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# **INTERNATIONAL TRADE AND TAX-MOTIVATED TRANSFER PRICING**

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# International Trade and Tax-Motivated Transfer Pricing

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## Abstract

We study the welfare and distribution effects of corporate taxation and transfer pricing in an asymmetric general oligopolistic equilibrium trade model. Without profit shifting, an increasing profit tax rate shifts welfare towards the taxing 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, 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. In the low-tax country, real profits decrease such that the labor share of income rises.

**JEL-Codes:** E25, F10, H25, H26, L13.

**Keywords:** General oligopolistic equilibrium, international trade, labor share, profit shifting, tax evasion, transfer pricing.

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# 1 Introduction

Roughly one-third of world trade is intrafirm trade.<sup>1</sup> In that case, international trade flows take place within multinational firms with transfer prices being set by these firms and not determined on a market. In presence of corporate tax rate differentials between countries, firms have an incentive to use this internal price setting possibility to shift profits between the countries in order to reduce their global tax bill.<sup>2</sup> There is strong empirical evidence that firms export more when they can use transfer pricing to shift profits.<sup>3</sup> P. Egger and Seidel (2013) find a 5.5% increase in intra-firm trade flows due to a 3.1% increase in the average host-country tax-gap to the United States. 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. As this strongly indicates that transfer pricing affects aggregate statistics<sup>4</sup>, 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 benefits the low-tax country as income imbalances resulting from asymmetric tax rates are partly reversed. Next to this cross-country demand channel, higher attractiveness of exporting leads to a positive supply effect that increases real wages in general equilibrium. As a result, 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 trade model based on Quint and Rudsinske (2020). The foundation for this model is developed in Neary (2016). His trade model allows to analyze oligopoly in general equilibrium, when countries are fundamentally symmetric. 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. In Quint and Rudsinske (2020) we extend this model to

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<sup>1</sup>See Antras (2003).

<sup>2</sup>For empirical evidence see e.g. Bernard et al. (2006) and Cristea and Nguyen (2016).

<sup>3</sup>See e.g. Clausing (2003), Clausing (2006), Liu et al. (2017).

<sup>4</sup>Vicard (2015) and Casella et al. (2018) provide estimates of the substantial tax revenue losses attributable to transfer pricing.

allow for segmented markets and country asymmetries, such that not only net trade but total traded quantities can be analyzed and tax rates can differ in the two countries.<sup>5</sup> This allows implementing a transfer pricing decision for intrafirm exports. Only real exporting flows enable profit shifting, such that none of the countries is a tax haven. 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. This is caused by an asymmetric price reaction, while nominal wages are unaffected. Transfer pricing generates an additional benefit from exporting for all firms because more exporting enables more profit shifting. This incentivizes exporting such that companies 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. We expect most profits to be shifted by multinational firms that are able to gain high profits in the first place. The ability to charge relatively high mark-ups makes such firms more likely to be large players in their specific sector. Accordingly, those firms' behavior mainly drives the aggregate effects of transfer pricing and we do not want to neglect the strategic considerations among those firms. In accordance with that and based on empirical observations, 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 is only

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<sup>5</sup>See also Rudsinske (2020) for an application of the model to the case of asymmetric import tariffs.

one country is affected or whether there exist linkages between markets, e.g. created by variable marginal costs. We account for both aspects by allowing firms to treat the markets as segmented and by explicitly modelling 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.

Brander (1981) was the first to stress that strategic interactions among firms can give rise to two-way trade in identical commodities. In the absence of transfer pricing, trade in our model functions similarly to the famous reciprocal dumping model in Brander and Krugman (1983), where the rivalry of oligopolistic firms is the single cause of international trade. Zhou (2018) builds a continuum-Ricardo general equilibrium trade model with oligopolistic competition. Due to free entry and exit, firms make zero profit in equilibrium. For our purposes of analyzing tax-motivated transfer pricing, the existence of strictly positive profits is a prerequisite. Thus, we exclude free entry in our setting.

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. For instance, Hirshleifer (1956) shows that optimal transfer prices should be set according to marginal costs in the absence of a competitive market. Bond (1980) extends this framework to allow for cross-country trade with differing tax rates. In this context, transfer prices have to balance the tax avoidance possibilities and the resource allocation efficiency. Elitzur and Mintz (1996) propose a more nuanced view on the internal decision making process, introducing a principal agent relation between the parent and the subsidiary. We assume centralized decision-making by the parent company, which from the firm's 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 as shown in 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. In these models<sup>6</sup>, governments may decide on tax rates and on different taxation systems such as differing transfer pricing benchmarks. Consequently, governments have to balance the benefit of increased tax revenue with the disadvantage of inefficient production or outflow of investment. For simplicity, 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 will first introduce the theoretical model and our solution strategy in section 2. After showing the effects of unilateral taxation in section 3, we will analyze the effects of transfer pricing in section 4. The final section concludes. All proofs are deferred to the appendix.

