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Abstract

We extend the Behrens et al. (2009) general equilibrium heterogeneous firms framework by horizontal foreign direct investment. The model features endogenously determined firm entrants, wages, productivity cutoffs, flexible price markups and allows for wage differentials across countries in equilibrium. The framework is especially suitable to analyze the welfare consequences of attracting FDI since it allows to study through which channels FDI might raise welfare - including the not yet explored impact on the wage differential and the price markups. From a policy perspective we compare a strategic and a cooperative FDI policy scenario and find that supranational coordination leads to welfare gains.

JEL Classification: F12, F23

Keywords: Multinational firms, FDI, firm heterogeneity

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1 Introduction

The growth of foreign direct investment (FDI) has been one of the major trends in the global economy for decades. As the World Investment Directory of the UNCTAD in 2002 reports, the world FDI stock has increased to over $7 trillion in 2002, which is about ten times the level of 1985. The tremendous expansion in worldwide FDI outflows since the mid-1980s was so remarkable that it outpaced the growth in the worldwide gross domestic product, domestic investments and even exports. According to the data, the sales of all FDI firms in 2001 are about $18 trillion, whereas the sales of all exporting firms amount to only $7 trillion. The empirical stylized facts about the growth of FDI go hand in hand with policy interventions that promote FDI. As reported in UNCTAD (2003) politicians try to attract FDI with tax holidays, job-creation or facility subsidies. Politicians do so, since they typically assume positive welfare effects of FDI. The arguments given are that FDI-liberalization leads to industry knowledge spillovers or technology transfers and lower consumer prices due to cross-border transport cost savings. Although the positive welfare arguments in favor of FDI are predominant, UNCTAD (2001) also notes that "assessing the consequences of promoting FDI for national welfare is a big task [...]."

We contribute to this discussion by constructing a rich general equilibrium framework and call into question, whether promoting FDI is able to raise welfare, and if so, through what channels. In order to examine this question we develop a general equilibrium model of international trade with heterogeneous firms that differ in their marginal labor requirement. Those heterogeneous firms choose, conditional on their productivity, whether to serve their domestic market and/or a foreign market either through exports or horizontal greenfield FDI. Our framework is especially suitable to analyze the welfare consequences of attracting FDI since it features endogenously determined firm entrants, wages and productivity cutoffs. In particular, it allows for wage differentials across countries in equilibrium and flexible price markups. Such a rich general equilibrium framework with heterogeneous firms and FDI has, to the best of our knowledge, not been established yet.

The focus of our paper is to study the welfare effects of FDI-liberalization. Along the lines of Chor (2009) we examine a country's incentive to lower the fixed costs of FDI. We distinguish between two policy scenarios. In the strategic FDI policy scenario, a country chooses the welfare maximizing degree of FDI-liberalization, taking the FDI policy in the other country as given. In the cooperative scenario both countries jointly choose the total welfare maximizing degree of FDI-liberalization. In the strategic FDI policy scenario we find that a country has an incentive to unilaterally attract FDI. The intuition is that lower fixed costs of FDI lead to a greater mass of consumed varieties and a lower normed average price (which is the average price over the choke price). Both effects unambiguously raise welfare in the FDI attracting country. Conversely, in the other country consumption varieties shrink, the normed average price increases and welfare decreases. This cross-country comparison clearly illustrates the benefits of attracting FDI firms. In the Nash-equilibrium both countries choose a FDI-liberalization policy that brings down fixed costs of FDI to zero.

In the cooperative scenario we find that countries also do have an incentive to lower the fixed costs of FDI, however not down to zero. Compared to the Nash-equilibrium, countries jointly maximize total welfare by choosing a strictly positive level for the fixed costs of FDI. The economic intuition is as follows. FDI-liberalization raises the mass of consumed varieties but does not unambiguously decrease the normed average price. To illustrate this ambiguous price change consider an initial scenario where fixed costs of FDI are prohibitively high. FDI-liberalization now leads to the creation of the first multinational that charges a relatively low price since this firm is highly productive compared to the average domestic firm. However, further reductions in the fixed costs of FDI also induce relatively underproductive firms to become multinationals. As a result, the normed average price increases and FDI-liberalization can actually decrease welfare if the new consumption varieties do not compensate for the higher normed average price.

Comparing the strategic with the cooperative scenario, we can clearly conclude that there are welfare gains from supranational coordination. However, since coordination is difficult to achieve, it is likely that countries over-invest into attracting FDI. For policy makers this is an important result since it implies that besides the indisputable positive aspects of FDI there are also potential welfare losses. Our model also identifies a clear difference between trade- and FDI-liberalization that leads to different policy recommendations. Jointly decreasing variable trade costs unambiguously increase welfare while our model predicts that for the fixed costs of FDI countries should rather commit for a strictly positive level to restrict the mass of multinationals.

1.1 Related Literature

First, our model is closely related to the seminal contribution on heterogeneous firms by Melitz (2003). His work incorporates heterogeneous firms, i.e. firms that differ in their marginal labor requirement, into the monopolistic competition framework by Krugman (1980). In particular, Melitz shows that trade liberalization leads to a selection effect such that only the most productive firms start exporting, firms with intermediate productivity serve the domestic market only, and the least productive firms exit.[1]

Although the Melitz model has substantially deepened our understanding of intra-industry reallocations, it relies on two restrictive assumptions: factor price equalization (FPE) and constant price markups. The assumption of symmetric countries induces FPE while a constant elasticity of substitution (CES) preference specification implies constant markups. The more recent heterogeneous firms literature has focused to forego either one of those assumptions. Bernard et al. (2003) introduce exogenous wage differences across countries in a Ricardian framework with Bertrand competition. Melitz and Ottaviano (2008) provide a model with endogenous markups, where markups decrease with trade liberalization. Although trade liberalization now leads to pro-competitive effects, the model does not allow for income effects as in Melitz (2003). Behrens et al. (2009) propose a new general equilibrium model of international trade that avoids both of the previous restrictive assumptions. It incorporates heterogeneous firms, endogenously determined firm entrants, wages and productivity cutoffs. Furthermore, the model does not rely on CES but instead uses a variable elasticity of substitution (VES) specification, introduced by Behrens and Murata (2007). Moreover, the model does not feature FPE in equilibrium. It therefore incorporates endogenous wages and flexible markups in which trade integration leads to both income and pro-competitive effects. From a theoretical point of view our model builds up on Behrens et al. (2009) and extends it by introducing horizontal greenfield FDI.

Second, the Melitz model was also influential for the FDI literature. The seminal contribution is provided by Helpman, Melitz and Yeaple (2004). Building up on the original Melitz framework they develop the first general equilibrium model with heterogeneous firms and horizontal FDI as an alternative to exporting. They are able to show that only firms with a relatively high productivity are able to serve a foreign market by exporting and only the most productive firms are able to adopt the FDI strategy. The latest strand of the heterogeneous firms literature is concerned about the welfare effects of FDI-liberalization. The important contribution by Chor (2009) analyzes the implications of governments' subsidies to attract FDI. The key result is that a country can raise its welfare by unilaterally

[1] The Melitz framework was motivated by an enormous literature that explored empirical patterns of firms' behavior. Starting from the mid-nineties, Bernard and Jensen (1999) observe that firms serving the foreign market via exporting are larger and exhibit a higher productivity than firms that refrain from foreign trade. Aw et al. (2000) verify that plants with a higher productivity take part in exporting whilst plants with low productivity exit the export market. Mayer and Ottaviano (2007) show that international operating firms are rare, bigger, pay higher wages, generate higher added value and employ more capital per worker. Furthermore, multinationals are on average even more productive than exporting firms.

introducing a small subsidy. This leads to a consumption gain similar as in our approach. Our model enriches the FDI-liberalization discussion since it allows for additional, potentially welfare increasing channels such as lower price markups or a higher relative wage. Although these arguments are often used in the political discussion, the Chor (2009) model cannot account for these arguments, due to the fact of CES preferences and FPE in equilibrium. Moreover, our approach is also different from a normative perspective. Chor (2009) does not discuss competition among countries for FDI while we focus on that issue and differentiate between a strategic and cooperative policy. As a result, our approach allows the identification of supranational gains from coordination.

