with their relative market sizes (demands). The exports of firms from different countries are only equalized if the expressions on the right of the second case are equal.

The above expression reveals two interrelated channels. For otherwise identical countries, a difference in marginal costs ($w \neq w^*$) or a difference in marginal revenues caused by demand asymmetries ($\lambda \neq \lambda^*$) is necessary for a net export quantity unequal to zero. By allowing countries to be exogenously asymmetric in one or both of these aspects in partial equilibrium, the resulting trade equilibrium can feature a non-zero net export quantity. However, in partial equilibrium this is not necessarily equivalent to a shift in welfare between the two countries because a sectoral trade imbalance can be compensated in other sectors.

The fundamental cause of the effect is the strategic behavior of oligopolistic firms. Figures 1.3 and 1.4 illustrate the optimization behavior of each country's oligopolistic firm in partial equilibrium, which includes setting quantities in both markets such that marginal revenues in both markets equal marginal costs. Given the marginal revenue functions that depend on aggregate demand, the marginal costs determine the supplied quantities in both markets.

When the two countries differ only in their marginal costs, as expressed in Figure 1.3, the high-cost country is net importer of the oligopolistic good in quantity terms. According to equation (1.19), this means that the demands are symmetric, but Foreign is the high-cost country if its wage rate is higher and thus the foreign firm exports less than its counterpart from Home ($NXQ > 0$). The result is not surprising since with equal demands in both countries each country's firm will supply the same quantity in each market, in order to equalize marginal revenues.

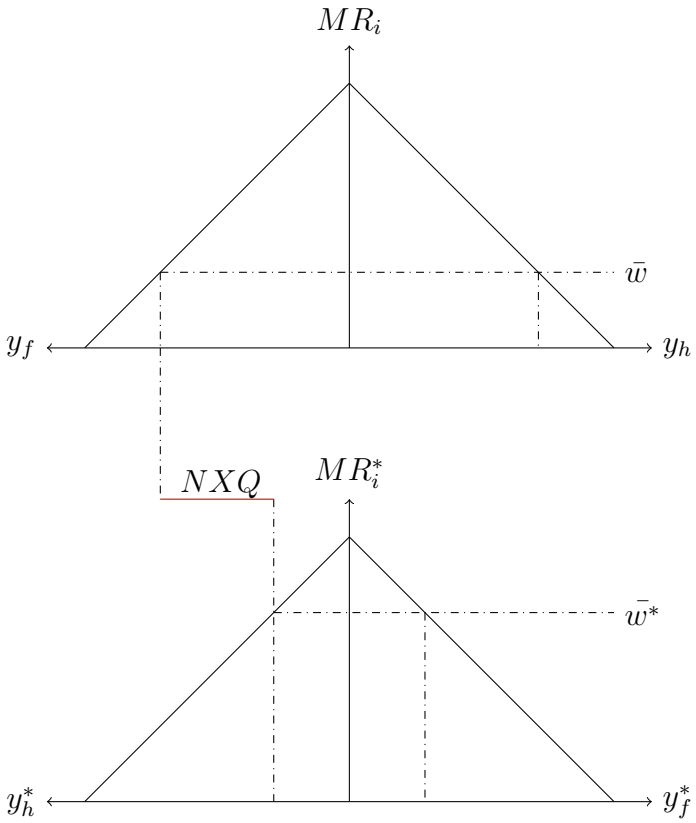

Figure 1.3: Marginal Cost Differences

Because the low-cost country's firm finds it profitable to have larger equilibrium quantities in both markets, this country necessarily runs an export surplus in terms of traded quantity. With equal demand in both countries, prices are identical as well, such that the low-cost country runs a sectoral trade balance surplus.

When the two countries differ only in their aggregate demand and thus marginal revenues are no longer symmetric in both markets, as illustrated in Figure 1.4, oligopolists acknowledge that additional supply affects their marginal revenues stronger in a market, where they already sell more. As each oligopolist sets quantities such that marginal revenues are equal in both markets, this means that

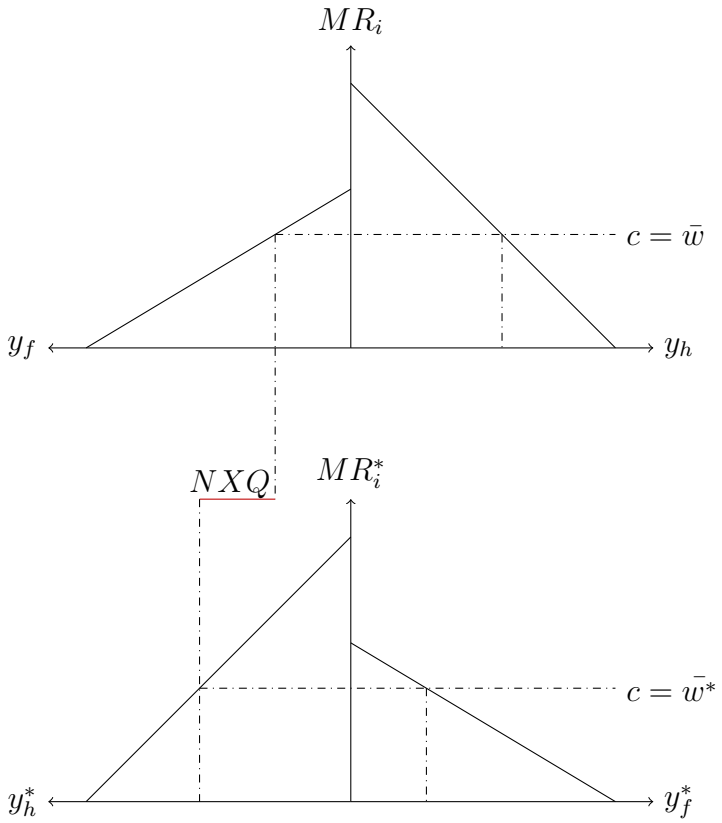

Figure 1.4: Marginal Revenue Differences

they accept a lower price in the smaller market. If Foreign's demand is lower ($\lambda^* > \lambda$), it has a sectoral terms of trade advantage ($p > p^*$).[19] At the same time, its firm exports more than the Home firm due to the demand asymmetry. Because the second case of equation (1.19) simplifies to $\lambda/\lambda^* < 1$ if wages are equalized, the Home country, which has higher demand, will be net importer in quantity terms. This is not surprising since its consumers demand more of the good.

In both of the described partial equilibrium cases trade imbalances emerge that are not compatible with a general equilibrium of symmetric sectors. Accordingly,

[19] $p > p^* \iff \frac{1}{3\lambda}(a + \lambda w + \lambda w^*) > \frac{1}{3\lambda^*}(a + \lambda^* w + \lambda^* w^*) \iff \frac{\lambda}{\lambda^*} < 1.$

prices and wages would have to adjust in order to restore balance of payments equilibrium. However, prices can still differ between the two countries in the new equilibrium, such that one country is net quantity exporter in all sectors.

Compared to partial equilibrium, in general equilibrium the balanced trade condition has to hold, but also supplied quantities and labor supply are now connected. Consider a symmetric starting point. A growing labor supply in Home implies that Home firms have to increase their sales proportionally. The equilibrium production is fully determined by the exogenous labor supply. Wages and prices have to adjust, such that firms use all labor in equilibrium. When L becomes larger than L^*, this has two simultaneous effects. First, the Home wage falls and will be lower than the foreign wage ($w < w^*$). Second, Home demand grows ($\lambda < \lambda^*$, such that also $p > p^*$).

As we have seen, the partial equilibrium marginal cost channel induces a positive net export quantity ($NXQ > 0$) of the low-cost country (Home in this case). The demand-side driven marginal revenue channel induces a negative net export quantity ($NXQ < 0$) for the larger market (also Home in this case). Proposition 1.2 shows that without running a trade balance deficit Foreign becomes a net importer in quantity terms and, thus, gains welfare at the cost of Home. This implies that the cost channel dominates the revenue channel for an asymmetric labor market policy in general oligopolistic equilibrium.

It is profitable for firms from both markets to supply more to the smaller Foreign market than they would in absence of strategic considerations, because this allows them to keep the price in the larger Home market, where they sell most of their output, artificially high. In a sense, firms from both countries are dumping on the smaller Foreign market. Additionally, Home production is larger, such that Home

firms generally wish to supply more to both markets than Foreign firms, and thus to export relatively more, which again is associated with downward pressure on the Foreign price as compared to the Home price. This is beneficial for Foreign consumers.

In our simple setting it follows from the balanced trade condition that the (Foreign) terms of trade $p/p^* = y_f/y_h^*$ are a sufficient statistic for the ratio of exported quantities. When the foreign terms of trade are one, there can be no consumption spillover because the trade balance has to be equalized. When they are larger than one, Home is exporting more than Foreign in quantity-terms, which is compensated for in the balance of trade by the price difference.

As mentioned in the beginning of this section, the importance of the cost and the revenue channel for the firm-level adjustment to country asymmetries remains intact for other types of asymmetries. Under oligopoly, such asymmetries can induce deviations from the law of one price, which gives rise to terms-of-trade based international shifts in consumption and welfare. Accordingly, when firms have market power and countries are not symmetric, it is important to take micro-level firm behavior into account as it affects macro-level outcomes.

1.6 Conclusion

We develop an asymmetric general oligopolistic equilibrium (AGOLE) model which allows new applications that so far have been outside the scope of general oligopolistic equilibrium models. We show how to solve the model and how to conduct comparative static analyses with an exogenous change in one country's labor market policy serving as example. On the micro level, the supply behavior of an

individual firm in the two segmented markets is affected by country asymmetries via their impact on marginal costs and marginal revenues. The firm-level adjustments, in turn, have macro-level effects. Asymmetries in countries' characteristics and policies can have international effects by inducing deviations from the law of one price. The resulting change in the terms of trade shifts consumption and welfare from one country to another. We argue that incorporating this mechanism is important when analyzing asymmetric countries or policies in presence of firms with market power, because it can shape the welfare and distributional effects of policies and globalization.

This paper offers a general equilibrium framework for studying the effects of asymmetries in countries' characteristics or policies when firms have market power. There are many possible applications of the AGOLE model and we hope to stimulate research in that area with the proposed methodology. Interesting future applications include, for example, imperfect labor markets, government interventions or unequally developed countries.

Chapter 2

International Trade and Tax-Motivated Transfer Pricing*

2.1 Introduction

In its "Transfer Pricing Guidelines" the OECD states that "[t]he role of multinational enterprises in world trade [...] increase[d] dramatically" (OECD, 2022b, p. 11) over the last two decades. Indeed, Antras (2003) showed that at the turn of the millennium roughly one-third of world trade was intrafirm trade. This poses a challenge for firms but also governments as the taxation of multinationals needs to be viewed in its international setting. As trade within multinational firms does not take place on a market with independent participants, some rules are necessary to

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set appropriate prices for tax purposes. The OECD sets out guidelines for such transfer prices, which should be set "at arm's length". Still, firms have the incentive and many possibilities to use the leeway in this framework in order to reduce their global tax bill by adjusting transfer prices.[1]

International trade makes profit shifting via transfer pricing possible, such that firms' supply decisions adjust. Empirically, multinationals' trading activity increases when tax rate differences become larger[2], which also affects aggregate country statistics.[3] Thus, the question naturally arises which welfare and distributional implications tax-motivated transfer pricing has for the countries involved.

We show in our model that the possibility of profit shifting via transfer price adjustments affects welfare and distribution through two channels. Firstly, income shifts from the high- to the low-tax country as firms reduce their overall tax payments. Secondly, exporting becomes more attractive for all firms, because reducing taxes is tied to the real activity of exporting. Therefore, firms do not only want to increase their intrafirm trade, but also their overall production leading to higher wages. In general equilibrium, welfare increases in the low- and decreases in the high-tax country. Additionally, the labor share of income rises in the low-tax country.

We analyze corporate taxation and tax motivated transfer pricing in an asymmetric general oligopolistic equilibrium (AGOLE) trade model based on Quint

[1] For empirical evidence see e.g. Bernard et al. (2006) and Cristea and Nguyen (2016).

[2] P. Egger and Seidel (2013) find a 5.5% increase in intrafirm trade flows due to a 3.1% increase in the average host-country tax-gap to the United States.

[3] Carloni et al. (2019) estimate that the observed 13.1 percentage points decrease in the U.S. corporate tax rate in 2017 may have increased the U.S. trade balance by 9% through tax-motivated transfer pricing. Vicard (2015) and Casella et al. (2018) provide estimates of the substantial tax revenue losses attributable to transfer pricing. Additionally, see e.g. Clausing (2003), Clausing (2006), Liu et al. (2017).

and Rudsinske (2020a). The key element – first introduced in Neary (2016) – are firms that are modeled as "large in the small" sector they supply to but "small in the large" economy. We allow for segmented markets and fundamental country asymmetries. Trade does not occur due to technological differences, but firms' strategic considerations matching the "reciprocal dumping"-argument in Brander and Krugman (1983). In this set-up, we can implement tax rates that differ in the two countries and lead to consumption changes in their own right. Additionally, we can not only identify net trade but also total traded quantities for each firm and in the aggregate. These two elements enable us to implement a transfer pricing decision for intrafirm exports.

Without profit shifting, an increasing profit tax rate shifts welfare towards the tax-increasing country as its income and hence demand increase while both decrease in the other country. The oligopolists' optimization is affected as the marginal revenues in the two markets will change. Firms' strategic behavior leads to larger supply in the tax-increasing country at higher prices and lower supply at lower prices in the other country. However, firms only adjust their supply to the countries and do not want to change their overall production. Hence, nominal wages remain unchanged and taken together with the price changes this leads to lower real wages in the country with the increased tax rate and higher real wages in the other country.

Transfer pricing generates an additional benefit from exporting for all firms because exports enable profit shifting. This incentivizes exporting such that companies not only shift their supplies between countries but want to expand production. Caused by this supply channel, nominal and real wages will rise in both countries as the total labor supply is fixed. Due to shifting tax incomes, a

cross-country demand channel relocates consumption from the high- to the low-tax country, thereby increasing welfare in the latter on cost of the former. In the low-tax country, real profits decrease such that the labor share of income rises.

Ramondo et al. (2016) find that intrafirm trade is concentrated among large affiliates within large multinational corporations, while Martin et al. (2020) show that tax avoidance even leads to increasing industry concentration because large firms can use it best. In line with their findings, we opt for an oligopolistic industry structure that accounts for firms' market power in their respective sector. Head and Spencer (2017) stress that oligopolistic firms need to be considered when assessing welfare effects of policies – especially when the allocation of profits across countries is involved. They also discuss the issue that oligopolistic firms might treat markets in each country as segmented rather than integrated and that it matters for policy analysis whether the market in only one country is affected or whether there exist linkages between markets. We account for both aspects by allowing firms to treat the markets as segmented and by explicitly modeling the labor market. While firms are able to set their quantities separately for both markets, their quantity reactions to policy changes in one of the markets will have repercussions on their supply in the other market via aggregate wage reactions in general equilibrium.

The general equilibrium is inherently necessary to capture the welfare, labor market and distribution effects. Most of the literature explores partial equilibria, only few models look at profit shifting within a general equilibrium framework. Existing general equilibrium approaches in that area usually focus on structurally different countries and on the influence of tax systems in presence of transfer pricing instead of the direct effects of transfer pricing for a given tax policy. For example, Krautheim and Schmidt-Eisenlohr (2011) analyze profit shifting between a large

country and a tax haven in a general equilibrium monopolistic competition model. Eichner and Runkel (2011) compare different corporate tax systems in a general equilibrium model, but do not explicitly include transfer prices to determine the extent of profit shifting. Bond and Gresik (2020) compare different tax regimes in presence of transfer pricing from a welfare perspective, but assume that only the high-tax country can provide headquarter services that are necessary for the production of differentiated goods. In contrast, our model allows to look at two countries that are similar in their industrial structure and we can assess the welfare effects that directly stem from the mere existence of transfer pricing possibilities.

Before we can analyze transfer pricing, we need to look at asymmetric profit taxation in the absence of transfer pricing. We find that a country benefits from unilaterally introducing a corporate tax because this relocates a part of foreign firms' profits towards domestic tax revenue, leading to tax exporting as foreigners bear the tax incidence (Krelove, 1992). The tax base decreases with profit shifting, which is why transfer pricing has a reverse effect. Kohl and Richter (2019) build on the heterogeneous firms monopolistic competition model by H. Egger and Kreickemeier (2012), that incorporates a fair wage-effort mechanism, and analyze a unilateral tax on operating profits. In contrast to our model without a transfer price scope, their tax distorts the companies' decisions. However, the tax is able to reduce inequality in the trading partner country, which is mainly in line with our results – though in our case the tax favors labor as compared to profit income in the taxing country as well.

The literature looks at transfer prices from different angles. Firstly, transfer prices are a device for decentralized decision making within a company that establishes multiple divisions (see e.g. Hirshleifer (1956), Bond (1980) and Elitzur

and Mintz (1996)). We assume centralized decision-making by the parent company, which from the firms' perspective might be the obvious organizational form to optimize profit shifting in presence of tax differences. Secondly, transfer prices matter when looking at intrafirm trade and profit-shifting possibilities. Early models included exogenous boundaries on transfer prices, which restricted profit shifting (Horst, 1971). Kant (1988) developed the concept of concealment costs that leads to endogenously determined transfer prices. Similar to Auerbach and Devereux (2018), we opt for the analytically more tractable way of setting exogenous boundaries on the transfer price decision. Much of the recent literature on transfer prices and taxation focuses on organizational and locational decisions and the incentives of tax-motivated transfer pricing (see e.g. Behrens et al. (2014), Peralta et al. (2006), Devereux and Keuschnigg (2013), Auerbach and Devereux (2018)). In these partial equilibrium models, governments may decide on tax rates and on different taxation systems such as differing transfer pricing benchmarks. In our general equilibrium approach, we do not include capital in the production process and assume that companies already made their locational decision, which they cannot change at a reasonable cost.

We first introduce the theoretical model and our solution strategy in Section 2. After showing the effects of unilateral taxation in Section 3, we analyze the effects of transfer pricing in Section 4. The final section concludes. All proofs are deferred to the appendix.

2.2 Transfer Pricing in the AGOLE Framework

We integrate national corporate taxation and a scope in transfer price decisions that allows for profit shifting into a two-country model of international trade in asymmetric general oligopolistic equilibrium.

2.2.1 Model Components

In the following, we will usually present expressions for the Home country only. Expressions for Foreign are analogous. Variables referring to Foreign will be marked with an asterisk.

Consumers

Each country is inhabited by one representative consumer, whose preferences are additively separable. The representative consumer inelastically supplies L units of labor to a perfectly competitive labor market. We use continuum-quadratic preferences:

$$U[\{y(z)\}] = \int_0^1 u[y(z)]dz \quad \text{with} \quad \frac{\partial U}{\partial y(z)} > 0 \text{ and } \frac{\partial^2 U}{\partial y(z)^2} < 0$$
$$\text{where} \quad u[y(z)] = ay(z) - 1/2\, by(z)^2.$$

Here, $y(z)$ is the amount of consumption of a homogeneous good produced in sector $z \in [0, 1]$ and a as well as b are parameters with $a, b > 0$. We assume that the parameters are set such that marginal utilities of each good are positive. The consumer is indifferent between domestic goods and imports in each sector z.

The yet to be determined wage rate w will result in a wage income of $w \cdot L$.

Wages are not taxed by the government. Additionally, aggregate after-tax profits (Π) of Home country companies and tax revenues (T) of the country are disbursed to consumers. Thus, we implicitly assume that companies are fully owned by the representative consumer in the parent's residence country. Therefore, the income of the representative consumer is given by

$$I = wL + \Pi + T. \tag{2.1}$$

With price $p(z)$ per unit of the good in sector z, the budget constraint is

$$\int_0^1 p(z)y(z)dz \leq I. \tag{2.2}$$

Utility function and budget constraint lead to the utility maximization problem represented by the Lagrangian:

$$\max_{y(z),\forall z} \mathcal{L} = \int_0^1 \left(ay(z) - 1/2\ by(z)^2\right) dz + \lambda \left(I - \int_0^1 p(z)y(z)dz\right)$$

The first order condition then gives $0 = a - by(z) - \lambda p(z)\ \forall z$ with λ being the Lagrange-parameter and therefore the marginal utility of income. The inverse Frisch demand follows straightforwardly and is given by

$$p(z) = \lambda^{-1} \frac{\partial u[y(z)]}{\partial y(z)} = 1/\lambda [a - by(z)]\ \forall z. \tag{2.3}$$

The Frisch demands specify a relation between price, quantity demanded and the marginal utility of income instead of income or utility as in Marshallian and Hicksian demand functions. The inverse demand functions (2.3) depend on the

marginal utility of income negatively. The marginal utility of income λ acts as a demand aggregator where a higher value indicates a lower demand for goods in every sector. The inverse formulation (λ^{-1}) can be interpreted as the marginal costs or the price of utility (Browning et al., 1985).

Producers

The producers aim to maximize their profits given the demand, the tax rates and the system of tax collection. Firms are assumed to have market power in their respective markets. However, they do not have direct influence on aggregate economic factors, as a continuum of sectors exists, which only jointly determine these factors.

In their profit maximization, the firms have to take the tax system into account. One company comprises two distinct legal entities. On the one hand, the parent company produces the good in one country and sells the good in the same country. On the other hand, the subsidiary sells the good in the other country, where it is incorporated, but does not produce itself. Instead, the subsidiary imports the good only from its parent company. Therefore, a transaction between the two entities emerges that is not mediated over a market and does not have any consequences on the profits of the multinational company in the absence of taxation. In our model, however, the two entities fall under different tax jurisdictions. The parent is subject to taxation in one country, whereas the subsidiary is taxed by the other. To attribute the profits before taxes to the two entities, the company sets a transfer price $\Phi(z)$ per quantity of the good for the intrafirm transactions. If tax rates differ between countries, manipulations of this transfer price can reduce the company's overall tax bill as the transfer price affects the allocation of tax bases.

The management of the multinational company sets the transfer price – as well as the quantities – to maximize the company's aggregate after-tax profits.

We assume that in both countries $n = n^* = 1$ firms exist in each sector z and that there are neither fixed costs of production nor transport costs. The firms play a static one-stage game where they compete in Cournot competition over output in the Home and Foreign market. They take the consumers' demand as given and perceive the inverse Frisch demand functions as linear – irrespective of the functional form of λ – as the companies by assumption do not have an individual influence outside their own sector.

Labor L is the only factor of production. It moves freely across sectors within a country, but not across national borders. The wage rate w is determined at the country level such that the inelastically supplied labor L equals the demand for labor resulting from goods production of the companies.

Production occurs with constant returns to scale and common technology in each sector z, such that marginal costs in sector z are constant. To keep the model as simple as possible, throughout the paper we consider only the case of identical technology across sectors as well as countries. The sector-specific common unit-labor requirements are $\gamma(z) = \gamma^*(z) = 1 \ \forall z$ so we can drop z throughout as the cost per unit is the wage rate w. Thus, the model does not capture a Ricardian-style technological comparative advantage anymore as it did in Neary (2016). The reasons for trade in our setting are strategic interactions among firms and profit shifting. However, we retain the assumption of a multitude of sectors even though they will be symmetrical. As companies remain small in the large, they do not take their effect on wages into account when maximizing their profits. Therefore, marginal costs are constant and equal across the countries where they

sell the good.

As all sectors are equal, there is no price heterogeneity that would affect the representative consumer's utility as in Neary (2016). Because of the strictly increasing marginal utility of consumption, we have a strictly monotonic relationship between consumption (or real income) and welfare defined as the representative consumer's utility. Accordingly, these terms can be used interchangeably when considering the direction of effects.

The tax system

We assume that the governments of Home and Foreign agreed to tax the multinational companies according to the source principle in conjunction with the territoriality principle. Profit streams resulting in a country will be taxed there, and not in the country where the parent company is located. Hence, profits realized in the subsidiary's residence country – and already taxed – are exempt from taxation in the parent companies' country. We assume that the tax revenues are redistributed to the individuals living in the country.

The Home country taxes all companies active in Home. On the one hand, the multinational companies, which produce in Home, are subject to the Home tax with income generated by sales at Home less the cost of production for these sales. Additionally, exports to their affiliates in Foreign are taxed according to the difference between transfer price and unit costs. On the other hand, the Home government applies its tax on the subsidiaries, which only sell in Home, but import the goods from their parent companies in Foreign. For these subsidiaries, the tax base in Home results from the generated turnover, where the transfer price payment to the Foreign parent is deducted. There are no withholding taxes on dividend

payments from subsidiaries to parents.

To ensure that the source principle holds, the governments commit to a common transfer price guideline. Companies are requested to set their transfer price Φ equal to the marginal costs of producing the good as is common in transfer pricing models (see e.g. Kind et al. (2005)). A company's net profit with the parent in Home and a subsidiary in Foreign is

$$\begin{aligned}\pi &= (1-\tau)\left[(p-w)y_h + (\Phi - w)y_f\right] + (1-\tau^*)\left[p^* - \Phi\right]y_f \\ &= (1-\tau)\left[p-w\right]y_h + (1-\tau^*)\left[p^*-w\right]y_f + \ (\tau^*-\tau)\left[\Phi - w\right]y_f, \quad (2.4)\end{aligned}$$

where the Home tax rate is τ and $0 \leq \tau^{(*)} < 1$. Here, y_i indicates the amount of the good sold by the company in country $i \in h, f$. Equation (2.4) shows that if Φ is set equal to marginal costs, profit shifting will not occur and the source principle strictly holds. A company can increase its net profit – given differentiated tax rates – by adequately manipulating the transfer price if there is some scope for deviations. If the Foreign tax rate is lower ($\tau > \tau^*$), the transfer price will be set as low as possible by the Home companies, such that a part of its profits is effectively shifted abroad. Additionally, we can see that the positive transfer price effect on a company's profit is tied to its exports. The more a company exports the more possibilities it has to shift profits to the low-tax jurisdiction. This means that a real activity is needed to shift profits towards the low-tax country.

To achieve some scope in the firms' transfer price decision, we assume that governments do not have complete information on the firms. We, therefore, implement that firms can deviate by g units from the marginal cost benchmark in either direction when setting the transfer price. To improve tractability, we do not

assume concealment costs attached to the deviation from the benchmark, which is analogous to other models on transfer pricing (see e.g. Auerbach and Devereux (2018)). The deviation parameter is assumed to be equal across countries. The range of possible transfer prices is given by

$$\Phi \in [w - g; w + g]\,. \tag{2.5}$$

We assume that companies will not set transfer prices outside these ranges as this would result in harsh penalties. Here, g is a parameter and will not be deliberately set by governments. It may be interpreted as a general ineffectiveness or legal in-expertise by administrations. However, we assume that this scope is small enough to ensure that there are no negative tax payments.

2.2.2 Partial Equilibrium

First, we analyze the effects in partial equilibrium. Therefore, we solve the Cournot equilibrium taking the demand aggregators $\lambda^{(*)}$ and the wages $w^{(*)}$ as exogenously given.

Cournot Equilibrium

The demand for goods produced by companies in a specific sector in one country is given by the inverse Frisch demand in equation (2.3). All companies active in that sector in the country compete in Cournot competition to satisfy this demand simultaneously. At this stage, companies will set their transfer prices as well. They will choose the upper (lower) bound if the tax rate in the parent's residence country is lower (higher) compared to the subsidiary's residence country.

Given the demand and the other companies' supply, firms maximize their profits by choosing their supplied quantities in both countries.

$$\begin{aligned}\max_{y_h, y_f, \Phi} \pi &= (1-\tau)\,[p-w]\,y_h + (1-\tau^*)\,[p^*-w]\,y_f + (\tau^*-\tau)\,[\Phi-w]\,y_f \\ &\quad \text{with } \Phi \in [w-g; w+g]\,,\ p = {}^1\!/\!_\lambda[a-by] \text{ and } p^* = {}^1\!/\!_{\lambda^*}[a-by^*],\end{aligned}$$

where y describes the total supply of the good in Home and y^* in Foreign.

The first order conditions for the firms' profit maximization over their quantities sold are

$$\frac{\partial \pi}{\partial y_h} = (1-\tau)\left[\frac{1}{\lambda}\,(a - 2\ b\ y_h - b\ y_h^*) - w\right] = 0 \tag{2.6}$$

$$\begin{aligned}\frac{\partial \pi}{\partial y_f} &= (1-\tau^*)\left[\frac{1}{\lambda^*}\left(a - 2\ b\ y_f - b\ y_f^*\right) - w\right] \\ &\quad +(\tau^*-\tau)(\Phi - w) = 0.\end{aligned} \tag{2.7}$$

These first order conditions can be transformed into reaction functions depending on the supply of Foreign companies in the respective markets. The equation for supply to the country Foreign shows an effect of the transfer price on exports.

$$y_h = \frac{a - \lambda w - b\ y_h^*}{2b} \tag{2.8}$$

$$y_f = \frac{a - \lambda^* w - b\ y_f^* + \frac{\tau^*-\tau}{1-\tau^*}\lambda^*(\Phi - w)}{2b} \tag{2.9}$$

As mentioned above, the transfer price will be set taking the difference in tax rates into account. It follows from ${}^{\partial\pi}\!/\!_{\partial\Phi} = (\tau^* - \tau)y_f$, which commands the company to either set the transfer price as high as possible or as low as possible. If $\tau^* > \tau$, profits can be magnified with marginal increases of the transfer price.

Hence, the rule is to set the transfer price as high as possible. This is reversed for $\tau^* < \tau$. Bearing in mind the admissible transfer price range in equation (2.5), it follows that the optimal transfer price is[4]

$$\Phi = \begin{cases} w + g & \text{if } \tau^* > \tau \\ w & \text{if } \tau^* = \tau \\ w - g & \text{if } \tau^* < \tau. \end{cases} \tag{2.10}$$

Combining the reaction function (2.9) and the optimal transfer price rule in equation (2.10) leads to

$$y_f = \frac{a - \lambda^* w - b\ y_f^* + \frac{|\tau^* - \tau|}{1-\tau^*}\lambda^* g}{2b}. \tag{2.11}$$

This formulation contains all cases for the optimal transfer price as the sign in equation (2.10) assures that the absolute value of the tax rate difference determines the transfer price effect on exports. By combining the reaction functions from Home's and Foreign's companies in the respective markets we obtain the Cournot-Nash-equilibrium supply for Home (Foreign) companies y_i (y_i^*) in both markets. The equilibrium supply of each individual company to the Home market is[5]

$$y_h = \frac{\lambda}{3b}\left\{\frac{a}{\lambda} - w + (w^* - w) - \frac{|\tau^* - \tau|}{1-\tau}\ g\right\} \tag{2.12}$$

$$y_h^* = \frac{\lambda}{3b}\left\{\frac{a}{\lambda} - w^* + (w - w^*) + 2\ \frac{|\tau^* - \tau|}{1-\tau}\ g\right\}. \tag{2.13}$$

[4] We assume that if tax rates are equal and profit shifting via transfer price manipulation is not possible, companies will set the transfer price equal to marginal costs.

[5] y_i indicates the supply of one company producing in Home (no asterisk) and selling in country i. y_i^* signals the supply of one company producing in Foreign (*) and selling this amount in country i.

The supplied quantities in Foreign are analogous:

$$y_f = \frac{\lambda^*}{3b}\left\{\frac{a}{\lambda^*} - w + (w^* - w) + 2\,\frac{|\tau^* - \tau|}{1-\tau^*}\,g\right\}. \tag{2.14}$$

$$y_f^* = \frac{\lambda^*}{3b}\left\{\frac{a}{\lambda^*} - w^* + (w - w^*) - \frac{|\tau^* - \tau|}{1-\tau^*}\,g\right\} \tag{2.15}$$

Partial Equilibrium Effects

We will first analyze the effects of demand, the tax rate and the scope for transfer pricing on the supplied quantities in Cournot equilibrium. From the inverse Frisch demand follows that an increase in demand in one of the countries can be represented by a decrease in the marginal utility of income $\lambda^{(*)}$ in partial equilibrium. The changes in supply by the Home firms in both markets are given by

$$\frac{\partial y_h}{\partial \lambda} = \frac{1}{3b}\left(-w + (w^* - w) - \frac{|\tau^* - \tau|}{1-\tau}g\right)$$

$$\frac{\partial y_f}{\partial \lambda^*} = \frac{1}{3b}\left(-w + (w^* - w) + 2\frac{|\tau^* - \tau|}{1-\tau^*}g\right).$$

Generally, higher demand (lower λ) induces a higher domestic supply. This might be counteracted by cost advantages of Foreign competitors. In the export market, however, the effect is more complicated, assuming that Foreign is the low-tax country. If λ^* decreases, i.e. Foreign demand increases, Home firms' supply to Foreign decreases via the transfer price channel. In the situation before the demand increase, the firm already exported more due to transfer pricing. Now, the additional supply after a demand increase is reduced by the already exported quantities.

If we look at the combined supply of one company – its production – demand shifts across countries only affect this via the transfer pricing mechanism, if the

sum of marginal utilities of income is fixed, i.e. $d\lambda = -d\lambda^*$.[6]

$$\begin{aligned}\frac{\partial(y_h + y_f)}{\partial\lambda} - \frac{\partial(y_h + y_f)}{\partial\lambda^*} &= -\frac{g}{3b}\frac{|\tau^* - \tau|}{1-\tau} - \frac{2g}{3b}\frac{|\tau^* - \tau|}{1-\tau^*} \\ &= -\frac{g}{3b}|\tau^* - \tau|\left(\frac{1}{1-\tau} + \frac{2}{1-\tau^*}\right) < 0\end{aligned}$$

This implies that if the transfer pricing benchmark is adhered to ($g = 0$), symmetric but opposing changes in demand do not change the overall production but rather the allocation across countries.

The tax rate only affects the supplied quantities in both markets via the transfer price, as the tax rate differential determines the gain from profit shifting via transfer pricing. However, if transfer prices are set according to marginal costs, taxes do not affect the companies' supply decision, but only the after-tax profits.

$$\begin{aligned}\frac{\partial y_h}{\partial\tau} &= -\lambda\frac{g}{3b}\frac{1-\tau^*}{(1-\tau)^2} \leq 0 \qquad \forall\tau \geq \tau^* \\ \frac{\partial y_f}{\partial\tau} &= \lambda^*\frac{2g}{3b}\frac{1}{1-\tau^*} \geq 0 \qquad \forall\tau \geq \tau^*\end{aligned}$$

If profit shifting is possible and the high tax country further raises its tax rate, its firms increase their exports. Exporting becomes more profitable as even more tax payments can be avoided. The same is true for the low-tax country firms that increase their exports as well. This results in higher competitive pressure such that all firms are inclined to reduce their domestic supply.

An increase in the range for possible transfer prices g will reduce the supply in

[6] We will introduce this in our general equilibrium setting.

the production country while increasing exports.

$$\begin{aligned}\frac{\partial y_h}{\partial g} &= -\lambda\frac{1}{3b}\frac{|\tau^* - \tau|}{1-\tau} < 0 \\ \frac{\partial y_f}{\partial g} &= \lambda^*\frac{2}{3b}\frac{|\tau^* - \tau|}{1-\tau^*} > 0\end{aligned}$$

As mentioned above, the profit shifting via transfer pricing is tied to the exports, thereby making exporting more profitable (see equation (2.9))[7] . At the same time, increased exports lead to higher competitive pressure and a reduction in firms' domestic supply. The production of a firm can become larger or smaller after an increase in g.

$$\frac{\partial(y_h + y_f)}{\partial g} = \frac{|\tau^* - \tau|}{3b}\left(2\frac{\lambda^*}{1-\tau^*} - \frac{\lambda}{1-\tau}\right)$$

The sign of the production change depends on the similarity of the parameters differentiating the countries. If the countries are sufficiently similar, production will increase.