## 2 Theoretical Model

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 general oligopolistic equilibrium. We build on the model developed by Neary (2016) and extended by Quint and Rudsinske (2020) for the case of country asymmetries and segmented markets.

### 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.

#### 2.1.1 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

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<sup>6</sup>See e.g. Behrens et al. (2014), Peralta et al. (2006), Devereux and Keuschnigg (2013), Auerbach and Devereux (2018).



competitive labor market. Following Neary (2016) 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  $a, b > 0$ . To assure the positive marginal utility of each good, we set  $a > b y(z)$ . 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 ( $\Pi$ ) 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

$$I = wL + \Pi + T. \tag{1}$$

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

$$\int_0^1 p(z)y(z)dz \leq I. \tag{2}$$

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  $\lambda$  being the Lagrange-parameter and therefore the marginal utility of income. The inverse Frisch demand follows

straightforwardly and is given by

$$p(z) = \lambda^{-1} \frac{\partial u[y(z)]}{\partial y(z)} = 1/\lambda[a - by(z)] \quad \forall z. \quad (3)$$

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

### 2.1.2 Producers

The producers aim to maximize their profits given the demand, the tax rates and the system of tax collection. 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 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 intra-firm 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  $n = 1$  firm exists in Home in each sector  $z$  and that there are neither fixed costs of production nor transport costs.<sup>7</sup> 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  $\lambda$  – 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 costs 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

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<sup>7</sup>This also implies that  $n^* = 1$  multinational is located in Foreign.

(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.

### 2.1.3 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 their 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  $\Phi$  equal to the marginal costs of producing the good as 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

$$\begin{aligned}\pi &= (1 - \tau) [(p - w)y_h + (\Phi - w)y_f] + (1 - \tau^*) [p^* - \Phi] y_f \\ &= (1 - \tau) [p - w] y_h + (1 - \tau^*) [p^* - w] y_f + (\tau^* - \tau) [\Phi - w] y_f,\end{aligned}\tag{4}$$

where the Home tax rate is  $\tau$  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 (4) shows that if  $\Phi$  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. This 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

$$\Phi \in [w - g; w + g]. \quad (5)$$

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 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.

### 2.2.1 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 (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.

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

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

$$\frac{\partial \pi}{\partial y_h} = (1 - \tau) \left[ \frac{1}{\lambda} (a - 2b y_h - b y_h^*) - w \right] = 0 \quad (6)$$

$$\begin{aligned} \frac{\partial \pi}{\partial y_f} &= (1 - \tau^*) \left[ \frac{1}{\lambda^*} (a - 2b y_f - b y_f^*) - w \right] \\ &\quad + (\tau^* - \tau)(\Phi - w) = 0. \end{aligned} \quad (7)$$

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.

$$y_h = \frac{a - \lambda w - b y_h^*}{2b} \quad (8)$$

$$y_f = \frac{a - \lambda^* w - b y_f^* + \frac{\tau^* - \tau}{1 - \tau^*} \lambda^* (\Phi - w)}{2b} \quad (9)$$

As mentioned above, the transfer price will be set according to the difference in tax rates. This also follows from  $\partial\pi/\partial\Phi = (\tau^* - \tau)y_f$ , which should be zero in optimum. This condition would only be fulfilled if tax rates are equal, i.e. profit shifting via transfer price manipulation is impossible, or if nothing is exported, which contradicts the first order condition (6). However, this condition 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 (5), it follows that the optimal transfer price is<sup>8</sup>

$$\Phi = \begin{cases} w + g & \text{if } \tau^* > \tau \\ w & \text{if } \tau^* = \tau \\ w - g & \text{if } \tau^* < \tau. \end{cases} \quad (10)$$

Combining the reaction function (9) and the optimal transfer price rule in equation (10) leads to

$$y_f = \frac{a - \lambda^* w - b y_f^* + \frac{|\tau^* - \tau|}{1 - \tau^*} \lambda^* g}{2b}. \quad (11)$$

This formulation contains all cases for the optimal transfer price as the cost element will vanish from the expression and the sign in equation (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<sup>9</sup>

$$y_h = \frac{\lambda}{3b} \left\{ \frac{a}{\lambda} - w + (w^* - w) - \frac{|\tau^* - \tau|}{1 - \tau} g \right\} \quad (12)$$

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<sup>8</sup>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.