The paper is organized as follows. Section 2 establishes the model framework while in Section 3 we discuss the strategic and the cooperative FDI policy regime. Section 4 concludes.

2 The model

2.1 Preferences and demand

In our model, we consider two potentially asymmetric countries. Consumers derive utility from the consumption of a final good which is provided as a continuum of horizontally differentiated varieties. The mass of consumers in country r is denoted by L_r. Let $p_{sr}(i)$ and $q_{sr}(i)$ denote the price and the per capita consumption of variety i when it is produced in country s and consumed in country r. In the following we differentiate between three types of firms: Domestic firms that solely produce for their domestic market, exporters that additionally sell in the foreign market and FDI multinationals. To avoid confusion we note that with respect to consumption varieties in country r, both domestic and FDI firms produce in country r and sell in country r while export varieties are produced in s and consumed in r. Hence, the per capita consumption in country r of a domestic or FDI variety i is denoted by $q_{rr}(i)$ while for an export variety i per capita consumption is denoted by $q_{sr}(i)$. Similar the price of a variety i in country r is denoted by $p_{rr}(i)$ if it is provided by a domestic or FDI firm while the price of an export variety i from country s is given by $p_{sr}(i)$.

The underlying preference structure, established in Behrens and Murata (2007), displays love-for-variety and is the same for all consumers. The utility maximization problem of consumers in country r is given by

$$\max_{q_{sr}(j), j\in\Omega_{sr}} U_r \equiv \sum_s \int_{\Omega_{sr}} \left[1-\mathrm{e}^{-\alpha q_{sr}(j)}\right] \mathrm{d}j \quad \text{s.t.} \quad \sum_s \int_{\Omega_{sr}} p_{sr}(j) q_{sr}(j) \mathrm{d}j = E_r, \tag{1}$$

where E_r denotes expenditure, $\alpha > 0$ is a parameter measuring the strength of love-for-variety and Ω_{sr} denotes the set of varieties produced in country s and consumed in country r. The solution of the maximization problem given in (1) yields the following demand functions

$$q_{sr}(i) = \frac{E_r}{N_r^c \overline{p}_r} - \frac{1}{\alpha} \left\{ \ln\left[\frac{p_{sr}(i)}{N_r^c \overline{p}_r}\right] + h_r \right\}, \quad \forall i \in \Omega_{sr}, \tag{2}$$

where N_r^c is the mass of consumed varieties in country r, and

$$\overline{p}_r \equiv \frac{1}{N_r^c} \sum_s \int_{\Omega_{sr}} p_{sr}(j) \mathrm{d}j \quad \text{and} \quad h_r \equiv -\sum_s \int_{\Omega_{sr}} \ln\left[\frac{p_{sr}(i)}{N_r^c \overline{p}_{sr}}\right] \frac{p_{sr}(j)}{N_r^c \overline{p}_{sr}} \mathrm{d}j \tag{3}$$

denote the average price and the differential entropy of the price distribution of all varieties consumed in country r. With the help of (2) and (3) we can derive the country specific reservation price p_r^d. The demand for variety i in country r will be positive if and only if the price of the respective variety is lower than this reservation price, no matter whether the variety is produced by a domestic firm, a foreign FDI firm or is exported from abroad. Formally,

$$q_{rr}(i) > 0 \quad \Leftrightarrow \quad p_{rr}(i) < p_r^d \quad \text{and} \quad q_{sr}(j) > 0 \quad \Leftrightarrow \quad p_{sr}(j) < p_r^d, \tag{4}$$

where the reservation price

$$p_r^d \equiv N_r^c \overline{p}_r \mathrm{e}^{\alpha E_r / (N_r^c \overline{p}_r) - h_r} \tag{5}$$

is a function of the price aggregates $\overline{p}_r$ and h_r. Using (2) and (5), the demands can be expressed as follows

$$q_{rr}(i) = \frac{1}{\alpha} \ln\left[\frac{p_r^d}{p_{rr}(i)}\right] \quad \text{and} \quad q_{sr}(j) = \frac{1}{\alpha} \ln\left[\frac{p_r^d}{p_{sr}(i)}\right]. \tag{6}$$

The price elasticity of demand for a variety i, derived from (6), is given by $1/\left[\alpha q_{rr}(i)\right]$ and $1/\left[\alpha q_{sr}(i)\right]$, respectively. Hence, if individuals consume more of any variety (which is e.g. the case if their expenditure increases), they become less price sensitive. With the help of (6), the utility function in (1) simplifies using $\mathrm{e}^{\alpha q_{sr}(i)} = p_{sr}(i)/p_r^d$ and we can rewrite indirect utility as

$$U_r = N_r^c - \sum_s \int_{\Omega_{sr}} \frac{p_{sr}(j)}{p_r^d} \mathrm{d}j = N_r^c \left(1 - \frac{\overline{p}_r}{p_r^d}\right). \tag{7}$$

2.2 Technology and market structure

On the firm side, each producer provides one unique final good variety. The only factor used for production is labor, with each consumer supplying one unit of labor. The total labor force in country r is therefore given by its country size L_r. The labor market is assumed to be characterized by perfect competition such that firms in country r take the wage w_r as given. In order to discover a product variety, firms invest the country's specific fixed costs F_r for research and development (R&D) paid in labor at the market wage. This investment enables the firm to discover its unique variety along with its firms specific marginal labor requirement $m(i) \geq 0$, where a lower $m(i)$ reflects a higher productivity. This productivity is drawn from a country-specific distribution G_r. Besides serving the domestic market, the firm may choose to serve the foreign market either by exporting or greenfield FDI. As will be shown, the decision whether and how to serve the foreign market depends on a firm's productivity draw. Exports from country s to r are subject to iceberg type trade costs $\tau_{sr} > 1$, which incur in terms of labor. Setting up a new production plant in the foreign country r is assumed to increase the fixed costs of production by P_r. Hence, as it is discussed at length in the literature the classical "proximity-concentration" trade-off emerges: FDI saves variable trade costs, while exporting saves additional overhead costs for building up a foreign production plant.

In our model, there are three possible sources for operating profits. First, the operating profits of firm i originated in country s from domestic sales are given by

$$\pi_s^D(i) = L_s q_{ss}(i) \left[p_{ss}(i) - \tau_{ss} m(i) w_s\right]. \tag{8}$$

Second, the operating profits from exporting to country r are given by

$$\pi_s^X(i) = L_r q_{sr}(i) \left[p_{sr}(i) - \tau_{sr} m(i) w_s\right]. \tag{9}$$

Third, the operating profits for using FDI in country r are given by

$$\pi_s^F(i) = L_r q_{rr}(i) \left[p_{rr}(i) - \tau_{rr} m(i) w_r\right] - m(i) w_r P_r. \tag{10}$$

where $q_{ss}(i)$, $q_{sr}(i)$ and $q_{rr}(i)$ in equations (8)-(10) are given by (6). Note that in our specification FDI "fixed" costs decrease in a firm's productivity level. We do so to countervail the fact that the most productive exporters have zero marginal costs in the limit. This implies that also the iceberg type trade costs vanish in the limit. To balance this artifact of iceberg type trade costs, we assume fixed FDI costs dependent on the marginal labor requirement as given by (10). Both, the variable trade costs and the fixed FDI costs now decrease with a lower marginal labor requirement. With this assumption, the model exhibits the "classical" ranking that the most productive firms use FDI while the medium productive firms export to foreign markets.[2]

We assume segmented markets without the possibility of arbitrage or resale. Hence, firms maximize profits with respect to their price $p_{sr}(i)$ separately for each market, taking into account the demand function as given by (6). The continuum of firms takes the reservation price p_r^d as given and the first-order condition for (operating) profits are

$$\ln\left[\frac{p_r^d}{p_{sr}(i)}\right] = \frac{p_{sr} - \tau_{sr} m(i) w_s}{p_{sr}(i)}, \quad i \in \Omega_{sr}. \tag{11}$$

Using (11) we can now show how productivity maps into the firm's price setting, sales revenue and profits.