2.2.3 General Equilibrium

Labor Market

With the Cournot-Nash-equilibrium supply derived above we can turn to the clearing of the labor market. As described, the representative consumer inelastically supplies $L^{(*)}$ units of labor in the respective countries. For simplicity we assume that countries are symmetric in their labor endowment and set $L = L^* = 1/2$. The labor demand depends on the equilibrium supply of goods produced in the

[7] Transfer price possibilities work similar but opposite to tariffs in our model. See Rudsinske (2020) for an application of the AGOLE model to the case of asymmetric import tariffs.

respective country. Each company in one sector in Home will produce $y_h + y_f$. The total labor demand is given by $L^D = \int_0^1 y_h + y_f \; dz$. In equilibrium demand has to equal supply. With $\bar{\lambda} \equiv \lambda + \lambda^*$ this yields in Home

$$\begin{aligned} L = \frac{1}{2} &= \int_0^1 y_h + y_f \; dz = y_h + y_f \\ &= \frac{1}{3b}\left\{2a - \bar{\lambda}\; w + \bar{\lambda}(w^* - w) + |\tau^* - \tau|\; g\; \left(\lambda^*\; \frac{2}{1-\tau^*} - \lambda \frac{1}{1-\tau}\right)\right\}. \end{aligned} \tag{2.16}$$

In combination with the analogously defined equilibrium on the labor market in Foreign, wages in both countries can be presented as

$$w = \frac{1}{\bar{\lambda}}\left\{2a - \frac{3}{2}b + \lambda^*\; g\; \frac{|\tau^* - \tau|}{1-\tau^*}\right\}; \tag{2.17}$$

$$w^* = \frac{1}{\bar{\lambda}}\left\{2a - \frac{3}{2}b + \lambda\; g\; \frac{|\tau^* - \tau|}{1-\tau}\right\}. \tag{2.18}$$

The equilibrium wages in both countries depend positively on the transfer pricing scope g and the tax differential $|\tau^* - \tau|$, weighted by the marginal utility of income in the export destination country. Wages are equal across countries if $g = 0$.

General Oligopolistic Equilibrium

In equilibrium the model is characterized by nine equations in nine endogenous variables. The Cournot equilibrium quantities ((2.12) – (2.15)) determine the supply of each multinational company to each country given the wages and the marginal utilities of income. The labor market clearing in each country determines the wage given the produced quantities in the respective country ((2.16) for Home, analogously for Foreign). Additionally, the prices are given by the representative consumers' inverse Frisch demand functions ((2.3) for Home, analogously for

Foreign).

The last equation implicitly determines the marginal utility of income. We use the budget constraint of the representative consumer to attain an implicit definition of the marginal utilities of income in equilibrium. The budget constraint is given by $p(y_h + y_h^*) = w\ L + \pi + T$. This can be rearranged to obtain a straightforward relationship that has to hold in equilibrium:

$$-\left(p^*\ y_f - p\ y_h^*\right) = \tau\ y_h^*\ \left(p - w^* - g\right) - \tau^*\ y_f\left(p^* - w + g\right) \tag{2.19}$$

On the left hand side we have the (negative) balance of trade of the Home country which has to equal the balance of capital on the right hand side in equilibrium. The balance of payments has to be even. However, we allow for trade imbalances if these are offset by capital transfers, which are possible due to differing tax payments of the companies across countries.

To attain the general equilibrium values of the endogenous variables and to solve the system of equations, we need to address the determination of the marginal utilities of income. Following Quint and Rudsinske (2020a), we normalize the aggregate marginal utility of income to unity, i.e. $\bar{\lambda} = 1$. Hence, the aggregate marginal utility of income is used as numéraire. This translates into the relationship between λ and λ^* that $\lambda^* = 1 - \lambda$, which allows us to substitute all λ^*. Additionally, we can say that both marginal utilities of income will lie between zero and one. This follows from the economic reasoning that a marginal utility has to be positive.

We can now further simplify the system of equations by expressing all endogenous variables, such that they only depend on exogenous parameters and λ.[8] These

[8] See Appendix B.1 for these equations.

formulations can then be used in the balance of payments condition such that we only have one equation in one variable left. To handle this equation, we first introduce some further assumptions. Without loss of generality we assume that Home is the high tax country, i.e. $0 \leq \tau^* \leq \tau < 1$. To improve tractability, we further simplify the model by assuming some structure on the utility function. To ensure that the condition of a positive marginal utility of consumption holds in any case, we set $b < a$. [9] Additionally, we ensure interior solutions to each firm's supply decision at $g = 0$ by setting $2a < 3b$. We show that there exists an equilibrium, which is unique if the transfer price scope is not too large, i.e. $g < \bar{g}$.

Lemma 2.1 (Existence and Uniqueness of $\hat{\lambda}^*$)**.** *There exists a solution to the condition of an even balance of payments in* $\lambda \in (0, 1)$*, which is unique if* $g \leq \bar{g}$*.*

Proof. See appendix. □

Unfortunately, we cannot determine the equilibrium marginal utility of income $\hat{\lambda}$ in closed form as in our equilibrium condition (2.19) it is derived from a quintic polynomial. According to Abel's impossibility theorem, there is no solution to this polynomial in radicals. However, it is possible to determine derivatives of $\hat{\lambda}$ with respect to exogenous parameters by implicitly differentiating the equilibrium condition.

To give the reader some intuition about the mechanisms that determine the general equilibrium supplies, we can break the system down into two fundamental conditions. The consumption indifference condition (CI) states that for utility maximization the origin of the product is inconsequential. The representative

[9] The most extreme case would be $y = L + L^* = 1$. More generally, we need $b < {}^{a}/_{(L+L^*)}$. Under our assumptions this also assures positive wages at $g = 0$, which require $b < 2a\,(({}^{n+1}/_{n})L + L^*)$.

consumer is indifferent between products in the same sector that are produced in Home and in Foreign. The market indifference condition (MI) states that in equilibrium firms have to be indifferent between selling the marginal unit in Home or in Foreign. We can plot these two conditions in a box diagram with the Home origin (0) in the lower left corner and the Foreign origin (0^*) in the upper right corner.

The CI is easily derived from the budget constraint.

$$CI: \qquad y_h = \frac{I}{p} - y_h^* \tag{2.20}$$

It gives us a function with perfect substitutability between Home and Foreign goods from the consumer's perspective, for whom real income I/p is exogenous. Thus, the slope of the CI line is -1 and an increase in real income in Home shifts it towards the upper-right corner. In equilibrium without tax rate differences, the intercept is exactly in the upper left corner of the graph. In this case both countries are symmetric and consume the same quantities such that $I/p = L = 1/2$. The same can analogously be done for the Foreign representative consumer giving us the same line in the graph.

The MI can be derived from the fact that the marginal revenues of a firm – including possible taxation effects – need to be equal in both markets in equilibrium. For Home, this follows straightforwardly from the profit maximization in equations (2.6) and (2.7) and can be rearranged[10] to

$$MI: \qquad y_h = -\lambda(1-\lambda)\frac{g}{b}\frac{(\tau-\tau^*)(2-\tau-\tau^*)}{(1-\tau)(1-\tau^*)} + y_h^*. \tag{2.20}$$

[10] For the derivation see the appendix.

This results in a line with the slope +1, which in our diagram again is the same from Foreign's perspective. The first term on the right-hand side is exogenous from the firm's perspective. This intercept can be interpreted as the aggregate export incentive across countries. When g or the tax rate difference increases, the MI shifts downwards. This implies higher export shares for all companies.

If countries have the same tax rates and there is no transfer pricing leeway, figure 2.1 shows how the equilibrium is determined at the intersection of MI and CI. We will use this depiction later on to graphically illustrate the effects of asymmetric taxation and transfer pricing possibilities on the consumers and producers.

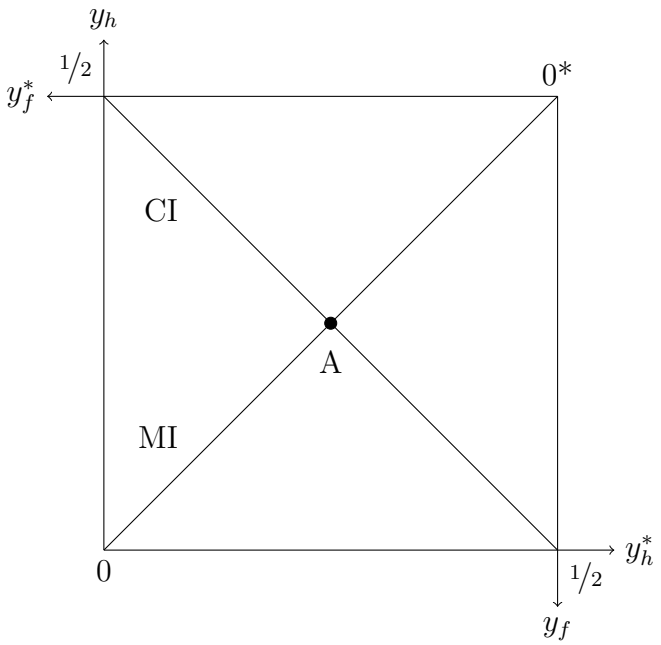

Figure 2.1: Symmetric Equilibrium with $\tau = \tau^*$

2.3 Effects of Asymmetric Taxation

To facilitate explaining the effects of transfer price manipulation, we first consider unilateral tax policy in our model, if the transfer prices are set equal to marginal costs. If both countries set the same tax rate, countries are symmetric in all exogenous parameters. Therefore, the equilibrium values of the marginal utilities of income in both countries need to be equal, i.e. $\hat{\lambda} = 1/2$. Accordingly, supplied quantities, prices and wages are the same in both countries.

If the Home country increases its tax rate, this does not influence the multinational companies' supply decision directly, when $g = 0$.[11] The same holds for the wages and the prices. However, the marginal utility of income in Home will fall in equilibrium and also affect the other variables in general equilibrium.

Lemma 2.2 (Effect of Unilateral Tax Policy on $\hat{\lambda}$)**.** *A unilateral increase in the tax rate decreases the marginal utility of income domestically and increases it in the other country for any* $\tau^{(*)}$*.*

Proof. See appendix. □

In the initial situation of equalized tax rates, both countries are identical which also implies identical marginal utilities of income. If then τ is increased, $\hat{\lambda}$ will decrease such that $\hat{\lambda} < 1/2$ for all $\tau > \tau^*$.

The reaction of the marginal utility of income stems from an income effect. In the high-tax country (Home) the income increases, while it decreases in the low-tax country (Foreign). This is due to higher tax payments of Foreign firms in Home. These additional tax revenues are given to Home's representative consumer. At the

[11] See equations (2.12) – (2.14) which do not depend on either tax rate with $g = 0$.

same time, the profits of the Foreign companies and the Foreign consumer's income are reduced. The incidence of the tax increase falls on the Foreign representative consumer, which we can characterize as tax exporting. The Home firms have to pay the tax as well, but this tax revenue is distributed to the Home representative consumer. Thus, for Home demand there is no difference between profits of Home firms and Home tax revenues paid by Home firms.

Therefore, demand in Home will increase while it decreases in Foreign. The oligopolistic firms will observe these changes in their marginal revenues in the two markets. As prices increase in the high-tax country, firms will sell more units of their good in this market, whereas reduced prices in Foreign lead to lower supplies. This is in line with the balance of payments in equation (2.19). As the balance of capital increases due to the differing tax payments, the (negative) balance of trade has to increase as well. All companies supply less to Foreign, where the mark-up has fallen. This, in turn, reduces tax revenues in Foreign as the tax base diminishes. This enhances the initial impetus reducing the income of Foreign's representative consumer and increasing it in Home.

Even though the companies will react to the demand changes, they do not have an incentive to increase their overall production, but rather shift their supply from the low-tax to the high-tax country. Therefore, nominal wages in both countries remain unchanged after a unilateral tax increase if $g = 0$. At the same time, real tax income in the high-tax country increases, if the tax rate increases.

Proposition 2.1 (Effects of Unilateral Tax Policy)**.** *A unilateral tax increase in the high-tax country raises consumed quantities in the high-tax and decreases them in the low-tax country. Real wages rise in the low- and fall in the high-tax country,*

while real profits decrease in both countries. Labor income gains relative to profit income in both countries.

Proof. See appendix. □

A unilateral increase in the high-tax country's tax rate favors the high-tax country. Most importantly, total consumption increases there, even though prices increase as well. In our setting, the welfare strictly increases in the consumed quantity. A higher quantity will directly lead to a higher utility for the representative consumer as given by the positive marginal utility of consumption.

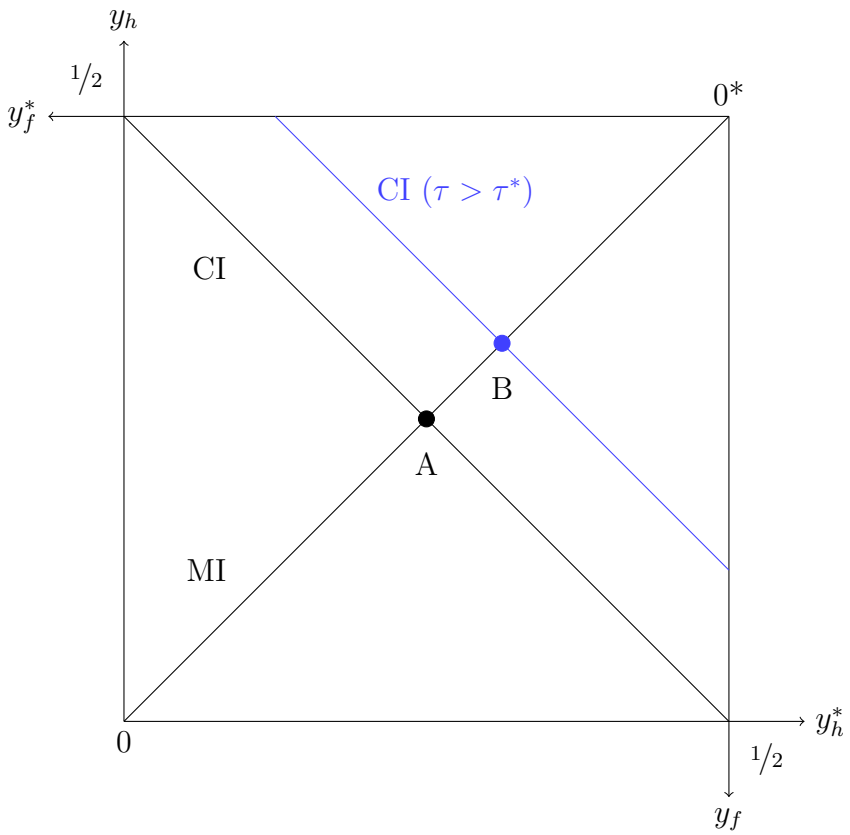

Figure 2.2: Unilateral Taxation with $\tau > \tau^*$

Figure 2.2 illustrates the situation of an increasing tax rate in Home. An increase in the Home tax rate shifts the CI line upwards, because Home gains tax revenue at the cost of Foreign profits and Foreign tax revenues, which increases the available real income of the Home representative consumer. The CI line's position can be interpreted as welfare, with a movement to the upper right corner indicating increasing welfare for Home. The MI line is unaffected by unilateral taxation, because the tax does not directly influence firms' profit optimization with $g = 0$.[12] Thus, the new equilibrium point B is at the intersection of the new CI and the unchanged MI line.

However, not only the distribution of income between countries, but also within countries is altered by unilateral tax policy. Tax revenues increase in Home and decrease in Foreign. More importantly, after-tax profits fall while wages remain unchanged. Therefore, the labor-to-profit ratio increases in both countries.

2.4 Effects of Transfer Pricing

Up to this point, multinational companies were assumed to adhere to the arm's-length benchmark in their transfer pricing decisions. Effectively, unilateral tax policy led to a redistribution of profits towards tax revenue in the high-tax country. This stimulates demand in Home and reduces it in Foreign. These changes in demand patterns caused an increase of supply and prices in the high-tax country and a reduction of these in the low-tax country.

Now we introduce some scope into the companies' transfer pricing decision. They can deviate from the transfer price benchmark of marginal costs in order to

[12] As seen in equation (2.20), the intercept is zero for $g = 0$.

reduce their tax payment in the high tax country. This will have two initial impacts on the economy. On the one hand, aggregate tax revenue will decrease. This is driven by a tax revenue decrease in the high-tax country, which is not compensated by increasing tax revenues in the low-tax country. It affects the countries' demands, because the income differences, which originated from the unilateral tax policy, are diminishing. The ensuing revenue mechanism will lead the firms to adjust their supplies. On the other hand, all companies have an additional incentive to export, as with each unit of exports more taxes can be avoided. The profit shifting mechanism gives rise to a supply side impetus.

We analyze how the equilibrium is affected by the initial increase in the transfer pricing scope parameter g at $g = 0$. First, we show the reaction of the demand aggregator $\hat{\lambda}$ in Home.

Lemma 2.3 (Effect of g on $\hat{\lambda}$)**.** *The equilibrium marginal utility of income in the high-tax country $\hat{\lambda}$ increases in the transfer pricing scope g.*

Proof. See appendix. □

Using this lemma, we can show the effect of g on the other variables. In equilibrium, all variables are affected by a marginal change of g. Firstly – and in line with partial equilibrium results in equation (2.16) – aggregate exports increase due to changing exporting incentives.

Proposition 2.2 (Trade Creation Effect)**.** *The number of exported units increases in the transfer pricing scope g.*

Proof. See appendix. □

The supply channel is portrayed by this trade creation effect and acts as an incentive for firms to increase their production. In general equilibrium, however, total production is fixed by the labor supply. Therefore, only the labor demand increases and nominal wages will rise in both countries if g is marginally increased as a consequence.

However, this supply channel is not the only effect of tax-motivated transfer prices in general equilibrium. Firms effectively reduce their tax payments and the imbalances between countries from asymmetric taxation get reduced. Therefore, an additional demand channel influences the firms' supply decisions by partially reversing the effect of asymmetric tax policy.

We exemplify the demand channel by looking at the prices. We show that the price in the high-tax country Home decreases, if g is increased. Income is transferred across countries. Most importantly, Home tax revenues are reduced as tax bases move towards the low-tax country Foreign. At the same time, tax payments are reduced leading to higher profits, especially for Foreign firms. The increased wages do not have a direct effect on demand as they remain within a country – even though they affect the companies' tax bases. The change in incomes across countries affects demand, which will lead to increasing prices in Foreign and decreasing prices in Home. This in turn affects the firms' marginal revenues in the two countries such that they increase their supply to Foreign and reduce the sold quantities in Home.

For Home country firms, both channels – demand and supply – operate in the same direction. They want to export more as they can avoid more taxes with increased exports. Additionally, the increased demand in Foreign stimulates exports further. Firms producing in the low-tax country Foreign face conflicting

incentives. On the one hand, they want to exploit tax saving possibilities by exporting more towards Home. On the other hand, prices in Home shrink making sales less profitable there.

The change in exports by Home and Foreign firms respectively if g increases is given by:

$$\begin{aligned}\frac{\partial y_f}{\partial g} &= \underbrace{\left(\frac{1}{2}-\frac{2}{3}\frac{a}{b}\right)\frac{\partial\hat{\lambda}}{\partial g}}_{\text{Demand-Channel}>0} \\ &\quad \underbrace{+\frac{1}{3b}\frac{(\tau-\tau^*)(3-2\tau-\tau^*)}{(1-\tau)(1-\tau^*)}\left(\hat{\lambda}(1-\hat{\lambda})+g(1-2\hat{\lambda})\frac{\partial\hat{\lambda}}{\partial g}\right)}_{\text{Supply-Channel}>0} \qquad (2.21)\\ \frac{\partial y_h^*}{\partial g} &= \underbrace{\left(\frac{2}{3}\frac{a}{b}-\frac{1}{2}\right)\frac{\partial\hat{\lambda}}{\partial g}}_{\text{Demand-Channel}<0} \\ &\quad \underbrace{+\frac{1}{3b}\frac{(\tau-\tau^*)(3-\tau-2\tau^*)}{(1-\tau)(1-\tau^*)}\left(\hat{\lambda}(1-\hat{\lambda})+g(1-2\hat{\lambda})\frac{\partial\hat{\lambda}}{\partial g}\right)}_{\text{Supply-Channel}>0} \qquad (2.22)\end{aligned}$$

The demand channels partly reverse the effects of asymmetric taxation seen in equations (B.1) and (B.2). With Lemma 2.3 we can determine the directions of the two channels at $g = 0$. Depending on the exogenous parameters, Foreign firms may increase or decrease their supply in Home.

Welfare will be affected by the possibility of tax motivated transfer pricing. Again, welfare is measured by the consumed quantities in either country. However, we cannot clearly show where consumption increases if tax-motivated transfer pricing is possible. It hinges on the export activity of Foreign firms. If the demand channel they experience is weaker than the supply channel, their exports increase

– possibly more than the exports from Home firms to Foreign. If, however, the demand channel outweighs the supply channel, Foreign firms will also supply more to their own country Foreign. In the latter case the reaction of consumption is straightforward, in the former case it is not possible to determine the sign of the changes in consumption in general.

Turning to welfare effects, we set $\tau^* = 0$ to abstract from complicating tax revenue effects in Foreign.[13] In that setting, Foreign firms will increase their exports, but by smaller amounts than Home firms. This translates into increased consumption in Foreign. As total production is unchanged, consumption in Home will decrease.

Proposition 2.3 (Cross-Country Welfare Effect)**.** *Welfare decreases in the high-tax country and increases in the low-tax country in the transfer pricing scope g for $\tau^* = 0$.*

Proof. See appendix. □

Graphically, the demand effect is captured by the CI line. The decreasing consumption corresponds to a downward-shift of the CI line as real income in Home (the intercept) decreases, while the opposite is true for Foreign. This effect persists for $g > 0$ as long as the transfer pricing scope does not become too large.[14] The supply effect corresponds to a downward-shift of the MI line as the intercept is no longer zero, but decreases. This partial effect of exporting attractiveness is unrelated to the CI line, that shifts without altering the aggregate trade quantity of the world.

[13] Due to mathematical complexity, it is computationally difficult to proof the proposition for the general case of $\tau^* > 0$. However, for a specific case such as $a = 1$ and $b = 3/4$ we show in the supplement that the welfare effect holds for all $0 < \tau^* < \tau < 1$.

[14] See the supplement for this derivation.

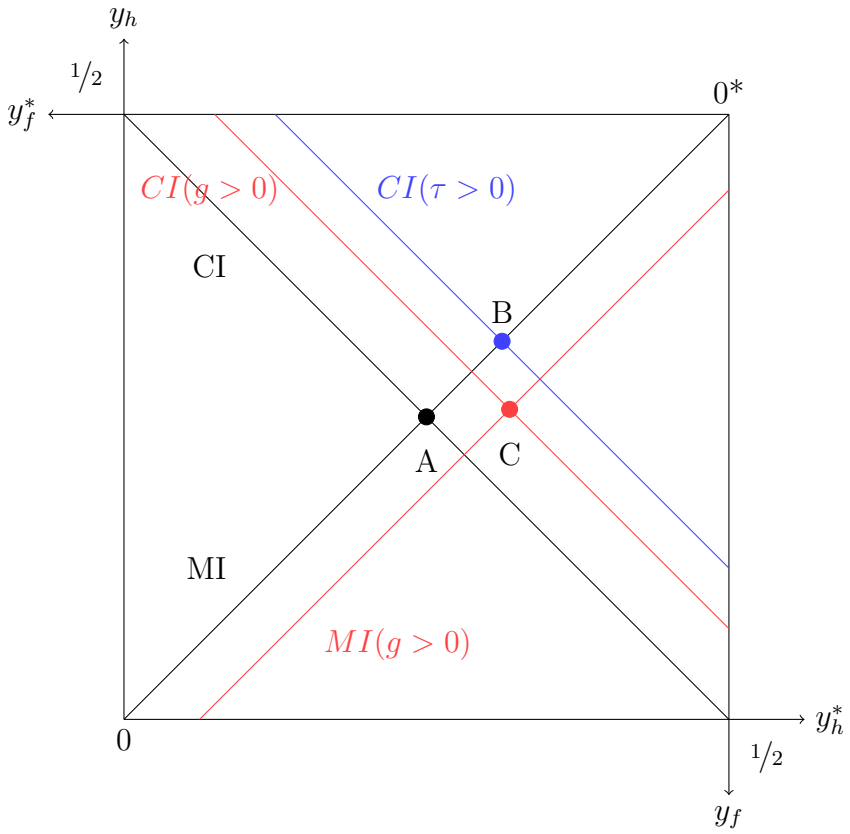

Figure 2.3: Transfer Pricing at $\tau^* = 0$

Figure 2.3 illustrates the effects of transfer pricing, when Home is the high-tax country. Firms can shift a part of the tax base to the low-tax country Foreign to reduce their tax payments. Hence, less of Foreign firms' profits are distributed to the Home country in the form of tax revenues. Thus, allowing for transfer pricing possibilities shifts the CI line towards its original location. Furthermore, each market is no longer identical to all firms, because all firms want to export more to be able to shift profits. Accordingly, the MI shifts to the bottom right, indicating a higher desire to export. The new intersection point C gives the new equilibrium with more exporting and less welfare-shifting between the countries as compared

to point B without transfer pricing but with tax differences.

We now turn to within-country distributive effects of transfer pricing in our framework. We focus on real wages and real profits and show that the firms do not necessarily gain from the profit shifting possibility.

Proposition 2.4 (Within-Country Distribution Effect)**.** *If the transfer pricing scope g rises, real wages increase in both countries. Real profits increase in g in the high-tax country and decrease in the low-tax country for* $\tau^* = 0$*. Thus, in the low-tax country the labor share grows.*

Proof. See appendix. □

In general equilibrium, nominal profits increase for Home firms and decrease for Foreign firms. All companies face higher wages, reducing their profits. However, wages in Foreign increase more strongly. Additionally, for Home firms the demand and supply channel work in the same direction so they increase exports to Foreign, where prices increase. This affects the profits positively. Foreign firms are faced with differing incentives and export to the shrinking market with decreasing prices. The benefit is therefore reduced and the negative wage effect prevails in Foreign. These nominal profit effects are reinforced by the price changes. In Foreign prices increase and profits decrease such that real profits will decrease as well. In Home, nominal profits increase and prices decrease resulting in increasing real profits.

2.5 Conclusion

We analyze the effects of corporate taxation and tax-motivated transfer pricing in a general oligopolistic equilibrium trade model with segmented markets. Without

profit shifting, an increasing profit tax rate shifts welfare towards the tax-increasing country, where it also decreases real wages, whereas real wages rise in the other country. Labor income increases relative to profit income in both countries. Transfer pricing generates an additional benefit from exporting, such that companies want to expand production. Caused by this supply channel, nominal and real wages will rise in both countries. Due to shifting tax incomes, a cross-country demand channel relocates consumption from the high- to the low-tax country, thereby increasing welfare in the latter on cost of the former. In the low-tax country, real profits decrease such that the labor share of income rises.

It would be interesting to develop a multi-country extension that might facilitate to bring some of the model's predictions to the data. Likewise, competition between national governments either in tax rates or in effective transfer pricing scope is an interesting avenue for future work.

Chapter 3

How Protectionism Harms Workers Under Oligopoly*

3.1 Introduction

Protectionist measures have been put forward as a tool to improve the economic situation of workers in recent political debates.[1] Economic theory suggests that a large country can improve its welfare by use of import tariffs under perfect competition; at least if there is no foreign retaliation. However, evidence of rising profit shares in the global economy points at a growing importance of large firms' market power.[2] The optimal tariff argument has been extended to the case of

*A previous version of this chapter circulated as cege Discussion Paper No. 407 (Rudsinske, 2020). I thank Udo Kreickemeier, Ansgar F. Quint, Julian Sengewald, Florian Unger as well as various seminar participants for valuable comments.

[1] See, for example, Polaski et al. (2020), Ernst et al. (2019) or the intention to "put American workers first" by Trump (2018).

[2] See, for example, Barkai (2020), De Loecker et al. (2020), Autor et al. (2020) as well as Shepotylo and Vakhitov (2020).

oligopolistic competition only in partial equilibrium.[3] To determine whether workers actually benefit from protectionism, one needs to consider distributional effects and, thus, turn to a general equilibrium. This raises the question whether a country can still benefit from unilaterally increasing its import tariffs in general oligopolistic equilibrium. To answer it, country asymmetries with regard to tariff rates need to be incorporated into a general oligopolistic equilibrium model.[4]

I show theoretically that even for the best possible case of absent foreign retaliation, although a country can raise its real income by means of import tariffs, real labor incomes falls. To reach the policy objective of raising workers' economic welfare, trade policy needs to be combined with social policy. Even when lump-sum transfers to labor income recipients are feasible without causing distortions, the marginal rise in tariff revenue will be large enough to compensate the marginal loss in real labor income only up to certain tariff rates in the initial symmetric situation. Thus, extensive trade policy with this objective additionally needs to integrate profit taxation, which might be distortionary in its own right.

With oligopolistic competition, import tariffs have an anti-competitive effect that reduces labor demand because firms want to shorten supply. Consequently, wages fall in general equilibrium. Empirical evidence supports such a negative effect of import tariffs on labor income.[5] Accordingly, import tariffs by itself are no suitable policy tool for improving the situation of workers.

If there is foreign retaliation, symmetric countries set identical tariffs in Nash

[3] See, for example, Brander and Spencer (1984). The approach to transfer it to general oligopolistic equilibrium by Colacicco (2012) is discussed later on in this section.

[4] In the GOLE context, this implies allowing the countries' marginal utilities of income to differ.

[5] Giovannetti et al. (2020) show that tariff protection lowered real wages in Egypt. Xu and Ouyang (2017) find that tariff reductions increased wages in China.

equilibrium and tariff revenue is never sufficient to compensate labor income – especially not relative to rising profit income. Furceri et al. (2019) analyze the effects of tariffs in 151 countries from 1963 to 2014 and find that tariffs increase income inequality. This is in line with my theoretical prediction of a falling ratio of labor to profit income, if profit income recipients earn more than workers ex ante.

I analyze unilateral and non-cooperative trade policy in a two-country asymmetric general oligopolistic equilibrium (AGOLE) trade model based on Quint and Rudsinske (2020a). Import tariffs act as a trade barrier, such that cross-country strategic competition is reduced and firms want to produce less. A general equilibrium is necessary to capture the negative wage effects related to this. At the same time, the general equilibrium opens a cross-country demand channel that causes asymmetric income and price effects in the two countries. While firms from both countries increase nominal markups when tariffs reduce cross-border competition, the tariff-increasing country gains a part of the foreign firms' markup adjustment in the form of tariff revenue. Thus, strategic competition among oligopolists causes foreign firms to bear a part of the tariff burden, in order to artificially inflate their foreign prices by reducing exports less than they would in absence of market power, thereby limiting their domestic supply. Without foreign retaliation, increasing the import tariff from a symmetric starting point raises domestic welfare at the other country's expense. However, this comes at the cost of favoring profit as compared to labor incomes, as real wages fall. For small initial symmetric tariffs, the protectionist government can use its tariff revenue to neutralize this distributional effect, the other government cannot. As the model does not feature any aggregate gains from trade, the non-cooperative Nash equilibrium is at prohibitive symmetric tariffs. Thus, free trade agreements can be desirable from a social welfare perspective even

without gains from trade as they lower firms' market power and raise the labor share under oligopolistic competition.

The paper is related to several strands of the literature. First, it extends the literature on optimal tariffs[6] to the case of general oligopolistic equilibrium. Fleming (1956) analyzes optimal tariffs for the case of two countries with differing but exogenous marginal utilities of income. While this stresses the role that country differences play, it does not reflect possible endogenous effects of trade policy on the marginal utility of income as present in this paper. When trade policy is able to shift real income between countries, this is likely to affect the marginal utility of income. With a decreasing marginal utility of consumption, higher consumption causes additional income to buy less utility at constant prices. A surge in domestic prices, which I show is a side effect of strategic import tariffs in general oligopolistic equilibrium, intensifies this channel.

Second, the paper is related to the literature on import tariffs under oligopoly as well as to the literature on the influence of import tariffs on the factor income distribution. Brander and Spencer (1992) show that tariffs distort pro-competitive effects of intra-industry trade in a reciprocal dumping model as described by Brander (1981). This is an important channel that transfers to the broader general equilibrium model presented here. However, a pronounced difference to their model is that marginal costs are no longer constant but endogenously affected by trade policy. Accordingly, domestic tariffs affect sales in the foreign country as well. When

[6] Kaldor (1940) and De Scitovszky (1942) formalize that at least in absence of foreign retaliation it can be optimal for a country to charge positive import duties. Bond (1990) generalizes the optimal tariff argument for a large economy from two-goods to higher dimensions. Gros (1987) shows that even for a small economy a positive tariff can be optimal under product differentiation and monopolistic competition. Felbermayr et al. (2013) extend this to the case of a large one-sector economy with heterogeneous firms and preferences that exhibit a constant elasticity of substitution.

foreign firms export less due to a rise in tariffs, they want to reduce production. In general equilibrium, this pushes down wages until full employment is restored, which results in higher sales by foreign firms in the foreign country. This effect on the factor income distribution is present in Bastos and Kreickemeier (2009), who model a specific symmetric tariff within a general oligopolistic equilibrium model that features labor unions. They find that a marginal decline in symmetric tariffs increases wages, decreases profits and does not affect prices and welfare. This corresponds to my results for symmetric tariffs, which is not surprising as tariffs are the sole source of asymmetry in the model. To analyze strategic trade policy, we have to allow countries to set different tariffs and then check how the factor income distribution is affected.

Their model is based on Neary (2016), who proposes a trade model for the case of general oligopolistic equilibrium (GOLE), where countries are symmetric in every characteristic necessary to ensure that their marginal utilities of income are identical. This allows to analyze strategic interactions among firms in a general equilibrium setting. The existing literature on tariffs in GOLE focuses on symmetric tariffs, which does not allow to study the strategic dimension of unilateral trade policy and the effects of asymmetric tariff rates.[7] Colacicco (2012) analyzes strategic trade policy in a GOLE-style framework, but only models the demand-side of one country, such that a cross-country demand channel is ruled out by definition.[8] Although

[7] J. Zhang (2017) analyzes a symmetric reduction in trade costs between two trading partners in a GOLE model with product differentiation. Fujiwara and Kamei (2018) focus on the effects of a symmetric tariff reduction in a GOLE model with an explicit division of labor. They find differences in the effects on productivity in trading and non-trading industries.

[8] He assumes that the total produced quantity in both countries will be supplied to and consumed in the home country. This rules out any strategic considerations of companies with regard to their supply decision over the home and the foreign market. Furthermore, the home country by definition has to run a trade balance deficit.

a vast literature on optimal tariffs exists, the influence of strategic interactions among large firms in a general equilibrium setting and the ability of governments to tackle tariff-induced distributional effects have not been analyzed adequately.

In Quint and Rudsinske (2020a) we extend the GOLE to feature asymmetric countries with segmented markets (AGOLE), which allows analysis of a wider variety of topics.[9] As the AGOLE allows to include asymmetric import tariffs, unilateral trade policy can be studied in this framework. Trade in the AGOLE model with a featureless economy, i.e. the same technology in all sectors, behaves similarly as in the partial oligopolistic equilibrium model of Brander and Krugman (1983). Strategic considerations among firms give rise to two-way trade in homogeneous goods. With positive tariffs in the AGOLE, marginal costs are higher for exporting, which pushes down markups on foreign relative to domestic sales ceteris paribus. Therefore, firms sell more domestically and reduce exports.

The paper is structured as follows. I introduce the theoretical model and the solution strategy in Section 2. In Section 3, I present the effects of symmetric import tariffs as a benchmark to stress the role of the cross-country demand channel in the asymmetric case. I present the welfare and distributional effects of unilaterally raising the import tariff in Section 4, where I also derive the non-cooperative Nash equilibrium tariffs. The final section concludes, while most proofs are deferred to the appendix.

[9] In Quint and Rudsinske (2020b), for example, we apply the AGOLE model to the case of tax-motivated transfer pricing.

3.2 Theoretical Model

I adapt a two-country model of international trade in general oligopolistic equilibrium developed by Neary (2016) and extended by Quint and Rudsinske (2020a) for the case of asymmetric countries with segmented markets. In the following, I will only present the expressions for the country Home in most cases. Expressions for Foreign are analogous. Variables referring to Foreign will be marked with an asterisk.

3.2.1 Demand and Supply

Each country is inhabited by one representative consumer. Her continuum-quadratic preferences are additively separable and she inelastically supplies L units of labor to a perfectly competitive labor market.

$$U[\{y(z)\}] = \int_0^1 u[y(z)]dz \quad \text{where} \quad u[y(z)] = ay(z) - \tfrac{1}{2}\, by(z)^2,$$

with $\frac{\partial U}{\partial y(z)} > 0$ and $\frac{\partial^2 U}{\partial y(z)^2} < 0$. Here, $y(z)$ is the amount of consumption of a homogeneous good produced in sector $z \in [0, 1]$ and a as well as b are parameters with $a, b > 0$. a and b are identical in both countries. The representative consumer is indifferent between domestic goods and imports in each sector z.