<sup>9</sup> $y_i$  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  $i$ .

$$y_h^* = \frac{\lambda}{3b} \left\{ \frac{a}{\lambda} - w^* + (w - w^*) + 2 \frac{|\tau^* - \tau|}{1 - \tau} g \right\}. \quad (13)$$

The supplied quantities in Foreign are analogous:

$$y_f = \frac{\lambda^*}{3b} \left\{ \frac{a}{\lambda^*} - w + (w^* - w) + 2 \frac{|\tau^* - \tau|}{1 - \tau^*} g \right\}. \quad (14)$$

$$y_f^* = \frac{\lambda^*}{3b} \left\{ \frac{a}{\lambda^*} - w^* + (w - w^*) - \frac{|\tau^* - \tau|}{1 - \tau^*} g \right\} \quad (15)$$

### 2.2.2 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

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

Generally, higher demand (lower  $\lambda$ ) 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  $\lambda^*$  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.<sup>10</sup>

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

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.

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

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 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

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<sup>10</sup>We will introduce this in our general equilibrium setting.

making exporting more profitable (see equation (9)). 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  $g$ .

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

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.

## 2.3 General Equilibrium

### 2.3.1 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 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

$$\begin{aligned} L = \frac{1}{2} &= \int_0^1 y_h + y_f dz = y_h + y_f \\ &= \frac{1}{3b} \left\{ 2a - \bar{\lambda} w + \bar{\lambda}(w^* - w) + |\tau^* - \tau| g \left( \lambda^* \frac{2}{1 - \tau^*} - \lambda \frac{1}{1 - \tau} \right) \right\}. \end{aligned} \quad (16)$$

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

$$w = \frac{1}{\bar{\lambda}} \left\{ 2a - \frac{3}{2}b + \lambda^* g \frac{|\tau^* - \tau|}{1 - \tau^*} \right\}; \quad (17)$$

$$w^* = \frac{1}{\bar{\lambda}} \left\{ 2a - \frac{3}{2}b + \lambda g \frac{|\tau^* - \tau|}{1 - \tau} \right\}. \quad (18)$$

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. We can also note that wages are equal across countries if  $g = 0$ .

### 2.3.2 General Oligopolistic Equilibrium

In equilibrium the model is characterized by nine equations in nine endogenous variables. The Cournot equilibrium quantities ((12) – (14)) 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 ((16) for Home, analogously for Foreign). Additionally, the prices are given by the representative consumers' inverse Drisch demand functions ((3) for Home, analogously for Foreign).

The last equation implicitly determines the marginal utility of income. Neary (2016) provides an explicit solution for these using the demand and the budget constraint in the respective country.<sup>11</sup> We adapt this method and 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:

$$-(p^* y_f - p y_h^*) = \tau y_h^* (p - w^* - g) - \tau^* y_f (p^* - w + g) \quad (19)$$

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

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<sup>11</sup>See footnote 13 in Neary (2016).

income. Analogously to Quint and Rudsinske (2020), 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  $\lambda$  and  $\lambda^*$  that  $\lambda^* = 1 - \lambda$ , which allows us to substitute all  $\lambda^*$ . 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  $\lambda$ .<sup>12</sup> These 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 positive marginal utility of consumption holds we take the most extreme case where  $y = L + L^* = 1$ . This leads to  $b < a$ .<sup>13</sup> 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 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 (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.

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<sup>12</sup>See the appendix for these equations.

<sup>13</sup>More generally, we need  $b < a/(L+L^*)$ . Under our assumptions this also assures positive wages at  $g = 0$ , which require  $b < 2a((n+1)/n)L + L^*$ .

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 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.

$$CI : \quad y_h = \frac{I}{p} - y_h^*$$

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 exactly 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 (6) and (7) and can be rearranged<sup>14</sup> to

$$MI : \quad y_h = -\lambda(1 - \lambda) \frac{g(\tau - \tau^*)(2 - \tau - \tau^*)}{b(1 - \tau)(1 - \tau^*)} + y_h^*. \quad (20)$$

This results in a line with the slope  $+1$ , which in our diagram again is the same from

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<sup>14</sup>For the derivation see the appendix.

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 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.