Lemma 1 *For a given type of firm (domestic, export, FDI), more productive firms i.) charge lower prices, ii.) sell larger quantities and iii.) earn higher operating profits in each market.*

Proof. Using the Lambert W function, defined as $\varphi = W(\varphi)\,\mathrm{e}^{W(\varphi)}$, the first-order condition (11) can be solved for the profit-maximizing prices, quantities and operating profits. Those values can be expressed in terms of m, as firms differ only in their marginal labor requirement.[3] For a firm originated in country s they are given by

$$p_{ss}(m) = \frac{\tau_{ss} m w_s}{W_s^D}, \quad q_{ss}(m) = \frac{1}{\alpha}\left(1 - W_s^D\right), \quad \pi_s^D = \frac{L_s \tau_{ss} m w_s}{\alpha}\frac{\left(1 - W_s^D\right)^2}{W_s^D}, \tag{12}$$

[2]At first sight, a more classical definition of FDI profits would be $\hat{\pi}_s^F(i) = L_r q_{rr}(i)\left[p_{rr}(i) - \tau_{rr} m(i) w_r\right] - w_r P_r$ with fixed costs independent of the productivity level. However, if we consider the most productive firms we get $\lim_{m\to 0} \pi_s^X = \frac{L_r w_r \tau_{rr}}{\mathrm{e}\alpha} m_r^D$, $\lim_{m\to 0} \hat{\pi}_s^F = \frac{L_r w_r \tau_{rr}}{\mathrm{e}\alpha} m_r^D - P_r w_r$, $\lim_{m\to 0} \pi_s^F = \frac{L_r w_r \tau_{rr}}{\mathrm{e}\alpha} m_r^D$. Hence, with the classical definition the most productive firms would use exporting instead of FDI. See also Behrens and Ottaviano (2009) for a related problem within an FDI extension of the Melitz and Ottaviano (2008) framework.¸

[3]See Corless et al. (1996) for a survey concerning the properties of the Lambert W function.

$$p_{sr}(m) = \frac{\tau_{sr} m w_s}{W_s^X}, \quad q_{sr}(m) = \frac{1}{\alpha}\left(1 - W_s^X\right), \quad \pi_s^X = \frac{L_r \tau_{sr} m w_s}{\alpha} \frac{\left(1 - W_s^X\right)^2}{W_s^X}, \tag{13}$$

$$p_{rr}(m) = \frac{\tau_{rr} m w_r}{W_s^F}, \; q_{rr}(m) = \frac{1}{\alpha}\left(1 - W_s^F\right), \; \pi_s^F = \frac{L_r \tau_{rr} m w_r}{\alpha} \frac{\left(1 - W_s^F\right)^2}{W_s^F} - m w_r P_r, \tag{14}$$

where we suppressed the arguments of the Lambert W function in order to alleviate notation.[4] The arguments are given by

$$W_s^D = W\left(\frac{\mathrm{e}\tau_{ss} m w_s}{p_s^d}\right), \quad W_s^X = W\left(\frac{\mathrm{e}\tau_{sr} m w_s}{p_r^d}\right) \quad \text{and} \quad W_s^F = W\left(\frac{\mathrm{e}\tau_{rr} m w_r}{p_r^d}\right) \tag{15}$$

Since $W' > 0$, we readily obtain $\partial p/\partial m > 0$, $\partial q/\partial m < 0$ and $\partial \pi/\partial m < 0$. ■

An important issue in the heterogeneous firms literature is to determine the so-called cutoff productivity for each market. A firm with a lower productivity as the respective cutoff productivity would set a price above the reservation price and would therefore face zero demand. Hence, serving this market is not profitable. To derive the cutoff productivity we need the sales quantity of a firm, conditional on its productivity. Using (6) and (11) the sales quantity is given by

$$q_{sr}(i) = (1/\alpha)\left[1 - \tau_{sr} m(i) w_s / p_{sr}(i)\right]. \tag{16}$$

The sales quantity given by (16) helps us to determine the maximum output of a firm, which is given by $q_{sr}(i) = 1/\alpha$ for a firm with the highest productivity draw $m = 0$. Contrary, the upper bound for m is given by the minimum output $q_{sr}(i) = 0$ at $p_{sr}(i) = \tau_{sr} m(i) w_s$. It then follows from (11) that $p_r^d = \tau_{sr} m(i) w_s$.

For domestic firms, this gives their cutoff marginal labor requirement, defined as $m_s^D \equiv p_s^d / w_s \tau_{ss}$. A domestic firm that draws m_s^D is indifferent between producing and not producing, whereas only firms with a draw below m_s^D remain active in the market. For exporters, this condition tells us that a firm located in s with a productivity draw $m_{sr}^x \equiv p_r^d / (\tau_{sr} w_s)$ is just indifferent between selling and not selling in country r via exporting. All firms in s with productivity draws below m_{sr}^x are productive enough to export to country r. In what follows, we refer to $m_{rr}^x \equiv m_r^D$ as the *domestic cutoff* in country r, whereas $m_{sr}^x \equiv m_s^X$

[4] It is shown by Behrens et al. (2009) that $W' > 0$ increases for all non-negative arguments and that $W(0) = 0$ and $W(\mathrm{e}) = 1$. Hence, $0 \leq W \leq 1$ if and only if $0 \leq m \leq m^D$.

with $s \neq r$ is the *export cutoff*. Export and domestic cutoffs are linked as follows

$$m_s^X = \frac{\tau_{rr}}{\tau_{sr}} \frac{w_r}{w_s} m_r^D. \tag{17}$$

It is now clear from expression (17) that the "classical" ranking, namely that exporting requires a higher productivity than selling domestically, does not necessarily hold anymore. The usual ranking only prevails if and only if $\tau_{rr} w_r < \tau_{sr} w_s$. An example for that case would be if wages are equalized ($w_s = w_r$) and internal trade is costless while trade between countries is costly.

We cannot use (16) to determine the FDI cutoff for two reasons. First, the profit maximizing quantity does not secure positive profits for FDI firms due to the fixed costs P_r. Second, FDI will not be chosen as soon as exporting is the more profitable strategy. Therefore, we need to determine the productivity level above which a firm would choose FDI instead of exporting. As it can be seen by Figure 1, firms will choose exporting over FDI for a productivity draw $m > m_s^T$ since the transport cost savings do not compensate for the fixed costs of FDI.[5] For this we have to compare FDI versus export profits, conditional on the productivity draw. Therefore, the *FDI cutoff* m_s^T is the solution of $\pi_s^F \left(m_s^T\right) = \pi_s^X \left(m_s^T\right)$. However, we cannot solve for m_s^T in general and have to rely on numerical methods.[6] Using this information about the cutoff productivities, we can reconsider the mass of firms. Given a mass of entrants N_s^E and export cutoffs m_{sr}^X (recall that $m_{ss}^X = m_s^D$) as in (17), only $N_s^p = N_s^E G_s \left(\max\left\{m_{sr}^x\right\}\right)$ firms survive in country s, namely those which are productive enough to sell at least in one market (which does not have to be the local market).[7] Furthermore, we can determine the mass of varieties consumed in country s as

$$N_s^c = \sum_r N_r^E G_r \left(m_{rs}^x\right), \tag{18}$$

which is the sum of all firms that are productive enough to serve market s. Multiplying

[5] It remains to show that m_s^T exists (in the positive range) and is unique. First, from $m_s^T > 0$ it directly follows that $\partial \pi_s^F / \partial m < \partial \pi_s^X / \partial m$, i.e. profits increase stronger with a higher productivity for FDI than for exporting in the domain of $m > m_s^T$. Due to the fact that we have iceberg type trade costs a higher productivity also leads to a vanishing of trade costs and we have $\partial \pi_s^F / \partial m > \partial \pi_s^X / \partial m$ for very high productivities (m close to zero). Second, there might exist a second threshold. We can ensure that this threshold is the corner solution at $m = 0$ from (13) and (14). Now we can conclude that the threshold m_s^T is unique. Firms with a productivity draw $m < m_s^T$ ($m > m_s^T$) consistently choose FDI (exporting) over exporting (FDI).