The yet to be determined wage rate will result in a wage income of wL. Additionally, aggregate profits (Π) and tariff revenues (T) are disbursed to the representative consumer. Accordingly, her income is given by

$$I = wL + \Pi + T. \tag{3.1}$$

With price $p(z)$ per unit of the good in sector z, the budget constraint is

$$\int_0^1 p(z)y(z)dz \leq I. \tag{3.2}$$

Utility function and budget constraint lead to the utility maximization problem represented by the Lagrangian: $\max_{y(z),\forall z} \mathcal{L} = \int_0^1 \left(ay(z) - 1/2\ by(z)^2\right) dz + \lambda \left(I - \int_0^1 p(z)y(z)dz\right)$. The first order condition then gives $0 = a - by(z) - \lambda p(z)$ for all sectors z with λ being the Lagrange-parameter and therefore the marginal utility of income. The inverse Frisch demand follows straightforwardly and is given by

$$p(z) = \lambda^{-1} \frac{\partial u[y(z)]}{\partial y(z)} = 1/\lambda [a - by(z)]. \tag{3.3}$$

The inverse demand functions (3.3) negatively depend on the marginal utility of income. A higher value of λ in equilibrium, ceteris paribus, indicates a lower equilibrium demand for goods.

The producers aim to maximize their profits given the demand and the import tariffs. Analogously to Neary (2016), firms are assumed to have market power in their respective markets. However, they do not have a deliberate influence on aggregate economic factors like λ and w, because a continuum of sectors exists and jointly determines those factors.

In their profit maximization, the firms have to take the tariff into account. They determine their domestic supply and their export supply separately. I assume that n firms exist in Home in each sector z and that there are neither fixed costs of production nor transport costs. The firms play a static one-stage game where they compete in Cournot competition over output in the Home and Foreign market. They take the consumers' demand as given and perceive the inverse demand as

linear – irrespective of the functional form of λ – as companies by assumption do not have an individual influence outside their own sector.

Production occurs with constant returns to scale and common technology in each sector z, such that cost $c(z)$ in sector z are linear in output. Labor is the only factor of production. Labor L moves freely across sectors within a country, but not across national borders, such that the wage rate is determined at the country level by combining the inelastically supplied labor L and the demand for labor resulting from the companies' production.

The sector-specific common unit-labor requirement is $\gamma(z)$. The unit-cost function for sector z is then given by $c(z) = w\gamma(z)$ where w is the national wage. To keep the model as simple as possible, I only consider the case of identical technology across sectors and countries $\gamma(z) = 1\ \forall z$ so we can drop the index z, although their is still a continuum of now identical sectors. Thus, the model does not capture a Ricardian-style technological comparative advantage as it did in Neary (2016). Trade in this setting is always of intra-industry type and caused solely by strategic considerations among oligopolists. As companies remain small in the large, they do not take their effect on wages into account when maximizing their profits. Therefore, marginal costs are constant and equal across the countries where they sell the good.

Because all sectors in a country are identical, they have identical prices. Accordingly, there is no endogenously changing price heterogeneity that could affect the utility of the representative consumer as in Neary (2016). With a strictly increasing marginal utility of consumption, this implies a strictly monotonic relationship between consumption (or real income) and welfare defined as utility of the representative consumer. Thus, for the direction of effects these terms can be used

interchangeably.

Before firms and consumers act, the national government sets an import tariff denoted by t, which uniformly applies to all sectors. Tariffs are specific, so they accrue per unit of imported goods. Profits of one Home firm are given by $\pi = (p - c)y_h + (p^* - c - t^*)y_f$, where y_h is domestic and y_f is export supply.

3.2.2 Cournot Equilibrium

For solving the Cournot equilibrium we take the demand parameters $\lambda^{(*)}$ and the wages $w^{(*)}$ as exogenously given. One country's demand for goods from a specific sector is given by equation (3.3). All companies active in that sector compete in Cournot competition to satisfy this demand simultaneously.

Firms will maximize their profits by choosing the amount of goods to produce and sell given the demand, the tariffs, and the other companies' supply.

$$\begin{aligned} \max_{y_h, y_f} \pi &= [p - w]\, y_h + [p^* - w - t^*]\, y_f \\ &\quad \text{with } p = {}^1\!/\!_\lambda[a - by] \text{ and } p^* = {}^1\!/\!_{\lambda^*}[a - by^*], \end{aligned}$$

where p and p^* are the inverse demand functions in Home and Foreign, and y describes the total supply of the good in Home and y^* in Foreign. y_i denotes the supply of one company producing in Home (no asterisk) to country i, whereas y_i^* denotes the supply of one company producing in Foreign (*) to country i, where i is either the country Home (h) or Foreign (f).

Bearing in mind that companies from the same country are symmetric, the first order conditions from the firms' profit maximization over their supplied quantities

can be rearranged to

$$\begin{aligned} w &= \frac{1}{\lambda}\left(a - b(n^* y_h^* + (n+1)y_h)\right), \\ w + t^* &= \frac{1}{\lambda^*}\left(a - b(n^* y_f^* + (n+1)y_f)\right). \end{aligned} \tag{3.4}$$

They can be transformed into reaction functions to the supply of Foreign companies in the respective markets.

$$y_h = \frac{a - \lambda w - b\ n^*\ y_h^*}{b(n+1)} \tag{3.5}$$

$$y_f = \frac{a - \lambda^*(w + t^*) - b\ n^*\ y_f^*}{b(n+1)} \tag{3.6}$$

The equation for supply to Foreign shows the expected negative effect of the foreign import tariff.

Combining the reaction functions, we obtain the Cournot-Nash-equilibrium supply for Home (Foreign) companies y_i (y_i^*) in both markets. The equilibrium supply of each individual company to the Home market is

$$y_h = \frac{a + \lambda\left\{n^*(w^* + t) - (n^* + 1)w\right\}}{b(n + n^* + 1)} \tag{3.7}$$

$$y_h^* = \frac{a + \lambda\left\{nw - (n+1)(w^* + t)\right\}}{b(n + n^* + 1)}. \tag{3.8}$$

The supplied quantities in Foreign are analogous:

$$y_f^* = \frac{a + \lambda^*\left\{n(w + t^*) - (n+1)w^*\right\}}{b(n + n^* + 1)} \tag{3.9}$$

$$y_f = \frac{a + \lambda^*\left\{n^* w^* - (n^* + 1)(w + t^*)\right\}}{b(n + n^* + 1)}. \tag{3.10}$$

This leads us to total production by Home firms $\bar{y} = n(y_h + y_f)$ and total supply to the Home market $y = ny_h + n^* y_h^*$:

$$\begin{aligned} \bar{y} &= \frac{n}{b(n+n^*+1)} \{2a + (\lambda+\lambda^*)(n^* w^* - (n^*+1)w) + \lambda n^* t - \lambda^*(n^*+1)t^*\} \\ y &= \frac{a(n+n^*) - \lambda\,(nw + n^*(w^*+t))}{b(n+n^*+1)}. \end{aligned}$$

3.2.3 Labor Market and General Equilibrium

With the Cournot-Nash-equilibrium supply derived above, we can now turn to the clearing of the labor market. Inelastic labor supply amounts to $L^{(*)}$ units in the respective countries. Labor demand depends on the total equilibrium production $\bar{y}$ in the respective country and is given by $L^D = \bar{y}$. In equilibrium demand has to equal supply, such that $L = \bar{y}$. In combination with the analogously defined equilibrium on the Foreign labor market, wages in both countries are defined as:

$$w = \frac{1}{\bar{\lambda}} \left\{ 2a - b \left[\frac{n+1}{n} L + L^* \right] - t^* \lambda^* \right\} \tag{3.11}$$

$$w^* = \frac{1}{\bar{\lambda}} \left\{ 2a - b \left[\frac{n^*+1}{n^*} L^* + L \right] - t \lambda \right\}, \tag{3.12}$$

where $\bar{\lambda} = \lambda + \lambda^*$. For equal labor endowment and industrial structure across countries, wages are equal if $t = t^* = 0$. The wage is reduced when the trading partner charges an import tariff.[10]

I normalize the aggregate marginal utility of income to unity, i.e. $\bar{\lambda} = 1$. Hence, the aggregate marginal utility of income is used as numéraire. This translates into the relationship between λ and λ^* that $\lambda^* = 1 - \lambda$. Additionally, we know that

[10] We know this because $\lambda > 0$ and $\lambda^* > 0$ have to hold in any case.

both marginal utilities of income will lie between zero and one because both have to be positive.

In equilibrium the model is characterized by nine equations in nine endogenous variables. The Cournot equilibrium quantities ((3.7) – (3.10)) determine the supply of each multinational company to each country. The labor market clearing in each country determines the wage rate ((3.11) and (3.12)). The prices are given by the representative consumers' inverse demand functions ((3.3) for Home, analogously for Foreign).

We can now use the budget constraint of the representative consumer as ninth equation to attain an implicit solution for the equilibrium marginal utility of income in Home. The budget constraint is given by

$$p \cdot (n\ y_h + n^*\ y_h^*) \quad = \quad w\ L + n\ \pi + T.$$

This can be rearranged to obtain that the Home balance of payments (BoP) has to be zero in equilibrium:

$$BoP = (n^* t y_h^* - n t^* y_f) + (n p^* y_f - n^* p y_h^*) = 0 \tag{3.13}$$

The left term in parentheses is the capital balance, which in this model is the Home tariff revenue minus the Foreign tariff revenue. The right term in parentheses depicts the trade balance, i.e. Home export value minus Home import value. This allows for trade imbalances if these imbalances are offset by capital transfers resulting from differing tariff payments of the companies across countries. Note that according to Walras' law the Foreign BoP will automatically be zero, if the

Home BoP is.

We can now further simplify the system of equations by expressing all endogenous variables in terms of exogenous parameters and λ only.[11] These formulations can then be inserted in the balance of payments condition such that we only have one equation in one variable left.

Without loss of generality Home is the high-tariff country, i.e. $0 \leq t^* \leq t$. For simplicity, assume $n = n^* = 1$ and $L = L^* = 1/2$. To ensure a positive marginal utility of consumption and positive quantities in absence of tariffs in any case, assume $2/3\ a < b < a$.[12]

For the admissible range $\lambda \in (0, 1)$ there exists one unique solution to the balance of payments condition under these assumptions if the tariffs are not too large. A tariff upper bound is obviously needed to ensure positive quantities and prices.[13]

Lemma 3.1 (Existence and Uniqueness)**.** *There exists a solution to the condition of an even balance of payments (3.13) in* $\lambda \in (0, 1)$*, which is unique if* $t = t^* \leq b \ \vee \ 0 \leq t^* \leq t < \bar{t}$*.*

Proof. See appendix. □

Unfortunately, we cannot determine the equilibrium marginal utility of income $\hat{\lambda}$ in closed form if $t \neq t^*$, as in the equilibrium condition (3.13) it is derived from a

[11] See Appendix C.1 for these equations.

[12] A positive marginal utility of consumption requires $a > b\ y$ in equilibrium. To ensure that this condition holds I take the most extreme case where $y = L + L^* = 1$. This leads to $b < a$. More generally, one needs $b < a/(L+L^*)$. This also assures positive wages at $t = 0$, which require $b < 2a\,((n+1/n)L + L^*)$. It is shown in the supplement that $\frac{2}{3}a < b$ is a sufficient condition for quantities to be positive for all admissible values of λ in absence of tariffs, i.e. $t = t^* = 0$.

[13] We will see later on that b is the prohibitive symmetric tariff, while due to complexity $\bar{t}$ is chosen as a sufficient but not a necessary upper bound for the higher Home tariff when tariffs are asymmetric.

quintic polynomial. According to Abel's impossibility theorem, there is no solution to this polynomial in radicals. However, it is possible to determine derivatives of $\hat{\lambda}$ with respect to exogenous parameters by implicitly differentiating the equilibrium condition given by equation (3.13).

3.3 Symmetric Tariffs

When countries are completely symmetric, their marginal utilities of income need to be equal to one another. With $1 = \lambda + \lambda^*$, this boils down to $\lambda = 1/2$ irrespective of the symmetric tariff rates. This makes the analysis of the symmetric case much easier. All prices and quantities are equal in both countries. Without any tariffs and fully symmetric countries, the model collapses to the case of no market segmentation. Symmetric tariffs do not distort the symmetry of the equilibrium. However, they do have an impact on international trade and the within-country income distribution.

Proposition 3.1 (Effects of Symmetric Tariffs)**.** *Rising symmetric tariffs reduce international trade and wages, and increase profits. Thus, the labor-profit ratio falls. The gain in tariff revenue is neither sufficient to offset the negative effect on labor income in absolute terms nor relative to profit incomes, if* $t > 0$.

Proof. See appendix. □

Because of the tariff barrier, firms want to export less. Thus, they want to reduce production. In order to restore labor market equilibrium, wages have to fall. Due to lower wage costs, firms supply more to their country of origin. Equilibrium prices are not affected, such that with the fall in wage costs profits grow. As prices

and consumption are not affected, also the representative consumer's income has to be unaffected. The fall in wage income has to account for both the rise in profit income and the surge in tariff revenue. Thus, the labor share of income decreases while the profit share increases.

In absence of good opportunities for governments to gain revenue, it can be interesting for them to cooperatively gain or even maximize tariff revenue at $t = b/2$.[14] However, for $t > 0$ the marginal gain in tariff revenue ($\frac{1}{4} - \frac{t}{2b}$) is not even sufficient to offset the negative marginal effect on labor income in absolute terms ($-\frac{1}{4}$) and especially not relative to profit incomes that marginally rise by $\frac{t}{2b}$. The terms show that the rise in tariff revenue is maximal at the initial zero-tariff situation with $\frac{1}{4}$, which exactly offsets the negative effect on labor income. If the tariffs rise symmetrically, the effect on labor income remains constant, but there is a rising positive effect on profit incomes which directly reduces the marginal increase in tariff revenue. At maximal tariff revenue with $t = \frac{b}{2}$, profit income has grown by $\frac{b}{16}$,[15] labor income has fallen by $\frac{b}{8}$[16] and tariff revenue has increased by what is left from the labor income reduction after accounting for rising profits, i.e. $\frac{b}{8} - \frac{b}{16} = \frac{b}{16}$. At that point as compared to $t = 0$, profit income has increased by 25% and labor income has dropped by $\frac{100}{8\frac{a}{b}-6}$%, which is larger the closer b is to a, i.e. the more the marginal utility of consumption reacts to a rise in consumption. Remember that we have $\frac{2}{3}a < b < a$. For a medium value of $b = \frac{4}{5}a$ wages would have fallen by 25%. As prices are not affected by symmetric tariffs, the result holds both in nominal and real terms. In that setting, moving to the prohibitive tariff

[14] See proof of Proposition 3.1 in the appendix.

[15] As the marginal change is linear in t starting from 0, we can calculate the area of the triangle, which is $\frac{1}{2}$ times the last marginal increase ($\frac{1}{4}$) times the last tariff ($\frac{b}{2}$).

[16] This follows from the constant $-\frac{1}{2}$ over the interval 0 to $\frac{b}{2}$ for $L = \frac{1}{2}$.

$t = b$ would result in a 50% loss of labor income accompanied by a 100% rise in profit income as compared to free trade with the ratio of labor to profit income falling by 75% from 2 to $\frac{1}{2}$. Figure 3.1 plots the development of aggregate profit income, tariff revenue and aggregate labor income for symmetric tariffs beginning from free trade ($t = 0$), over revenue-maximizing symmetric tariffs ($t = b/2$) up to prohibitive tariffs ($t = b$) for the case of $b = 1$.[17] The three sources of income always add up to zero because symmetric tariffs do not change aggregate income when there are no gains from trade.

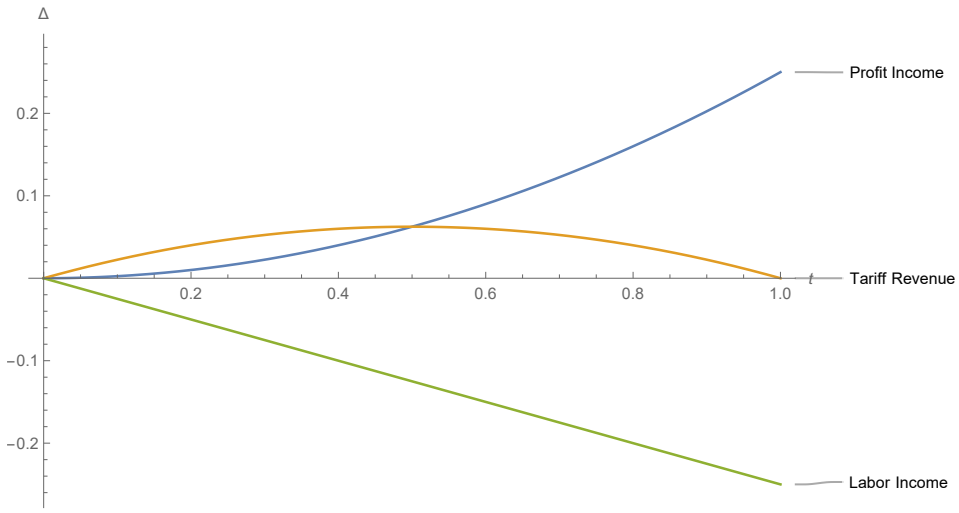

Figure 3.1: Income Differences Compared to $t = 0$ (for $b = 1$)

To give the reader some intuition about the mechanisms that determine the general equilibrium, I decompose the model's operating principle into two fundamental conditions, which is analogous to Quint and Rudsinske (2020a). The consumption indifference condition (CI) states that for utility maximization the origin of the product is inconsequential. The representative consumer is indifferent

[17] b is only a scale parameter here and does not change economic intuitions.

between products in the same sector that are produced in Home and in Foreign. The market indifference condition (MI) states that in equilibrium firms have to be indifferent between selling the marginal unit in Home or in Foreign. We can plot these two conditions in a box diagram with the Home origin (0) in the lower left corner and the Foreign origin (0*) in the upper right corner. The usual notation applies.

The CI is easily derived from the budget constraint.

$$\begin{aligned} I &= p(y_h + y_h^*) \\ CI: y_h &= \frac{I}{p} - y_h^* \end{aligned}$$

It gives us a function with perfect substitutability between Home and Foreign goods from the consumer's perspective, for whom real income I/p is exogenous. Thus, the slope of the CI line is -1 and an increase in real income in Home shifts it towards the upper-right corner. In our initial equilibrium with $I/p = L/n = 1/2$ the intercept is exactly in the upper left corner of the graph. The same can analogously be done for the Foreign representative consumer giving us exactly the same line in the graph.

The MI can be derived from the fact that the marginal revenues of a firm need to be equal in both markets in equilibrium. This follows straightforwardly from the profit maximization in equations (3.4) and (3.5) and can be rearranged to

$$\frac{1}{\lambda}(a - b\bar{y}) = \frac{1}{\lambda} b y_h + \frac{1}{\lambda^*}(a - b\bar{y^*} - b y_f) - t^*$$

and

$$\frac{1}{\lambda}(a - b\bar{y}) = \frac{1}{\lambda}by_h^* + \frac{1}{\lambda^*}(a - b\bar{y^*} - by_f^*) + t.$$

Because these equations have the same left-hand side, we can set the right-hand sides equal, rearrange, and get

$$\frac{t + t^*}{b} = \frac{y_h - y_h^*}{\lambda} + \frac{y_f^* - y_f}{\lambda^*}.$$

This shows that the lower b and the higher the tariffs, the more has to be consumed from domestic producers on each market, where markets are weighted with their demand aggregator (λ^{-1}). b is a parameter from the quadratic sub-utility, where lower b means that marginal utility of consumption is decreasing slower in consumption. From inverse Frisch demand we know that with lower b prices will react less strongly to consumption changes. In that case prices will react less to the direct supply effect of the tariffs and thus dampen it less, such that the equilibrium quantity reactions are larger. Using the normalization $\lambda = 1 - \lambda^*$, as well as $y_f + y_h = L/n = L^*/n^* = y_h^* + y_f^*$ this equation can be rearranged to get a function that we can use to illustrate the equilibrium:

$$MI : y_h(y_h^*) = \frac{t + t^*}{b}\lambda(1 - \lambda) + y_h^*$$

The line has a slope of +1, which in our diagram again is the same from Foreign's perspective. The first term on the right-hand side is exogenous from the firm's perspective as it entails the demand aggregator λ, and the model parameters b, t, and t^*.

Figure 3.2 shows the symmetric-tariff equilibrium at the intersection of MI and

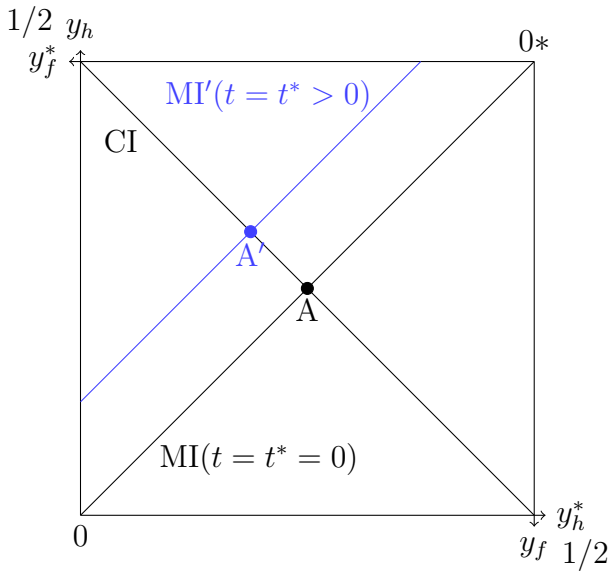

Figure 3.2: Symmetric Equilibrium with $t = t^*$

CI. Without any tariffs we are in point A and both markets are identical from the perspective of all firms. With symmetric but positive tariffs, each firm's domestic market will become relatively more attractive ceteris paribus, such that the MI line shifts towards the upper left corner where international trade decreases. The CI line does not move, which shows us that countries are still doing equally well from a welfare perspective. We can use this graphical depiction later to illustrate the effects of asymmetric tariffs on the consumers and producers. The main point I will stress is that with asymmetric tariffs the CI line shifts and affects the general equilibrium outcome. Also the shift of the MI line will be affected if the countries' marginal utilities of income become asymmetric with an asymmetric tariff, which changes the equilibrium value of λ.

There is no distortion in production across sectors in the featureless economy, such that welfare, real income and consumption do not change. Also the cross-

country demand channel (the CI curve) is switched off as long as both countries are fully symmetric. This is a benchmark scenario that we can use to better understand the mechanisms at work and to compare the effects of asymmetric tariffs in the next section with, where the cross-country demand channel comes into play.

3.4 Asymmetric Tariffs

Let us now allow tariffs to be asymmetric. This enables us to analyze the effects of an marginally increasing Home tariff while keeping the Foreign tariff fixed and equal to the initial tariff in Home for simplicity.[18] Accordingly, Foreign does not engage in retaliation so far. First, we need to determine the effect of an increase in t on the equilibrium marginal utility of income $\hat{\lambda}$.

Lemma 3.2 (Effect of Unilateral Tariff on $\hat{\lambda}$)**.** *A unilateral increase in t decreases the marginal utility of income $\hat{\lambda}$ in the high-tariff country, if $t^* = t < b \ \vee \ 0 \leq t^* \leq t < \bar{t}$.*

Proof. See appendix. □

A first intuition for this result is that domestic tariff revenue rises, which increases domestic income. With higher income, ceteris paribus, the marginal utility of income falls. There is also a general equilibrium price effect affecting this outcome, which follows shortly.

With this result at hand, we can now turn to the analysis of the effects that a unilaterally increasing Home tariff has. Tariffs make it less attractive to sell abroad. When Foreign firms want to reduce exports following a tariff increase in Home,

[18] Note that the propositions in this section do not change fundamentally for $t > t^*$, which I show in extensions 1 and 2 in the supplement as general as possible given the model's complexity.

Home firms will react and fill this supply gap by shifting supply from Foreign to Home. While firms from both countries raise nominal markups when tariffs reduce cross-border competition, the tariff-increasing country Home gains a part of Foreign firms' markup adjustment in the form of tariff revenue. Strategic competition among oligopolists causes Foreign firms to bear a part of the tariff burden. They do this in order to artificially inflate their prices in Foreign by limiting their supply. As production is fixed in general equilibrium, this involves reducing exports less than they would in absence of market power. Consequently, their export price is artificially low, which benefits Home via the terms of trade. One important difference to a case of a large country reaping rents from a foreign monopolist is that the Home oligopolists sell identical products, such that strategic competition gives rise to supply and production reactions in both countries.

Home real income rises at the cost of Foreign. With increasing demand in Home, and symmetrically decreasing demand in Foreign, Foreign exports fall less than Home exports thereby enabling Home to consume more. This cross-country demand channel is an essential mechanism to explain how asymmetric tariffs affect welfare in general oligopolistic equilibrium. It captures the standard terms-of-trade effect that is known from other settings. Because Home demand is higher due to the increased tariff revenue, prices increase in Home relative to Foreign.

Lemma 3.3 (Asymmetric Price Reaction)**.** *When Home raises its tariff at $t = t^*$, prices increase in Home and decrease in Foreign.*

Proof. See appendix. □

As exporting is less attractive with the higher Home tariff, Foreign firms want to produce less. Additionally, in presence of higher trade barriers Home oligopolists

experience growing market power domestically and want to artificially reduce supply to benefit from higher prices, which in equilibrium with fixed labor supply pushes down wages and thus firms' cost. This way, the rising market power comes with higher nominal markups, which explain the growing nominal profits at constant sales, that we find in both countries for $t > 0$. With a fixed labor supply but decreasing labor demand as a result of firms wanting to reduce production, nominal wages are affected. They decrease in Foreign, are unaffected in Home if $t^* = 0$ and decrease in Home if $t^* > 0$.

Also real wages fall in both countries with rising trade barriers in place. Nominal profits rise in both countries. Due to the asymmetric price reactions, real profits (in domestic prices) increase in Foreign. They decrease in Home for low initial tariffs and rise for high initial tariffs. The labor-profit ratio always declines in Foreign, and in Home as well if $t > 0$. This leads to rising inequality if ex ante profit income recipients are richer than workers. Foreign tariff revenue is diminished. Even the rise in Home tariff revenue is too low to neutralize the distributional effect or to compensate labor incomes in Home in nominal and even more so in real terms, if the initial symmetric tariffs are too high.[19]

Proposition 3.2 (Income and Distribution)**.** *When Home raises its tariff at $t = t^*$, real wages decrease in both countries, while real profits increase in Foreign. The reaction of Home real profits is negative for low and positive for high initial tariffs.*

[19] To compensate the marginal distributional effect or the marginal real labor income effect with the marginal rise in tariff revenue, initial symmetric tariffs need to be below certain thresholds, that are both lower than $b/3$, which is a third of the prohibitive symmetric tariff and lower than the revenue maximizing symmetric tariff $b/2$. The threshold is higher for the real labor income effect if a is large relative to b, which implies that the distributional effect of a unilateral tariff increase is the first that cannot be compensated anymore when initial symmetric tariffs would rise. If a is small relative to b, prices react more strongly to growing Home consumption, such that the real wage effect is harder to compensate.

The labor-profit ratio always declines in Foreign, and also in Home if $t > 0$*. Only up to certain initial symmetric tariffs, Home could use its rising tariff revenue to neutralize the distributional effect or the negative effect on labor income, Foreign can never do that because its tariff revenue declines.*

Proof. See appendix. □

If a country raises its tariff from a symmetric starting point, its consumption rises due to the cross-country demand channel and international trade declines. When both countries start at zero tariffs, it is always optimal for each of them to deviate and increase its tariff unilaterally. The unilaterally optimal tariff without Foreign retaliation is lower than prohibitive.[20] A welfare benefit from an increasing tariff goes hand in hand with a loss abroad, because it is a simple reallocation of consumption. Thus, the other country is always better off with catching up to the same tariff. With equal tariffs, both countries have the same welfare again – and again an incentive to deviate upwards. This stops when trade has come to a halt. Thus, prohibitive symmetric tariffs are the unique Nash-equilibrium and we already know that it benefits profit as compared to labor incomes.

Proposition 3.3 (Trade, Welfare and Nash-Equilibrium)**.** *When Home raises its tariff at* $t = t^*$*, consumption increases in Home and decreases in Foreign due to changing terms of trade, while the total quantity traded internationally declines. There exists a unique Nash-equilibrium with prohibitive tariffs.*

Proof. See appendix. □

[20] Due to the model's complexity, the optimal unilateral tariff cannot be derived in closed form. I show this even for the extremely simple case of $a = 1, b = 4/5, t^* = 0$ in the proof of Proposition 3.3 in the supplement, where I also prove that the resulting optimal tariff is, nevertheless, strictly positive and benefits the tariff-imposing country.

World welfare in this setting is not affected by tariffs as there are no gains from trade. When there are comparative advantages, it is likely that the Nash-equilibrium tariff would not be prohibitive but still positive to balance the positive and negative effects of unilateral deviations. In that case, any tariffs and accordingly the Nash-equilibrium outcome would be detrimental from the world's welfare perspective.

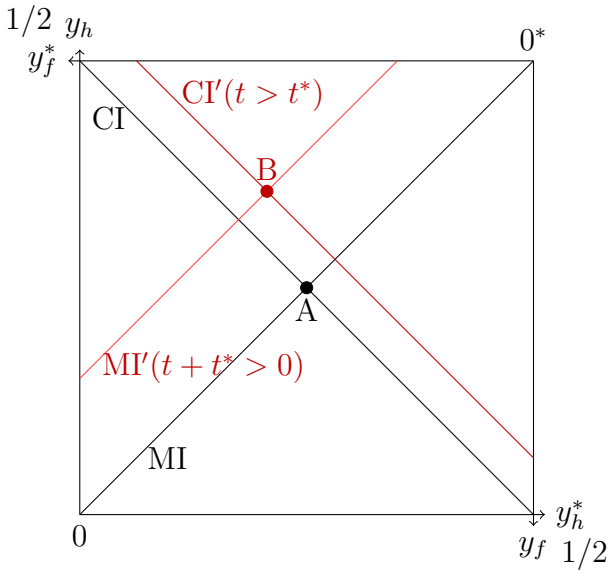

Figure 3.3: Asymmetric Equilibrium with $t > t^* = 0$

Figure 3.3 shows the new equilibrium in point B with a positive tariff in Home and $t^* = 0$. Exporting is less attractive with the tariff, such that the MI curve shifts upwards. Firms need to export less to be indifferent between both markets again. This is also true for Home firms, which are not charged a tariff here, because they face growing competition on the Foreign market from Foreign firms that have reduced their exports in favor of domestic supply. At the same time, Home gains tariff income that is partly absorbed from Foreign profits. This cross-country income reallocation increases real income in Home at the cost of Foreign and gives rise to the cross-country demand channel. As Home now consumes more, the CI

curve shifts upwards, though less than the MI curve, such that also Foreign exports unequivocally decrease if t does not get too large.[21]

3.5 Conclusion

We have analyzed the welfare and distributional effects of unilateral import tariffs in general oligopolistic equilibrium. Import tariffs reduce cross-country strategic competition. To optimize profits, firms want to produce less. They reduce their labor demand such that wages have to fall to restore full employment. A unilaterally higher import tariff can increase welfare, but comes at the cost of favoring profit as compared to labor incomes. The ratio of labor to profit income declines in both countries. With oligopoly, import tariffs have a strong distributional effect that governments should take into account, although tariff revenue alone can be too low to neutralize it.

The AGOLE framework allows to show that even though unilaterally raising the tariff can increase real income in absence of foreign retaliation, trade policy needs to be accompanied by social policy measures or even by profit taxation when the policy objective is to improve the situation of workers in a globalizing world. Possible inefficiencies of profit taxation or lump-sum transfers should be considered jointly with trade policy in order to reach a particular policy objective. In this respect, import tariffs do not appear to be a suitable tool for improving the situation of workers in presence of large firms with market power.

For future work it could be interesting to integrate a Ricardian comparative

[21] An in-depth analysis is provided in extension 1 in the supplement. From Proposition 3.3 follows that at least for small deviations of t from t^* the MI shift has to be the larger one as the reduction in the exported quantity is larger for Home firms.

advantage in order to analyze how a counteracting gains from trade channel would affect the countries' tariff setting. Asymmetries in countries' labor endowment and market concentration could result in asymmetric optimal tariffs, which might be useful in bridging the gap between the theoretical and the empirical literature on "trade wars". Likewise, the introduction of labor market imperfections might be insightful. Furthermore, export subsidies or other forms of trade policy could be analyzed in the AGOLE framework.

Chapter 4

Building Bridges: Bilateral Manager Connections and International Trade*

4.1 Introduction

Recent advances in both theoretical and empirical economics have stressed the importance of micro-level factors for macro-level outcomes. It is well established that both firm heterogeneity (Melitz, 2003) and network structures (Chaney, 2014) are crucial for our understanding of international trade flows. Likewise, the international business literature has recognized that characteristics of managers and board members affect entrepreneurial success and firm internationalization

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in terms of export performance (Peng, 2001; Nam et al., 2018). Cultural, legal and various other trade barriers make it costly for firms to establish and maintain international business relationships. Having a manager who is personally connected to a foreign country might facilitate exporting to or sourcing from that country. However, whether a manager actually benefits from such a connection can depend on individual characteristics like gender. Gender discrimination in female managers' country of origin might impair their ability to benefit from their connections. Despite the undisputed relevance of these relationships, the pro-trade effects of top manager connections, their size, and the way they are determined by the interplay between countries' institutional differences and individual manager characteristics remain gaps in the literature.

We combine data on international connections of individual managers due to nationality with country-level bilateral trade flows and firm-level foreign sales by destination. The resulting country-level data set comprises bilateral manager connections and trade for more than 2000 country-pair-year observations for the four 5-year periods between 2000 and 2015, and the firm-level data set comprises connections and foreign sales of 3,584 firms in 77 countries between 1999 and 2017. This unique database enables us to examine the pro-trade effect of bilateral manager connections both on the firm and on the country level. On the country level, our structural gravity estimates reveal a positive and economically meaningful effect. Connections appear to be of slightly higher relevance for the exporter than for the importer. Our results stress the macro-level importance of personal manager characteristics for overcoming trade frictions. On the micro level, we confirm this finding since manager connections to a foreign country increase foreign sales in this country. Furthermore, firms indeed benefit from manager connections in overcoming

trade barriers as the pro-trade effect of connections is positively moderated by institutional distance but negatively moderated by institutional development in the destination. Moreover, the positive effect also depends on informal institutions in the destination, whereat connections are worth more in destination cultures with high uncertainty avoidance but less in the face of individualistic instead of collectivist cultures. This interplay between individual manager characteristics and the institutional environment is further highlighted by weaker effects of female connections in the face of gender-discriminating institutions. Notably, this gives rise to a spillover effect reducing the pro-trade effect of female connections in otherwise non-discriminatory home countries. Our research is connected to multiple streams of the international trade and international business literature, which we highlight in the following.

First, we contribute to the gravity literature (e.g. Anderson, 1979; Eaton and Kortum, 2002; Anderson and Van Wincoop, 2003) that is concerned with explaining bilateral trade flows. Our results stress that bilateral trade barriers can be reduced by top managers' international connections. Bailey et al. (2021) use Facebook data to construct a measure of social connectedness between 180 countries. They find that bilateral trade in a gravity framework increases in social connectedness of a country pair and also in sharing social connections with a similar set of countries. Instead of social media connections, we utilize manager connections extracted from firm data. Managers are the economic agents that build and maintain international trade connections and should have a sizable impact on aggregate outcomes. Analyzing the effect of firm-heterogeneity in destination-specific trade costs, our work is also related to the heterogeneous firms literature in international trade (Melitz, 2003; Bernard et al., 2007).

Our paper also adds to the rich literature on the trade-migration nexus, which originated with the seminal contributions of Gould (1994) and Head and Ries (1998).[1] Most closely related to us is a strand of this literature that focuses on the potential destination-specific trade effect of immigrants, although our focus is not on immigrants in general, but on top managers with foreign nationality. For instance, foreign managers might only work in another country for a certain period of time without ever immigrating. Furthermore, a manager who emigrates to a foreign country but keeps his management position in his home country also constitutes a foreign manager, but an emigrant rather than an immigrant. On the level of establishments in Germany, Andrews et al. (2017) find a pro-trade effect of foreign workers that is specific for broad geographic regions. On the level of Italian provinces, Bratti et al. (2020) find a positive effect of the regional stock of immigrant entrepreneurs, who individually own a small business, on regional manufacturing exports. Using country-level OECD data for the year 2010, Aleksynska and Peri (2014) find a pro-trade effect of immigrants who work in business network occupations and show that business networks are especially trade enhancing between countries with different legal origin and different official language. In contrast to the existing literature, we analyze the trade effects of top managers in a global panel of publicly listed firms, that likely account for a major part of global trade. We demonstrate this destination-specific pro-trade effect of foreign top managers both on the country level and the firm level. To develop a deeper understanding of the trade barriers that foreign top manager help overcoming, we utilize a broad set of countries' cultural and institutional

[1] We refer the reader to Hatzigeorgiou and Lodefalk (2021) for a more comprehensive review of the extensive literature on the trade-migration nexus.

characteristics. Moreover, we also account for heterogeneity in managers' abilities to utilize their connection to a foreign country. To the best of our knowledge, we are the first to differentiate between male and female foreign managers and to demonstrate that female managers from countries with gender-discriminating institutions face a severe disadvantage in that respect.