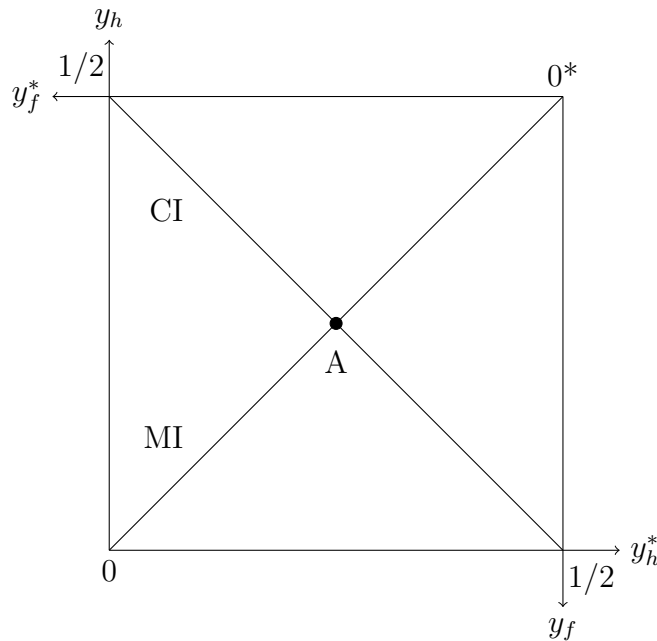


Figure 1: Symmetric Equilibrium with  $\tau = \tau^*$

### 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  $g = 0$ .<sup>15</sup> 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** (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  $\tau$  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 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. Because of this cross-country demand effect, prices as well as quantities increase in Home and decrease in Foreign. This is in line with the balance of payments in equation (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

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<sup>15</sup>See equations (12) – (14) which do not depend on either tax rate with  $g = 0$ .

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  $g = 0$ . Nevertheless, prices in the high-tax country increase, while they decrease in the low-tax country. Each company raises its supply to the high- and reduces its supply to the low-tax country. If the tax rate increases with  $g = 0$ , real tax income in the high-tax country increases.

**Proposition 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 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  $g = 0$ .<sup>16</sup> Thus, the new equilibrium point B is at the intersection of the new CI and the unchanged MI line.

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<sup>16</sup>As seen in equation (20), the intercept is zero for  $g = 0$ .



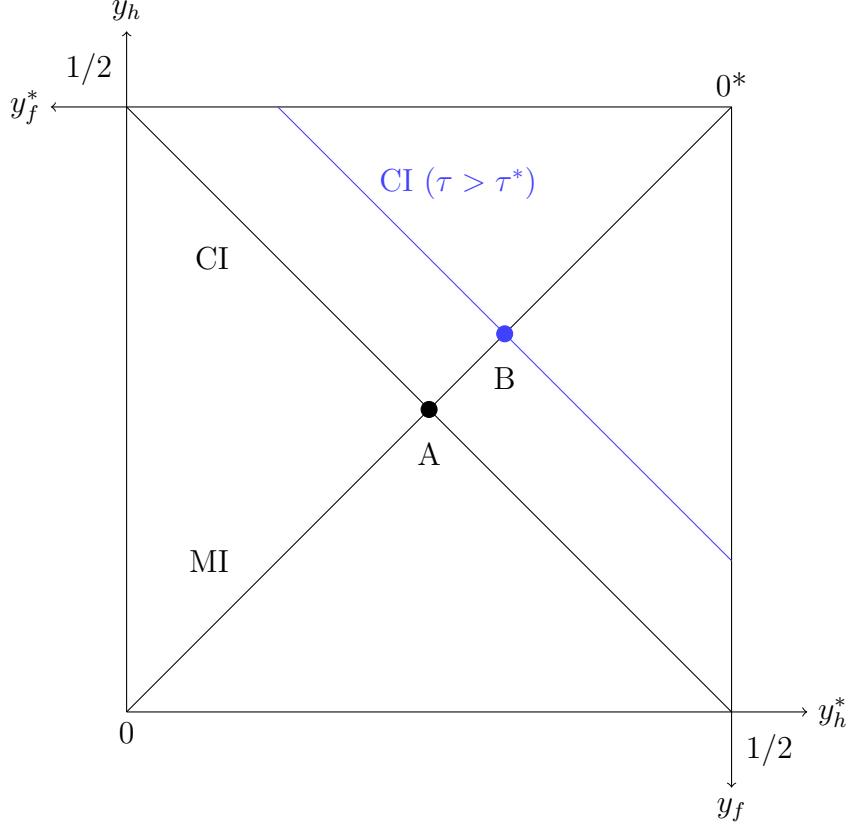


Figure 2: Unilateral Taxation with  $\tau > \tau^*$

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.

## 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 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. On the other hand, all companies have an additional incentive to export, as with each unit of exports more taxes can be avoided. This 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 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 (16) – aggregate exports increase due to changing exporting incentives.

**Proposition 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 the 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 in turn results in decreasing prices in Home and increasing prices in Foreign.