[6] We cannot solve for m_s^T since the Lambert W function has different arguments, see Corless et al. (1996).

[7] Since $m_s^T < m_s^X$ we do not need to consider FDI firms for this reasoning.

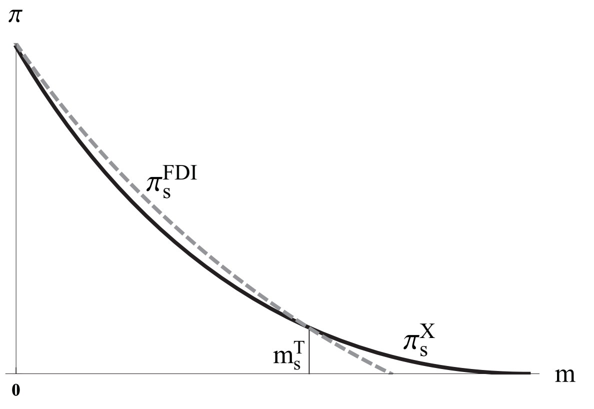

Figure 1: Export and FDI profits conditional on the marginal labor requirement m.

both sides of (11) by $p_{rs}(i)$, integrating over Ω_{sr} and summing the resulting expressions across s, the average price across all varieties sold in market r can be written as

$$\overline{p}_s \equiv \frac{1}{N_s^c} \sum_r \int_{\Omega_{rs}} p_{rs}(j) \, \mathrm{d}j = \frac{1}{N_s^c} \sum_r \tau_{rs} w_r \int_{\Omega_{rs}} m_r(j) \, \mathrm{d}j + \frac{\alpha E_s}{N_s^c}, \tag{19}$$

where the first term is the average marginal delivered costs, and the second term is the average markup in the market s. Expression (19) shows that the average markup is decreasing in the mass N_s^c of firms competing in country s and increasing in expenditure E_s. Hence, similar to Melitz and Ottaviano (2008), the average price displays a pro-competitive effect for a greater mass of firms. Furthermore, the average markup rises with expenditure because demand becomes less price elastic for larger quantities.

2.3 Equilibrium

The equilibrium of our model is characterized by the mass of entrants N_s^E, the domestic cutoff m_s^D in each country and the relative wage $\omega \equiv \omega_s/\omega_r$ between the two countries. Those determinants are derived by solving the zero expected profit condition, the labor market clearing condition and the current account balance.

In the Appendix we state the general equilibrium conditions without assuming a specific assumption about the productivity distribution. In what follows, we adopt the commonly made assumption that firms' productivity draws follow a Pareto distribution.[8] We assume identical shape parameters $k \geq 1$, but to capture differences in technological possibilities, we allow the upper bounds to vary across countries, i.e. $G_s(m) = (m/m_s^{max})^k$. A lower m_s^{max} implies that firms in country s have a higher probability of drawing a better productivity. With the Pareto distribution and the help of equations (12)-(15), we can simplify the equilibrium conditions. First, using the general equilibrium conditions given in the Appendix the labor market clearing condition can be written as

$$\begin{aligned} L_s &= N_s^E \left[\frac{\kappa_1}{\alpha (m_s^{max})^k} \left[L_s \tau_{ss} \left(m_s^D\right)^{k+1} + L_r \tau_{sr} \left(\left(m_s^X\right)^{k+1} - \left(m_s^T\right)^{k+1} \right) \right] + F_s \right] \\ &+ \frac{N_r^E \kappa_1 L_s \tau_{ss}}{\alpha (m_r^{max})^k} \left(m_r^T\right)^{k+1} + \frac{N_r^E P_r \kappa_4}{(m_r^{max})^k} \left(m_r^T\right)^{k+1}. \end{aligned} \quad (20)$$

The terms κ_1 to κ_4 are positive constants that solely depend on the shape parameter k of the Pareto distribution and are also stated in the Appendix. Second, zero expected profits imply

$$\begin{aligned} \mu_s^{max} &\equiv \frac{F_s (m_s^{max})^k \alpha}{\kappa_2} \\ &= L_s \tau_{ss} \left(m_s^D\right)^{k+1} + L_r \tau_{sr} \left(m_s^X\right)^{k+1} \\ &- L_s \tau_{sr} \left(m_s^T\right)^{k+1} + L_r \tau_{rr} w_r / w_s \left(m_s^T\right)^{k+1} - \frac{\kappa_4}{\kappa_2} \alpha P_r w_r / w_s \left(m_s^T\right)^{k+1}, \end{aligned} \quad (21)$$

where the term μ_r^{max} can be interpreted as a measure of "technological possibilities": the lower the fixed labor requirement for entry F_r or the lower the upper bound m_r^{max}, the lower will be μ_r^{max}. Third, the current account balance requires that $CA_{rs} = CA_{sr}$ with

$$\begin{aligned} CA_{sr} &= \frac{N_s^E L_r \tau_{sr} w_s \kappa_3}{\alpha (m_s^{max})^k} \left[\left(m_s^X\right)^{k+1} - \left(m_r^T\right)^{k+1} \right] \\ &+ \frac{N_r^E w_s}{\alpha (m_r^{max})^k} \left[L_s \tau_{ss} \left(m_r^T\right)^{k+1} \kappa_2 - \alpha P_s \left(m_r^T\right)^{k+1} \kappa_4 \right]. \end{aligned} \quad (22)$$

Note that if we consider infinitely high fixed costs of FDI, the threshold productivity m_s^T approaches zero. In this case the zero expected profit condition, labor market clearing and trade balance reduce to the terms that are given in Behrens et al. (2009).

[8] The Pareto distribution is motivated by studies that examine the firm size distribution, see Axtell (2001), and often used in the theoretical literature, for instance in Melitz and Ottaviano (2008) or Bernard et al. (2003).

3 FDI-liberalization

In the previous section we have developed the theoretical framework to study the welfare effects of FDI. In this section, we use this framework to examine a country's incentive to lower the fixed costs of FDI. We distinguish between two policy scenarios. In the strategic FDI policy scenario, a country chooses the welfare maximizing degree of FDI-liberalization, taking the FDI policy in the other country as given. In the cooperative scenario both countries jointly choose the total welfare maximizing degree of FDI-liberalization.

In the following we solve the model by using both analytical and numerical methods to derive comparative static results with respect to the fixed costs of FDI. To develop the economic intuition for the rich set of general equilibrium effects we start in Section 3.1 and Section 3.2 with the assumption of prohibitively high trade costs. With this assumption the classical productivity ranking of firms, i.e., low productive firms only serve their domestic market, medium productive firms export and high productive firms become multinationals, still prevails but the mass of exporters shrinks to zero. Therefore, firms that are productive enough to serve the foreign market become multinationals. In Section 3.1 we consider the cooperative policy scenario where countries can commit to a specific degree of FDI-liberalization, e.g. to jointly grant the same level of tax holidays for foreign FDI firms. In Section 3.2 we study the incentive to deviate from the cooperative policy and determine the strategic Nash-equilibrium policy. In the following Sections 3.3 and 3.4 we consider low trade costs, such that a positive mass of firms exports. We derive the strategic FDI policy in Section 3.3 and finish the welfare analysis in Section 3.4 where we study the cooperative policy.