This notion of individual manager characteristics such as nationality as determinants of firm behavior in general and internationalization in particular also gained much interest in the international business literature (e.g. Pisani et al., 2018). In this context, the crucial role of connections to the destination proposed by Chaney (2014) gains further empirical support as destination-specific knowledge and export experience of individual managers are identified as the most important manager characteristics for exporting behavior. However, the combination of data on destination-specific manager connections with destination-specific sales poses a serious challenge, which is why previous empirical studies almost exclusively concentrate on only one country of origin. For instance, Sala and Yalcin (2015) exploit employer-employee matched data to demonstrate a positive effect of manager export experience in a sample of Danish firms. Likewise, Mion and Opromolla (2014) focus on Portugal and show that this positive effect also holds for managers' export experience acquired in previous firms. Nam et al. (2018) rely on a sample of Korean firms to identify that international experience and government connections in the board of directors increase export performance. We attempt to overcome this restriction to a single country by combining individual manager characteristics and destination-specific sales for an international sample of firms. To the best of our knowledge, we construct the first data set that enables an investigation of the relationship between destination-specific manager connections and destination-specific

firm-level sales in a multinational setting.

Our unique database also enables us to sharpen the institutional perspective on international trade and international business. Following the seminal work of North (1990) and North (1991), institutions constitute the 'rules of the game' that shape the behavior of market participants. In this sense, institutions play a crucial role for economic success by determining the transaction costs and uncertainty connected to virtually every economic activity (North, 1987). For instance, Nunn (2007) demonstrates that the provision of crucial market-supporting institutions like contract enforcement is an even more important determinant of a country's comparative advantage than physical capital and skilled labor combined. Accordingly, the role of weak institutions and institutional distance as trade barriers is well-documented (e.g. Álvarez et al., 2018; Dollar and Kraay, 2003). Likewise, the idea that trade networks in general and personnel connections in particular are utilized to overcome these barriers is not new (Combes et al., 2005). Accordingly, Hilmersson and Jansson (2012) demonstrate that firm networks reduce the uncertainty arising from institutional distance. In the same tradition, P. H. Egger et al. (2012) argue that migrants in the workforce provide institutional knowledge, and Bailey et al. (2021) provide evidence that private connections via online social networks mitigate institutional trade barriers for the same reason. However, to the best of our knowledge, we provide the first empirical investigation of the interplay between individual manager connections and institutional trade barriers. We provide evidence that firms benefit from manager connections in coping with weak institutions and bridging institutional distance.

Finally, we deliver new insights into the current and highly relevant debate on the relationship between gender and economic performance. Numerous recent

studies deal with gender diversity and firm performance but provide mixed evidence (Ahern and Dittmar, 2012; Miller and del Carmen Triana, 2009; Triana et al., 2014). This combination of high relevance and conflicting results regarding the general relationship has led to a closer look at specific aspects of management. Despite this growing interest in gender diversity and the extensive literature on the determinants of export performance, the investigation of gender as a determinant for export performance has received surprisingly little attention (Chen et al., 2016). As noteworthy exceptions regarding the effects of female ownership, Orser et al. (2010) find that female majority-owned Canadian firms are less likely to export while Lee et al. (2016) also show a weaker export performance of female-owned ventures in a Korean sample. There is some evidence of similar effects for female managers (e.g. Lukason and Vissak, 2020), but this relationship is usually just mentioned as a statistical side note and not accompanied by efforts to provide evidence in favor of a specific explanation.[2] In this context, we offer one potential missing link by investigating the nexus between gender, manager connections, and trade. Namely, we again consult the institutional view and attempt to explain gender differences as a result of institutionalized gender discrimination. As a reaction to the mixed empirical evidence regarding gender effects on firm performance, research only recently started to consider the influence of institutional moderators (L. Zhang, 2020). We deliver further support for this new and promising approach as our results not only show gender differences but also provide evidence that these differences are largely driven by institutional constraints on women. More specifically, we find that both informal constraints due to cultural bias against

[2]Qualitative research on female entrepreneurial behavior offers some explanatory approaches (e.g. Welch et al., 2008) but we are not aware of any quantitative investigations of specific explanations.

and formal regulatory restrictions on female managers in the destination impede women's ability to utilize their connections to this destination. First of all, these findings indicate the existence and real economic impact of performance-reducing institutionalized discrimination against women in general. Beyond that, our findings constitute the first evidence of cross-boarder effects of these institutions we are aware of. If manager connections are a valuable resource but female connections are less beneficial for trade with discriminating countries, then female managers face a performance disadvantage. As a consequence, discriminatory institutions of trading partners have a negative spillover effect on the performance of female managers even in otherwise non-discriminatory countries.

The rest of the paper is structured as follows. We provide some theoretical background for the concept of manager connections and its role in structural gravity in Section 4.2. In Section 4.3, we describe the data, set out how the bilateral measure of manager connections is constructed, and discuss descriptive statistics regarding the global prevalence of manager connections. Building upon this database, we line out our estimation strategy in Section 4.4. Section 4.5 presents the empirical results for both the firm- and the country-level analyses. Next to the general pro-trade effect of manager connections we also study how this effect is moderated by institutional factors, and how it differs by managers' gender under certain institutional conditions. Results of several robustness checks are discussed in Section 4.6. The final Section 4.7 concludes.

4.2 Theoretical Background

International trade faces many challenges from geographical distance over institutional and cultural differences up to asymmetric information and agency problems. On the other hand, connections between countries such as shared borders or common institutions foster trade. However, beyond these external connections, participants in international trade also utilize their own connections to other countries to mitigate the negative effects of distance and different environments (Chaney, 2014; White, 2007).

Our concept of manager connections draws on the idea of networks between trade participants and brings it down to the micro level of individual managers within potentially exporting firms. In this setting, a manager connection describes a connection between two countries in the person of a manager. Although many different constellations of such connections are conceivable, the most intuitive appearance of is a foreign manager since this manager naturally connects the country of his firm with his home country.

In this micro-level setting, especially top-level managers shape organizational behavior (Hambrick and Mason, 1984). Thus, from personality traits of individual managers (Chatterjee and Hambrick, 2007) to the overall composition of the top management team (Carpenter et al., 2004), manager characteristics are decisive determinants for a firm's strategic decisions and performance (Hambrick, 2007; B. B. Nielsen and S. Nielsen, 2013). Accordingly, it is no surprise that this crucial influence of individual manager characteristics also holds for export activities (Agnihotri and Bhattacharya, 2015; Halikias and Panayotopoulou, 2003). In this context, the intuition behind this relationship is that a manager's background

affects his or her decision-making, which in turn determines firm behavior.

We can further explain this influence with the Resource-Based View (Wernerfelt, 1984), where manager characteristics can constitute a competitive advantage (Peteraf, 1993; Cockburn et al., 2000) as managers bring in personal resources such as knowledge and skills (Castanias and Helfat, 1991). Thus, connected managers enhance export performance because they provide relational resources such as personal networks and human resources such as destination-specific skills or knowledge (İpek, 2018). For instance, managerial ties to a potential export destination enhance the quality of available information (Chung, 2012) and generate new information on export opportunities (Andersen, 2006; Ellis and Pecotich, 2001), which facilitates market entry (Peng, 2001). Moreover, connected managers promote export activities through valuable destination-specific skills such as language skills Williams and Chaston (2004), legal expertise (Bagley, 2008), or cultural sensitivity (Styles et al., 2008).

The value of these country-specific knowledge and skills depends on the institutional development in the destination. Information asymmetries and difficulties in contract enforcement constitute severe trade barriers (Ma et al., 2012), whereas well-developed institutions such as efficient law enforcement facilitate trade (Araujo et al., 2016). If connected managers provide additional information and are better in maintaining relationships with reliable trading partners, they can serve the same purpose. Thus, strong institutions and manager connections might constitute partial substitutes.

This effect should be even stronger when the institutional environments between origin and destination differ strongly. Regardless of the institutional development, information asymmetries also arise when important information regarding legal

issues is scarce just because the legal system of the destination differs and its peculiarities are unknown to exporting firms (Jansen and Piermartini, 2009). Furthermore, informal mechanisms to overcome these issues, such as reputation, can only prevail between sufficiently close societies (Dixit, 2003). Accordingly, just like institutional development in the destination, institutional distance severely reduces export performance (He et al., 2013). Connected managers can mitigate these problems either by directly providing information or by building reputation and trust more easily, thus bridging the gap between two different institutional environments.

Because manager connections as micro-level phenomenon influence the costs of international trade between firms, they also have the potential to significantly affect macro-level bilateral trade flows. Chaney (2014) offers a model of trade frictions based on information frictions, where firms only export to markets, in which they have a contact. We argue that having a manager of foreign nationality constitutes a contact to that country and comes with knowledge regarding cultural, social, and legal characteristics of the country. In that respect, a foreign manager can reduce information asymmetries and, thus, trade frictions to the respective country. Accordingly, a higher number of bilaterally connected managers should facilitate bilateral trade also on the macro level. H. Egger and Kreickemeier (2012) develop a model of international trade with heterogeneous owner-managers that need to hire a local expert in the foreign market in order to serve that market. While their model does not allow for labor migration or foreign managers, it is straightforward to imagine that some firms might send a former manager from their headquarter country to the foreign country in order to become a local expert managing the foreign affiliate. Likewise, firms might be inclined to hire someone who is already

living in the foreign country but has ties to the headquarter country as an affiliate manager, because this comes with many beneficial effects like lower communication costs.

To assess whether bilateral manager connections are relevant for bilateral trade, we analyze their effect in a structural gravity model. Based on Armington (1969), Anderson (1979) offered a first theoretical derivation of the gravity equation in economics, which was empirically established by Tinbergen (1962).[3] An important insight from the subsequent theoretical side was that the simple gravity equation should be extended to account for multilateral resistance (e.g. Eaton and Kortum (2002); Anderson and Van Wincoop (2003)). The resulting structural gravity model can be summarized by the following equation:

$$TRADE_{odt} = \frac{Y_{ot}}{\Omega_{ot}} \frac{X_{dt}}{\Phi_{dt}} \phi_{odt} \tag{4.1}$$

The trade flow $TRADE_{odt}$ from country o to country d in period t is determined by the product of o's production Y and d's consumption X, both adjusted for exporter and importer multilateral resistance Ω_{ot} and Φ_{dt}. Additionally, there is an effect of what Head and Mayer (2014, p. 137) call "bilateral accessibility", ϕ_{odt}, a combined measure of trade costs and the elasticity of the trade flow under consideration with respect to trade costs.

Often the distance elasticity is estimated by using bilateral distances as a proxy for ϕ_{od}. However, bilateral accessibility ϕ_{odt} includes more than the geographical distance between two countries. Therefore, controlling for other bilateral factors

[3] See, e.g., Krugman (1980), Bergstrand (1985), Bergstrand (1989), Deardorff (1998), Eaton and Kortum (2002), Chaney (2008), Helpman et al. (2008), and Chaney (2018) for further theoretical foundations.

that determine accessibility such as a common language or former colonial ties emerged as standard practice. We introduce bilateral manager connections as a new factor affecting bilateral accessibility and analyze its effects on trade in a gravity framework. To do this, we specify $\phi_{odt} = exp(log(DIST_{od}) + log(CONO_{odt}) + log(COND_{odt}) + Z_{odt} + u_{odt})$, where $DIST_{od}$ is the geographical distance, $CONO_{odt}$ are bilaterally connected managers in the origin, $COND_{odt}$ are bilaterally connected managers in the destination, Z are bilateral control variables like being members of the same regional trade agreement, and u is an error term. We expect having more bilaterally connected managers to raise bilateral imports and exports on the country level, as more domestic firms can benefit from better abilities to engage in foreign markets. It is also possible that other firms without foreign managers benefit due to spillover-effects or facilitated network access. So we expect positive coefficient estimates for manager connections in both directions.

4.3 Data and Methodology

In this section, we describe our database and provide descriptive statistics. A list of all variables including their definitions and detailed sources is also provided in Appendix D.1.

4.3.1 Manager Connections

We construct manager connections based on data from BoardEx. BoardEx covers large, publicly listed companies around the world on a yearly basis (Fernandes et al., 2013) and constitutes a well-established database for manager characteristics (e.g. Adams and Kirchmaier, 2016; Cai et al., 2019). We then construct manager

connections using manager nationality. Starting from the country the firm operates in as the country of origin, one manager has a connection to a destination if this destination is their nationality. We can formally capture this definition with the dummy variable CON_{miodt} that takes on the value 1 if a manager m of firm i in origin country o holds the nationality of destination country d at time t.

Building upon this definition, we can easily distinguish between female and male connections by considering the gender of the manager. That said, the dummy variable $MCON_{miodt}$ takes on a value of 1 only if CON_{miodt} equals one and the manager is male. The other way around, $FCON_{miodt}$ also requires a value of 1 for CON_{miodt} but in addition that the manager is female. As all managers in our sample identify as either male or female, the overall manager connections in each sample constitute the sum of male and female connections.

4.3.2 Firm-Level Manager Connections and Foreign Sales

To measure manager connections on the firm level, we construct two variables. The first measure is the dummy variable $i.CON_{iodt}$ that indicates whether at least one manager in the firm has a connection to the destination. As a second, more fine-grained measure, we aggregate the number of manager connections to a destination within a given company. Thus, our variable CON_{iodt} does not just indicate the presence of a connection as a dummy variable but rather counts the number of manager connections to a destination resulting in a discrete measure. Multiple connected managers in one firm result in more firm-level manager connections to one destination. We can formally define the firm-level manager connections to destination d, CON_{iodt}, as the sum of CON_{miodt} over managers m within firm

i. In the same way, we define the firm-level female connections $FCON_{iodt}$ as the sum of $FCON_{miodt}$ over m and firm-level male connections $MCON_{iodt}$ as the sum of $MCON_{miodt}$ over m. In addition to these measures of the presence of manager connections, we also construct a dummy variables indicating the establishment of a new connection. More specifically, $i.ADDCON_{iodt}$ captures the establishment of a connection between the firm and destination d as it equals one if $CON_{iodt} > CON_{iodt-1}$.

To investigate the effect of manager connections to a destination on the firm level, we link them with the foreign sales in this destination. However, usual data sources for firm-level exports are either not segregated by destination (e.g. Pisani et al., 2018) or only available for single countries (e.g. Hiller, 2013). Instead, we rely on firms' self-reported sales by geographic segments provided by Bureau van Dijk's database Osiris. Although geographic segments data were traditionally used to measure firm diversification (Muñoz-Bullón and Sánchez-Bueno, 2012) or geographic orientation (Banalieva and Dhanaraj, 2013; Rugman et al., 2012), recent studies employ them as a more fine-grained measure for internationalization in general (D'Angelo et al., 2016) and especially for export activities (e.g. Bauweraerts et al., 2019; Merino et al., 2015). This interpretation is reinforced by recent evidence that aggregated firm-level sales to foreign geographic segments are strongly correlated with traditional measures of the country-level export volume (Tito, 2019). Sales to a geographic segment that differs from the firm's home country clearly constitute foreign sales (Cahan et al., 2005). Thus, foreign sales derived from the reported sales to different geographic segments provide a suitable measure for our purpose that allows us to differentiate between distinct destinations.

However, company reports on geographic segments are not standardized, which

creates a matching problem between destinations of foreign sales and destinations of manager connections. Whereas our manager connections always refer to a country as the destination, the names of reported geographic segments may include everything from country names over continents and regions up to broad terms such as "non-US" or "foreign". To match the reported geographic segments with destination countries, we conduct a straightforward conceptual content analysis. Modern economic research primarily utilizes conceptual content analysis to extract meaning from text in a systematic and quantifiable way (Duriau et al., 2007). However, its most simplistic form of encoding communication in order to provide a literal description of its content (Krippendorff, 2018) is sufficient for our purpose of identifying countries in the reported geographical segments. Thus, we employ a machine-coding measurement approach based on a fixed, dictionary-like coding scheme (Gephart, 1993) developed in three steps. As a starting point, we construct a list of potential country names utilizing manager nationality and firm country of origin. Second, we manually search for alternative spelling including alternative terms as well as mistakes in the geographical segment names.[4] Third, we complete the code by manually searching the remaining geographical segment names for additional countries.

The resulting coding scheme allows us to parse and translate the geographical segment names into country names. Subsequently, we identify and exclude all geographical segment names that included characters clearly indicating a segment consisting of more than one country. Specifically, we exclude all entries featuring

[4]For instance, our final list of identifiers for the ISO-3 country code "USA" included a variety of segment names such as "united states", "unites stades", "usa", "us", "u.s.", or "u s".

'/', '&', '+', and 'and'.[5] Furthermore, we exclude all entries featuring phrases such as 'non' and 'outside' to avoid misclassifications of segment names such as "non-US". In the next step, we exclude all identified countries that are equal to a firm's country of origin as we are only interested in foreign sales. We conclude our search by manually double-checking the coding results for misclassifications.

Since the foreign sales reported in the geographical segments only encompass the most important segments and not all reports refer to single countries, we cannot impute zero values for missing destinations. For the manager connections, however, we are confident that no observation of a connection between a firm and a destination actually means that no such connection exists. Thus, we substitute missing values for manager connections on the firm level with zeros. The resulting sample comprises 32,047 observations nested in connections between 3,584 firms in 77 origin countries and 147 destination countries.

Table D.2 provides summary statistics for the firm-level variables. Not surprisingly, $SALES_{iodt}$ shows a large range accompanied by a high standard deviation and a skewed distribution. The median of 0 for CON_{iodt} reveals that most of the destinations are not connected to the exporting firm. Indeed, as indicated by the mean of $i.CON_{iodt}$, around 28% of the firm-destination pairs are connected. Furthermore, most of the connections feature only one or two connected managers with multiple connections to one destination being the exception. This is not surprising as top management teams are limited in size and seldom feature multiple managers from the same foreign country. Likewise, it is not surprising that the clear majority of manager connections is established by male managers, as female

[5]However, we preserved country names featuring 'and', namely Trinidad and Tobago as well as Bosnia and Herzegovina.

managers still constitute a minority in the entire population of top managers.

Figure D.1 displays all combinations between CON_{iodt} and $SALES_{iodt}$. The positive slope of the simple linear regression line without any control variables serves as a first indication for a positive relationship between the two variables. While we observe a fairly large variance of sales in absence of connections, observations converge towards higher values of sales when more connections are present.

4.3.3 Country-Level Manager Connections and Bilateral Trade

As the focal explanatory variable for our country-level analysis, we construct an aggregated country-level measure for manager connections, $CONO_{odt}$ based on the individual manager characteristics. Similar to the firm-level measure, we compute this measure on the country level by counting the number of connections to a destination within one country of origin in the same year. Again, we also distinguish between female and male connections based on the gender of the connected manager. The other way around, we construct $COND_{odt}$ in a similar way by counting the number of connections within a destination to the country of origin.

In contrast to the firm-level data, however, one manager can establish multiple connections when they work for multiple companies establishing a connection for each firm. Another difference between the firm-level and the country-level measure is that we do not replace missing values with zeros. While we can be confident to capture all manager connections within one reporting firm, this assumption does not hold for entire countries, where missing values might just reflect missing firm-data instead of an actual absence of any connection.

For the gravity analysis we use data on countries and country-pair characteristics like bilateral distance and GDP as well as the BACI trade flows from CEPII's gravity database. BACI reconciles trade flows taken from the United Nations Comtrade database reported by both the exporter and the importer to provide a harmonized trade flow (Head et al., 2010; Mayer et al., 2014). We use the available bilateral migration data for the years 2000, 2005, 2010, and 2015 from the United Nations. The data set provides bilateral stocks of immigrants and emigrants. Missing country pairs can be assumed to have no sizable stock of bilateral migrants, which is why we set missing values equal to zero. The migrant stock is measured as the number of persons. We add one person to each pair when using log transformations in order to avoid losing observations with zero values. We restrict our country-level analyses to the 5-year periods from 2000 to 2015.

Our country-level data features a total of $16,616$ bilateral manager connections in the 4 years 2000, 2005, 2010 and 2015. The mean value of non-zero bilateral connections is 7.6. Table D.3 provides summary statistics for the main variables used in the country-level regressions. The table has three segments, the first contains data of complete observations (including control variables) that can be used in regressions where $COND_{odt}$ is not included, the second where $CONO_{odt}$ is not included, and the third where both are included simultaneously. Every export flow is an import flow at the same time, and the same holds for the movement of people. We employ the same data points, such that for two countries a and b we have that $CONO_{abt} = COND_{bat}$ and that $IMI_{abt} = EMI_{bat}$. Some aspects are interesting to observe when comparing the different segments of the table. Country pairs that have at least one connected manager in both directions are on average closer to each other, more likely to have a common regional trade agreement, they

have larger bilateral stocks of migrants and they trade more with each other.

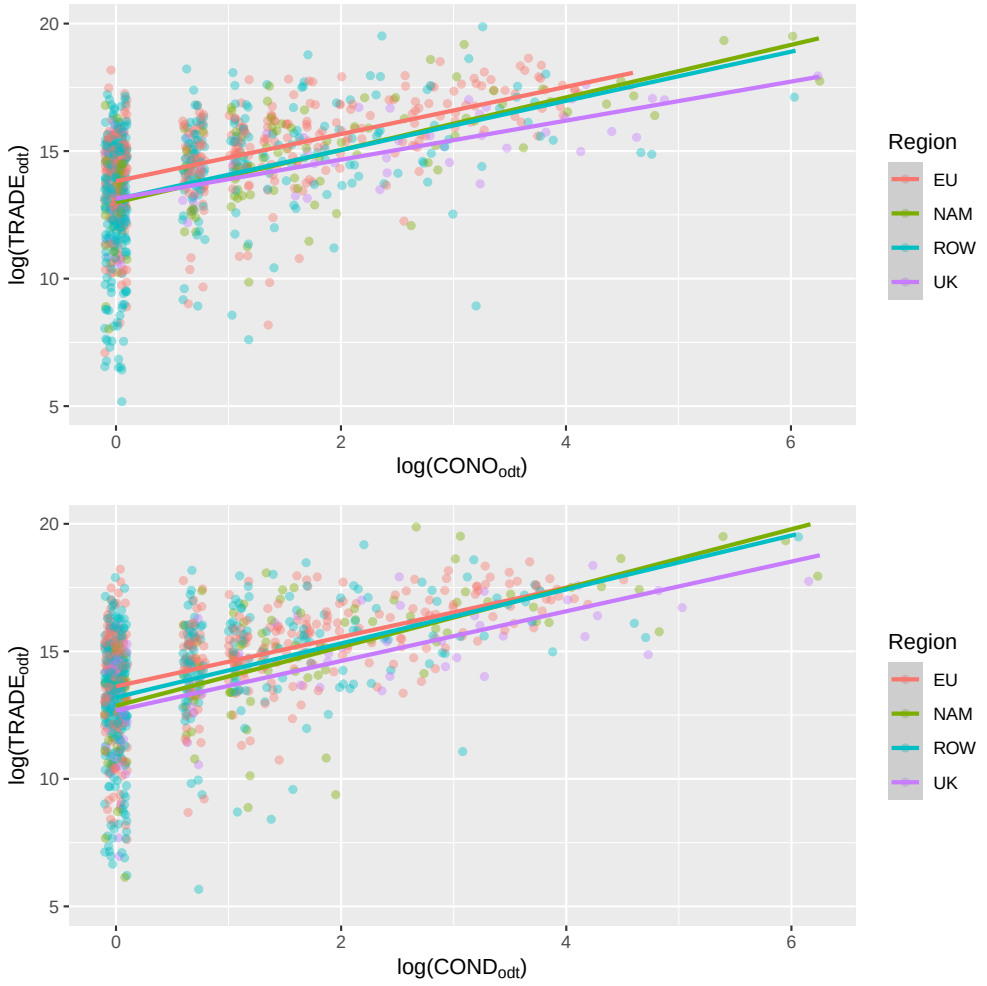

Figure 4.1: BoardEx Managers and Trade in 2015

Figures D.2 illustrates the log number of all connected managers working in a certain country (log_number_o) and the log number of all managers connected to a certain country but working elsewhere (log_number_d) on a world map. Most manager connections are observed for managers working in the United States, but also Canada and the European countries exhibit high numbers. The picture looks similar for countries to which managers working elsewhere are connected,

although in this case more countries are covered as they do not need to be covered by BoardEx.

Figure 4.1 plots bilateral manager connections and trade. The positive slopes of the simple linear regression lines for the four regional sub-samples indicate a positive relationship between manager connections and trade before controlling for any other factors. The relationship is very similar for connections of managers in the importing and in the exporting country. It is also similar across different regions of the world. The variability of the trade volume diminishes with an increasing number of managerial connections. While some countries trade a lot with each other despite having few manager connections, which might for example be related to trade in natural resources where connections could be of lower importance, we do not observe country pairs with many manager connections that trade little with each other. This is a preliminary indication that trade costs might be lower when countries are well connected to each other. "Region" in Figure 4.1 states the geographic region where the connected managers are working.

4.3.4 Institutional Variables

To assess characteristics of the institutional environment, we use the Worldwide Governance Indicators (WGI) provided by the World Bank (Kaufmann et al., 2011). For the main analysis, we employ the Control of Corruption indicator in the destination, CC_{odt}, defined as "the extent to which public power is exercised for private gain, including both petty and grand forms of corruption" (Kaufmann et al., 2011, p. 223). While corruption seems to be a particularly relevant example for a characteristic of low institutional development that personal manager connections

can help to overcome, we present the results for other indices in the robustness tests. However, we are not only interested in the institutions of the destination but also in the institutional distance $CCdis_{odt}$ between origin and destination. Thus, we compute our measure for the institutional distance between two countries as the difference between the index in the origin and the destination $CC_{ot} - CC_{dt}$ (Álvarez et al., 2018). Since the simple distance accounts for the direction of the distance by allowing negative values, we also calculate the absolute value of this distance $|CCdis_{odt}|$ in order to capture the institutional distance as a measure of institutional dissimilarities regardless of the direction.

To capture the informal institutional environment in the destination, we draw on Hofstede's cultural dimensions provided by Hofstede Insights. Hofstede's cultural dimensions (Hofstede, 1984; Hofstede, 2001) in general constitute the most-established database for cultural variables in international business research (Beugelsdijk et al., 2017). In particular, we utilize the dimensions Uncertainty Avoidance, $UNCAVOID$, and Individualism, $INDIVID$. Uncertainty Avoidance "indicates to what extent a culture programs its members to feel either uncomfortable or comfortable in [...] situations [that] are novel, unknown, surprising, and different from usual" (Hofstede, 2011, p.10). Thus, we utilize Uncertainty Avoidance as a potential cultural influence on the value of manager connections as uncertainty reducing devices. "Individualism on the one side versus its opposite, Collectivism, as a societal, not an individual characteristic, is the degree to which people in a society are integrated into groups. On the individualist side we find cultures in which the ties between individuals are loose" (Hofstede, 2011, p.11). As such, in a more collectivist society personal connections are of higher importance, which might enhance the effect of manager connections in our framework.

Beyond these measures of institutional development and institutional distance, we are also interested in specifically gender-related institutions. As a source for formal regulatory restrictions on female managers, we draw on *Women, Business and the Law* (WBL) provided by the World Bank as a source. The WBL index provides a measure for the "laws and regulations that restrict women's economic opportunities" (World Bank, 2021, p. 2). In addition to the overall index, WBL provides several indices, of which we are especially interested in the index for mobility. This "mobility indicator measures constraints on a woman's agency and freedom of movement, both of which are likely to influence her decision to enter the labor force and engage in entrepreneurial activity" (World Bank, 2021, p.73). We deem this indicator as particularly fitting for our purpose since such regulations directly constrain the ability to utilize international connections in a business environment.

Moreover, we are also interested in informal gender-related institutions grounded in culture and values. For this purpose, we rely on the Gender Social Norms Index (GSNI) provided by the United Nations Development Programme. More specifically, we utilize the economic dimension of the GSNI as this dimension specifically captures the bias against women in business. At that, the GSNI measures the percentage of individuals with a bias against women based on the questions of whether men should have more right to a job than women and whether men make better business executives than women (United Nations Development Programme, 2020, p. 8). Thus, the GSNI captures exactly the influences of informal institutions that might affect the ability of female managers to utilize cross-cultural connections.

Figures D.3 and D.4 provide an overview of the different levels of WGI and $UNCAVOID$ around the world by displaying the mean value for each destination

country in our data. For WGI, we can see the typical pattern of indicators for institutional development. North America, Europe, and the mature democracies with market-based economies in Asia (most prominently South Korea, Japan, and Australia) show high values. Emerging economies such as the 'BRICS' states (i.e. Brazil, Russia, India, China, and South Africa) take a middle position. Less developed markets like in Sub-Saharan countries feature lower values and states where public institutions are challenged by civil war, such as Libya or Afghanistan, are placed at the lower end of the scale. For $UNCAVOID$, however, the painted picture is different and less structured. For instance, Europe features cultures with a very high tolerance for uncertainty in Scandinavia alongside very uncertainty avoiding cultures in Western and Eastern Europe. Thus, a comparison between the two maps illustrates that cultural values differ within geographic regions as well as within groups of countries with the same level of formal institutional development.[6]

4.4 Estimation Strategy

4.4.1 Country-Level Analysis

Building upon the data described in Section 4.3, the following equation specifies our estimation strategy based on the structural gravity model described in Section 4.2. After including origin-year (η_{ot}) and destination-year (ν_{dt}) fixed effects to control for all potentially time-varying exporter- and importer-specific characteristics, and with ϵ_{odt} as an error term absorbing u_{odt}, we can write the log of country o's exports

[6] See Figures D.5 and D.6 for similar overviews regarding WBL and GSNI.

to country d as

$$log(TRADE_{odt}) = \beta_1 log(CONO_{odt}) + \beta_2 log(COND_{odt}) + \beta_3 log(DIST_{od}) + \gamma C_{odt} + \eta_{ot} + \nu_{dt} + \epsilon_{odt}.$$

The fixed effects also capture cross-country differences in the aggregate number of managers, such that our estimates for the trade effect of bilateral manager connections are not biased by potentially unobserved differences in country size. After controlling for idiosyncratic shocks on the exporter-year and the importer-year level, we exploit the variation in trade flows within country pairs over time and between country pairs. We can use both directions of manager connections, $CONO_{odt}$ and $COND_{odt}$, simultaneously. When estimated over all country pairs, using $COND_{odt}$ without $CONO_{odt}$ on o's exports as dependent variable is equivalent to using $CONO_{odt}$ without $COND_{odt}$ on o's imports as dependent variable, because all bilateral control variables are non-directional except for immigrants and emigrants which are always considered simultaneously. Using both directions for bilateral manager connections simultaneously accounts for the fact that exporting managers and importing managers can be influential at the same time.

We do not include country-pair fixed effects in the country-level regressions as with four observations per country pair (2000, 2005, 2010, 2015) this would remove much of the variation that we want to use for identification, namely that between country pairs. Further variables included to control for country-pair specific factors that affect trade are the usual ones from CEPII's gravity database: being part of a common regional trade agreement, contiguity, having a common official or primary language, having a common language spoken by at least 9 percent, a religious proximity index, common legal origins before 1991, common legal origins after 1991,

having ever had the same colonizer, and having ever been in a colonial relationship. We also control for the log number of bilateral immigrants and emigrants to make sure that results are not driven by a correlation between overall migration and trade.

We report ordinary least squares (OLS) estimates for comparison, but following Santos Silva and Tenreyro (2006) our preferred estimator is Poisson pseudo maximum likelihood (PPML), as it allows to include zero trade flows and avoids potential problems of biased estimates under heteroskedasticity in a log-linearized model. In our PPML regressions we use trade flows in levels, where missing trade values are replaced with zeros if both countries exist in a given year.

4.4.2 Firm-Level Analysis

To investigate the relationship between manager connections and foreign sales on the firm level, we apply a linear fixed effects regression model. We include directional country-pair-year fixed effects to control for unobserved factors common to all firms in one country exporting to a certain other country in a given year. The residual variation is between firms from such an origin-destination-year group. Most importantly, however, our data structure also allows for firm-year fixed effects as we are able to observe foreign sales to multiple destinations within one firm. This controls for all general firm-level variance including factors such as firm size and size of the management team, but also all unobservable firm-level characteristics (Andrews et al., 2017). Since standard control variables could not achieve that, firm-year fixed effects are necessary to reliably isolate the effect of manager characteristics (Bertrand and Schoar, 2003). Accordingly, the former

residual variation is adjusted for firm-year specific factors, which leaves that part of the variation that stems from sales across different destinations within a firm in a given year.

Thus, beyond the different fixed effects, the only variables included in the regression are the manager connections to the destination and the foreign sales to the same destination. This results in the equation

$$asinh(SALES_{iodt}) = \beta_1 asinh(CON_{iodt}) + \gamma_{odt} + \eta_{it} + \epsilon_{iodt}, \tag{4.2}$$

In addition to the dependent variable $asinh(SALES_{iodt})$ and our main explanatory variable $asinh(CON_{iodt})$, γ_{odt} represents country-pair-year fixed effects, η_{it} represents firm-year fixed effects. Note that η_{it} also accounts for fixed effects on higher levels such as industry and origin country and that destination-year effects are already captured as they constitute a linear combination of γ_{odt} and η_{it}.

Both the dependent variable foreign sales and the main explanatory variable manager connections are transformed using the inverse hyperbolic sine transformation ($asinh$) as an approximation of the natural logarithm (Bellemare and Wichman, 2020). We rely on $asinh$ since our manager connections include zero values (MacKinnon and Magee, 1990; Burbidge et al., 1988). In contrast to the alternative approach of adding a constant value before log-transforming to avoid the loss of zero values, the asinh-transformation keeps zeros without introducing a potential bias (Bellemare and Wichman, 2020).

To investigate the moderating effect of the institutional environment on the focal relationship between manager connections and foreign sales, we enrich Equation 4.2 with an interaction effect. The resulting equation exemplarily features one

possible moderating effect, namely institutions in the destination country, although analogous equations can be formed with institutional distance or other factors as interaction terms. The main effect of the moderating variable is captured by γ_{odt}.

$$\begin{aligned} asinh(SALES_{iodt}) &= \beta_1 asinh(CON_{iodt}) + \beta_2 asinh(CON_{iodt}) \times CC_{dt} \\ &\quad + \gamma_{odt} + \eta_{it} + \epsilon_{iodt} \end{aligned}$$

4.5 Results

In the following, we provide the results of our empirical analysis. First, we provide the results for the main effect of manager connections on international trade both on the country and the firm level. Subsequently, we take a closer look at the firm level by introducing institutional moderators. We conclude our analysis by investigating gender differences on the effect of manager connections and how they are driven by gender-specific discriminatory institutions.

4.5.1 Manager Connections and International Trade

We start our analysis with the effects of bilateral manager connections on the country level in a gravity setting. Table 4.1 presents the country-level results for both OLS and PPML estimation. We find significant, positive, and economically relevant pro-trade effects of manager connections. OLS 1 and PPML 1 include only managers in the exporting country. Accordingly, the estimated effect is that of manager connections on export value. OLS 2 and PPML 2 include only managers in the importing country, such that the estimate can be interpreted as the effect of manager connections on import value. OLS 3 and PPML 3 include managers

in both countries simultaneously. If manager connections in the importing and exporting country are related, both should be included to avoid biased estimates. Thus, and due to the arguments in favor of PPML discussed earlier, our preferred specification is PPML 3.

Table 4.1: Country-Level Results

	$log(TRADE_{odt})$			$TRADE_{odt}$		
	OLS 1	OLS 2	OLS 3	PPML 1	PPML 2	PPML 3
$log(CONO_{odt})$	0.10***		0.16***	0.20***		0.15***
	(0.04)		(0.04)	(0.03)		(0.04)
$log(COND_{odt})$		0.08**	0.08**		0.17***	0.07*
		(0.04)	(0.04)		(0.04)	(0.04)
Origin-year FE	YES	YES	YES	YES	YES	YES
Destination-year FE	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES
R^2	0.92	0.92	0.93			
Adj. R^2	0.89	0.89	0.89			
Within R^2	0.57	0.56	0.73			
Pseudo R^2				0.96	0.95	0.96
Observations	2,004	2,003	976	2,010	2,009	976

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$. Standard errors (clustered on the country-pair level) in parentheses.

Using both directions of manager connections simultaneously results in a loss of observations, because manager data for both countries has to be available. The resulting sample might have somewhat different properties, i.e. consist mostly of high-income countries, which are less institutionally distant from each other and might benefit less from manager connections as a result.