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

$$\begin{aligned} \frac{\partial y_f}{\partial g} &= \underbrace{\left( \frac{1}{2} - \frac{2a}{3b} \right) \frac{\partial \hat{\lambda}}{\partial g}}_{\text{Demand-Channel} > 0} \\ &+ \underbrace{\frac{1}{3b} \frac{(\tau - \tau^*)(3 - 2\tau - \tau^*)}{(1 - \tau)(1 - \tau^*)} \left( \hat{\lambda}(1 - \hat{\lambda}) + g(1 - 2\hat{\lambda}) \frac{\partial \hat{\lambda}}{\partial g} \right)}_{\text{Supply-Channel} > 0} \end{aligned} \quad (21)$$

$$\begin{aligned} \frac{\partial y_h^*}{\partial g} &= \underbrace{\left( \frac{2a}{3b} - \frac{1}{2} \right) \frac{\partial \hat{\lambda}}{\partial g}}_{\text{Demand-Channel} < 0} \\ &+ \underbrace{\frac{1}{3b} \frac{(\tau - \tau^*)(3 - \tau - 2\tau^*)}{(1 - \tau)(1 - \tau^*)} \left( \hat{\lambda}(1 - \hat{\lambda}) + g(1 - 2\hat{\lambda}) \frac{\partial \hat{\lambda}}{\partial g} \right)}_{\text{Supply-Channel} > 0} \end{aligned} \quad (22)$$

The demand channels partly reverse the effects of asymmetric taxation seen in equations (24) and (25). With Lemma 3 we can determine the directions of the two channels at  $g = 0$ . The supply channel is positive for all companies reflecting the exporting incentives. However, the demand channel counteracts the supply channel for exports from the low- to the high-tax country. Firms producing in the low-tax country Foreign experience conflicting incentives. 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. Here, 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.<sup>17</sup> 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 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 there 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

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<sup>17</sup>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  $0 < \tau^* < \tau < 1$ .

the transfer pricing scope does not become too large.<sup>18</sup> 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. However, Home firms export less and Foreign firms export more in the new equilibrium with  $\tau^* = 0$ .

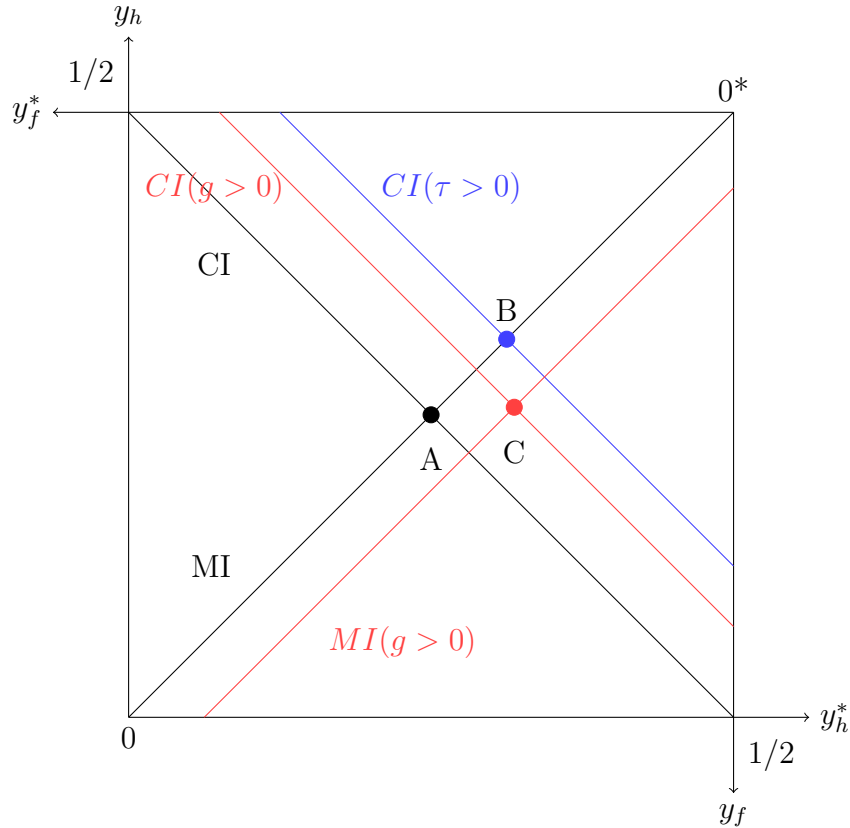


Figure 3: Transfer Pricing at  $\tau^* = 0$

Figure 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

<sup>18</sup>See the supplement for this derivation.

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 distributive effects of transfer pricing within our framework. 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.

**Proposition 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. □

## 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.

## Appendix

### Endogenous variables depending on exogenous parameters and $\lambda$

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

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

The prices are given by

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

and wages are

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

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

## Derivation of the Market Indifference Curve

Here, we derive the Market Indifference (MI) curve resulting from profit maximization.