3.1 High Trade Costs: Cooperative Policy

We start with the following assumptions that lead to closed form solutions of the equilibrium determinants: First, we assume that inter-country trade costs are prohibitively high such that $m_r^X < m_r^F$ holds where m_r^F is given by $\pi_r^F\left(m_r^F\right) = 0$. As a result, the mass of exporters shrinks to zero and only multinationals serve a foreign market. Second, we consider symmetrical countries, i.e., countries are identical in their country sizes, technological possibilities, internal and external trade costs, entry costs and fixed costs of FDI. This directly implies that all endogenously determined cutoffs, wages and masses of firms are also identical and the relative wage is one. Finally, to simplify the notation we assume zero intra-country trade costs and set the income to one, i.e. $\tau_{rr} = \tau_{ss} = 1$ and $E_r = E_s = 1$.

Given these assumptions we can drop the indices and the FDI cutoff can be derived by solving $\pi^F\left(m^F\right)=0$ for m^F. The solution is given by

$$m^F = m^D \cdot (\xi+1) \cdot \mathrm{e}^{\xi} \quad \text{with} \quad \xi \equiv \frac{\alpha P - \sqrt{\alpha P\left(\alpha P + 4L\tau\right)}}{2L\tau}. \tag{23}$$

In the following it is convenient to use the following monotonic transformation of (23): $\left(m^F\right)^{k+1} = \chi \cdot \left(m^D\right)^{k+1}$ with $\chi^{1/(1+k)} \equiv (\xi+1)\cdot \mathrm{e}^{\xi}$. It directly follows from (23) that $\partial\chi/\partial P < 0$. Hence, infinitely high fixed costs $P \to \infty$ lead to $m^F \to 0$ while infinitesimally low fixed costs $P \to 0$ lead to $m^F \to m^D$. In words, if the fixed costs of FDI are large no firm uses FDI while if the fixed costs vanish all surviving firms are multinationals. Using this transformation, the labor market clearing condition (20) and the zero expected profit condition (21) reduce to

$$\mu^{max} = L\left(m^D\right)^{k+1} + L\chi\left(m^D\right)^{k+1} - \frac{\kappa_4}{\kappa_2}\alpha P\chi\left(m^D\right)^{k+1}, \tag{24}$$

and

$$L = N^E\left[\frac{\kappa_1 L}{\alpha\left(m^{max}\right)^k}\left(m^D\right)^{k+1}(1+\chi) + F + \frac{\kappa_4}{\left(m^{max}\right)^k}P\chi\left(m^D\right)^{k+1}\right]. \tag{25}$$

Using (24) and (25) we can uniquely solve for the mass of entrants N^E and the domestic cutoff m^D given by

$$\left(m^D\right)^{k+1} = \frac{\mu^{max}\kappa_2}{L\kappa_2(1+\chi) - P\alpha\kappa_4\chi} \quad \text{and} \quad N^E = \frac{\kappa_2}{(\kappa_1+\kappa_2)}\frac{L}{F} - \frac{\alpha\kappa_4}{(\kappa_1+\kappa_2)}\frac{\chi P}{(1+\chi)F}. \tag{26}$$

Note that N^E, as given by (26), differs fundamentally from $N^E = \kappa_2 L/\left[(\kappa_1+\kappa_2)F\right]$ as derived in Behrens et al. (2009). In particular, they find the mass of entrants to be independent of any trade costs. We can directly conclude from (26) that in the presence of some FDI the mass of entrants is always lower since the second term of N^E in (26) is strictly positive for $P > 0$. Intuitively, the easier it is for highly productive firms to penetrate foreign markets, the lower will be the expected profits of all firms. Furthermore, FDI firms behave like domestic firms in their price setting and do not have to account for variable trade costs like exporters. This accelerated competition effect leads to the fact that lower expected profits yield to a lower mass of entrants.

After having derived the mass of entrants and the domestic cutoff, the mass of consumed varieties N^C and the average price $\overline{p}$ are crucial for a welfare analysis. Both are given by

$$N^C = \frac{\alpha\left(1+\chi^{\frac{k}{1+k}}\right)}{(\kappa_1+\kappa_2)(1+\chi)} \cdot \frac{1}{m^D} \quad \text{and} \quad \overline{p} = \frac{(1+\chi)}{\left(1+\chi^{\frac{k}{1+k}}\right)} \cdot \frac{k}{1+k} \cdot p^d + \frac{\alpha}{N^C}, \tag{27}$$

where the first term of $\overline{p}$ in (27) are the average marginal costs, and the second term is the average markup. Finally, using (26), (27) and the term $\kappa_3 \equiv \kappa_1 + \kappa_2$ we can define

$$p^N \equiv \frac{\overline{p}}{p^d} = \frac{(\kappa_3 + k(1+\kappa_3))(1+\chi)}{(1+k)\left(1+\chi^{\frac{k}{k+1}}\right)} \tag{28}$$

as the *normed* average price. Using this we can simplify indirect utility to

$$U = N^C\left(1-p^N\right) = \frac{\alpha}{m^D}\left[\frac{1-k\chi+(1+k)\chi^{\frac{k}{1+k}}}{(1+\chi)(k+1)\kappa_3} - 1\right]. \tag{29}$$

It is evident from (29) that welfare increases in the mass of consumed varieties N^C and a lower normed average price p^N. In the following we show that for some parameter values FDI-liberalization leads to an unambiguous welfare increase while for others there exists a trade-off between the normed average price and the mass of consumed varieties.

We now analyze how the fixed costs of FDI impact the equilibrium mass of entrants, surviving firms, consumed varieties, average and normed average price, markup and most important welfare. For all variables we state two polar cases in Table 1. First, the free trade scenario where FDI is costless ($P \to 0$ denoted by $OPEN$) and second the autarkic scenario where FDI is infinitely costly ($P \to \infty$ denoted by AUT). A comparison of the autarky and free trade scenario is summarized in Proposition 1.

Proposition 1

i.) *The domestic cutoff m^D is higher under autarky than under free trade.*

ii.) *The masses of entrants N^E under autarky and under free trade are equal.*

iii.) *The mass of surviving firms N^S under autarky is higher than under free trade.*

iv.) *The mass of consumed varieties N^C under autarky is lower than under free trade.*

v.) *The average price $\overline{p}$ under autarky is higher than under free trade.*

vi.) *The normed average prices p^N under autarky and under free trade are equal.*

vii.) *Welfare under autarky is lower than under free trade.*

Starting from an initial autarkic scenario and introducing FDI-liberalization, i.e. a gradual reduction of P, leads to the following comparative static results summarized in Proposition 2.

Proposition 2

FDI-liberalization leads to

i.) an ambiguous change in the domestic cutoff: $m^D(P)$ is humped-shaped.

ii.) an ambiguous change in the in the mass of entrants: $N^E(P)$ is U-shaped.

iii.) a lower mass of surviving firms N^S.

iv.) a higher mass of consumed varieties N^C.

v.) a lower average price $\overline{p}$.

vi.) an ambiguous change in the normed average price: $p^N(P)$ is U-shaped.

vii.) an ambiguous change in welfare: $U(P)$ is humped-shaped.

Some comparative static results of Proposition 2 are different compared to bilateral trade liberalization in Behrens et al. (2009). First, consider statement i.) in Proposition 2. Starting from an initial autarkic scenario, FDI-liberalization first leads to softer competition, i.e. a higher domestic cutoff m^D. The reason is that for fixed costs of FDI larger than a threshold $P > P^*$, FDI-liberalization allows some rare multinationals to break-even at a lower productivity level.[9] As a result, the domestic cutoff m^D increases at first. Below this threshold P^*, further decreases in the fixed costs of FDI trigger the classic competition effect of trade liberalization (lower domestic cutoff), like it would be the case with falling variable trade costs in Behrens et al. (2009), Melitz (2003) or Melitz and Ottaviano (2008). This new non-monotonic effect how FDI-liberalization impacts the equilibrium productivity cutoff has, to the best of our knowledge, not been explored in the literature yet.