Manager connections have an additional, independent pro-trade effect, as they capture different information than migration, which has already been studied extensively. It is not surprising that estimates are slightly larger in PPML 1 and PPML 2. This can be driven by both the sample selection including institutionally more distant country pairs and by exclusion of a potentially relevant variable,

namely the bilateral manager connections in the other country.

We now proceed with the firm-level analysis and present the results in Table 4.2. We test the main effect of manager connections first with the discrete variable CON_{iodt} that counts the number of connections and second with the dummy variable $i.CON_{iodt}$ indicating the presence of at least one connection. Furthermore, we employ the dummy variables $i.ADDCON_{iodt}$, capturing the event of establishing an additional connection to a destination. The coefficients are positive and highly significant for all measures of manager connections. Thus, we find a positive relationship between manager connections to a destination and foreign sales to this destination reinforcing the country-level results on the firm level.

Table 4.2: Firm-Level Results: Main Effect of Manager Connections

Dep. Var.: $asinh(SALES_{iodt})$	(1)	(2)	(3)
$asinh(CON_{iodt})$	0.34^{***}		
	(0.05)		
$i.CON_{iodt}$		0.45^{***}	
		(0.06)	
$i.ADDCON_{iodt}$			0.17^{*}
			(0.09)
Firm-year FE	YES	YES	YES
Country-pair-year FE	YES	YES	YES
Adj. R^2	0.74	0.74	0.70
Observations	32,047	32,047	21,077

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors (three-way clustered by firm-year, destination, and country pair) in parentheses.

4.5.2 Manager Connections and Institutions

Table 4.3 presents the results of interactions between manager connections and institutional moderators, namely the institutional development in the destination, the institutional distance between destination and origin, and informal institutions in the destination. The results show a consistent pattern of significant interactions with all institutional variables providing evidence for the notion of institutional influences on the effect of manager connections.

Table 4.3: Firm-Level Results: Moderating Effect of Institutions

Dep. Var.: $asinh(SALES_{iodt})$	(1)	(2)	(3)	(4)	(5)
$asinh(CON_{iodt})$	0.43***	0.20***	0.28***	0.10	0.51***
	(0.09)	(0.07)	(0.05)	(0.13)	(0.11)
$asinh(CON_{iodt}) \times CC_{dt}$	−0.08*				
	(0.04)				
$asinh(CON_{iodt}) \times CCabsdis_{odt}$		0.16***			
		(0.05)			
$asinh(CON_{iodt}) \times CCdis_{odt}$			0.10**		
			(0.04)		
$asinh(CON_{iodt}) \times UNCAVOID_d$				0.00**	
				(0.00)	
$asinh(CON_{iodt}) \times INDIVID_d$					−0.00**
					(0.00)
Firm-year FE	YES	YES	YES	YES	YES
Country-pair-year FE	YES	YES	YES	YES	YES
Adj. R^2	0.74	0.74	0.74	0.69	0.69
Observations	31,474	31,416	31,416	31,210	31,210

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$. Standard errors (three-way clustered by firm-year, destination, and country pair) in parentheses.

First, the negative and significant interaction effect between CON_{iodt} and CC_{dt} indicates that strong institutions in the destination diminish the positive effect of manager connections. Figure D.7 illustrates this moderating relationship by plotting the average marginal effects of manager connections at different levels of WGI_{dt}. While the marginal effect of manager connections is largest at low levels

of CC_{dt} it decreases at higher values. Hence, our results provide evidence that manager connections indeed serve as a substitute for functioning institutions in the destination.

Second, the positive and significant interaction effect between CON_{iodt} and $|CCdis_{odt}|$ reveals that the effect of manager connections increases with larger institutional distance. Accordingly, the main effect of CON_{iodt} (i.e. the effect when $|CCdis_{odt}|$ equals zero) becomes smaller and also less significant. The marginal effects in Figure D.8 illustrate this connection indicating that the positive effect of manager connections continually increases with larger institutional distance. This observation fits the notion that manager connections serve as means to bridge institutional distances.

Third, the significant interaction between CON_{iodt} and $CCdis_{odt}$ reinforces the moderating effect of institutional distance, and the positive coefficient reveals that the bridging of institutional distance by manager connections is particularly valuable when the institutions in the origin are better developed than in the destination. This finding connects the two effects of manager connections, namely to bridge institutional distance and to compensate for weak institutions.

Fourth, the significant interaction terms between CON_{iodt} and $UNCAVOID_d$ as well as $INDIVID_d$ provides evidence that the effect of manager connections also depends on the informal institutional environment in the destination. Namely, the positive moderating effect of $UNCAVOID_d$ suggests that manager connections serve as means to reduce uncertainty, which makes them especially valuable in cultures with high uncertainty avoidance. Interestingly, the insignificant main effect (i.e. the effect when $UNCAVOID_d$ equals zero) suggests, that the positive effect of CON_{iodt} might even vanish in the face of uncertainty embracing cultures. In a

similar fashion, cultures embracing individualism rely less on personal relationships, which diminishes the positive effect of manager connections as indicated by the negative moderating effect of $INDIVID_d$.

4.5.3 Manager Connections and Gender Discrimination

Table 4.4 provides the results for our analysis of gender differences in the effect of manager connections. The first model provides only the main effect of manager connections, now distinguished by gender. Subsequently, we include gender-related institutional moderators in the destination to further explore and contextualize gender differences. Overall, we find evidence that both male and female connections have a positive effect on foreign sales, but that the effect of female connections can be severely diminished by gender-related regulatory constraints and cultural bias against women in the destination.

Regarding the main effect of $MCON_{iodt}$, we find a positive and significant effect on foreign sales. For $FCON_{iodt}$ the effect is also positive, albeit smaller than the effect of their male counterparts. Taken alone, these differences do not provide enough information for a closer interpretation and might even only occur due to a smaller sample size of female connections. However, the results for the gender-related institutions presented in models (2), (3), and (4) provide further insights regarding gender differences in the effect of manager connections.

First, the positive and significant interaction between $FCON_{iodt}$ and WBL_{dt} indicates that formal gender-related institutions in the destination affect male and female connections differently. More specifically, the effect of female connections becomes stronger, when the laws in the destination country restrict women less

Table 4.4: Firm-Level Results: Gender Differences in Manager Connections

Dep. Var.: $asinh(SALES_{iodt})$	(1)	(2)	(3)	(4)
$asinh(MCON_{iodt})$	0.33^{***}	0.73	2.00^{**}	0.08
	(0.06)	(0.51)	(0.81)	(0.10)
$asinh(FCON_{iodt})$	0.24^{***}	-1.81^{*}	-5.03^{***}	0.53^{***}
	(0.08)	(0.95)	(1.26)	(0.16)
$asinh(MCON_{iodt}) \times WBL_{dt}$		−0.00		
		(0.01)		
$asinh(FCON_{iodt}) \times WBL_{dt}$		0.02^{**}		
		(0.01)		
$asinh(MCON_{iodt}) \times FMOBIL_{dt}$			-0.02^{**}	
			(0.01)	
$asinh(FCON_{iodt}) \times FMOBIL_{dt}$			0.05^{***}	
			(0.01)	
$asinh(MCON_{iodt}) \times GSNI_{d}$				0.01^{***}
				(0.00)
$asinh(FCON_{iodt}) \times GSNI_{d}$				-0.01^{*}
				(0.00)
Firm-year FE	YES	YES	YES	YES
Country-pair-year FE	YES	YES	YES	YES
Adj. R^2	0.74	0.75	0.75	0.74
Observations	32,047	31,667	31,667	27,037

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors (three-way clustered by firm-year, destination, and country pair) in parentheses.

and promote gender equality instead. Figure D.9 visualizes this connection by plotting the marginal effects of $FCON_{iodt}$ over different levels of WBL_{dt} with the marginal effects of $MCON_{iodt}$ as a reference. Besides the positive moderating effect, the graph illustrates that in the absence of regulatory restrictions on female managers (i.e. when WBL_{dt} equals 100) male and female connections are roughly equally valuable. Likewise, the interaction effect of female mobility, $FMOBIL_{dt}$, as a moderator of $FCON_{iodt}$ is positive and significant. Thus, the effect of female

connections becomes stronger with less constraints on the freedom of movement for women in the destination. The significant and negative main effect of $FCON_{iodt}$ in both models (i.e. the effect when WBL_{dt} or $FMOBIL_{dt}$ equals zero) indicates that female connections might even be detrimental for foreign sales, when the regulatory environment in the destination severely restricts female managers. Although we have to treat the exact estimates especially for very low values of WBL_{dt} and $FMOBIL_{dt}$ with caution since no destination actually shows such harsh restrictions, the significant and positive moderating effect clearly provides evidence for a detrimental effect of institutional restrictions.

Second, the inclusion of $GSNI_d$ as a moderator for $FCON_{iodt}$ shows a negative and significant interaction effect. This implies that destinations with informal institutions biased against female managers diminish the generally positive effect of female connections. Furthermore, the main effect of female connections (i.e. the effect when $GSNI_d$ equals zero) becomes considerably larger than the effect of male connections, indicating that destinations with feminine informal institutions benefit female connections as compared to male connections. Figure D.10 depicts the marginal effect of $FCON_{iodt}$ conditional on the level of $GSNI_d$, together with the marginal effect of $MCON_{iodt}$ for comparison. This illustrates the observation that, depending on $GSNI_d$, the effect of $FCON_{iodt}$ can be larger or smaller compared to $MCON_{iodt}$. These results provide evidence for informal institutions as one driver of gender differences in the effect of manager connections.

If exporting is a crucial element for firm success and connected managers are able to raise bilateral exports to an important market, this would incentivize firms to hire connected managers. However, if important destination markets are discriminating against women, which reduces the connection effect of female

managers, firms may find it optimal to hire male managers. In this sense, our results indicate that there might be an unintended importing of gender inequality from discriminating destination markets under a performance-based hiring system in an otherwise non-discriminating origin country.

4.6 Robustness Checks

We conduct several robustness tests both for the firm- and country-level analyses. First and foremost, we conduct subsample analyses to rule out the possibility of biased results due to imbalanced data coverage or extreme values. Furthermore, we test alternative measures for key variables as well as alternative model specifications. Last but not least, we construct manager connections from another source to show that our results are not driven by peculiarities of the BoardEx data. We present result tables for all robustness tests in the appendix.

First, we analyze several regional subsamples to test whether our results are driven by imbalances in the data coverage. Especially the worldwide scope of the manager database might come with the drawback of a bias towards Western industrialized economies and in particular the United States. To rule out this possibility on the country level, we construct different regional subsets. We do not include connections in both directions simultaneously, as this would reduce the number of observations considerably. Our results are robust in different regional subsets of the data, namely the European Union including the United Kingdom (see Table D.4) and a set of all countries except for the European Union and the United Kingdom (see Table D.5). As our firm-level data set is more restricted, we cannot construct multiple regional subsets. Instead we construct only one subset

without the USA, which is the country of origin for most firms. Again, our results remain qualitatively unchanged (see Table D.10).

Furthermore, we conduct outlier analyses to ensure that our results are not driven by few uncommon observations. As we are mainly interested in outliers in the sense of unusual extreme values, we identified potential outliers in CON_{iodt} on the firm level and CON_{odt} on the country level via the interquartile range criterion (Aggarwal, 2017).[7] Since our results remain qualitatively unchanged when we exclude these outliers (see Tables D.11 and D.6) we are confident that neither certain subsamples nor outliers drive our results.

The effects of manager connections might not take place immediately but take some time to play out. Hence, we rerun our models with connections lagged by one period and obtain qualitatively similar results to our main analysis (see Table D.8). On the firm level, we also run two models with connections lagged by one and two years. In addition, we conduct a lead-lag analysis to address the concern of reversed causality and to investigate the timing of effects. The results indicate that manager connections increase destination-specific sales in the same and following years, while we find no evidence of lead effects (see Table D.12).

We run a robustness test where we include the squared value of log manager connections on the country-level. We do not find strong evidence for such higher-dimensional effects (see D.7). Although we consider the chosen clusters for our standard errors on the firm level to be appropriate, to the best of our knowledge, there is no consensus in the literature for our type of data and estimation structure. Hence, we provide the results with alternative standard error clusters for our main

[7] According to the interquartile range criterion, observations are defined as outliers when their value is larger than $Q3 + 1.5 * IQR$ or smaller than $Q1 - 1.5 * IQR$ with $Q1$ and $Q3$ representing the first and third quartile and IQR representing the interquartile range.

effect of manager connections. The positive effect remains highly significant in every specification regardless of the chosen cluster for standard errors (see Table D.13). Regarding our analysis of institutional moderators, we test the robustness against measurement error by including alternative variables that measure institutional development. Specifically, we test alternative subindices of the WGI, namely Rule of Law, Regulatory Quality, and Government Effectiveness.[8] Compared to our main measure, Corruption Control, these alternatives might more precisely capture other dimensions of institutional quality that are especially important for international trade (Álvarez et al., 2018). The results including these alternative variables instead of CC_{dt}, as well as the institutional distances based on these variables, generally support the findings of our main analysis with the sole exception of the moderating effect of Regulatory Quality in the destination, which only comes close to significance (see Table D.14).

Finally, Table D.9 presents the results of our country-level analysis when we use completely different data on manager connections. We construct these for the year 2018 from Bureau van Dijk's Amadeus database[9]. Amadeus also constitutes a well established source for manager data (Lel et al., 2019; Belenzon et al., 2016) capturing European companies of all sizes including small businesses (Burgstahler et al., 2006; Cucculelli et al., 2019). Apart from the small variation that we consider

[8]Rule of law is defined as "the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence" (Kaufmann et al., 2011, p. 223). Regulatory Quality is defined as "the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development" (Kaufmann et al., 2011, p. 223). Government Effectiveness is defined as "the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies" (Kaufmann et al., 2011, p. 223).

[9]https://www.bvdinfo.com/en-gb/our-products/data/international/amadeus

nationality and place of birth as factors that constitute a connection to another country, the process of aggregating connection on the country-level remains the same. The pro-trade effect of manager connections remains significant and even similar in magnitude when we use these alternative data.

4.7 Conclusions

We construct a novel database of bilateral manager connections and use it to analyze the effects of bilateral manager connections on the firm and on the country level. On the country level, we find positive effects on both bilateral exports and imports. In this context, connections appear to be of slightly higher relevance for the exporter than for the importer. On the firm level, we confirm these positive effects of manager connections for destination-specific foreign sales. Building upon these results, we also provide evidence that manager connections bridge institutional distance and compensate weak institutions, as their effect is stronger for institutionally distant destinations with weak institutions. Furthermore, we find gender differences in the effect of manager connections that are mainly driven by discriminatory institutions in the destination country. This could give rise to an unintended importing of gender inequality regarding management positions. Our results highlight the importance of individual manager connections for both firm- and macro-level outcomes.

There are some limitations specific to our approach of identifying manager connections. First and foremost, nationality constitutes by no means the only possible source of connections. Future research might extend our results to other origins of connections. Moreover, just like gender, other individual manager

characteristics such as personality traits, educational background or language skills might moderate the effect of manager connections. The same could be true for firm-level characteristics such as firm-governance or industry.

Finally, we want to address the issue of endogeneity. On the one hand, we are confident that our results are robust to endogeneity due to omitted variable bias. On the other hand, we cannot claim to provide terminal evidence for causal effects due to the potential for reverse causality. This problem is less severe for our analysis of institutional moderators. Since it seems unlikely that firm-level relationships significantly affect country-level institutions in the short run, exogeneity is a reasonable assumption for these institutional variables. However, this assumption does not hold for the main relationship between manager connections and trade. Anderson and Yotov (2020) compare trade elasticities in a short-run gravity model with their long-run equivalents after efficient investment in bilateral capacities took place. Manager connections can be a firm-specific improvement in bilateral capacities that reduces bilateral trade costs. In such a framework, causality could run in both directions simultaneously and lead to an equilibrium situation where higher bilateral capacities in the form of manager connections are associated with more bilateral trade. While the intuition behind a causal effect of manager connections on trade is persuasive, it is also plausible that trade might lead to the establishment of connections. In this sense, our results do not disentangle the two distinct causal effects, but provide a proxy for the equilibrium relationship.

Similar to the productivity effect of high-skilled immigrant workers demonstrated by Malchow-Møller et al. (2019), the pro-trade effect of manager connections in our setting might constitute a comparable factor that raises firms' revenues and profits by reducing destination-specific effective trade costs, such that mea-

sured productivity would increase. Furthermore, alternative sources of manager connections such as working experience or personal ties might hold potential for further analysis. Likewise, gender most likely does not constitute the only relevant individual characteristic that interacts with manager connections and different institutional settings. Here, other demographic characteristics such as race or age as well as individual assets such as language skills or international experience provide promising avenues for further examination.

All in all, our measure for manager connections as well as our findings regarding the interplay between these connections, trade, institutions, and gender offer valuable insights and open up various opportunities for further investigation. We hope that future research might draw on more extensive data to dive deeper into these important interdependencies and further explore the role of individual-level factors for macro-level outcomes.

Chapter 5

Institutional Discrimination Against Female Managers as a Barrier to Firm Internationalization and International Trade*

5.1 Introduction

The increasing internationalization of businesses and the empowerment of women in general and female managers in particular are two of the most relevant de-

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velopments of the last decades affecting firms and societies all around the world. Accordingly, determinants, moderators and outcomes of firm internationalization and international trade, as well as gender diversity have been subject of extensive research and debate in the scientific literature. On the one hand, numerous studies investigate the influence of manager characteristics and the institutional environment on firm internationalization and international trade (Tihanyi et al., 2000; Hitt et al., 2006; Sala and Yalcin, 2015; Tan and Chintakananda, 2016; Freixanet and Renart, 2020). On the other hand, a large and fast-growing body of literature examines how gender diversity affects different areas of firm performance (Baker et al., 2020), while also recognizing the important role institutional influences play in these relationships (L. Zhang, 2020; Hoch and Seyberth, 2021). However, to the best of our knowledge, the only attempt to connect manager gender and internationalization while recognizing institutional influences has been made for the case of destination-specific pro-trade effects of managers with foreign nationality depending on the institutional environment in the destination (Hoch and Rudsinske, 2021).

We aim to close this gap by investigating how the interaction between the female share of directors and gender-related institutions in the destination country affects firm internationalization and international trade. Our expectation is that firms and countries with a higher share of female directors sell relatively less in destinations with formal and informal institutions that are unfavorable for female managers. Formal gender-related institutions are laws and regulations regarding women's economic activities, while informal gender-related institutions refer to cultural values and social norms with respect to gender equality. Both formal restrictions and informal bias against female managers constitute an institutional

environment that deters business activity of international firms with gender-diverse boards towards a destination country. To test this hypothesis empirically on the firm level, we draw on a sample of international firms reporting foreign sales in 141 destination countries and combine it with data on the gender-related institutional environment in these countries. We utilize firm-year and country-pair-year fixed effects to mitigate the problem of endogeneity due to omitted variable bias, while an event study addresses potential reverse causality. On the country level, we employ a structural gravity framework with three-way fixed effects and the share of female directors aggregated from firm-level board data. We find a significant interaction effect between female shares of directors and gender-related institutions in the destination on firm-level foreign sales and country-level exports. This result suggests that differences in board gender ratios affect internationalization processes as more gender-diverse firms gravitate towards markets where their female directors face less adverse institutional conditions.

Since our research question arises at the intersection of firm internationalization and gender diversity, we hope that our results contribute to both strands of literature. Notably, we are not aware of any studies connecting this nexus between gender and internationalization with an institutional perspective. First, we add nuance to the understanding of internationalization processes by introducing the interaction between the share of female board members and gender-discriminating institutions in the destination country as a relevant determinant of internationalization. To the best of our knowledge, we are not only the first to examine this particular interaction but also the first to consider the role of gender-related institutional influences on internationalization processes in general.

Second, we also contribute to the highly relevant literature on the economic

outcomes of gender diversity. In this context, we enhance recent research studying the effects of gender diversity on export performance (Basuil and Datta, 2019) by providing first evidence that the relationship between board gender diversity and exports depends on the destination-country-specific institutional environment. On a similar note, Orser et al. (2010) draw on social feminism to explain gender differences in export performance with systemic differences in opportunity, and provide empirical evidence that characteristics of the exporting firm constitute such systemic factors. To the best of our knowledge, Hoch and Rudsinske (2021) provide the only empirical evidence of similar systemic gender differences in export performance connected to the institutional environment in the destination, as they find an institution-dependent and gender-specific effect of managers' personal connections to foreign countries. We enhance and generalize these ideas by providing evidence that the effect of female managers on export performance depends on institutionalized gender-related disadvantages in the destination country.

Third, we add insights into the debate surrounding gender discrimination on the labor market (Islam et al., 2019; Klasen, 2020) and especially regarding female managers. Up to now, extensive research demonstrates that gender discriminating institutions affect the chances of women to reach managerial positions (Terjesen and Singh, 2008) as well as their performance as managers (Hoch and Seyberth, 2021). In an international setting, however, national discriminatory institutions are no isolated entities but interact with other institutional influences across borders. For instance, multinational firms from less discriminating origin countries might mitigate institutionalized discrimination in destination countries (C. Wu et al., 2008) and even utilize their less discriminatory hiring policy as a competitive advantage (Siegel et al., 2019). In contrast, our results imply that the ramifications

of discriminatory institutions in the destination can surpass borders and spill over to the origin country. Specifically, gender discrimination in an important export destination might lead to discrimination against female managers even in a hypothetical origin country featuring completely non-discriminatory gender-related institutions.

Finally, we add to the literature on international trade as the interaction between female directors and gender-discriminating institutions extends to bilateral trade flows on the country level. An increase in the aggregate board female share is connected to lower exports to a discriminating destination as compared to less discriminatory destinations. Buyers in countries with discriminating institutions appear to be biased, whereas we do not find robust effects of that type for bilateral imports, indicating that sellers are less selective in choosing business partners. While the previous literature has focused mostly on the effects of trade on issues like the gender wage gap (Do et al., 2011; Sauré and Zoabi, 2014), to the best of our knowledge, we are the first to show effects of gender discrimination on bilateral trade. Gender-discriminating institutions in a destination constitute non-monetary trade costs when exporters rely on female managers. This has the potential to hamper international integration of gender-discriminating countries and could be detrimental from a welfare perspective. In this way, our results relate to the literature on the effects of gender inequality on aggregate income and economic growth (Cuberes and Teignier, 2014; Cuberes and Teignier, 2016).

The rest of the paper is structured as follows. In Section 5.2, we describe the data, set out how we construct board female shares on the firm and the country level, and discuss descriptive statistics regarding the main variables of interest. Building upon this data, we line out our empirical strategy for the two levels in

Section 5.3. Section 5.4 presents the empirical results for both the firm- and the country-level analyses as well as for several robustness checks. The final Section 5.5 discusses implications, limitations and potential for further research.

5.2 Data

5.2.1 Female Directors

We assess the prevalence of female managers based on the share of female members of the board of directors in large, publicly listed companies. For the firm-level analysis, we obtain the share of female board members from the BoardEx database provided by Wharton Research Data Services (2022). BoardEx is a common source for data on board composition and characteristics of individual board members (e.g. Adams, 2016). For the country-level analysis, we aggregate this measure as the number of board seats occupied by female managers divided by the total number of board seats. In addition, we obtain the available country-level data on the female share of seats on boards of the largest publicly listed companies from the OECD (2022a) for 37 OECD-countries between 2003 and 2019. Due to this restriction to OECD-countries, we only utilize the OECD database as a robustness test to ensure the validity of the main analysis based on our more comprehensive, self-constructed measure.

5.2.2 Firm Internationalization and International Trade

As a proxy for firm internationalization, we use country-specific foreign sales. We obtain the data on foreign sales from sales by geographic segments reported in

the commercial database Osiris provided by Bureau van Dijk (2022). Osiris in general, as well as the data on geographic segments, are well-established data sources and regularly utilized in business research on internationalization (e.g. Banalieva and Dhanaraj, 2013). Since we investigate countries as destinations of firm internationalization, we only include geographic segments that can be clearly matched to country names.[1]

For the country-level analysis, we employ data on bilateral trade (BACI database) and common regional trade agreements (gravity database) from CEPII (2021). We use the BACI trade flows. Missing trade values are replaced with zeros if both countries exist in a given year. BACI reconciles trade flows taken from the United Nations Comtrade database reported by both the exporter and the importer to provide a harmonized trade flow (Head et al., 2010; Head and Mayer, 2014).

We neither include firm-level sales in the home country nor countries' internal trade. First of all, our research question concerns internationalization processes. Furthermore, we believe that institutions in the origin country affect the outcomes of management gender differently than institutions in the destination country for several reasons. One is the natural predisposition to sell domestically. Another one is that domestic institutions already heavily influence the manager selection before even turning to their trade effects.

5.2.3 Gender-Related Institutions

We apply different institutional variables distinguishing between formal and informal gender-related institutions. In general, institutions constitute rules defining human-made constraints for the members of a given society (North, 1990; North, 1991).

[1]For a detailed description of the matching process see Hoch and Rudsinske (2021).

Formal institutions are formally codified rules such as laws and regulations (Scott, 1995), while informal institutions are non-codified rules such as social norms and values (Peng et al., 2008).

As a measure for formal gender-related institutions, we use the *Women, Business and the Law Index* (WBL, World Bank, 2021). The WBL is compiled by the World Bank and measures "laws and regulations that restrict women's economic opportunities" (World Bank, 2021, p. 2). A higher index value implies fewer institutional restrictions against women.

To assess informal gender-related institutions, we utilize the *Gender Social Norms Index* ($GSNI$) provided by the United Nations Development Programme (United Nations Development Programme, 2020). The $GSNI$ captures culturally institutionalized bias against women based on questions regarding gender equality in the World Values Survey. More specifically, we employ the $GSNI$ based on the intersection approach, which measures the percentage of respondents who revealed at least two biases against women in their answers. Furthermore, we use $GSNIECON$, the economic dimension of the $GSNI$, which measures the percentage of people with a bias against women in business contexts. This dimension of social bias seems particularly relevant to our research question as it explicitly includes the bias that "men make better business executives than women" (United Nations Development Programme, 2020, p. 8).

5.2.4 Descriptive Statistics

Our final firm-level sample contains data from 2008 to 2017 on all firms in BoardEx that additionally report foreign sales on the country level in Osiris to at least

one destination country with available institutional data. The resulting database comprises 31,377 observations on foreign sales of 3,368 firms in 141 destination countries. However, the number of observations that can be used in the regression analysis is limited by the availability of the different institutional variables.

Table E.1 provides summary statistics for all variables in the firm-level analysis. On average, 12% of the board members in our sample are female and there exist completely male but no completely female boards. The ranges and standard deviations of all three institutional variables indicate that our sample covers a variety of countries with different gender-related institutional environments. To further illustrate the composition of our international sample, Figure E.1 maps the number of observations by origin country and Figure E.2 does the same by destination country.

Table E.2 provides summary statistics for the country-level database. The data-set features the ten years from 2008 until 2017, with trade flows for 198 origins and 198 destinations, as well as female shares for 104 countries. We observe female shares between 0% and 53%, with an average of 11%. The median value is 10%, while the interquartile range spans from 5% to 15%. For an overview of country-level female shares in the year 2017 see Figure E.3. The alternative female shares for OECD countries are a little higher on average with a mean of 17% and a median of 14%.

Regarding our institutional variables, there is substantial variation in the level of institutional discrimination both for the formal (WBL) and the informal ($GSNI$) institutions. Figures E.4 and E.5 depict this variation by mapping the values of WBL in 2017 and of the time-invariant $GSNI$ for each country.

As we use the same country-level data to construct institutions and female

shares of both the origin and the destination, summary statistics are the same in these cases. 18% of the country-pair-year observations feature a common regional trade agreement. The average trade flow is around 600 million USD, although the distribution is skewed with a median value of only 1.2 million USD. Zero trade flows account for at least a quarter of the observations.

5.3 Empirical Strategy

5.3.1 Firm Level

To investigate the interaction effect between board female shares and gender-related institutions in the destination country on firm-level internationalization, we estimate the following fixed effects regression model.

$$log(ForeignSales_{id,t}) = \beta_1 FemaleShare_{i,t} \times Institutions_{d,t} + \gamma_{i,t} + \nu_{od,t} + \epsilon_{id,t}$$

The dependent variable $ForeignSales_{id,t}$ represents the foreign sales of firm i in destination country d and year t. The only explanatory variable is the interaction term between our measures for the board gender ratio, $FemaleShare_{i,t}$, and the gender-related institutional variables, $Institutions_{d,t}$. The firm-year fixed effects, $\gamma_{i,t}$, control for all unobserved firm-level variables. This controls for time-invariant characteristics such as firm age as well as time-varying factors such as board composition or firm performance and also includes higher-level fixed effects such as industry-year fixed effects and origin country fixed effects. Likewise, the directional country-pair-year fixed effects $\nu_{od,t}$ control for all bilateral factors on the country-level such as geographic and institutional distance or free trade agreements and

also include destination-year fixed effects. We do not include the main effect of $FemaleShare_{i,t}$ and $Institutions_{d,t}$, since these are already included in $\gamma_{i,t}$ and $\nu_{od,t}$ respectively. $\epsilon_{id,t}$ represents the error term.

While the institutional variables can be treated as exogenous in our setting, the relationship between the female share of directors and foreign sales to destinations with different institutions might work in two directions. First, female managers might actually be discriminated against in the destination, which would result in their firms selling less in discriminating countries. Likewise, it is possible that firm owners only expect such discriminatory effects and do not hire female managers when discriminating countries are important destinations for their firm. Both of these causal mechanisms would result in relatively less sales to countries with discriminating institutions for firms with a relatively high female share. However, the chronology of events would be different since discrimination could either take place after a female director is hired, or during the hiring decision if the detrimental effect of discriminating institutions is already anticipated by the firm. In the latter case, firms hiring a female manager would already sell relatively less in countries with discriminatory institutions before the event of a new female manger entering the board.

Hence, we conduct an event-study to investigate whether discrimination actually takes place in the destination country or is only anticipated by the firm in the origin country. The variable *Event* takes a value of one if a firm's number of female board members increased relative to the previous year, and a value of zero otherwise. Hence, *Event* captures the event of at least one new, additional female director on the board.

$$
\begin{aligned}
log(ForeignSales_{id,t}) &= \beta_1 Event_{i,t+2*} \times Institutions_{d,t} \\
&+ \beta_2 Event_{i,t} \times Institutions_{d,t} + \beta_3 Event_{i,t-1} \times Institutions_{d,t} \\
&+ \beta_4 Event_{i,t-2*} \times Institutions_{d,t} + \gamma_{i,t} + \nu_{od,t} + \epsilon_{id,t}
\end{aligned} \tag{5.1}
$$

We utilize an ordinary least squares regression specification similar to the one used before, but now include the event variable instead of the female share. Equation 5.1 shows the specification, where an index time with an asterisk indicates that all further available years in that time direction are included for the indicator construction. Hence, $Event_{i,t+2*}$ will not only equal one if an event takes place two years ahead but also if it takes place three or more years ahead. The first lead (one year prior to the event), $Event_{i,t+1}$, is not included and serves as point of reference.

5.3.2 Country Level

On the country-level we employ a structural gravity framework (Eaton and Kortum, 2002; Anderson and Van Wincoop, 2003). After including origin-year ($\eta_{o,t}$), destination-year ($\nu_{d,t}$), and directional country-pair (ω_{od}) fixed effects to control for all potentially time-varying exporter- and importer-specific characteristics as well as time-invariant country-pair factors, and with $\epsilon_{od,t}$ as error term, we can write country o's exports to country d in period t as

$$
Exports_{od,t} = exp[\beta_1 FemaleShare_{o,t} \times Institution_{d,t} + \beta_2 RTA_{od,t} + \eta_{o,t} + \nu_{d,t} + \omega_{od}] + \epsilon_{od,t}.
$$

The existence of a common regional trade agreement (RTA) is included as control variable. $Institution$ can be, for example, $GSNI$ or WBL. An alternative specification substitutes $FemaleShare_{o,t} \times Institution_{d,t}$ with $FemaleShare_{d,t} \times Institution_{o,t}$. This can be interpreted as the effect on imports instead of exports. We employ a Poisson pseudo maximum likelihood (PPML) estimator for the above equation to keep observations with zero trade flows and to avoid potential problems of biased estimates under heteroskedasticity (Santos Silva and Tenreyro, 2006).

5.4 Results

5.4.1 Firm Level

Table 5.1 shows the results of our main analysis on the firm level. We provide two models for the interactions between $FemaleShare$ and the institutional moderators: Models (1) and (2) include $GSNI$, Models (3) and (4) include $GSNIECON$, and Models (5) and (6) include WBL. For each of these interactions, we provide one model with $FemaleShare$ in the current year and one with $FemaleShare$ lagged by one year since the effects of a newly appointed female director might not take place immediately.

All models reveal a significant interaction between $FemaleShare$ and the respective institutional variable. At that, the interaction effect is negative for $GSNI$ as well as for $GSNIECON$ and positive for WBL. According to that, the effect of gender diversity on foreign sales depends on the formal gender-related environment as its effect size is smaller in destinations with an institutionalized social bias against women and larger in destinations where women face less formal

Table 5.1: Firm Level Results

Dep. Var.: $log(ForeignSales_t)$	(1)	(2)	(3)	(4)	(5)	(6)
$FemaleShare \times GSNI$	-0.05^{***}					
	(0.01)					
$FemaleShare_{t-1} \times GSNI$		-0.05^{***}				
		(0.02)				
$FemaleShare \times GSNIECON$			-0.04^{***}			
			(0.01)			
$FemaleShare_{t-1} \times GSNIECON$				-0.04^{***}		
				(0.02)		
$FemaleShare \times WBL$					0.08^{***}	
					(0.02)	
$FemaleShare_{t-1} \times WBL$						0.10^{***}
						(0.02)
Firm-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Origin-destination-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.71	0.69	0.71	0.69	0.72	0.70
Observations	26,405	17,912	26,405	17,912	31,222	21,087

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors (two-way clustered by firm and country-pair) in parentheses.

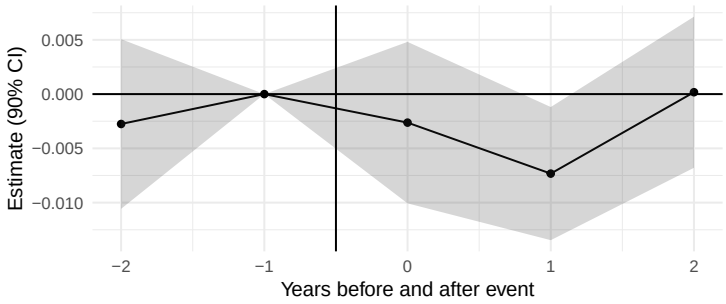
restrictions in the labor market. Taken together, these results provide evidence in favor of our main hypothesis that the effect of gender diversity on foreign sales depends on the gender-related institutions in the host country.

For an intuitive illustration of this finding consider the following numerical example. An international firm starts with an equal value of $ForeignSales$ in two different host countries A and B with $GSNI_A = 25$ and $GSNI_B = 65$, which is approximately equivalent to the 25^{th} and 75^{th} percentile of $GSNI$, and experiences an increase in $FemaleShare$ by 10 percentage points (0.1 units). According to our estimate for the interaction between $GSNI$ and $FemaleShare$ in Model (1), the effect of an increase in $FemaleShare$ by one unit on foreign sales depends on $GSNI$ as it changes by $100 * (e^{-0.05} - 1) \approx -4.88$ percentage points for every additional unit in $GSNI$. Hence, in our example, an increase in $FemaleShare$ by

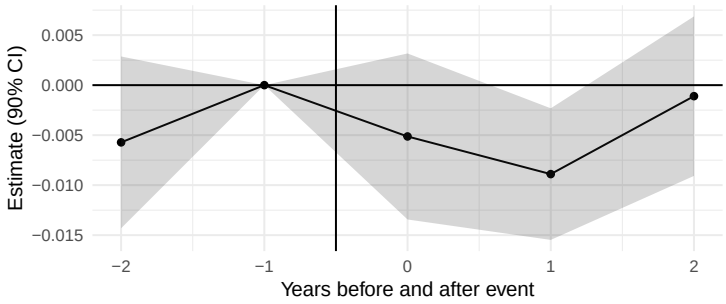
0.1 is associated with a percent change in $ForeignSales$ that is 19.52 percentage points smaller in country B compared to country A. Note that this difference occurs regardless of the size and direction of a possible main effect of $FemaleShare$ on foreign sales. For instance, if the main effect of $FemaleShare$ (i.e. the effect when $GSNI = 0$) would be zero, a ten percentage points $FemaleShare$ increase would be connected to a decrease in foreign sales to A by 12.2% and a decrease in foreign sales to B by 31.72%.