Equations (6) and (7) can then 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:

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

## Proofs

### Lemma 1

*Proof.* First, we reformulate the condition of equalized balance of trade and balance of capital to the condition that the balance of payments is zero in equilibrium.

$$BoP = 0$$

$$\begin{aligned} 0 &= [p^*(\lambda) y_f(\lambda) - p(\lambda) y_h^*(\lambda)] \\ &\quad + \tau y_h^*(\lambda) [p(\lambda) - w^*(\lambda) - g] - \tau^* y_f [p^*(\lambda) - w(\lambda) + g] \end{aligned} \quad (23)$$



In the limiting cases of the admissible  $\lambda$ , we can show in the supplement that the right-hand side of this equation, the *BoP*, is

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

Additionally, the *BoP* is differentiable with respect to  $\lambda$ , which implies continuity of the *BoP*. Therefore, there has to be at least one solution of the above equation 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 balance of payments can be rearranged to

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

with

$$\begin{aligned}x_1 &= -\frac{1}{9}a^2(7+4\tau) - \frac{1}{2}b^2 \left( 1 + \frac{1}{2} \tau^* \right) + \frac{1}{3}ab(4+\tau+\tau^*) + \frac{1}{3}ag(\tau^*-\tau) - \frac{1}{2}b\tau^*g \\ &\quad + \frac{1}{3}a\Delta \left( -1 + \frac{5}{3}\tau - \frac{2}{3}\tau^* + \frac{2}{3}\tau\tau^* - \frac{2}{3}\tau^2 \right) + \frac{1}{2}b\tau^*\Delta(1-\tau) \\ x_2 &= \frac{1}{4}b^2(4+\tau+\tau^*) - \frac{2}{3}\frac{a}{b}(4+\tau+\tau^*) + \frac{4}{9}a^2(4+\tau+\tau^*) + \left( \frac{2}{3}a - \frac{1}{2}b \right) g(\tau-\tau^*) \\ &\quad + \Delta \left[ a \left( \frac{2}{3} - \frac{23}{9}\tau + \frac{2}{3}\tau^2 + \frac{17}{9}\tau^* - \frac{2}{9}\tau^{*2} - \frac{4}{9}\tau\tau^* \right) + b \left( \frac{7}{6}\tau - \frac{1}{3}\tau^2 - \frac{13}{6}\tau^* + \frac{1}{3}\tau^{*2} + \tau\tau^* \right) \right. \\ &\quad \left. + g \left( -\tau + \frac{1}{3}\tau^2 - \tau^* + \frac{1}{3}\tau^{*2} + \frac{4}{3}\tau\tau^* \right) \right] \\ &\quad \Delta^2 \left( \frac{1}{3}\tau - \frac{4}{9}\tau^2 + \frac{1}{9}\tau^3 + \frac{2}{3}\tau^* - \frac{1}{9}\tau^{*2} - \frac{13}{9}\tau\tau^* + \frac{7}{9}\tau^2\tau^* + \frac{1}{9}\tau\tau^{*2} \right) \\ x_3 &= \Delta \left[ a \left( \frac{20}{9}\tau - \frac{4}{9}\tau^2 - \frac{20}{9}\tau^* + \frac{4}{9}\tau^{*2} \right) + b \left( -\frac{5}{3}\tau + \frac{1}{3}\tau^2 + \frac{5}{3}\tau^* - \frac{1}{3}\tau^{*2} \right) \right. \\ &\quad \left. + g \left( \tau - \frac{1}{3}\tau^2 + \tau^* - \frac{1}{3}\tau^{*2} - \frac{4}{3}\tau\tau^* \right) \right. \\ &\quad \left. + \Delta \left( -\frac{4}{3}\tau + \tau^2 - \frac{2}{9}\tau^3 - \frac{5}{3}\tau^* + \frac{2}{3}\tau^{*2} - \frac{1}{9}\tau^{*2} + \frac{13}{3}\tau\tau^* - \frac{5}{3}\tau^2\tau^* - \tau\tau^{*2} \right) \right] \\ x_4 &= \Delta^2 \left[ \tau - \frac{5}{9}\tau^2 + \frac{1}{9}\tau^3 + \tau^* - \frac{5}{9}\tau^{*2} + \frac{1}{9}\tau^{*3} - \frac{26}{3}\tau\tau^* + \frac{8}{9}\tau^2\tau^* + \frac{8}{9}\tau\tau^{*2} \right]\end{aligned}$$

$$\Delta = \frac{(\tau - \tau^*) g}{(1 - \tau)(1 - \tau^*)}$$

Hence, the derivative of the balance of payment with respect to  $\lambda$  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

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

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 shown in the supplement. 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 two summands 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 negative derivative. The remaining three summands of the derivative ( $\overline{dBoP}(\lambda)$ ) are a quadratic polynomial.