Second, consider statement vii.) of Proposition 2. Welfare as given by (29) increases in the mass of consumed varieties and a lower normed average price. As illustrated in the left graph of Figure 2, FDI-liberalization rises the mass of consumed varieties but does not unambiguously lower the normed average price. The normed average price actually increases for sufficiently low levels of P and has a negative impact on welfare everything else equal. How can we explain this U-shaped normed average price? Consider an initial scenario where fixed costs of FDI are prohibitively high. FDI-liberalization now leads to the

[9] The threshold level is given by $P^* = (L/\alpha)\left(6\kappa_2 + \kappa_4 - \sqrt{4\kappa_2^2 + 12\kappa_2\kappa_4 + \kappa_4^2}\right)/(4\kappa_4)$.

i.)	$m^D_{AUT} = \left(\frac{\mu^{max}}{L}\right)^{\frac{1}{k+1}}$	$m^D_{OPEN} = \left(\frac{\mu^{max}}{2L}\right)^{\frac{1}{k+1}}$
ii.)	$N^E_{AUT} = \frac{\kappa_2}{\kappa_3}\frac{L}{F}$	$N^E_{OPEN} = \frac{\kappa_2}{\kappa_3}\frac{L}{F}$
iii.)	$N^S_{AUT} = \frac{\alpha}{\kappa_3}\left(\frac{L}{\mu^{max}}\right)^{\frac{1}{k+1}}$	$N^S_{OPEN} = \frac{\alpha}{\kappa_3}\left(\frac{L}{2^k\mu^{max}}\right)^{\frac{1}{k+1}}$
iv.)	$N^C_{AUT} = \frac{\alpha}{\kappa_3}\left(\frac{L}{\mu^{max}}\right)^{\frac{1}{k+1}}$	$N^C_{OPEN} = \frac{\alpha}{\kappa_3}\left(\frac{2L}{\mu^{max}}\right)^{\frac{1}{k+1}}$
v.)	$\overline{p}_{AUT} = \frac{\kappa_3+k(1+\kappa_3)}{1+k}\left(\frac{\mu^{max}}{L}\right)^{\frac{1}{k+1}}$	$\overline{p}_{OPEN} = \frac{\kappa_3+k(1+\kappa_3)}{1+k}\left(\frac{\mu^{max}}{2L}\right)^{\frac{1}{k+1}}$
vi.)	$p^N_{AUT} = \frac{\kappa_3+k(1+\kappa_3)}{1+k}$	$p^N_{OPEN} = \frac{\kappa_3+k(1+\kappa_3)}{1+k}$
vii.)	$U_{AUT} = \alpha\left[\frac{1}{\kappa_3(k+1)} - 1\right]\left(\frac{L}{\mu^{max}}\right)^{\frac{1}{k+1}}$	$U_{OPEN} = \alpha\left[\frac{1}{\kappa_3(k+1)} - 1\right]\left(\frac{2L}{\mu^{max}}\right)^{\frac{1}{k+1}}$

Table 1: Comparison of the autarky and free trade scenario.

creation of the first multinational that charges a relatively low price since this firm is highly productive compared to the average domestic firm. However, further reductions in the fixed costs of FDI also induce relatively underproductive firms to become multinationals. As a result, the normed average price increases. This trade-off between relatively underproductive multinationals that introduce new consumable varieties but also increase the normed average price uniquely determines the welfare maximizing degree of FDI-liberalization. The right graph of Figure 2 clearly illustrates, that if countries can cooperatively commit themselves for a total welfare maximizing FDI policy, countries would set a strictly positive level for the fixed costs of FDI. That is, they would *not* reduce the fixed costs of FDI to zero. In the following Section 3.2 we now explore whether countries have a unilateral incentive to deviate from a cooperative policy by further decreasing fixed costs of FDI.

3.2 High Trade Costs: Strategic Nash-Equilibrium Policy

In this section we examine the strategic FDI policy and determine the Nash-equilibrium. To derive a home country H's best response, i.e., the welfare maximizing fixed cost level P_H for a given fixed cost FDI level P_F in the other foreign country F, we have to study asymmetrical countries that differ in their fixed costs of FDI. Similar as in Section 3.1 we can express the foreign country's FDI cutoff by solving $\pi^F_F\left(m^F_F\right) = 0$ for m^F_F in terms of the home country's domestic cutoff m^D_H. Under the assumption that countries differ solely

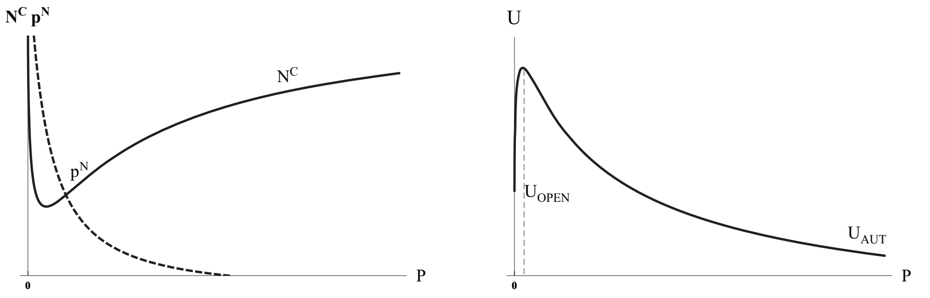

Figure 2: Welfare, normed average price and consumed varieties.

in their fixed costs of FDI the cutoff m_F^F is given by

$$m_F^F = m_H^D \cdot (\xi_F + 1) \cdot \mathrm{e}^{\xi_F} \quad \text{with} \quad \xi_F \equiv \frac{\alpha P_H - \sqrt{\alpha P_H \left(\alpha P_H + 4L\right)}}{2L}. \tag{30}$$

Again it is convenient to use a monotonic transformation of (30): $\left(m_F^F\right)^{k+1} = \chi_F \cdot \left(m_H^D\right)^{k+1}$ with $\chi_F^{1/(1+k)} \equiv (\xi_F + 1) \cdot \mathrm{e}^{\xi_F}$ and $\partial \chi_F / \partial P_H < 0$. Similar to the case of bilateral changes, attracting FDI by the home country H leads to the fact that firms in the foreign country F, that are at least as productive as the domestic cutoff firm in the home country, become multinationals.[10] Using the labor market clearing condition (20) and the zero expected profit condition (21), we can solve for the domestic cutoff in the home country H that is given by

$$\left(m_H^D\right)^{k+1} = \frac{F \left(m^{max}\right)^k \alpha \left[P_F w_F \alpha \kappa_4 \chi_H + L \kappa_2 \left(w_F - w_H \chi_H\right)\right]}{w_F L^2 \kappa_2^2 - w_F \left(L\kappa_2 - P_H \alpha \kappa_4\right)\left(L\kappa_2 - P_F \alpha \kappa_4\right) \chi_H \chi_F}, \tag{31}$$

which still is a function of the countries' wages. However, for a complete characterization of the model we need the relative wage for which we cannot derive closed form solutions. Therefore we rely on numerical simulations.