Table E.3 contains the regression output from our event study, which Figure 5.1 illustrates graphically. The estimate plotted for year 2 prior to an event is the one for the interaction of the independent variable $Event_{i,t+2*}$ that also contains all available years before the second year prior to the event. There are no significant pre-trends. Likewise, contemporary effects are insignificant. This is plausible since firms often have to fulfill contracts from previous years and a new manager does not upset the sales structure within a few months. The lagged values are significant for the informal institutions, indicating that informal gender attitudes in the destination indeed affect firm sales after a new female member entered the board.

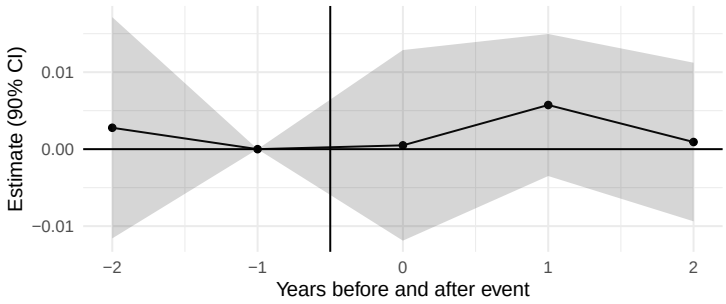
However, the one-year lagged effect is not significant for formal institutions. A potential reason for not being able to establish a chronology here could be that firms are able to anticipate problems due to formal institutions better than in the case of informal institutions. This would either decrease the likelihood of appointing a new female director in the first place or at least the likelihood of that exact manager being selected to negotiate contracts with firms from discriminatory countries. In this case, the effect identified in the main analysis would be between firms rather than within firms. Accordingly, systematic discrimination in important



(a) GSNI



(b) GSNIECON



(c) WBL

Event study coefficient estimates for the *Event* interactions with 90% confidence interval. Dependent variable: $log(ForeignSales)$.

Figure 5.1: Firm-Level Event Study Plots

sales destinations could transfer to firms hiring decisions in the origin countries.

The long-term effects for all three institutional variables are insignificant. These are the coefficient estimates plotted for year 2 after the event, however, the underlying independent variable $Event_{i,t-2*}$ also contains all available years following

the second year after the event. Therefore, conclusions should only be drawn with caution as, for example, a female manager might have left the firm already some years after having been hired. Especially in the case of informal institutions it is also possible that firms only learn about that type of discrimination after their female managers have experienced it or they merely recognize worse performance measures and, as a result, choose other managers to negotiate future contracts with firms from such countries. It is even conceivable that prejudices of managers in discriminatory countries wane as a consequence of the experience from interacting with female business partners. We leave the identification of mechanisms for potential long-term adjustments for future research.

5.4.2 Country Level

Table 5.2 shows the results of the related analysis on the country-level. Models (1)-(3) can be interpreted as the export effect. Here, all interactions remain significant just like in the firm-level regressions. Accordingly, gender discrimination matters also on the aggregate level. When it comes to buying other firms' products, trust in quality and in-time delivery matters. Individuals in countries with gender-discriminating institutions are less inclined to import from female-run businesses.

Following Model (1), $100 * (e^{\beta} - 1) * GSNI_d \approx -1.98 * GSNI_d$ gives the percentage point difference of the percentage change in exports following a one unit change in the $FemaleShare_o$ as compared to a non-discriminatory destination ($GSNI_d = 0$). The absolute effect is unknown from this specification, as the main effect is captured by the origin-year fixed effect. Looking at a 10 percentage points increase in the female share (0.1 units), this roughly amounts to $-0.2 * GSNI_d$.

Consequently, exports to a destination with the average $GSNI$ in our sample of 59 will change by 11.8 percentage points less as compared to a destination with a $GSNI$ of zero. If the main effect would be zero for example, this results in an 11.8% reduction in bilateral exports. This is comparable to no longer being member of a common regional trade agreement, which has a positive effect of $100 * (e^{0.1} - 1)\% \approx 10.5\%$ in that specification (which is not ideal for estimating RTA effects).

Table 5.2: Country-Level Results

Dep. Var.: *Exports*	(1)	(2)	(3)	(4)	(5)	(6)
$FemaleShare_o \times GSNI_d$	-0.02^{***}					
	(0.00)					
$FemaleShare_o \times GSNIECON_d$		-0.02^{***}				
		(0.00)				
$FemaleShare_o \times WBL_d$			0.03^{***}			
			(0.00)			
$FemaleShare_d \times GSNI_o$				-0.01		
				(0.00)		
$FemaleShare_d \times GSNIECON_o$					-0.01	
					(0.00)	
$FemaleShare_d \times WBL_o$						-0.00
						(0.01)
RTA	0.10^{***}	0.10^{***}	0.10^{***}	0.09^{***}	0.09^{***}	0.10^{***}
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Origin-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Destination-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Origin-destination FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj. Pseudo R^2	1.00	1.00	1.00	0.99	0.99	0.99
Observations	58,417	58,417	137,348	58,364	58,364	136,905

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors (clustered on the country-pair level) in parentheses. Estimation method: PPML.

Models (4)-(6) test something that we cannot analyze on the firm-level. They take the female share of the importing country and the institutions of the exporting country as elements of the interaction term. As such, results can be interpreted as

the effect of the original interaction term on imports instead of exports. Interestingly, we find no significant effects here. This indicates that individuals in discriminating countries do not severely differ in their business activities with female-run firms when it comes to selling their own products. This observation seems reasonable, since the role of trust and reputation is more important for the buyer than for the seller when information asymmetries are present. In that sense, earning money seems to dominate gender biases.

5.4.3 Robustness Checks

As described in Section 5.2, the coverage of origin countries on the firm level is limited by the data availability in *BoardEx* and *Osiris* which leads to a composition that is slightly skewed towards industrial countries. To ensure that our results are not driven by this selection of countries, we run two subsample analyses based on the classification of countries as *High Income* by the OECD. The results for the subsample excluding all high-income origin countries, presented in Table E.4, confirm the results of our main analysis. The results of the subsample analysis of only high-income countries, reported in Table E.5, overall also support our main findings, albeit the interaction between the two versions of $GSNI$ and the lagged female share become insignificant. Similar analyses on the country level are reported in Table E.6 and reveal a pattern that is broadly consistent with the firm level. While our results are robust to a sample excluding high-income countries in Models (4)-(6), only $GSNIECON$ and WBL remain significant in a sample consisting of high-income countries only (Models (1)-(3)). Although the interaction with $GSNI$ is no longer significant in that subsample (p-value $\approx 16\%$),

the estimated coefficient is still negative.

Although we believe the chosen standard error clusters to be appropriate for our analysis, we are not aware of any standards or best practice for similar settings in the international business literature. Thus, we run robustness tests for the firm-level analysis with differently clustered standard errors. Table E.7 features one-way clustered standard errors on the firm level as is common in the business literature (e.g. Martincus and Carballo, 2008) and Table E.8 adopts standard errors clustered on the country-pair level, which emerged as the standard for gravity models (Yotov et al., 2016) in comparable settings. Our results remain highly significant in all of these alternative specifications. On the country-level, we apply the error-correction for gravity models proposed by Weidner and Zylkin (2021). We do not display the results here as the bias correction only concerns decimal places for the coefficient estimates and the estimated standard errors that are not displayed in our tables, such that significance levels continue to hold and our results are basically unaffected.

Table E.9 presents results from the country-level regressions once the lagged female share is included instead of the contemporary one. Results remain almost unchanged for exports, while for imports the interactions with the two $GSNI$ variables now become marginally significant with coefficient estimates that are roughly half the size of those for exports.

Finally, we repeat the country-level regressions with an alternative, although less extensive data source for the share of female top managers in publicly listed firms in OECD countries from OECD (2022a). Accordingly, we have much less available observations and the panel is now restricted to a special set of country-pairs. As presented in Table E.10, the effect on exports of the interaction with the overall

$GSNI$ remains negative but no longer exceed usual levels of significance (p-value $\approx 18\%$). However, results are stable for the interactions with $GSNIECON$ and WBL. Additionally, the interaction with WBL now becomes significantly positive for imports as well. Given the special OECD sample characteristics (note for example that RTA becomes insignificant), we generally consider this as indication of the reliability of our female share data.

5.5 Discussion and Conclusion

5.5.1 Implications

Our results show that discriminatory gender-related institutions deteriorate firm-level foreign sales and country-level exports in the face of high shares of female directors. These findings have important implications for our understanding of the interplay between firm internationalization, managers' gender, and the institutional environment but also practical implications for international business firms and national law makers.

Firstly, gender-discriminating institutions in destination countries also affect female managers in the origin country. Hence, female managers in otherwise less discriminatory countries might still suffer from discrimination in other countries. This imported discrimination, in turn, might affect both the performance of female managers and the chances of women to reach these managerial positions in the first place.

Our findings also have serious implications for the destination countries. In the face of a slowly but constantly rising share of female managers, countries

with gender-discriminating institutions do not only harm local firms with female managers but also deter international firms and trade, which can hinder economic growth, economic integration and, thus, reduce welfare.

In that respect, gender as an individual characteristic of large firms' top managers has notable macro-level export effects, which stresses the role of firms and micro-level factors for aggregate outcomes. However, our country-level results regarding imports indicate that sellers are less selective in choosing business partners since we do not find strong evidence for gender discrimination in this direction.

5.5.2 Limitations and Future Research

Our sample is restricted to large, publicly listed firms that already act on an international level. While this is a valid and particularly relevant sample for our research question, internationalization of small businesses might be different. For instance, smaller firms experience larger difficulties in the internationalization process and react more sensitive to unfavorable host-country institutions (Lskavyan and Spatareanu, 2008). Hence, the influence of gender-related host-country institutions might also depend on firm characteristics such as firm size or international experience. Likewise, the interplay between gender diversity, gender-related institutions and other important factors of internationalization processes such as entry mode might be worth further investigation.

Furthermore, our work is subject to the typical limitations of real world data. Firstly, data quality and availability differs around the globe. While our firm-level sample covers 141 destination countries featuring a large variety of institutional environments, it is still biased towards countries with high levels of institutional and

economical development and a similar bias arises for the coverage of home countries. Although we are confident that this bias does not threaten the validity of our results, developing economies constitute a particularly interesting setting both as host countries for international firms and as home countries for internationalization processes. For instance, the concept of institutional escapism (B. Wu and Deng, 2020) might also apply to gender diverse firms escaping from gender-discriminating home countries.

Due to our conservative fixed effects setting to avoid omitted variable bias, we can only estimate the interaction effect between gender diversity and host country institutions. However, we cannot estimate the overall or marginal effects of the share of female directors depending on the institutional moderator. Future research could further investigate the size and direction of the relationship between the board gender ratio and internationalization depending on institutional moderators.

Despite our efforts to address endogeneity we cannot claim providing terminal evidence for a causal relationship let alone identifying the exact causal mechanism. In particular, unobserved factors on the firm-destination level, which are the only factors our fixed effects in the firm-level analysis do not control for, might still cause omitted variable bias. For instance, a change in the female share of directors might be connected with a changing cultural distance between firm culture and destination culture that, in turn, affects the foreign sales to this destination. Moreover, we cannot disentangle the different possible reasons for a direct causal effect of the female share of directors. A relative reduction in foreign sales in the face of discriminatory institutions might occur either because potential buyers avoid the firm or because the firm avoids discriminatory markets be it due to the anticipated difficulties or due to personal preferences. Future research could further examine

these potential causal mechanisms by applying different methods such as qualitative analyses.

5.5.3 Conclusion

Our results provide evidence that the interaction between the share of female board members and gender-related host country institutions affects firm internationalization and international trade. Gender-discriminating institutions in the destination country deteriorate both foreign sales of international firms and exports of countries with a high share of female directors. Our findings illustrate the complex interactions between individual manager characteristics and national institutions in international business and international trade as they imply that the detrimental effects of institutionalized gender-discrimination do not stop at national borders.

Conclusions

The main contributions of this thesis relate to two broad strands of the international trade literature. It contributes to the theoretical literature on general equilibrium models of international trade under oligopolistic competition (e.g. Neary, 2016) by extending them to the case of segmented markets and asymmetric countries. It deploys this model to analyze asymmetric labor market policies, corporate taxation, tax-motivated transfer pricing and optimal tariff policy. Distributional effects between countries as well as between labor and profit incomes are shown to be of special interest in this class of models. Additionally, this thesis adds to the empirical literature on firm heterogeneity (e.g. Bernard et al., 2007). It shows how personal attributes of top managers can affect firm-destination-specific trade barriers.

The first chapter develops a trade model with segmented markets that allows to analyze oligopolistic behavior across asymmetric countries. Firms' oligopolistic behavior has macro-level effects when countries are asymmetric. This can induce deviations from the law of one price, which gives rise to terms-of-trade based international shifts in consumption and welfare.

Corporate taxation and tax-motivated transfer pricing are incorporated into this model in the second chapter. They affect multinationals' supply decisions

as well as income in the two countries. Without transfer pricing, a higher profit tax rate shifts welfare towards the taxing country. Tax-motivated transfer pricing introduces an additional incentive for all firms to export and, consequently, to expand production. Thus, real wages in both countries rise, when transfer pricing becomes possible. Tax income shifts such that consumption is relocated from the high- to the low-tax country.

Import tariffs in this setting are studied in the third chapter. Their anti-competitive effect reduces labor demand as firms want to shorten supply. Unilaterally raising the import tariff increases domestic welfare at the foreign country's expense, but also favors profit relative to labor incomes, as real wages fall. If supporting workers is the policy objective, tariffs are no suitable tool under oligopoly.

The fourth chapter shows a destination-specific pro-trade effect of top managers' nationality. The effect is especially pronounced for institutionally distant destinations, which can be seen as bridging the gap between institutionally dissimilar countries. Likewise, the effect is more pronounced for destinations with less developed institutions, which indicates that manager connections help overcoming trade barriers created by low institutional quality.

Finally, the fifth chapter uncovers trade-reducing effects of institutional discrimination against female managers in destination markets. The combination of a high female share of directors and gender-discriminating institutions in a destination reduces sales in that foreign country relative to less discriminatory destinations. Our findings suggest that institutionalized discrimination against female managers is a barrier to firm internationalization on the micro and international trade on the macro level. Importantly, this might give rise to disadvantages for female managers even in non-discriminatory countries.

There is plenty of scope for future research in the realm of asymmetric general oligopolistic equilibrium models. Many questions of policy relevance demand the flexibility to analyze asymmetric countries, which the model presented in Chapter 1 offers. Chapters 2 and 3 have used this framework to study corporate tax and trade policy. Further germane avenues for theoretical analysis include environmental policy, innovation policy and industrial policy. Beyond that, Chapters 4 and 5 empirically investigated the role of firm heterogeneity in destination-specific trade barriers. Numerous firm-level factors different from manager nationality and gender might influence trade barriers to certain markets only. This is a promising point of departure for future empirical research.

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Appendix A

Appendix to Asymmetric General Oligopolistic Equilibrium

A.1 Endogenous Variables Depending on Exogenous Parameters and λ

$$
\begin{aligned}
y_h &= \frac{\lambda}{b}\left\{b\frac{L}{n} + \frac{1-2\lambda}{n+n^*+1}\frac{a}{\lambda}\right\} \\
y_f &= \frac{1-\lambda}{b}\left\{b\frac{L}{n} + \frac{2\lambda-1}{n+n^*+1}\frac{a}{1-\lambda}\right\} \\
y_h^* &= \frac{\lambda}{b}\left\{b\frac{L^*}{n^*} + \frac{1-2\lambda}{n+n^*+1}\frac{a}{\lambda}\right\} \\
y_f^* &= \frac{1-\lambda}{b}\left\{b\frac{L^*}{n^*} + \frac{2\lambda-1}{n+n^*+1}\frac{a}{1-\lambda}\right\} \\
p &= a\left(1 + \frac{n+n^*+{}^{1-\lambda}\!/_{\lambda}}{n+n^*+1}\right) - b(L+L^*) \\
p^* &= a\left(1 + \frac{n+n^*+{}^{\lambda}\!/_{1-\lambda}}{n+n^*+1}\right) - b(L+L^*)
\end{aligned}
$$

$$\begin{aligned} w &= 2a - b\left(\frac{n+1}{n}L + L^*\right) \\ w^* &= 2a - b\left(\frac{n^*+1}{n^*}L^* + L\right) \end{aligned}$$

A.2 Marginal Utility of Income in General Equilibrium

Under the assumptions of Section 4 with $\gamma(z) = \gamma^*(z) = 1\ \forall z$, $n = n^* = 1$, $b(L + L^*) < a$ and $2/5 < L/L^* < 5/2$, the balance of trade equilibrium condition can be rearranged to

$$0 = \Xi \equiv \epsilon\lambda^3 + \zeta\lambda^2 + \eta\lambda + \theta$$

with

$$\begin{aligned} \epsilon &= -\left(b(L^* + L^*) - \frac{4}{3}a\right)^2, \\ \zeta &= \frac{8}{3}a^2 - 5abL - 3abL^* + 2b^2L^2 + 3b^2LL^* + b^2L^{*2}, \\ \eta &= \left(bL - \frac{1}{3}a\right)(2a - b(L + L^*)), \\ \theta &= -\frac{1}{9}a^2. \end{aligned}$$

Accordingly, the discriminant is

$$\zeta^2\eta^2 - 4\epsilon\eta^3 - 4\zeta^3\theta - 27\epsilon^2\theta^2 + 18\epsilon\zeta\eta\theta > 0.$$

As the coefficients are real numbers and the discriminant is positive, this cubic polynomial has three distinct real roots. However, two of these are complex. In the proof of Proposition 1.2 we use mathematical software to determine the applicable

root. We can further restrict the values of the marginal utility of income in equilibrium using Newton's method to approximate roots. At $\lambda = 1/4$ and $\lambda = 3/4$ it holds respectively that

$$\frac{1}{4} - \left.\frac{\Xi}{\partial\Xi/\partial\lambda}\right|_{\lambda=1/4} > \frac{1}{4} \quad \text{and} \quad \frac{3}{4} - \left.\frac{\Xi}{\partial\Xi/\partial\lambda}\right|_{\lambda=3/4} < \frac{3}{4}.$$

This implies that $1/4 < \hat{\lambda} < 3/4$. For the case of symmetric countries ($L = L^*$), the balance of trade condition can be rearranged to

$$\begin{aligned} 0 &= -\frac{1}{9}a^2 + \lambda\left\{-\frac{2}{3}a^2 + \frac{8}{3}abL - 2b^2L^2\right\} \\ &\quad +\lambda^2\left\{\frac{8}{3}a^2 - 8abL + 6b^2L^2\right\} - \lambda^3\left\{2bL - \frac{4}{3}a\right\}^2 \\ 0 &= (2\lambda - 1)\left\{\frac{1}{3}\frac{a^2}{b}(8\lambda(\lambda-1) - 1) + \lambda(\lambda-1)L\left(6bL - 8a\right)\right\}. \end{aligned}$$

The condition is fulfilled for symmetric countries with $\lambda = 1/2$.

A.3 Supplement

The supplement (Mathematica Notebook) is available from the author upon reasonable request.

Appendix B

Appendix to International Trade and Tax-Motivated Transfer Pricing

B.1 Endogenous Variables Depending on Exogenous Parameters and λ

We present these equations in a more general way without applying the assumptions on $L^{(*)}$ and $n^{(*)}$. Still, we set $0 \leq \tau^* \leq \tau$. The supplied quantities in Cournot equilibrium are

$$\begin{aligned} y_h &= \frac{\lambda}{b}\left\{b\frac{L}{n} + \frac{1-2\lambda}{n+n^*+1}\frac{a}{\lambda} - (1-\lambda)g\frac{(\tau-\tau^*)}{n+n^*+1}\left(\frac{n^*}{1-\tau} + \frac{n^*+1}{1-\tau^*}\right)\right\} \\ y_f &= \frac{1-\lambda}{b}\left\{b\frac{L}{n} + \frac{2\lambda-1}{n+n^*+1}\frac{a}{1-\lambda} + \lambda g\frac{(\tau-\tau^*)}{n+n^*+1}\left(\frac{n^*}{1-\tau} + \frac{n^*+1}{1-\tau^*}\right)\right\} \end{aligned}$$

$$
\begin{aligned}
y_h^* &= \frac{\lambda}{b}\left\{b\frac{L^*}{n^*} + \frac{1-2\lambda}{n+n^*+1}\frac{a}{\lambda} + (1-\lambda)g\frac{(\tau-\tau^*)}{n+n^*+1}\left(\frac{n}{1-\tau^*} + \frac{n+1}{1-\tau}\right)\right\} \\
y_f^* &= \frac{1-\lambda}{b}\left\{b\frac{L^*}{n^*} + \frac{2\lambda-1}{n+n^*+1}\frac{a}{1-\lambda} - \lambda g\frac{(\tau-\tau^*)}{n+n^*+1}\left(\frac{n}{1-\tau^*} + \frac{n+1}{1-\tau}\right)\right\}.
\end{aligned}
$$

The prices are given by

$$
\begin{aligned}
p &= a\left(1 + \frac{n+n^*+{}^{1-\lambda}\!/\!_{\lambda}}{n+n^*+1}\right) - b(L+L^*) \\
&\quad -(1-\lambda)g\frac{(\tau-\tau^*)}{n+n^*+1}\left(\frac{n^*}{1-\tau} - \frac{n}{1-\tau^*}\right) \\
p^* &= a\left(1 + \frac{n+n^*+{}^{\lambda}\!/\!_{1-\lambda}}{n+n^*+1}\right) - b(L+L^*) \\
&\quad -\lambda g\frac{(\tau-\tau^*)}{n+n^*+1}\left(\frac{n}{1-\tau^*} - \frac{n^*}{1-\tau}\right)
\end{aligned}
$$

and wages are

$$
\begin{aligned}
w &= 2a - b\left(\frac{n+1}{n}L + L^*\right) + (1-\lambda)g\frac{(\tau-\tau^*)}{1-\tau^*} \\
w^* &= 2a - b\left(\frac{n^*+1}{n^*}L^* + L\right) + \lambda g\frac{(\tau-\tau^*)}{1-\tau}.
\end{aligned}
$$

B.2 Derivation of the Market Indifference Curve

Here, we derive the Market Indifference (MI) curve resulting from profit maximization. Equations (2.6) and (2.7) can be rearranged to

$$
\frac{1}{\lambda}(a-by) = \frac{1}{\lambda}by_h + \frac{1}{\lambda^*}(a-by^*-by_f) + \frac{\tau-\tau^*}{1-\tau^*}g
$$

and

$$
\frac{1}{\lambda}(a-by) = \frac{1}{\lambda}by_h^* + \frac{1}{\lambda^*}(a-by^*-by_f^*) - \frac{\tau-\tau^*}{1-\tau}g.
$$

Because these equations have the same left-hand side, we can set the right-hand sides equal, rearrange, and get

$$\frac{g}{b}\frac{(\tau-\tau^*)(2-\tau-\tau^*)}{(1-\tau)(1-\tau^*)} = \frac{y_h^*-y_h}{\lambda} + \frac{y_f-y_f^*}{\lambda^*}.$$

Using the normalization $\lambda^* = 1-\lambda$, as well as $y_f + y_h = 1/2$ and $y_h^* + y_f^* = 1/2$, this equation can be rearranged to get the function we use to illustrate the equilibrium:

$$y_h(y_h^*) = -\lambda(1-\lambda)\frac{g}{b}\frac{(\tau-\tau^*)(2-\tau-\tau^*)}{(1-\tau)(1-\tau^*)} + y_h^*.$$

B.3 Proofs

Lemma 2.1

Proof. The balance of payments can be rearranged to

$$BoP = \frac{1}{b}\left(x_1 + x_2\ \lambda + x_3\ \lambda^2 + x_4\ \lambda^3 + \frac{1}{9}a^2\left(\frac{\tau-1}{\lambda} + \frac{\lambda-\tau^*}{(1-\lambda)}\right)\right)$$

with

$$\begin{aligned}
x_1 &= -\frac{1}{9}a^2(7+4\tau) - \frac{1}{2}b^2\left(1+\frac{1}{2}\ \tau^*\right) + \frac{1}{3}ab(4+\tau+\tau^*) + \frac{1}{3}ag(\tau^*-\tau) \\
&\quad -\frac{1}{2}b\tau^* g + \frac{1}{3}a\Delta\left(-1+\frac{5}{3}\tau - \frac{2}{3}\tau^* + \frac{2}{3}\tau\tau^* - \frac{2}{3}\tau^2\right) + \frac{1}{2}b\tau^*\Delta(1-\tau), \\
x_2 &= \left(\frac{2}{3}a - \frac{1}{2}b\right)^2(4+\tau+\tau^*) + \left(\frac{2}{3}a - \frac{1}{2}b\right)g(\tau-\tau^*) \\
&\quad +\Delta\Bigg[a\left(\frac{2}{3} - \frac{23}{9}\tau + \frac{2}{3}\tau^2 + \frac{17}{9}\tau^* - \frac{2}{9}\tau^{*2} - \frac{4}{9}\tau\tau^*\right) \\
&\quad +b\left(\frac{7}{6}\tau - \frac{1}{3}\tau^2 - \frac{13}{6}\tau^* + \frac{1}{3}\tau^{*2} + \tau\tau^*\right)
\end{aligned}$$

$$
\begin{aligned}
& g\left(-\tau+\frac{1}{3}\tau^2-\tau^*+\frac{1}{3}\tau^{*2}+\frac{4}{3}\tau\tau^*\right)\Big] \\
& +\Delta^2\left(\frac{1}{3}\tau-\frac{4}{9}\tau^2+\frac{1}{9}\tau^3+\frac{2}{3}\tau^*-\frac{1}{9}\tau^{*2}-\frac{13}{9}\tau\tau^*+\frac{7}{9}\tau^2\tau^*+\frac{1}{9}\tau\tau^{*2}\right), \\
x_3 &= \Delta\Big[a\left(\frac{20}{9}\tau-\frac{4}{9}\tau^2-\frac{20}{9}\tau^*+\frac{4}{9}\tau^{*2}\right)+b\left(-\frac{5}{3}\tau+\frac{1}{3}\tau^2+\frac{5}{3}\tau^*-\frac{1}{3}\tau^{*2}\right) \\
& +g\left(\tau-\frac{1}{3}\tau^2+\tau^*-\frac{1}{3}\tau^{*2}-\frac{4}{3}\tau\tau^*\right) \\
& +\Delta\left(-\frac{4}{3}\tau+\tau^2-\frac{2}{9}\tau^3-\frac{5}{3}\tau^*+\frac{2}{3}\tau^{*2}-\frac{1}{9}\tau^{*2}+\frac{13}{3}\tau\tau^*-\frac{5}{3}\tau^2\tau^*-\tau\tau^{*2}\right)\Big], \\
x_4 &= \Delta^2\left[\tau-\frac{5}{9}\tau^2+\frac{1}{9}\tau^3+\tau^*-\frac{5}{9}\tau^{*2}+\frac{1}{9}\tau^{*3}-\frac{26}{3}\tau\tau^*+\frac{8}{9}\tau^2\tau^*+\frac{8}{9}\tau\tau^{*2}\right], \\
\Delta &= \frac{(\tau-\tau^*)\,g}{(1-\tau)(1-\tau^*)}.
\end{aligned}
$$

In the limiting cases of the admissible $\lambda \in (0,1)$, the BoP is determined by the last summand $1/9a^2\left((\tau-1)/\lambda+(\lambda-\tau^*)/(1-\lambda)\right)$. This yields

$$
\begin{aligned}
\lim_{\lambda\to 0^+} BoP &= -\infty \\
\lim_{\lambda\to 1^-} BoP &= \infty.
\end{aligned}
$$

Additionally, the BoP is differentiable with respect to λ, which implies continuity of the BoP. As in equilibrium $BoP = 0$ has to hold, there has to be at least one solution for $\lambda \in (0,1)$.

In order to ensure uniqueness of our equilibrium, we derive a sufficient condition on the transfer price parameter g. Uniqueness is sufficiently ensured, if the derivative of the balance of payments is positive for all $\lambda \in (0,1)$. The derivative of the balance of payment with respect to λ is

$$
\frac{\partial BoP}{\partial \lambda} = \frac{1}{b}\left(x_2 + 2\,x_3\,\lambda + 3\,x_4\,\lambda^2 + \frac{1}{9}a^2\left(\frac{1-\tau}{\lambda^2}+\frac{1-\tau^*}{(1-\lambda)^2}\right)\right),
$$

where

$$\begin{aligned} x_2 &\gtrless 0 \\ 2\ x_3\ \lambda &\gtrless 0 \\ 3\ x_4\ \lambda^2 &> 0 \\ \frac{1}{9}a^2\left(\frac{1-\tau}{\lambda^2}+\frac{1-\tau^*}{(1-\lambda)^2}\right) &> 0 \end{aligned}$$

for $0 \leq \tau^* \leq \tau < 1$ as well as $\lambda \in (0,1)$ as derived in the supplement. For $\tau = \tau^*$, $\frac{\partial BoP}{\partial \lambda}$ is strictly positive and uniqueness is given. This results from $\Delta = 0$ which implies $x_3 = x_4 = 0$, but $x_2 > 0$ as $a > b$. To ensure a positive derivative for $\tau > \tau^*$, we derive a sufficient upper bound on g based on the first three summands of the derivative. As we know that the last summand will be positive, it suffices to show that for a range of g, the first three summands are non-negative in aggregate to assure a strictly positive derivative. The remaining three summands of the derivative ($\overline{dBoP}(\lambda)$) are a quadratic polynomial.

$$\begin{aligned} \overline{dBoP}(\lambda) &= \frac{\partial BoP}{\partial \lambda} - \frac{1}{b}\left(\frac{1}{9}a^2\left(\frac{1-\tau}{\lambda^2}+\frac{1-\tau^*}{(1-\lambda)^2}\right)\right) \\ &= \frac{1}{b}\left(x_2 + 2\ x_3\ \lambda + 3\ x_4\ \lambda^2\right) \end{aligned}$$

This polynomial will have one global minimum at $\tilde{\lambda}$, where the derivative of $\overline{dBoP}(\lambda)$ with respect to λ is zero.

$$\begin{aligned} 0 &= \frac{1}{b}(2\ x_3 + 6\ x_4\ \lambda) \\ \tilde{\lambda} &= -\frac{1}{3}\frac{x_3}{x_4} \end{aligned}$$

To ensure non-negativity of this global minimum, we need to show the conditions under which the minimum value $\overline{dBoP}(\tilde{\lambda})$ is non-negative.

$$\begin{aligned} \overline{dBoP}(\tilde{\lambda}) &\geq 0 \\ \frac{1}{b}\left(x_2 - \frac{1}{3}\frac{{x_3}^2}{x_4}\right) &\geq 0 \end{aligned}$$

This can be rearranged to determine a lower and an upper bound on g which assure non-negativity. As $g \geq 0$ by the model assumptions, we have an upper bound $\bar{g}$ as given in the supplement, which only depends on the exogenous parameters.

As the disregarded element of the derivative of the balance of payments is strictly positive, the complete derivative of the balance of payments will be strictly positive if g is below the value $\bar{g}$. This assures the uniqueness of the equilibrium $\hat{\lambda}$:

$$\frac{\partial BoP}{\partial \lambda} > \overline{dBoP} \geq \overline{dBoP}(\tilde{\lambda}) \geq 0 \qquad \forall\ 0 \leq g < \bar{g}.$$

□

Lemma 2.2

Proof. In the equilibrium condition (2.19), $\hat{\lambda}$ is implicitly defined for $0 \leq \tau^* \leq \tau$. Hence, the derivatives of $\hat{\lambda}$ with respect to τ and τ^* are given by

$$\begin{aligned} \frac{\partial \hat{\lambda}}{\partial \tau} &= -\frac{\partial BoP/\partial \tau}{\partial BoP/\partial \lambda}, \\ \frac{\partial \hat{\lambda}}{\partial \tau^*} &= -\frac{\partial BoP/\partial \tau^*}{\partial BoP/\partial \lambda}. \end{aligned}$$

At $g = 0$, the derivative of the balance of payments with regard to λ is positive resulting from the proof of uniqueness. Additionally,

$$\begin{aligned}\frac{\partial BoP}{\partial \tau} &= \frac{1}{36\ b\ \lambda}\left(2\ a\ (1-2\lambda)+3\ b\ \lambda\right)^2 > 0,\\ \frac{\partial BoP}{\partial \tau^*} &= -\frac{1}{36\ b\ (1-\lambda)}\left(2\ a\ (1-2\lambda)-3\ b\ (1-\lambda)\right)^2 < 0.\end{aligned}$$

Therefore, $\hat{\lambda}$ has a negative first derivative with respect to the Home tax rate and a positive derivative with respect to the Foreign tax rate. This shows that the high-tax (low-tax) country's marginal utility of income $\hat{\lambda}\ (1-\hat{\lambda})$ decreases, if they increase their tax rate τ (τ^*) respectively for all $\tau^* \leq \tau$.

Additionally, we established that at equalized tax rates across countries $\hat{\lambda} = 1/2$ holds. For $g = 0$ Newton's method yields a lower bound on the equilibrium $\hat{\lambda}$ for any combination of tax rates $0 \leq \tau^* \leq \tau$ as shown in the supplement, such that $1/5 < \hat{\lambda} \leq 1/2$.

$$\frac{1}{5} - \left.\frac{BoP}{\partial BoP/\partial \lambda}\right|_{\lambda=1/5} > \frac{1}{5}$$

Therefore, it suffices to proof the following propositions only for values $\lambda \in (1/5, 1/2]$.

□

Proposition 2.1

Proof. The proposition follows from inspection of the endogenous variables' derivatives with respect to the Home tax rate τ with $\frac{\partial \hat{\lambda}}{\partial \tau} < 0$ and $g = 0$. For the supplied

quantities we have

$$\frac{\partial y_h}{\partial \tau} = \frac{\partial y_h^*}{\partial \tau} = \underbrace{\left(\frac{1}{2} - \frac{2}{3}\frac{a}{b}\right)}_{<0} \underbrace{\frac{\partial \hat{\lambda}}{\partial \tau}}_{<0} > 0 \tag{B.1}$$

$$\frac{\partial y_f}{\partial \tau} = \frac{\partial y_f^*}{\partial \tau} = \underbrace{\left(\frac{2}{3}\frac{a}{b} - \frac{1}{2}\right)}_{>0} \underbrace{\frac{\partial \hat{\lambda}}{\partial \tau}}_{<0} < 0. \tag{B.2}$$

All companies supply more to the high-tax country Home, such that consumption and welfare increases there. The nominal wages do not change in either country

$$\frac{\partial w}{\partial \tau} = \frac{\partial w^*}{\partial \tau} = 0.$$

The changes in the countries' prices after an increase of τ are

$$\begin{aligned} \frac{\partial p}{\partial \tau} &= -\frac{1}{3} a \frac{\partial \hat{\lambda}/\partial \tau}{\hat{\lambda}^2} > 0 \\ \frac{\partial p^*}{\partial \tau} &= \frac{1}{3} a \frac{\partial \hat{\lambda}/\partial \tau}{(1-\hat{\lambda})^2} < 0. \end{aligned}$$

Nominal wages remain constant while the prices increase in Home and decrease in Foreign. Therefore, the real wages decrease in high-tax country Home, when the tax rate is increased.

$$\begin{aligned} \frac{\partial \left(w/p\right)}{\partial \tau} &= \frac{\partial w/\partial \tau \; p - w \; \partial p/\partial \tau}{p^2} \\ &= -\frac{w}{p^2}\frac{\partial p}{\partial \tau} < 0. \end{aligned}$$

In low-tax country Foreign, real wages will increase.

$$\begin{aligned}\frac{\partial \left({}^{w^*}\!/_{p*}\right)}{\partial \tau} &= \frac{{}^{\partial w^*}\!/_{\partial \tau}\ p^* - w^*\ {}^{\partial p^*}\!/_{\partial \tau}}{p^{*2}} \\ &= -\frac{w^*}{p^{*2}}\frac{\partial p^*}{\partial \tau} > 0.\end{aligned}$$

For $g = 0$, profits will be equal across countries as provided quantities are equal in the respective markets. Additionally, the wage rates are equal in both countries. Therefore, the nominal profit changes are symmetric in both countries. We can show with mathematical software in the supplement that the nominal profits decrease in both countries. Straightforwardly, real profits will decrease in the high-tax country Home as well due to increasing prices. In the low-tax country Foreign, however, nominal profits as well as the price level decrease. Still, we can show in the supplement that real profits decrease in Foreign as well.