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

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

$$0 = \frac{1}{b} (2 x_3 + 6 x_4 \lambda)$$

$$\tilde{\lambda} = -\frac{1}{3} \frac{x_3}{x_4}$$

To ensure non-negativity of this global maximum, 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  $g$  to assure non-negativity. As  $g \geq 0$  by the model assumptions, we have an upper bound  $\bar{g}$  as given in the supplement.

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 this value  $\bar{g}$ . This assures the uniqueness of the equilibrium  $\hat{\lambda}$ .

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

□

## Lemma 2

*Proof.* In the equilibrium condition (19),  $\hat{\lambda}$  is implicitly defined for  $0 \leq \tau^* \leq \tau$ . Hence, the derivatives of  $\hat{\lambda}$  with respect to  $\tau$  and  $\tau^*$  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  $\lambda$  is positive resulting from the proof of uniqueness. Additionally,

$$\begin{aligned}\frac{\partial BoP}{\partial \tau} &= \frac{1}{36 b \lambda} (2 a (1 - 2\lambda) + 3 b \lambda)^2 > 0, \\ \frac{\partial BoP}{\partial \tau^*} &= -\frac{1}{36 b (1 - \lambda)} (2 a (1 - 2\lambda) - 3 b (1 - \lambda))^2 < 0.\end{aligned}$$

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  $\tau$  ( $\tau^*$ ) respectively for all  $\tau^* \leq \tau$ .

Additionally, we established that at equalized tax rates across countries  $\hat{\lambda} = 1/2$  holds. We show in the supplement that  $\frac{1}{2} \geq \hat{\lambda} > 1/5$  for  $g = 0$  for any combination of tax rates  $0 \leq \tau^* \leq \tau$ . Therefore, it suffices to proof the following propositions only for values  $\lambda \in [1/2, 4/5)$ .  $\square$

### Proposition 1

*Proof.* The above statements follow from inspection of the endogenous variables' derivatives with respect to the Home tax rate  $\tau$  with  $\frac{\partial \hat{\lambda}}{\partial \tau} < 0$  and  $g = 0$ . For the supplied quantities we have

$$\frac{\partial y_h}{\partial \tau} = \frac{\partial y_h^*}{\partial \tau} = \underbrace{\left(\frac{1}{2} - \frac{2a}{3b}\right)}_{<0} \underbrace{\frac{\partial \hat{\lambda}}{\partial \tau}}_{<0} > 0 \quad (24)$$

$$\frac{\partial y_f}{\partial \tau} = \frac{\partial y_f^*}{\partial \tau} = \underbrace{\left(\frac{2a}{3b} - \frac{1}{2}\right)}_{>0} \underbrace{\frac{\partial \hat{\lambda}}{\partial \tau}}_{<0} < 0. \quad (25)$$

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  $\tau$  are

$$\begin{aligned}\frac{\partial p}{\partial \tau} &= \frac{1}{3}a \frac{-\partial \hat{\lambda}/\partial \tau}{\hat{\lambda}^2} > 0 \\ \frac{\partial p^*}{\partial \tau} &= \frac{1}{3}a \frac{\partial \hat{\lambda}/\partial \tau}{(1 - \hat{\lambda})^2} < 0.\end{aligned}$$

Accordingly, 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 taxes are increased.

$$\begin{aligned}\frac{\partial (w/p)}{\partial \tau} &= \frac{\partial w/\partial \tau \cdot p - w \cdot \partial p/\partial \tau}{p^2} \\ &= -\frac{w}{p^2} \frac{\partial p}{\partial \tau} < 0.\end{aligned}$$

In low-tax country Foreign, real wages will increase.

$$\begin{aligned}\frac{\partial (w^*/p^*)}{\partial \tau} &= \frac{\partial w^*/\partial \tau \cdot p^* - w^* \cdot \partial p^*/\partial \tau}{p^{*2}} \\ &= -\frac{w^*}{p^{*2}} \frac{\partial p^*}{\partial \tau} > 0.\end{aligned}$$

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

$$\frac{\partial}{\partial \tau} \left( \frac{1/2w}{\pi} \right) = \frac{1}{2\pi^2} \left( \underbrace{\frac{\partial w}{\partial \tau}}_{=0} \pi - w \underbrace{\frac{\partial \pi}{\partial \tau}}_{<0} \right) > 0$$