In Figure 3 we have depicted the case of constant fixed costs of FDI P_F in the foreign country while the home country marginally deviates and attracts FDI by lowering fixed costs P_H. The cross country comparison reveals that further decreasing the fixed costs of FDI P_H leads to a greater mass of consumed varieties and a lower normed average price

[10] Note that in case of perfect FDI-liberalization all domestic firms are multinationals since $P_H \to 0$ implies $m_F^F \to m_H^D$.

in the FDI attracting home country H. Both channels unambiguously increase welfare. Hence, there exists an incentive for the country H to marginally attract more FDI firms than the foreign country F. The intuition is that lower fixed costs of FDI in country H increase expected profits for country F's firms. This leads to a greater mass of entrants and tougher competition in the foreign country. For country H firms, serving country F is now less attractive, due to the tougher competition in country F. Therefore, the mass of entrants in country H decreases and the domestic cutoff increases. As a result, the relative wage in the country with a greater mass of entrants is higher. Nevertheless, more FDI firms in the home country H increase the mass of consumption varieties and decrease the normed average price. We can conclude that in a policy scenario where both countries set the level of fixed costs of FDI independently, the Nash-equilibrium policy is zero fixed costs of FDI in both countries. To further check whether there is no incentive to deviate from the Nash-equilibrium policy we provide Figure 4 where we have depicted the case of zero fixed costs of FDI in both countries. Marginally increasing fixed costs of FDI P_H in the home country lowers welfare in both countries and we can therefore conclude that the Nash-equilibrium is stable.

3.3 Low Trade Costs: Strategic Nash-Equilibrium Policy

In the following we examine the case of low trade costs to secure that our results also holds in the presence of exporters. We now consider the comprehensive model where countries are potentially asymmetric with respect to their fixed costs of FDI and some firms choose exporting rather than FDI. Hence, we assume that inter-country trade costs are sufficiently low such that $m_s^X > m_s^T > 0$ with $s = H, F$ holds where m_s^X is given by $\pi_s^X\left(m_s^X\right) = 0$ and m_s^T is the solution of $\pi_s^F\left(m_s^T\right) = \pi_s^X\left(m_s^T\right)$. As discussed in Section 2.2 we cannot solve $\pi_s^F\left(m_s^T\right) = \pi_s^X\left(m_s^T\right)$ for the FDI cutoff m_s^T. Hence, we cannot provide closed form solutions for the endogenously determined productivity cutoffs, wages and masses of firms. We rather provide numerical simulations.

As in the previous section 3.2, we consider the case that country H marginally lowers the fixed costs of FDI P_H below P_F and thereby attracts more FDI firms than country F. All the results are qualitatively summarized in the graphs provided by Figure 5. We conclude from the cross country comparison that marginally attracting more FDI firms than the foreign country leads to a greater mass of consumed varieties and a lower normed average price in the attracting country. Both channels unambiguously increase welfare in the attracting home country. Note that Figure 5 provides one numerical example, however

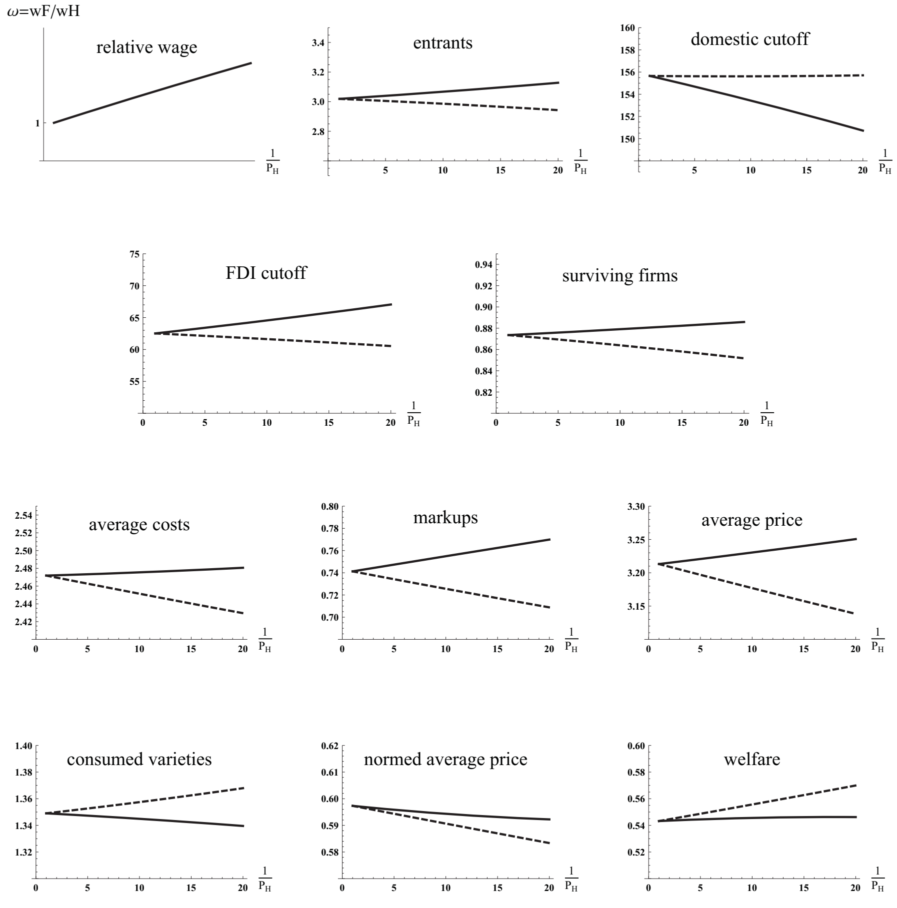

Figure 3: Comparative statics, lower fixed costs of FDI in country H. The black solid line indicates country F, the dashed line indicates country H. Parameters: $L_H = L_F = 10$, $\tau_{HH} = \tau_{FF} = 1$, $\tau_{HF} = \tau_{FH} = 1.3$, $F_F = F_H = 1$, $P_F = 0.25$, $\alpha = 1$, $k = 2$, $m_H^{max} = m_F^{max} = 10$. Note that the productivity cutoffs are monotonically transformed to m^{k+1}.

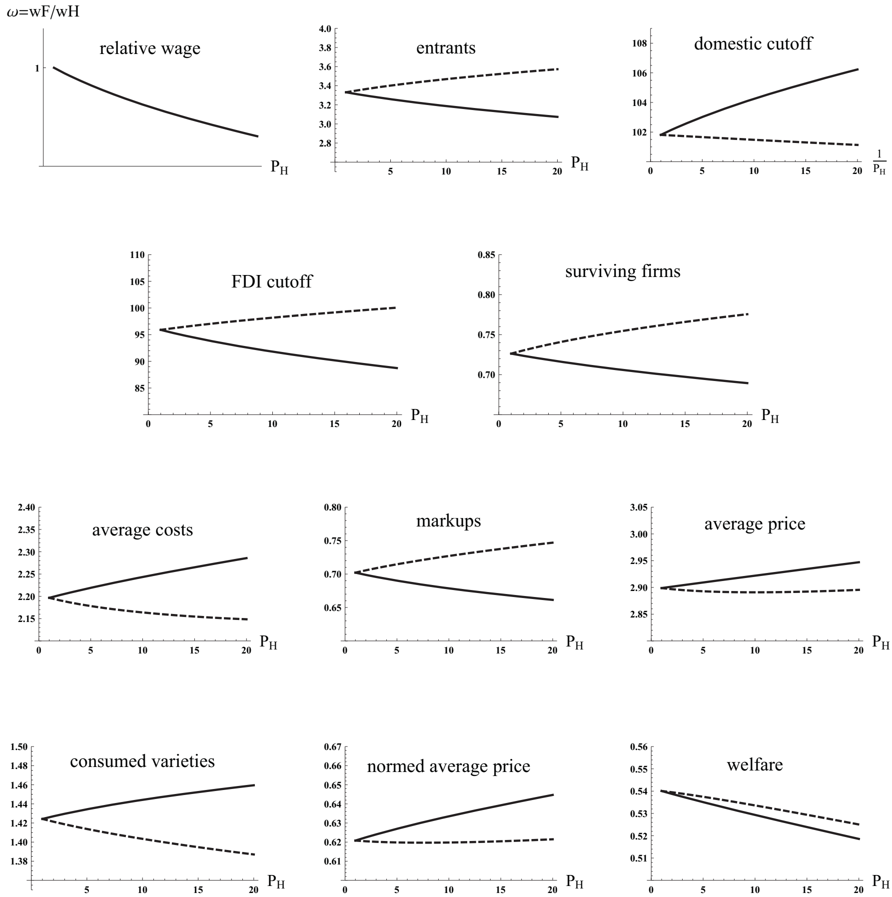

Figure 4: Comparative statics, lower fixed costs of FDI in country H. The black solid line indicates country F, the dashed line indicates country H. Parameters: $L_H = L_F = 10$, $\tau_{HH} = \tau_{FF} = 1$, $\tau_{HF} = \tau_{FH} = 1.3$, $F_F = F_H = 1$, $P_F = 0$, $\alpha = 1$, $k = 2$, $m_H^{max} = m_F^{max} = 10$. Note that the productivity cutoffs are monotonically transformed to m^{k+1}.