The labor-to-profit ratio will decrease in both countries:

$$\frac{\partial}{\partial \tau}\left(\frac{{}^1\!/_2\ w}{\pi}\right) = \frac{1}{2\pi^2}\left(\underbrace{\frac{\partial w}{\partial \tau}}_{=0}\ \pi - w\ \underbrace{\frac{\partial \pi}{\partial \tau}}_{<0}\right) > 0.$$

The ratio in Foreign is defined analogously and increases as well. □

Lemma 2.3

Proof. We know that for equalized tax rates ($\tau = \tau^*$), the countries are identical and therefore $\hat{\lambda} = {}^1\!/_2$. Lemma 2.2 showed that the marginal utility of income in Home decreases with the tax rate τ. Therefore, at $g = 0$ the marginal utility of income in Foreign has to be smaller than a half for any tax rate in Home with

$\tau^* < \tau$.

The derivative $\frac{\partial \hat{\lambda}}{\partial g}$ can be determined by implicit differentiation of the balance of payments condition.

$$\frac{\partial \hat{\lambda}}{\partial g} = -\frac{\partial BoP/\partial g}{\partial BoP/\partial \lambda}$$

We know from showing the uniqueness of the equilibrium solution that $\frac{\partial BoP}{\partial \lambda} > 0$ for any $g < \bar{g}$. The derivative of the balance of payments with respect to g at $g = 0$ is given by

$$\begin{aligned}
\frac{\partial BoP}{\partial g} \;=\; & \frac{1}{b}\Bigg\{\frac{1}{3}a(\tau^* - \tau) - \frac{1}{2}b\tau^* + \frac{\tau - \tau^*}{(1-\tau)(1-\tau^*)} \\
& \cdot \left(\frac{1}{3}a\left(-1 + \frac{5}{3}\tau - \frac{2}{3}\tau^* + \frac{2}{3}\tau\tau^* - \frac{2}{3}\tau^2\right) + \frac{1}{2}b\tau^*(1-\tau)\right) \\
& + \lambda\Bigg\{\frac{2}{3}a(\tau - \tau^*) + \frac{1}{2}b(\tau^* - \tau) \\
& + \frac{\tau - \tau^*}{(1-\tau)(1-\tau^*)}\Bigg[a\left(\frac{2}{3} - \frac{23}{9}\tau + \frac{2}{3}\tau^2 + \frac{17}{9}\tau^* - \frac{2}{9}\tau^{*2} - \frac{4}{9}\tau\tau^*\right) \\
& + b\left(\frac{7}{6}\tau - \frac{1}{3}\tau^2 - \frac{13}{6}\tau^* + \frac{1}{3}\tau^{*2} + \tau\tau^*\right)\Bigg]\Bigg\} \\
& + \lambda^2\frac{\tau - \tau^*}{(1-\tau)(1-\tau^*)}\Bigg[a\left(\frac{20}{9}\tau - \frac{4}{9}\tau^2 - \frac{20}{9}\tau^* + \frac{4}{9}\tau^{*2}\right) \\
& + b\left(-\frac{5}{3}\tau + \frac{1}{3}\tau^2 + \frac{5}{3}\tau^* - \frac{1}{3}\tau^{*2}\right)\Bigg]\Bigg\}.
\end{aligned}$$

It follows that for all possible parameter values and $\lambda \leq 1/2$ this derivative is negative, as shown in the supplement. Hence, for all $\lambda \leq 1/2$ it follows that $\frac{\partial \hat{\lambda}}{\partial g} > 0$ at $g = 0$. As we have that $\hat{\lambda} < 1/2$ for $g = 0$, this is the case for the initial marginal increase in g. □

Proposition 2.2

Proof. The sum of exports for $\tau > \tau^*$ is given by

$$\begin{aligned} y_f + y_h^* &= \frac{1-\hat{\lambda}}{b}\left\{\frac{1}{2}b + \frac{1}{3}a\frac{2\hat{\lambda}-1}{1-\hat{\lambda}} + \frac{1}{3}\hat{\lambda}\frac{\tau-\tau^*}{(1-\tau)(1-\tau^*)}(3-2\tau-\tau^*)g\right\} \\ &\quad + \frac{\hat{\lambda}}{b}\left\{\frac{1}{2}b + \frac{1}{3}a\frac{1-2\hat{\lambda}}{\hat{\lambda}} + \frac{1}{3}(1-\hat{\lambda})\frac{\tau-\tau^*}{(1-\tau)(1-\tau^*)}(3-\tau-2\tau^*)g\right\} \\ &= \frac{1}{2} + \frac{g}{b}\hat{\lambda}(1-\hat{\lambda})\frac{\tau-\tau^*}{(1-\tau)(1-\tau^*)}(2-\tau-\tau^*). \end{aligned}$$

Its derivative with respect to g is

$$\frac{\partial}{\partial g}(y_f + y_h^*) = \frac{1}{b}\frac{\tau-\tau^*}{(1-\tau)(1-\tau^*)}(2-\tau-\tau^*)\left[\hat{\lambda}(1-\hat{\lambda}) + g(1-2\hat{\lambda})\frac{\partial\hat{\lambda}}{\partial g}\right].$$

The derivative is positive for $g = 0$. □

Proposition 2.3

Proof. For $\tau^* = 0$ we can show in the supplement that the exports of Foreign companies increase at $g = 0$. Additionally, we can show that the Home companies' increase in exports is larger than Foreign firms' increase in exports. This implies that consumption in Home will decrease, but increase in Foreign. □

Proposition 2.4

Proof. The changes in prices are given by

$$\frac{\partial p}{\partial g} = \frac{1}{3}\left[-\frac{a}{\hat{\lambda}^2}\frac{\partial\hat{\lambda}}{\partial g} - \frac{(\tau-\tau^*)^2}{(1-\tau)(1-\tau^*)}\left(1-\hat{\lambda}-g\frac{\partial\hat{\lambda}}{\partial g}\right)\right]$$

$$\frac{\partial p^*}{\partial g} = \frac{1}{3}\left[\frac{a}{(1-\hat{\lambda})^2}\frac{\partial \hat{\lambda}}{\partial g} + \frac{(\tau-\tau^*)^2}{(1-\tau)(1-\tau^*)}\left(g\frac{\partial \hat{\lambda}}{\partial g} + \hat{\lambda}\right)\right] > 0.$$

In Foreign, the sign of the price change is straightforward for $\frac{\partial \hat{\lambda}}{\partial g} > 0$. For Home, the derivative is negative if $g = 0$:

$$\frac{\partial p}{\partial g} = \frac{1}{3}\left[-\frac{a}{\hat{\lambda}^2}\frac{\partial \hat{\lambda}}{\partial g} - \frac{(\tau-\tau^*)^2}{(1-\tau)(1-\tau^*)}\left(1-\hat{\lambda}\right)\right] < 0.$$

The signs of the derivative of nominal profits for $g = 0$ and $\tau^* = 0$ are shown with mathematical software in the supplement for Home and Foreign. The Home companies' nominal profits increase, while they decrease for Foreign firms. The derivative of real profits in Foreign is given by

$$\begin{aligned} \frac{\partial(\pi^*/p^*)}{\partial g} &= \frac{\partial\pi^*/\partial g \; p^* - \pi^* \; \partial p^*/\partial g}{p^{*2}} < 0 \\ \text{with} \quad & \partial\pi^*/\partial g < 0 \\ \text{and} \quad & \partial p^*/\partial g > 0. \end{aligned}$$

Analogously, it holds for Home firms and their increasing real profits:

$$\begin{aligned} \frac{\partial(\pi/p)}{\partial g} &= \frac{\partial\pi/\partial g \; p - \pi \; \partial p/\partial g}{p^2} > 0 \\ \text{with} \quad & \partial\pi/\partial g > 0 \\ \text{and} \quad & \partial p/\partial g < 0. \end{aligned}$$

In equilibrium the derivatives of the nominal wages are given by:

$$\frac{\partial w}{\partial g} = \frac{\tau-\tau^*}{1-\tau}\left(1-\hat{\lambda}-g\frac{\partial \hat{\lambda}}{\partial g}\right)$$

$$\frac{\partial w^*}{\partial g} = \frac{\tau - \tau^*}{1 - \tau^*} \left(\hat{\lambda} + g \frac{\partial \hat{\lambda}}{\partial g} \right) > 0$$

In Home, wages will increase, if $g = 0$. As prices decrease in Home, real wages increase in this country. In Foreign, prices as well as nominal wages increase. However, at $\tau^* = 0$, there is no tax income in Foreign and real profits decrease. At the same time, real income increases such that real wages have to increase in Foreign as well. The distribution effect in Foreign follows straightforwardly from the wage and the profit effects. □

B.4 Supplement

The supplement (Mathematica Notebook) is available from the author upon reasonable request.

Appendix C

Appendix to How Protectionism Harms Workers Under Oligopoly

C.1 Endogenous Variables Depending on λ

I present these equations in a more general way without applying the assumptions on $L^{(*)}$ and $n^{(*)}$. Still $0 \leq t^* \leq t$ .The supplied quantities are

$$\begin{aligned}
y_h &= \lambda\frac{L}{n} + \frac{(1-2\lambda)a + (\lambda-\lambda^2)(n^*t + (n^*+1)t^*)}{b(n+n^*+1)} \\
y_f &= (1-\lambda)\frac{L}{n} + \frac{(2\lambda-1)a - (\lambda-\lambda^2)(n^*t + (n^*+1)t^*)}{b(n+n^*+1)} \\
y_h^* &= \lambda\frac{L^*}{n^*} + \frac{(1-2\lambda)a - (\lambda-\lambda^2)(nt^* + (n+1)t)}{b(n+n^*+1)} \\
y_f^* &= (1-\lambda)\frac{L^*}{n^*} + \frac{(2\lambda-1)a + (\lambda-\lambda^2)(nt^* + (n+1)t)}{b(n+n^*+1)}.
\end{aligned}$$

The prices are given by

$$\begin{aligned} p &= \frac{a(2(n+n^*)+1/\lambda)-(1-\lambda)(nt^*-n^*t)}{n+n^*+1} - b(L+L^*) \\ p^* &= \frac{a(2(n+n^*)+1/(1-\lambda))-\lambda(n^*t-nt^*)}{n+n^*+1} - b(L+L^*) \end{aligned}$$

and wages are

$$\begin{aligned} w &= \frac{1}{\bar{\lambda}}\left\{2a - b\left[\frac{n+1}{n}L + L^*\right] - t^*(1-\lambda)\right\} \\ w^* &= \frac{1}{\bar{\lambda}}\left\{2a - b\left[\frac{n^*+1}{n^*}L^* + L\right] - t\lambda\right\}. \end{aligned}$$

C.2 Proofs

Proof of Lemma 3.1 (Existence and Uniqueness)

Proof. In equilibrium, the balance of payments has to be equal to zero.

$$BoP \equiv (n^* t y_h^* - n t^* y_f) + (n p^* y_f - n^* p y_h^*) = 0$$

The usual assumptions apply. I show in the supplement, that the limits of the BoP for the most extreme admissible λs are

$$\begin{aligned} \lim_{\lambda \to 0^+} BoP &= -\infty < 0 \\ \lim_{\lambda \to 1^-} BoP &= +\infty > 0. \end{aligned}$$

Furthermore, the BoP is differentiable with respect to λ for $\lambda \in (0,1)$, which implies continuity. Therefore, at least one solution for the above equation exists

in $\lambda \in (0,1)$. Uniqueness is sufficiently ensured, if the derivative of the balance of payments with respect to λ is strictly positive for $\lambda \in (0,1)$. The balance of payments can be rearranged to

$$BoP = \frac{1}{9b}\left(x_1 + x_2\lambda - x_3\lambda^2 + (t^* - t)^2\lambda^3 + a^2\frac{1-2\lambda^2}{\lambda(\lambda-1)}\right)$$

with

$$\begin{aligned} x_1 &= \frac{1}{2}\left(-12a^2 + 2a(12b + 4t + 5t^*) - 9b(b + t^*)\right), \\ x_2 &= \frac{1}{2}\left(32a^2 - 2a(24b + t + 17t^*) + b(18b - 3t + 21t^*) - 2t(4t - t^*) + 10t^{*2}\right), \\ x_3 &= (t^* - t)(-8a + 6b + 3t + 6t^*). \end{aligned}$$

Hence, the derivative is given by

$$\frac{\partial BoP}{\partial \lambda} = \frac{1}{9b}\left(x_2 - 2x_3\lambda + 3(t^* - t)^2\lambda^2 + a^2\frac{1 - 2\lambda + 2\lambda^2}{\lambda^2(\lambda-1)^2}\right),$$

where

$$a^2\frac{1 - 2\lambda + 2\lambda^2}{\lambda^2(\lambda-1)^2} \;>\; 0.$$

We can calculate the global minimum of the quadratic part $x_2 - 2x_3\lambda + 3(t^* - t)^2\lambda^2$, which is at $\lambda_{min} = \frac{-8a+6b+6t^*+3t}{3(t^*-t)}$. Then we add this global minimum to the "rest" $a^2\frac{1-2\lambda+2\lambda^2}{\lambda^2(\lambda-1)^2}$, which is always positive, and derive an upper bound $\bar{t}$ for the Home tariff, such that this sum (a lower bound for the derivative) is always positive under our usual assumptions, which sufficiently ensures uniqueness. I show in the supplement with mathematical software that uniqueness is guaranteed for

$t = t^* \leq b$, for $0 \leq t^* \leq t < \bar{t}$ and for $0 \leq t^* < t \leq \bar{t}$.

$$\bar{t} = \frac{10a - 9b}{18} + \frac{\sqrt{44a^2 - 28ab + 15b^2}}{6\sqrt{3}}$$

This is a sufficient and no necessary condition in several ways. Note that we demand the "rest" of the function $\frac{\partial BoP}{\partial \lambda}$ for all possible λ to be at least as large as the global minimum of the quadratic part, even if that global minimum is not at an equilibrium value of lambda or not even within the allowed range of lambda. I choose this procedure for simplicity because it allows to derive one specific upper bound on t, while a more general approach results in a plethora of possible upper bounds depending in its functional forms on the values of the other parameters. □

Proof of Proposition 3.1 (Effects of Symmetric Tariffs)

In the symmetric case we have $\lambda = 1/2$ and $t = t^*$. I prove in the supplement, that indeed λ does not change with t. The usual assumptions from the main text apply. We can simplify the equilibrium prices and quantities:

$$\begin{aligned}
p = p^* &= 2a - b \\
\frac{\partial p}{\partial t} &= 0 \\
w = w^* &= \frac{4a - 3b - t}{2} \\
\frac{\partial w}{\partial t} &= -\frac{1}{2} < 0 \\
y_h = y_f^* &= \frac{b + t}{4b} \\
\frac{\partial y_h}{\partial t} &= \frac{1}{4b} > 0
\end{aligned}$$

$$\begin{aligned} y_f = y_h^* &= \frac{b-t}{4b} \\ \frac{\partial y_f}{\partial t} &= -\frac{1}{4b} < 0 \\ \pi = \pi^* &= \frac{b^2+t^2}{4b} \\ \frac{\partial \pi}{\partial t} &= \frac{2t}{4b} > 0 \\ T = T^* &= \frac{(b-t)t}{4b} \\ \frac{\partial T}{\partial t} &= \frac{1}{4} - \frac{2t}{4b} \end{aligned}$$

$\frac{\partial T}{\partial t} > 0$ for $t < b/2$ and $\frac{\partial T}{\partial t} < 0$ for $t > b/2$, such that $t^{rm} = b/2 < \bar{t}$ is the revenue maximizing symmetric tariff. At this tariff, we have $y_h = \frac{3}{8}$ and $y_f = \frac{1}{8}$ as compared to both being $\frac{1}{4}$ without tariffs. This shows that at this point the tariff has reduced international trade by 50%, which can be called a tariff of substantial size. Thus, $\bar{t}$ is not critically low.

$t = b$ is the prohibitive tariff, where international trade becomes zero. Higher symmetric tariffs would result in negative traded quantities, which we rule out by assumption. The prohibitive tariff can be higher than $\bar{t}$ in some cases, but remember that $\bar{t}$ is a sufficient and no necessary upper bound.

Proof of Lemma 3.2 (Effect of Unilateral Tariff on λ)

Proof. The derivative can be obtained by implicit differentiation using the BoP, i.e. $\frac{\partial \lambda}{\partial t} = -\frac{\partial BoP/\partial t}{\partial BoP/\partial \lambda}$. From the proof of lemma 3.1 we know that $\partial BoP/\partial \lambda$ is positive for $0 \leq t^* \leq t < \bar{t}$. The same holds for $\partial BoP/\partial t$ if $0 < \lambda \leq 1/2$ (confirmation is

provided in the supplement):

$$\begin{aligned}\frac{\partial BoP}{\partial t} &= \frac{1}{18b}[3b\lambda(-1+4\lambda) - 2a(-4+\lambda+8\lambda^2) \\ &\quad +2(-1+\lambda)\lambda(t^* - 2t\lambda + 2t(4+\lambda))] > 0\end{aligned}$$

Accordingly, $\frac{\partial \lambda}{\partial t}$ is negative, which is why the assumption of $\lambda \leq 1/2$ is valid because with $t = t^*$ we start from $\lambda = 1/2$ and it declines thereafter in t.

$$\begin{aligned}\frac{\partial \lambda}{\partial t} &= [\ (-1+\lambda)^2\lambda^2(b(3-12\lambda)\lambda + 2a(-4+\lambda+8\lambda^2) \\ &\quad -2(-1+\lambda)\lambda(t^* - 2t^*\lambda + 2t(4+\lambda)))\ ]\ /\ [\ -2a(-1+\lambda)^2\lambda^2 \\ &\quad \cdot(24b + t + t^*(17-16\lambda) + 16t\lambda) + a^2(2 - 4\lambda + 36\lambda^2 \\ &\quad -64\lambda^3 + 32\lambda^4) + (-1+\lambda)^2\lambda^2(18b^2 - 3b(t - 8t\lambda + t^*(-7+8\lambda)) \\ &\quad +2(t^{*2}(5 - 12\lambda + 3\lambda^2) + t^2(-4 + 6\lambda + 3\lambda^2) - t^*t(1 - 6\lambda + 6\lambda^2)))\ ]\end{aligned}$$

For a marginal increase in one of the initially symmetric tariffs, i.e. at $t = t^*$, the same holds as long as we are below the prohibitive tariff b (see supplement). In this quasi-symmetric case we get a closed-form result for the derivative, i.e. $\frac{\partial \lambda}{\partial t} = \frac{-3a-3b/2+9t/2}{48a^2-2a(24b+18t)+18b^2+18bt}$, because we know that we start at $t = t^*$ and $\lambda = 1/2$ which allows to get rid of the complexity problem of not having a closed-form expression for λ. □

Proof of Lemma 3.3 (Asymmetric Price Reaction)

Proof. Taking the derivatives of the equilibrium price equations with respect to t leads to

$$\begin{aligned}\frac{\partial p}{\partial t} &= \frac{1}{3}\left(1-\lambda+\frac{\partial \lambda}{\partial t}(t^*-t-\frac{a}{\lambda^2})\right),\\ \frac{\partial p^*}{\partial t} &= \frac{1}{3}\left(-\lambda+\frac{\partial \lambda}{\partial t}(t^*-t-\frac{a}{(\lambda-1)^2})\right).\end{aligned}$$

Evaluating them at $t=t^*$ with $\lambda=1/2$ and the respective term for $\frac{\partial \lambda}{\partial t}$ gives us a positive expression for Home and a negative one for Foreign as confirmed with mathematical software in the supplement.

□

Proof of Proposition 3.2 (Income and Distribution)

Proof.

$$\begin{aligned}\frac{\partial w}{\partial t} &= t^*\frac{\partial \lambda}{\partial t}\\ \frac{\partial w^*}{\partial t} &= -\lambda - t\frac{\partial \lambda}{\partial t}\end{aligned}$$

Taking the derivatives of the equilibrium nominal wages (formulas given above) and also of real wages (given in the supplement) with respect to t and evaluating them at $t=t^*$ with $\lambda=1/2$ and the respective term for $\frac{\partial \lambda}{\partial t}$ gives us negative expressions for nominal wages (no reaction in Home if $t^*=0$), with Foreign wages falling more strongly, and negative expressions for real wages, which fall more strongly in Home, as shown in the supplement with mathematical software.

The same procedure is then applied to profits. For strictly positive tariffs I show in the supplement that nominal profits rise in both countries, but stronger in Home. Real profits rise in Foreign. They fall in Home for low and rise for high initial symmetric tariffs with $b/8 < t = t^* = 2(2a - b) - \sqrt{16a^2 - 16ab + 3b^2} < b/3$ being the cutoff where the reaction is zero, which is positive and smaller than the revenue maximizing symmetric tariff $b/2$.

The labor-profit ratio is $\frac{Lw}{n\pi}$. Taking the derivatives of it for both countries with respect to t and evaluating them at $t = t^*$ with $\lambda = 1/2$ and the respective term for $\frac{\partial \lambda}{\partial t}$ gives us negative expressions for both countries (no reaction for Home if initially $t = t^* = 0$). This is straightforward because in both countries nominal wages are falling and nominal profits are rising. The decline is larger in Home for small but positive initial tariffs and larger in Foreign for high initial tariffs, as shown in the supplement with mathematical software.

Furthermore, I show in the supplement that Foreign tariff revenue decreases in t starting from a symmetric-tariff equilibrium, while Home revenue rises (equations given below) up to a certain initial tariff, and I compare the marginal (nominal and real) tariff revenue change in Home with the marginal change in (nominal and real) Home labor income. I also check up to which initial symmetric tariffs the marginal rise in Home tariff revenue is sufficient to keep the Home labor-profit ratio at its initial level by means of transfers to workers, i.e. $t = t^*$ for which $\frac{wL}{n\pi} = \frac{\frac{\partial wL}{\partial t} + \frac{\partial T}{\partial t}}{\frac{\partial \pi}{\partial t}}$ holds. The marginal rise in tariff revenue has to overcompensate the marginal fall in labor income in a certain proportion relative to the marginal rise in profit income. For the labor-profit ratio to remain unchanged, this proportion is exactly the initial labor-profit ratio. Up to certain initial symmetric tariffs (not determinable in closed-form) that are lower than $b/3$, and thus the revenue maximizing symmetric

tariff $b/2$, the marginal rise in Home nominal tariff revenue is large enough to offset the marginal distributional effect, i.e. to restore the old labor-profit-ratio, and the marginal rise in Home real tariff revenue is large enough to offset the marginal negative effect on Home real labor income, if non-distortionary transfer payments to workers are possible. Up to certain initial symmetric tariffs, that are lower than the prohibitive but can sometimes be higher than the revenue maximizing symmetric tariffs, the marginal rise in Home nominal tariff revenue is larger than the marginal loss in nominal Home labor income.

$$\begin{aligned}
\frac{\partial(ty_h^*)}{\partial t} &= \frac{\lambda}{2} + \frac{a(1-2\lambda) - (t^*+2t)(\lambda-\lambda^2)}{3b} \\
&\quad + t\left(\frac{\frac{\partial\lambda}{\partial t}}{2} + \frac{2(\lambda^2-\lambda) - \frac{\partial\lambda}{\partial t}(2a + (t^*+2t)(1-2\lambda))}{3b}\right) \\
\frac{\partial(t^*y_f)}{\partial t} &= \frac{-t^*}{2}\frac{\partial\lambda}{\partial t} + \frac{\lambda^2-\lambda + \frac{\partial\lambda}{\partial t}(2a - (2t^*+t)(1-2\lambda))}{3b}
\end{aligned}$$

□

Proof of Proposition 3.3 (Trade, Welfare, Nash-Equilibrium)

Proof.

$$\frac{\partial(y_f + y_h^*)}{\partial t} = \frac{\lambda^2 - \lambda + \frac{\partial\lambda}{\partial t}(2\lambda-1)(t^*+t)}{b}$$

Taking the derivative of the sum of Home and Foreign exports with respect to t and evaluating it at $t = t^*$ with $\lambda = 1/2$ and the respective term for $\frac{\partial\lambda}{\partial t}$ gives us $-\frac{1}{4b} < 0$.

Taking the derivative of Home's terms of trade with respect to t and evaluating

it at $t = t^*$ with $\lambda = 1/2$ and the respective term for $\frac{\partial \lambda}{\partial t}$ gives us a positive expression as shown in the supplement with mathematical software.

Taking the derivatives of the equilibrium export quantities with respect to t leads to

$$\begin{aligned}
\frac{\partial y_f}{\partial t} &= \frac{-1}{2}\frac{\partial \lambda}{\partial t} + \frac{1}{3b}\left(-\lambda + \lambda^2 + \frac{\partial \lambda}{\partial t}((t + 2t^*)(2\lambda - 1) + 2a)\right) < 0, \\
\frac{\partial y_h^*}{\partial t} &= \frac{1}{2}\frac{\partial \lambda}{\partial t} + \frac{1}{3b}\left(-2(\lambda - \lambda^2) + \frac{\partial \lambda}{\partial t}((2t + t^*)(2\lambda - 1) - 2a)\right) < 0,
\end{aligned}$$

Evaluating them at $t = t^*$ with $\lambda = 1/2$ and the respective term for $\frac{\partial \lambda}{\partial t}$ gives us negative expressions for export supplies, with Home exports decreasing more strongly than Foreign exports, as confirmed in the supplement with mathematical software.

$$\frac{\partial (y_h^* - y_f)}{\partial t} = \frac{\lambda^2 - \lambda + \frac{\partial \lambda}{\partial t}\,(3b - 4a + (2\lambda - 1)(t - t^*))}{3b}$$

Welfare is strictly increasing in consumption (or real income), which is given by $y_h + y_h^* = 1/2 - y_f + y_h^*$ in Home. Thus, for the direction of its change we can focus on the change in the difference of exports $y_h^* - y_f$. In the supplement I show in detail that there is a positive welfare effect from an increasing tariff for Home if the initially symmetric tariffs are below the prohibitive level b.

It follows that whenever a country has the lower tariff than the other country, its welfare and consumption would be higher when increasing the tariff to the level of the other country – resulting again in identical welfare in both countries, while before welfare was lower in the low-tariff country. Thus, also for the low

tariff country it would be optimal to increase the tariff at least up to this level. Accordingly, in this zero-sum consumption-game there can be no Nash-equilibrium where otherwise symmetric countries differ in their consumption level, because the low-consumption country could always set the same tariff as the other country, which results in identical consumption. At identical tariffs, it would again be beneficial for both to increase the tariff further as long as there are exports that yield tariff revenue. This shows that a locally stable equilibrium exists at symmetric prohibitive tariffs $t = t^* = b$, where no country has an incentive to marginally deviate anymore. Confirmation is provided in the supplement. However, the possibility remains, that for a certain t there exists another $t^* << t \leq b$ at which both countries have the same welfare, i.e. export the same quantity, as well. I prove in the supplement that there exists no such $t^* \neq b$, which guarantees the uniqueness of the Nash-equilibrium at $t = t^* = b$. □

C.3 Supplement

The supplement (Mathematica Notebook) is available from the author upon reasonable request.

Appendix D

Appendix to Building Bridges: Bilateral Manager Connections and International Trade

D.1 Codebook

Table D.1: Codebook

Variable	Definition	Source
CON_{miodt}	Dummy variable equal to 1 if manager m is connected to d via nationality	BoardEx
$MCON_{miodt}$	Dummy variable equal to 1 if manager m is male and connected to d via nationality	BoardEx
$FCON_{miodt}$	Dummy variable equal to 1 if manager m is female and connected to d via nationality	BoardEx
CON_{iodt}	Number of manager connections from i to d, computed as the sum of CON_{miodt} in i	BoardEx, Authors' calculation
$i.CON_{iodt}$	Dummy variable equal to 1 if $CON_{iodt} > 0$	BoardEx, Authors' calculation
$i.ADDCON_{iodt}$	Dummy variable equal to 1 if $CON_{iodt} > CON_{iodt-1}$	BoardEx, Authors' calculation
$MCON_{iodt}$	Number of male manager connections from firm i to d	BoardEx, Authors' calculation
$FCON_{iodt}$	Number of female manager connections from firm i to d	BoardEx, Authors' calculation
$SALES_{iodt}$	Foreign sales of firm i in destination d in 1000 current USD	Osiris
$CONO_{odt}$	Number of manager connections to d in o	BoardEx, Authors' calculation
$COND_{odt}$	Number of manager connections to o in d	BoardEx, Authors' calculation
$TRADE_{odt}$	Trade flow from o to d in 1000 current USD	BACI, CEPII
$DIST_{od}$	Population-weighted distance between most populated cities in o and d in km	CEPII
IMI_{odt}	Number (or "stock") of international migrants from d in o	UN Int. Migrant Stock
EMI_{odt}	Number (or "stock") of international migrants from o in d	UN Int. Migrant Stock
CC_{dt}	Control of corruption index of the Worldwide Governance Indicators in d	WGI, Authors' calculation
$CCdis_{odt}$	Institutional distance between o and d computed as the difference between CC_{ot} and CC_{dt}	WGI, Authors' calculation
$\lvert CCdis_{odt}\rvert$	Absolute institutional distance between o and d computed as the absolute value of $WGIdis_{odt}$	WGI, Authors' calculation
WBL_{dt}	Absence of regulatory restrictions on women in d	WBL
$FMOBIL_{dt}$	Women's freedom of movement in d	WBL
$GSNI_{d}$	Economic dimension of the Gender Social Norms Index in d	United Nations
RTA_{odt}	Common regional trade agreement	CEPII
$COMLANG_{odt}$	Common official language	CEPII

Indices: Manager m; Firm i; Origin (country) o; Destination (country) d; Time t.
Detailed Sources:
Amadeus: Amadeus Managers, Bureau van Dijk, https://www.bvdinfo.com/en-gb/our-products/data/international/amadeus
BoardEx: https://www.boardex.com/
Osiris: Bureau van Dijk, Osiris Financials, https://www.bvdinfo.com/en-gb/our-products/data/international/osiris
CEPII's gravity database: (Head et al., 2010; Mayer et al., 2014), http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=8
Int. Migrant Stock: United Nations, https://www.un.org/en/development/desa/population/migration/data/estimates2/estimates15.asp
WGI: Worldwide Governance Indicators (Kaufmann et al., 2011), https://info.worldbank.org/governance/wgi/
WBL: Women in Business, and the law (World Bank, 2021), https://wbl.worldbank.org/en/wbl
Gender Social Norms Index (United Nations Development Programme, 2020), http://hdr.undp.org/en/gsni

D.2 Summary Statistics

Table D.2: Firm-Level Descriptive Statistics

	n	Mean	SD	Min	P25	Median	P75	Max
$SALES_{iodt}$	32,047	938,584.53	4,209,780	0.79	18,332	107,807.50	497,459.51	131488000
CON_{iodt}	32,047	0.53	1.195	0	0	0	1	15
$i.CON_{iodt}$	32,047	0.28	0.45	0	0	0	1	1
$i.ADDCON_{iodt}$	21,077	0.05	0.21	0	0	0	0	1
$MCON_{iodt}$	32,047	0.47	1.096	0	0	0	1	15
$FCON_{iodt}$	32,047	0.06	0.27	0	0	0	0	4

Table D.3: Country-Level Descriptive Statistics

Variable	n	Mean	SD	Min	P25	Median	P75	Max
$CONO_{odt}$	2,120	7.4	24.4	1.0	1.0	2.0	5.0	519.0
IMI_{odt}	2,120	115,247.8	545,158.0	0.0	2,566.5	14,936.5	65,370.5	12,168,662.0
EMI_{odt}	2,120	92,996.5	490,202.7	0.0	1,527.8	10,264.0	44,780.0	12,168,662.0
$COMLANG_{odt}$	2,120	0.3	0.4	0.0	0.0	0.0	1.0	1.0
$DIST_{od}$	2,120	5,329.1	4,501.2	59.6	1,297.7	4458.1	8,707.7	19,263.9
RTA_{odt}	2,120	0.5	0.5	0.0	0.0	1.0	1.0	1.0
$TRADE_{odt}$	2,120	10,175,400.7	26,457,852.2	0.0	557,851.7	2,526,845.1	8,170,714.9	428,574,812.2
$COND_{odt}$	2,120	7.4	24.4	1.0	1.0	2.0	5.0	519.0
IMI_{odt}	2,120	92,996.5	490,202.7	0.0	1,527.8	10,264.0	44,780.0	12,168,662.0
EMI_{odt}	2,120	115,247.8	545,158.0	0.0	2,566.5	14,936.5	65,370.5	12,168,662.0
$COMLANG_{odt}$	2,120	0.3	0.4	0.0	0.0	0.0	1.0	1.0
$DIST_{od}$	2,120	5,329.1	4,501.2	59.6	1,297.7	4,458.1	8,707.7	19,263.9
RTA_{odt}	2,120	0.5	0.5	0.0	0.0	1.0	1.0	1.0
$TRADE_{odt}$	2,120	10,707,773.5	26,786,177.9	0.0	566,890.8	2,764,486.0	9,176,300.5	428,574,812.2
$CONO_{odt}$ & $COND_{odt}$	1,014	13.0	34.1	1	2.0	4.0	12.8	519.0
IMI_{odt} & EMI_{odt}	1,014	149,448.0	671,359.1	0	9,406.2	26,556.0	110,059.2	12,168,662.0
$COMLANG_{odt}$	1,014	0.3	0.5	0	0.0	0.0	1.0	1.0
$DIST_{od}$	1,014	4,625.8	4,585.6	173	959.6	2,396.8	6,895.1	19,147.1
RTA_{odt}	1,014	0.6	0.5	0	0.0	1.0	1.0	1.0
$TRADE_{odt}$	1,014	17,650,897.2	35,559,098.2	0	2,281,982.3	6,645,530.6	19,596,733.0	428,574,812.2