The ratio in Foreign is defined analogously and increases as well.  $\square$

### Lemma 3

*Proof.* We know that for equalized tax rates ( $\tau = \tau^*$ ), the countries are identical and therefore  $\hat{\lambda} = 1/2$ . Lemma 2 showed that the marginal utility of income in Home decreases with the tax rate  $\tau$ . 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

$$\begin{aligned} \frac{\partial BoP}{\partial g} &= \frac{1}{3}a(\tau^* - \tau) - \frac{1}{2}b\tau^* \\ &+ \frac{\tau - \tau^*}{(1 - \tau)(1 - \tau^*)} \left( \frac{1}{3}a \left( -1 + \frac{5}{3}\tau - \frac{2}{3}\tau^* + \frac{2}{3}\tau\tau^* - \frac{2}{3}\tau^{*2} \right) + \frac{1}{2}b\tau^*(1 - \tau) \right) \\ &+ \lambda \left\{ \frac{2}{3}a(\tau - \tau^*) + \frac{1}{2}b(\tau^* - \tau) \right. \\ &\quad \left. + \frac{\tau - \tau^*}{(1 - \tau)(1 - \tau^*)} \left[ a \left( \frac{2}{3} - \frac{23}{9}\tau + \frac{2}{3}\tau^2 + \frac{17}{9}\tau^* - \frac{2}{9}\tau^{*2} - \frac{4}{9}\tau\tau^* \right) \right. \right. \\ &\quad \left. \left. + b \left( \frac{7}{6}\tau - \frac{1}{3}\tau^2 - \frac{13}{6}\tau^* + \frac{1}{3}\tau^{*2} + \tau\tau^* \right) \right] \right\} \\ &+ \lambda^2 \frac{\tau - \tau^*}{(1 - \tau)(1 - \tau^*)} \left[ a \left( \frac{20}{9}\tau - \frac{4}{9}\tau^2 - \frac{20}{9}\tau^* + \frac{4}{9}\tau^{*2} \right) \right. \\ &\quad \left. + b \left( -\frac{5}{3}\tau + \frac{1}{3}\tau^2 + \frac{5}{3}\tau^* - \frac{1}{3}\tau^{*2} \right) \right] \end{aligned}$$

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  $g$ .  $\square$

## Proposition 2

*Proof.* The sum of exports 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 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 4

*Proof.* The changes in prices are given by

$$\begin{aligned}
\frac{\partial p}{\partial g} &= \frac{1}{3} \left[ -\frac{a}{\hat{\lambda}^2} \frac{\partial \hat{\lambda}}{\partial g} - \frac{(\tau - \tau^*)^2}{(1 - \tau)(1 - \tau^*)} \left( 1 - \hat{\lambda} - g \frac{\partial \hat{\lambda}}{\partial g} \right) \right] \\
\frac{\partial p^*}{\partial g} &= \frac{1}{3} \left[ \frac{a}{(1 - \hat{\lambda})^2} \frac{\partial \hat{\lambda}}{\partial g} + \frac{(\tau - \tau^*)^2}{(1 - \tau)(1 - \tau^*)} \left( g \frac{\partial \hat{\lambda}}{\partial g} + \hat{\lambda} \right) \right] > 0.
\end{aligned}$$

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  $g = 0$

$$\frac{\partial p}{\partial g} = \frac{1}{3} \left[ -\frac{a}{\hat{\lambda}^2} \frac{\partial \hat{\lambda}}{\partial g} - \frac{(\tau - \tau^*)^2}{(1 - \tau)(1 - \tau^*)} (1 - \hat{\lambda}) \right] < 0.$$

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

$$\begin{aligned} \frac{\partial(\pi^*/p^*)}{\partial g} &= \frac{\partial \pi^*/\partial g \cdot p^* - \pi^* \cdot \partial p^*/\partial g}{p^{*2}} < 0 \\ \text{with} \quad \partial \pi^*/\partial g &< 0 \\ \text{and} \quad \partial p^*/\partial g &> 0 \end{aligned}$$

Analogously, it holds for Home firms and their increasing real profits.

$$\begin{aligned} \frac{\partial(\pi/p)}{\partial g} &= \frac{\partial \pi/\partial g \cdot p - \pi \cdot \partial p/\partial g}{p^2} > 0 \\ \text{with} \quad \partial \pi/\partial g &> 0 \\ \text{and} \quad \partial p/\partial g &< 0 \end{aligned}$$

In equilibrium the derivatives of the nominal wages are given by:

$$\begin{aligned} \frac{\partial w}{\partial g} &= \frac{\tau - \tau^*}{1 - \tau} \left( 1 - \hat{\lambda} - g \frac{\partial \hat{\lambda}}{\partial g} \right) \\ \frac{\partial w^*}{\partial g} &= \frac{\tau - \tau^*}{1 - \tau^*} \left( \hat{\lambda} + g \frac{\partial \hat{\lambda}}{\partial g} \right) > 0 \end{aligned}$$

For Foreign, it is straightforward to show that the wages will increase if  $g$  increases. In Home wages will increase, if  $g = 0$ . As prices decrease in Home, it is straightforward that real wages increase in this country, In Foreign, prices as well as nominal wages decrease. 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. □

## Supplement

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

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