D.3 Supplementary Figures

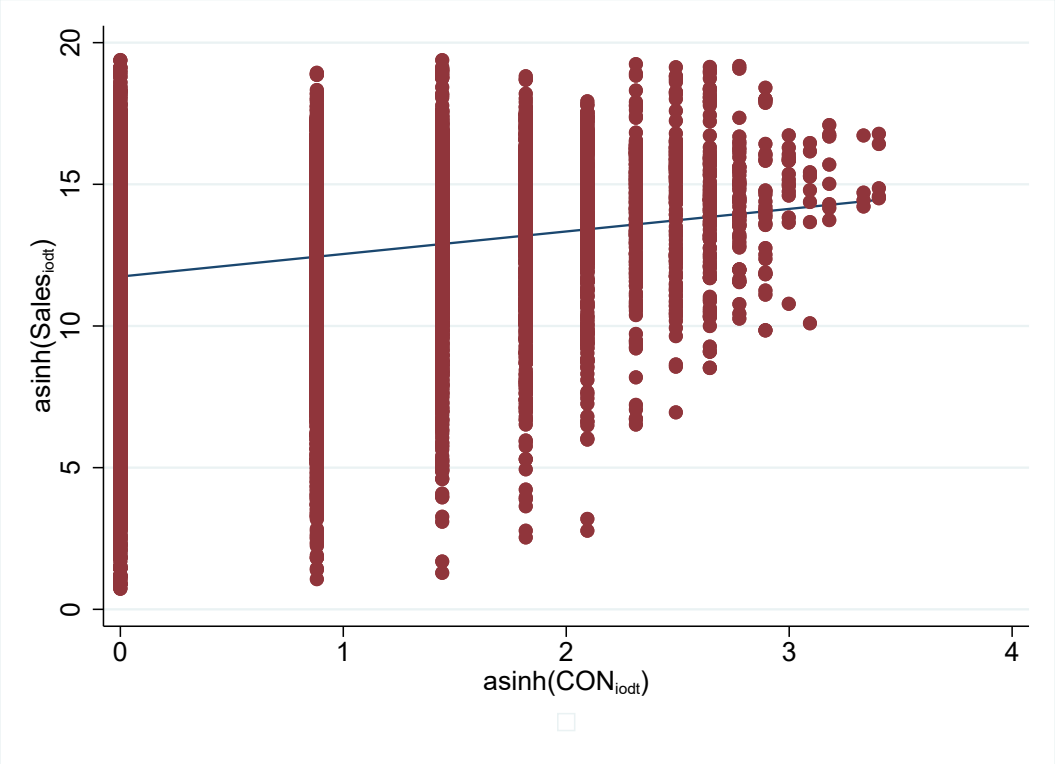

Figure D.1: Firm-Level Scatterplot

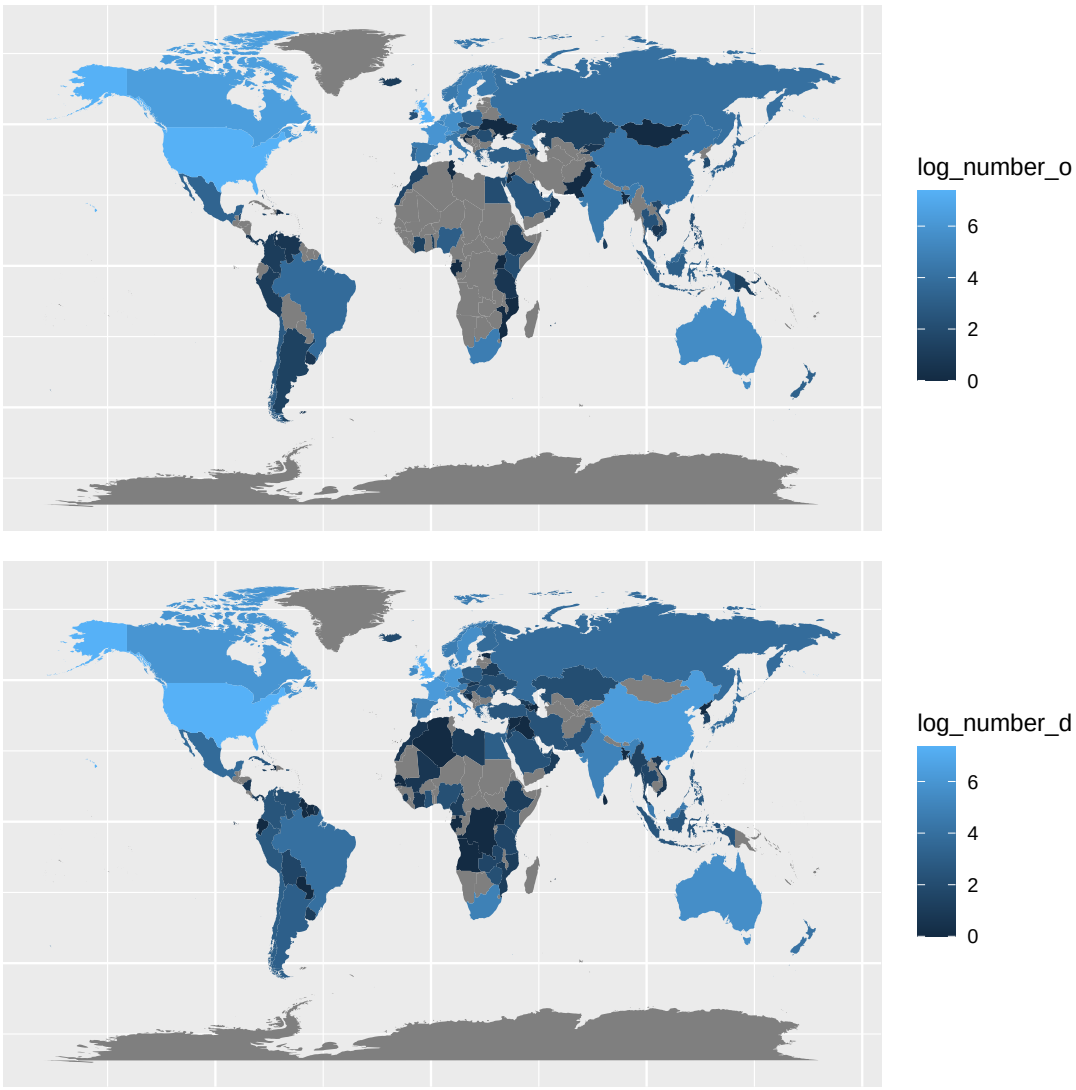

Figure D.2: Log Number of Manager Connections in BoardEx 2015

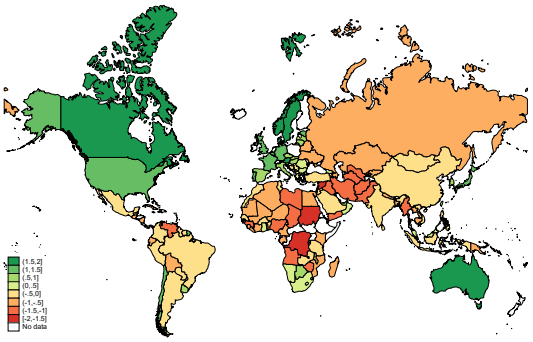

Figure D.3: Map of WGI

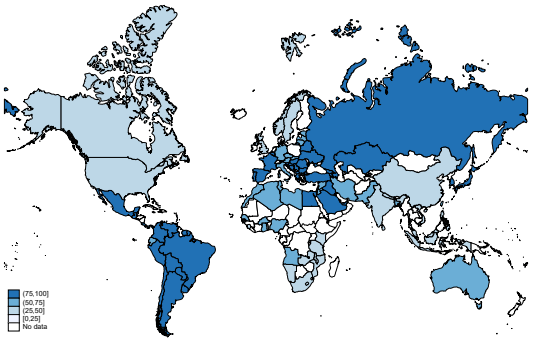

Figure D.4: Map of UNCAVOID

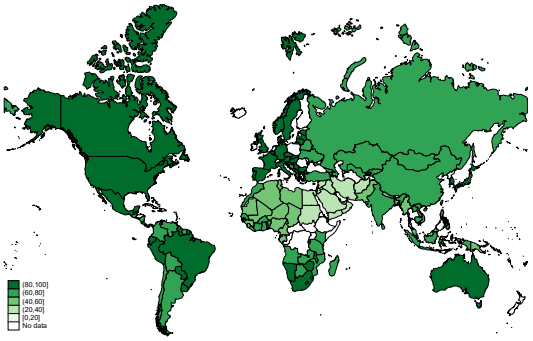

Figure D.5: Map of WBL

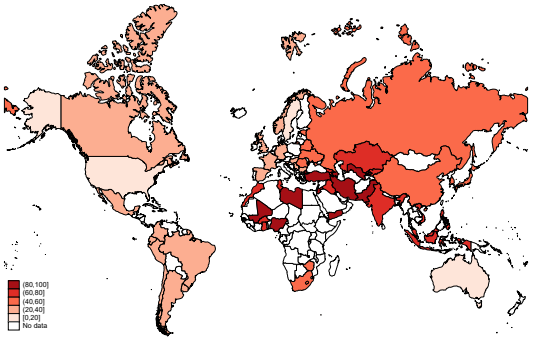

Figure D.6: Map of GSNI

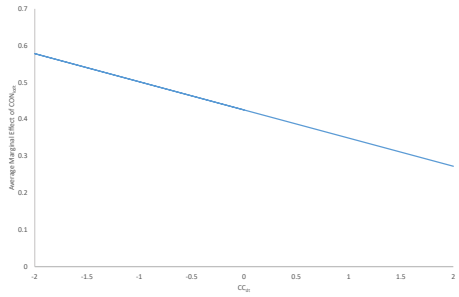

Figure D.7: Average Marginal Effects of Connections Dependent on CC_d

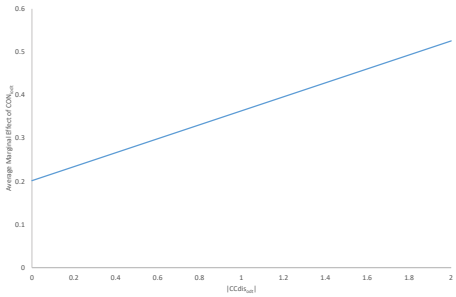

Figure D.8: Average Marginal Effects of Connections Dependent on $|CCdis_{odt}|$

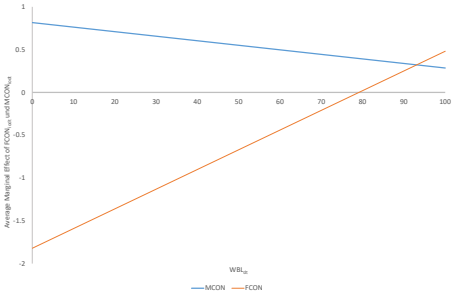

Figure D.9: Average Marginal Effects of $FCON_{iodt}$ Dependent on WBL_{dt}

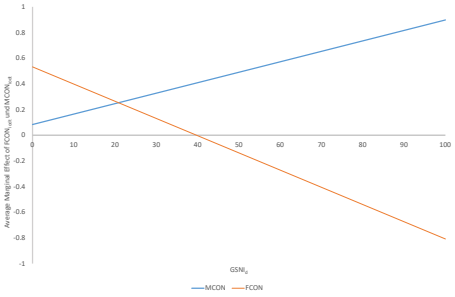

Figure D.10: Average Marginal Effects of $FCON_{iodt}$ Dependent on $GSNI_d$

D.4 Robustness Checks

D.4.1 Country Level

Table D.4: Country-Level Results: Only Managers in EU or UK

	$log(TRADE_{odt})$		$TRADE_{odt}$	
	OLS 1	OLS 2	PPML 1	PPML 2
$log(CONO_{odt})$	0.07**		0.11***	
	(0.03)		(0.02)	
$log(COND_{odt})$		0.07*		0.10***
		(0.04)		(0.03)
Origin-year FE	YES	YES	YES	YES
Destination-year FE	YES	YES	YES	YES
Controls	YES	YES	YES	YES
R^2	0.96	0.95		
Adj. R^2	0.94	0.92		
Within R^2	0.64	0.57		
Pseudo R^2			0.97	0.95
Observations	1,131	1,131	1,131	1,131

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors (clustered on the country-pair level) in parentheses.

Table D.5: Country-Level Results: Only Managers in NAM or ROW

	$log(TRADE_{odt})$		$TRADE_{odt}$	
	OLS 1	OLS 2	PPML 1	PPML 2
$log(CONO_{odt})$	0.11		0.22***	
	(0.07)		(0.08)	
$log(COND_{odt})$		0.08		0.14**
		(0.06)		(0.06)
Origin-year FE	YES	YES	YES	YES
Destination-year FE	YES	YES	YES	YES
Controls	YES	YES	YES	YES
R^2	0.93	0.94		
Adj. R^2	0.87	0.89		
Within R^2	0.43	0.42		
Pseudo R^2			0.97	0.97
Observations	873	872	879	877

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors (clustered on the country-pair level) in parentheses.

Table D.6: Country-Level Results Without Outliers

	$log(TRADE_{odt})$			$TRADE_{odt}$		
	OLS 1	OLS 2	OLS 3	PPML 1	PPML 2	PPML 3
$log(CONO_{odt})$	0.07**		0.13***	0.18***		0.14***
	(0.04)		(0.04)	(0.03)		(0.04)
$log(COND_{odt})$		0.06*	0.07**		0.15***	0.05
		(0.04)	(0.04)		(0.04)	(0.04)
Origin-year FE	YES	YES	YES	YES	YES	YES
Destination-year FE	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES
R^2	0.92	0.92	0.92			
Adj. R^2	0.89	0.89	0.89			
Within R^2	0.55	0.54	0.69			
Pseudo R^2				0.95	0.94	0.96
Observations	1,951	1,950	926	1,957	1,956	926

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors (clustered on the country-pair level) in parentheses. Observations with extreme values for manager connections have been excluded.

Table D.7: Country-Level Results with Squared Connections

	$log(TRADE_{odt})$			$TRADE_{odt}$		
	OLS 1	OLS 2	OLS 3	PPML 1	PPML 2	PPML 3
$log(CONO_{odt})$	0.02		0.10*	0.16***		0.13**
	(0.05)		(0.06)	(0.04)		(0.05)
$log(CONO_{odt})^2$	0.02*		0.01	0.01		0.00
	(0.01)		(0.01)	(0.01)		(0.01)
$log(COND_{odt})$		0.01	0.02		0.11**	0.01
		(0.06)	(0.06)		(0.05)	(0.05)
$log(COND_{odt})^2$		0.02	0.02		0.01	0.01
		(0.01)	(0.01)		(0.01)	(0.01)
Origin-year FE	YES	YES	YES	YES	YES	YES
Destination-year FE	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES
R^2	0.92	0.92	0.93			
Adj. R^2	0.89	0.89	0.89			
Within R^2	0.58	0.56	0.74			
Pseudo R^2				0.96	0.95	0.96
Observations	2,004	2,003	976	2,010	2,009	976

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$. Standard errors (clustered on the country-pair level) in parentheses.

Table D.8: Country-Level Results with Lagged Connections

	$log(TRADE_{odt})$			$TRADE_{odt}$		
	OLS 1	OLS 2	OLS 3	PPML 1	PPML 2	PPML 3
$l.log(CONO_{odt})$	0.13***		0.18***	0.19***		0.17***
	(0.05)		(0.05)	(0.03)		(0.05)
$l.log(COND_{odt})$		0.12**	0.06		0.17***	0.05
		(0.05)	(0.05)		(0.04)	(0.05)
Origin-year FE	YES	YES	YES	YES	YES	YES
Destination-year FE	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES
R^2	0.94	0.94	0.93			
Adj. R^2	0.91	0.91	0.89			
Within R^2	0.62	0.63	0.77			
Pseudo R^2				0.96	0.96	0.97
Observations	1,077	1,075	522	1,080	1,078	522

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$. Standard errors (clustered on the country-pair level) in parentheses. "l." indicates a variable that is lagged by one period, i.e. 5 years.

Table D.9: Country-Level Results with Amadeus Data

	$log(TRADE_{odt})$			$TRADE_{odt}$		
	OLS 1	OLS 2	OLS 3	PPML 1	PPML 2	PPML 3
$log(CONO_{odt})$	0.15***		0.20***	0.19***		0.06
	(0.03)		(0.04)	(0.03)		(0.06)
$log(COND_{odt})$		0.15***	0.15***		0.19***	0.13***
		(0.04)	(0.04)		(0.04)	(0.05)
Origin FE	YES	YES	YES	YES	YES	YES
Destination FE	YES	YES	YES	YES	YES	YES
R^2	0.90	0.84	0.94			
Adj. R^2	0.89	0.83	0.93			
Within R^2	0.34	0.19	0.67			
Pseudo R^2				0.95	0.95	0.96
Observations	3,450	3,424	1,116	3,465	3,463	1,116

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors (two-way-clustered on the importer and exporter level) in parentheses. Data is for the year 2018. All specifications include the following control variables: log(DIST), common regional trade agreement, contiguity, common official or primary language, common language spoken by at least 9 percent, religious proximity index, common legal origins before 1991, common legal origins after 1991, ever had same colonizer, ever in colonial relationship.

D.4.2 Firm Level

Table D.10: Firm-Level Results Without USA

Dep. Var.: $asinh(SALES_{iodt})$	(1)	(2)	(3)	(4)	(5)	(6)
$asinh(CON_{iodt})$	0.36^{***}	0.46^{***}	0.20^{**}	0.58^{***}		
	(0.06)	(0.10)	(0.08)	(0.12)		
$asinh(CON_{iodt}) \times CC_{dt}$		-0.09^{*}				
		(0.05)				
$asinh(CON_{iodt}) \times \lvert CCdis_{odt} \rvert$			0.18^{***}			
			(0.06)			
$asinh(CON_{iodt}) \times INDIVID_{d}$				-0.00^{**}		
				(0.00)		
$asinh(MCON_{iodt})$					0.96^{*}	0.03
					(0.58)	(0.10)
$asinh(FCON_{iodt})$					-1.75^{*}	0.52^{***}
					(1.02)	(0.17)
$asinh(MCON_{iodt}) \times WBL_{dt}$					-0.01	
					(0.01)	
$asinh(FCON_{iodt}) \times WBL_{dt}$					0.02^{*}	
					(0.01)	
$asinh(MCON_{iodt}) \times GSNI_{d}$						0.01^{***}
						(0.00)
$asinh(FCON_{iodt}) \times GSNI_{d}$						-0.01^{*}
						(0.01)
Firm-year FE	YES	YES	YES	YES	YES	YES
Country-pair-year FE	YES	YES	YES	YES	YES	YES
Adj. R^2	0.69	0.69	0.69	0.70	0.70	0.70
Observations	26,190	25,705	25,647	25,416	25,833	21,984

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors (three-way clustered by firm-year, destination, and country pair) in parentheses.

Table D.11: Firm-Level Results Without Outliers in $asinh(CON_{iodt})$

Dep. Var.: $asinh(SALES_{iodt})$	(1)	(2)	(3)	(4)	(5)	(6)
$asinh(CON_{iodt})$	0.37^{***}	0.46^{***}	0.22^{***}	0.64^{***}		
	(0.05)	(0.09)	(0.07)	(0.12)		
$asinh(CON_{iodt}) \times CC_{dt}$		-0.08^{*}				
		(0.04)				
$asinh(CON_{iodt}) \times \lvert CCdis_{odt} \rvert$			0.17^{***}			
			(0.06)			
$asinh(CON_{iodt}) \times INDIVID_{d}$				-0.00^{***}		
				(0.00)		
$asinh(MCON_{iodt})$					0.76	0.07
					(0.52)	(0.10)
$asinh(FCON_{iodt})$					-2.52^{***}	0.62^{***}
					(0.84)	(0.17)
$asinh(MCON_{iodt}) \times WBL_{dt}$					-0.00	
					(0.01)	
$asinh(FCON_{iodt}) \times WBL_{dt}$					0.03^{***}	
					(0.01)	
$asinh(MCON_{iodt}) \times GSNI_{d}$						0.01^{***}
						(0.00)
$asinh(FCON_{iodt}) \times GSNI_{d}$						-0.02^{**}
						(0.01)
Firm-year FE	YES	YES	YES	YES	YES	YES
Country-pair-year FE	YES	YES	YES	YES	YES	YES
Adj. R^2	0.74	0.74	0.74	0.75	0.75	0.74
Observations	31,458	30,892	30,834	30,621	31,078	26,484

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors (three-way clustered by firm-year, destination, and country pair) in parentheses.

Table D.12: Firm-Level Results: Lagged Connections and Lead-Lag Analysis

Dep. Var.: $asinh(SALES_{iodt})$	(1)	(2)	(3)	(4)
$asinh(CON_{iodt-2})$		0.39^{***}	0.31^{***}	
		(0.06)	(0.07)	
$asinh(CON_{iodt-1})$	0.38^{***}		0.10	0.22^{***}
	0.06		(0.07)	(0.07)
$asinh(CON_{iodt})$				0.07
				(0.07)
$asinh(CON_{iodt+1})$				0.10
				(0.08)
Firm-year FE	YES	YES	YES	YES
Country-pair-year FE	YES	YES	YES	YES
Adj. R^2	0.71	0.66	0.64	0.67
Observations	20,916	15,553	14,327	14,327

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors (three-way clustered by firm-year, destination, and country pair) in parentheses.

Table D.13: Firm-Level Results: Different Levels for Standard Errors

Dep. Var.: $asinh(SALES_{iodt})$	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$asinh(CON_{iodt})$	0.34^{***}	0.34^{***}	0.34^{***}	0.34^{***}	0.34^{***}	0.34^{***}	0.34^{***}
	(0.08)	(0.05)	(0.09)	(0.06)	(0.08)	(0.06)	(0.08)
Firm-year FE	YES	YES	YES	YES	YES	YES	YES
Country-pair-year FE	YES	YES	YES	YES	YES	YES	YES
Cluster:							
Firm	YES	YES		YES			
Origin			YES		YES		
Destination	YES		YES				
Country-pair	YES	YES				YES	
Firm-destination							YES
Adj. R^2	0.74	0.74	0.74	0.74	0.74	0.74	0.74
Observations	32,047	32,047	32,047	32,047	32,047	32,047	32,047

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors in parentheses are clustered as indicated. Multiple clusters indicate multiway-clustering.

Table D.14: Firm-Level Results: Alternative Institutional Moderators

Dep. Var.: $asinh(SALES_{iodt})$	(1)	(2)	(3)	(4)	(5)	(6)
$asinh(CON_{iodt})$	0.43^{***}	0.28^{***}	0.42^{***}	0.29^{***}	0.47^{***}	0.28^{***}
	(0.09)	(0.05)	(0.09)	(0.05)	(0.11)	(0.05)
$asinh(CON_{iodt}) \times RL_{dt}$	-0.08^{*}					
	(0.04)					
$asinh(CON_{iodt}) \times RLdis_{dt}$		0.12^{***}				
		(0.04)				
$asinh(CON_{iodt}) \times RQ_{dt}$			-0.07			
			(0.05)			
$asinh(CON_{iodt}) \times RQdis_{dt}$				0.09^{**}		
				(0.04)		
$asinh(CON_{iodt}) \times GE_{dt}$					-0.10^{*}	
					(0.06)	
$asinh(CON_{iodt}) \times GEdis_{dt}$						0.13^{**}
						(0.06)
Firm-year FE	YES	YES	YES	YES	YES	YES
Country-pair-year FE	YES	YES	YES	YES	YES	YES
Adj. R^2	0.74	0.74	0.74	0.74	0.74	0.74
Observations	31,479	31,451	31,474	31,416	31,474	31,416

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors (three-way clustered by firm-year, destination, and country pair) in parentheses.

Appendix E

Appendix to Institutional Discrimination Against Female Managers as a Barrier to Firm Internationalization and International Trade

E.1 Descriptive Statistics

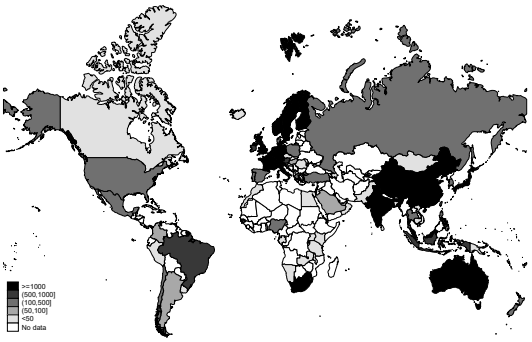

Figure E.1: Observations by Origin Country

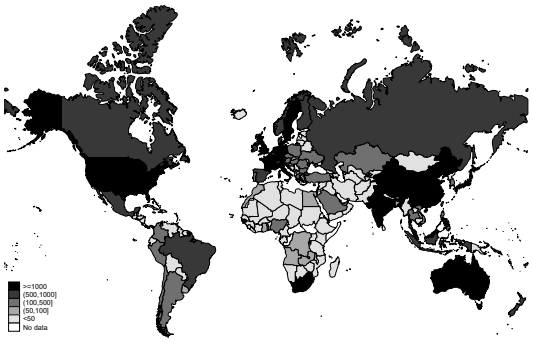

Figure E.2: Observations by Destination Country

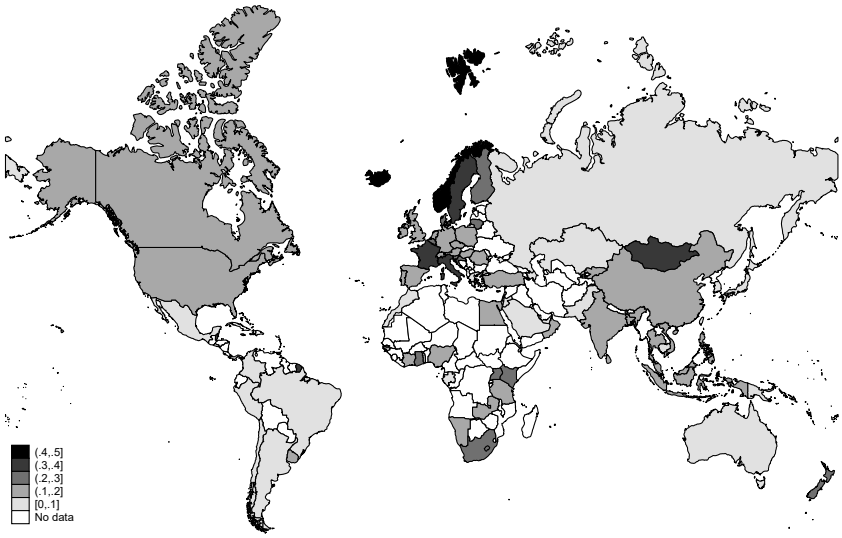

Figure E.3: Country-Level Female Shares in 2017

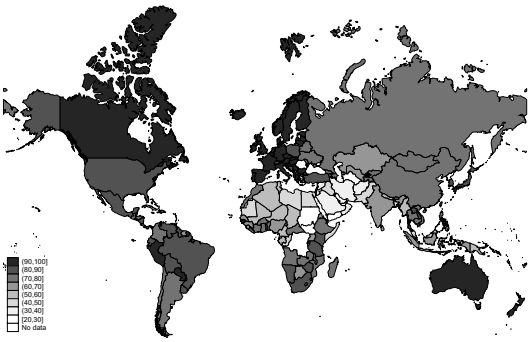

Figure E.4: WBL (2017) by Country

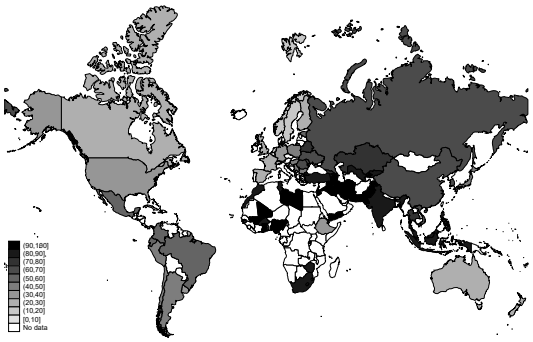

Figure E.5: $GSNI$ by Country

Table E.1: Firm-Level Summary Statistics

	n	Mean	SD	Min	P25	Median	P75	Max
$FemaleShare$	31,377	0.12	0.14	0	0	0.1	0.2	0.67
$log(ForeignSales)$	31,377	17.63	2.62	4.86	16.1	17.85	19.44	25.21
WBL	31,222	83.5	12.92	23.75	73.63	83.75	94.38	100
$GSNI$	26,405	43.97	22.03	10.75	26.81	33.07	64.42	98.07
$GSNIECON$	26,405	35.56	19.61	9.16	18.06	29.8	54.87	91.97

Table E.2: Country-Level Summary Statistics

	n	Mean	SD	Min	P25	Median	P75	Max
$Exports$	263,122	611.5	5,743.0	0.0	0.0	1.2	46.0	452,286.9
$FemaleShare$	169,702	0.11	0.09	0.00	0.05	0.10	0.15	0.53
$GSNI$	112,989	59.1	26.6	7.4	35.1	60.8	84.8	98.1
$GSNIECON$	112,989	49.8	24.0	8.7	28.4	50.9	72.1	92.0
RTA	263,122	0.18	0.39	0.00	0.00	0.00	0.00	1.00
WBL	245,158	73.4	18.3	23.8	63.1	76.3	86.9	100.0

Exports shown in 1,000,000 current USD, but used in 1,000 current USD in the regressions.

E.2 Event Study Regression Results

Table E.3: Firm-Level Event Study

Dep. Var.: $log(ForeignSales_t)$	(1)	(2)	(3)
$Event_{t+2*} \times GSNI$	−0.00		
	(0.00)		
$Event_t \times GSNI$	−0.00		
	(0.00)		
$Event_{t-1} \times GSNI$	−0.01**		
	(0.00)		
$Event_{t-2*} \times GSNI$	0.00		
	(0.00)		
$Event_{t+2*} \times GSNIECON$		−0.01	
		(0.01)	
$Event_t \times GSNIECON$		−0.01	
		(0.01)	
$Event_{t-1} \times GSNIECON$		−0.01**	
		(0.00)	
$Event_{t-2*} \times GSNIECON$		−0.00	
		(0.00)	
$Event_{t+2*} \times WBL$			0.00
			(0.01)
$Event_t \times WBL$			0.00
			(0.01)
$Event_{t-1} \times WBL$			0.01
			(0.01)
$Event_{t-2*} \times WBL$			0.00
			(0.01)
Firm-year FE	Yes	Yes	Yes
Origin-destination-year FE	Yes	Yes	Yes
Adj. R^2	0.71	0.71	0.73
Observations	9,693	9,693	11,486

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$. Standard errors (clustered on the firm and the country-pair level) in parentheses. An index time with an asterisk indicates that all further available years in that time direction are included for the indicator construction.

E.3 Robustness Checks

Table E.4: Firm-Level Subsample Analysis: Without High Income Countries

Dep. Var.: $log(ForeignSales_t)$	(1)	(2)	(3)	(4)	(5)	(6)
$FemaleShare \times GSNI$	-0.07^{***}					
	(0.03)					
$FemaleShare \times GSNI_{t-1}$		-0.09^{***}				
		(0.03)				
$FemaleShare \times GSNIECON$			-0.06^{**}			
			(0.03)			
$FemaleShare \times GSNIECON_{t-1}$				-0.08^{**}		
				(0.03)		
$FemaleShare \times WBL$					0.09^{**}	
					(0.04)	
$FemaleShare \times WBL_{t-1}$						0.14^{***}
						(0.04)
Firm-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Origin-destination-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.52	0.46	0.52	0.46	0.54	0.49
Observations	9,374	6,314	9,374	6,314	10,805	7,195

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors (two-way clustered by firm and country-pair) in parentheses.

Table E.5: Firm-Level Subsample Analysis: Only High Income Countries

Dep. Var.: $log(ForeignSales_t)$	(1)	(2)	(3)	(4)	(5)	(6)
$FemaleShare \times GSNI$	-0.03^{*}					
	(0.02)					
$FemaleShare \times GSNI_{t-1}$		-0.02				
		(0.02)				
$FemaleShare \times GSNIECON$			-0.03^{**}			
			(0.02)			
$FemaleShare \times GSNIECON_{t-1}$				-0.02		
				(0.02)		
$FemaleShare \times WBL$					0.07^{***}	
					(0.02)	
$FemaleShare \times WBL_{t-1}$						0.06^{***}
						(0.02)
Firm-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Origin-destination-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.79	0.79	0.79	0.79	0.79	0.79
Observations	17,031	11,598	17,031	11,598	20,417	13,892

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors (two-way clustered by firm and country-pair) in parentheses.

Table E.6: Country-Level Subsamples

Dep. Var.: *Exports*	(1)	(2)	(3)	(4)	(5)	(6)
$FemaleShare_o \times GSNI_d$	-0.01			-0.03^{**}		
	(0.00)			(0.01)		
$FemaleShare_o \times GSNIECON_d$		-0.01^{*}			-0.03^{**}	
		(0.01)			(0.01)	
$FemaleShare_o \times WBL_d$			0.02^{***}			0.03^{**}
			(0.00)			(0.02)
RTA	0.11^{***}	0.11^{***}	0.12^{***}	0.03	0.02	0.03
	(0.03)	(0.03)	(0.03)	(0.05)	(0.05)	(0.04)
Origin-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Destination-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Origin-destination FE	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	1.00	1.00	1.00	0.99	0.99	0.99
Observations	33,034	33,034	78,626	22,685	22,685	52,707

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors (clustered on the country-pair level) in parentheses. Estimation method: PPML. Models (1)-(3) use a sample restricted to high-income origin countries, while Models (4)-(6) are based on a sample excluding high-income origins.

Table E.7: Firm-Level Results with SE Clustered on the Firm-Level

Dep. Var.: $log(ForeignSales_t)$	(1)	(2)	(3)	(4)	(5)	(6)
$FemaleShare \times GSNI$	-0.05^{***}					
	(0.02)					
$FemaleShare \times GSNI_{t-1}$		-0.05^{**}				
		(0.02)				
$FemaleShare \times GSNIECON$			-0.04^{***}			
			(0.02)			
$FemaleShare \times GSNIECON_{t-1}$				-0.04^{**}		
				(0.02)		
$FemaleShare \times WBL$					0.08^{***}	
					(0.03)	
$FemaleShare \times WBL_{t-1}$						0.10^{***}
						(0.03)
Firm-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Origin-destination-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.71	0.69	0.71	0.69	0.72	0.70
Observations	26,405	17,912	26,405	17,912	31,222	21,087

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors (one-way clustered by firm) in parentheses.

Table E.8: Firm-Level Results with SE Clustered on the Country-Pair-Level

Dep. Var.: $log(ForeignSales_t)$	(1)	(2)	(3)	(4)	(5)	(6)
$FemaleShare \times GSNI$	-0.05^{***}					
	(0.02)					
$FemaleShare \times GSNI_{t-1}$		-0.05^{**}				
		(0.02)				
$FemaleShare \times GSNIECON$			-0.04^{***}			
			(0.02)			
$FemaleShare \times GSNIECON_{t-1}$				-0.04^{**}		
				(0.02)		
$FemaleShare \times WBL$					0.08^{***}	
					(0.02)	
$FemaleShare \times WBL_{t-1}$						0.10^{***}
						(0.03)
Firm-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Origin-destination-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.71	0.69	0.71	0.69	0.72	0.70
Observations	26,405	17,912	26,405	17,912	31,222	21,087

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors (one-way clustered by country-pair) in parentheses.

Table E.9: Country-Level Results with Lags

Dep. Var.: $Exports_t$	(1)	(2)	(3)	(4)	(5)	(6)
$FemaleShare_{o,t-1} \times GSNI_d$	-0.02^{***}					
	(0.00)					
$FemaleShare_{o,t-1} \times GSNIECON_d$		-0.02^{***}				
		(0.00)				
$FemaleShare_{o,t-1} \times WBL_{dt}$			0.02^{***}			
			(0.00)			
$FemaleShare_{d,t-1} \times GSNI_o$				-0.01^{*}		
				(0.00)		
$FemaleShare_{d,t-1} \times GSNIECON_o$					-0.01^{*}	
					(0.01)	
$FemaleShare_{d,t-1} \times WBL_{ot}$						0.01
						(0.01)
RTA	0.10^{***}	0.10^{***}	0.10^{***}	0.09^{***}	0.09^{***}	0.10^{***}
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Origin-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Destination-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Origin-destination FE	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	1.00	1.00	1.00	1.00	1.00	0.99
Observations	51,575	51,575	121,191	51,534	51,534	120,787

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors (clustered on the country-pair level) in parentheses. Estimation method: PPML.

Table E.10: Country-Level Results Using OECD Female Shares

Dep. Var.: *Exports*	(1)	(2)	(3)	(4)	(5)	(6)
$oecdShare_o \times GSNI_d$	−0.00					
	(0.00)					
$oecdShare_o \times GSNIECON_d$		−0.01*				
		(0.00)				
$oecdShare_o \times WBL_d$			0.02***			
			(0.00)			
$oecdShare_d \times GSNI_o$				−0.00		
				(0.00)		
$oecdShare_d \times GSNIECON_o$					−0.00	
					(0.00)	
$oecdShare_d \times WBL_o$						0.01**
						(0.01)
RTA	−0.04	−0.04	−0.02	−0.01	−0.01	−0.00
	(0.06)	(0.06)	(0.05)	(0.05)	(0.05)	(0.04)
Origin-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Destination-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Origin-destination FE	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	1.00	1.00	1.00	1.00	1.00	1.00
Observations	31,346	31,346	75,136	31,330	31,330	74,621

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors (clustered on the country-pair level) in parentheses. Estimation method: PPML.

Declaration of Co-Authorship

I hereby declare that this thesis incorporates material that is the result of joint research as follows:

Chapter 1: "Asymmetric General Oligopolistic Equilibrium" is based on joint work with Ansgar F. Quint. The concept and the theoretical analysis were developed and conducted jointly and in equal shares, just like the writing was shared equally. Everything was mutually discussed and improved such that this chapter should be considered as joint work.

Chapter 2: "International Trade and Tax-Motivated Transfer Pricing" is based on joint work with Ansgar F. Quint. The concept and the theoretical analysis were developed and conducted jointly and in equal shares, just like the writing was shared equally. Everything was mutually discussed and improved such that this chapter should be considered as joint work.

Chapter 3: "How Protectionism Harms Workers Under Oligopoly" is single-authored.

Chapter 4: "Building Bridges: Bilateral Manager Connections and International Trade" is based on joint work with Felix Hoch. The concept and the empirical analysis were developed and conducted jointly and in equal shares, just like the writing was shared equally. Everything was mutually discussed and improved such that this chapter should be considered as joint work.

Chapter 5: "Institutional Discrimination Against Female Managers as a Barrier to Firm Internationalization and International Trade" is based on joint work with Felix Hoch. The concept and the empirical analysis were developed and conducted jointly and in equal shares, just like the writing was shared equally. Everything was mutually discussed and improved such that this chapter should be considered as joint work.

Göttingen, March 8, 2022

Jonas F. Rudsinske

Declaration for Admission to the Doctoral Examination

Ph.D. program in Economics

I confirm

1. that the dissertation "Essays on International Trade, Trade Barriers, and Oligopolistic Competition" that I submitted was produced independently without assistance from external parties, and not contrary to high scientific standards and integrity,

2. that I have adhered to the examination regulations, including upholding a high degree of scientific integrity, which includes the strict and proper use of citations so that the inclusion of other ideas in the dissertation are clearly distinguished,

3. that in the process of completing this doctoral thesis, no intermediaries were compensated to assist me neither with the admissions or preparation processes, and in this process,

    - no remuneration or equivalent compensation were provided
    - no services were engaged that may contradict the purpose of producing a doctoral thesis

4. that I have not submitted this dissertation or parts of this dissertation elsewhere.

I am aware that false claims and the discovery of those false claims now, and in the future with regards to the declaration for admission to the doctoral examination can lead to the invalidation or revoking of the doctoral degree.

Göttingen, March 8, 2022

Jonas F. Rudsinske