$P_H = 0.55$	ω	m_F^T	m_H^T	N_F^E	N_H^E	U_F	U_H
-10%	-0.42	12.87	0.99	1.33	-1.58	-1.16	0.46
-20%	-0.89	27.81	1.79	3.09	-3.46	-2.64	0.57

Table 2: Percentage changes for the wage, cutoffs, entrants and welfare for lower fixed costs of FDI in country H. Other parameters: $L_H = L_F = 10$, $\tau_{HH} = \tau_{FF} = 1$, $\tau_{HF} = \tau_{FH} = 1.3$, $F_H = F_F = 1$, $P_F = 0.55$, $\alpha = 1$, $k = 2$, $m_H^{max} = m_F^{max} = 10$.

further parameter constellations confirm this to be a stable pattern.

What follows is a detailed discussion of the comparative statics with respect to P_H. We start with a qualitative discussion of the domestic cutoffs and the mass of entrants. As the graphs indicate marginally lowering the fixed costs of FDI in the home country H translate into a higher (lower) domestic cutoff in country H (F). At the same time the mass of entrants in country H (F) decreases (increases). The economic intuition is that more firms are attracted to enter country F due to higher expected profits from serving the foreign market. Hence, the toughness of competition increases in country F while we find softer selection in country H. With regard to foreign market entry the export cutoff in country H (F) decreases (increases) while both FDI cutoffs unambiguously increase. Intuitively, the FDI strategy for country F firms becomes more profitable due to the lower fixed costs of FDI. Country F firms therefore substitute exports by FDI. This is the standard "proximity-concentration" trade-off prediction. However, with endogenous wage differentials in equilibrium, we can identify a new wage effect that dampens the reallocation: As production is shifted from the foreign country F to the attracting home country H, labor demand increases (decreases) in country H (F). This reallocation of production changes the relative wage, i.e. the relative wage level in country H (F) increases (decreases). This wage effect now leads to repercussions of FDI costs to the export cutoffs. The lower relative wage in country F favors exports since exporting firms located in country F now benefit from relatively lower labor costs. On the other hand, the lower relative wage in country F also favors FDI in that country while exporters from the attracting country H suffer from relatively higher labor costs.

It is crucial to note that this effect on the endogenously determined wage differential cannot be found in the strand of literature that incorporates factor price equalization as e.g. Helpman, Melitz and Yeaple (2004) or Chor (2009). In contrast to this strand of the literature we find that FDI-liberalization is a double-edged sword: FDI-liberalization

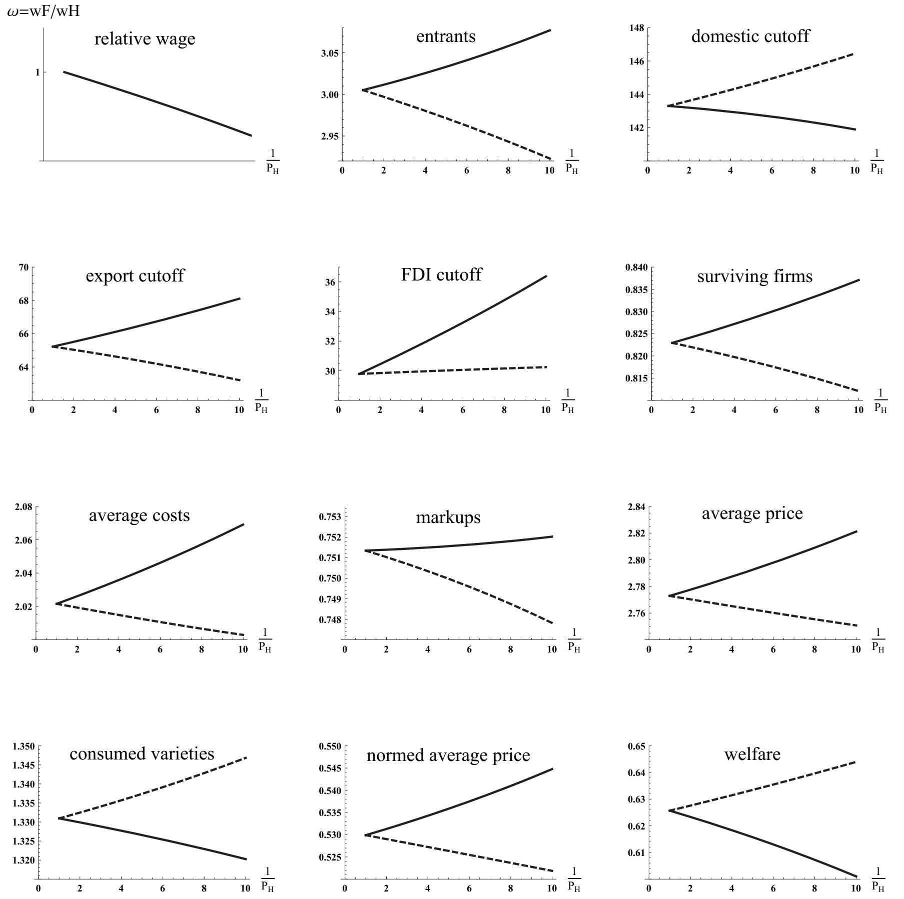

Figure 5: Comparative statics, lower fixed costs of FDI in country H. The black solid line indicates country F, the dashed line indicates country H. Parameters: $L_H = L_F = 10$, $\tau_{HH} = \tau_{FF} = 1$, $\tau_{HF} = \tau_{FH} = 1.3$, $F_H = F_F = 1$, $P_F = 0.55$, $\alpha = 1$, $k = 2$, $m_H^{max} = m_F^{max} = 10$. Note that the productivity cutoffs are monotonically transformed to m^{k+1}.

$P = 0.55$	m^T	N^E	U
-10%	13.81	-0.24	-0.09
-20%	29.23	-0.33	-0.43

Table 3: Percentage changes for the wage, cutoffs, entrants and welfare for lower fixed costs of FDI. Other parameters: $L_H = L_F = 10$, $\tau_{HH} = \tau_{FF} = 1$, $\tau_{HF} = \tau_{FH} = 1.3$, $F_H = F_F = 1$, $\alpha = 1$, $k = 2$, $m_H^{max} = m_F^{max} = 10$.

introduces new FDI varieties but simultaneously yields to tougher foreign market entry for the own exporters. Now consider the welfare effects in detail. Everything else equal welfare in a country increases in the mass of consumed varieties and a lower normed average price. Since FDI in country H and exporting into country H (F) becomes easier (harder), the mass of consumed varieties increases (decreases) in country H (F). Average marginal costs and markups decrease (increase) in country H (F). As a result the normed average price decreases (increases) in country H (F). Both effects yield to the fact that welfare in country H (F) unambiguously increases (decreases). Hence, we confirm our result of Section 3.2 that countries actually have a unilateral incentive to marginally lower the fixed costs of FDI.[11]

Proposition 3 *The strategic Nash-equilibrium policy is zero fixed costs of FDI* ($P_H^{Nash} = P_F^{Nash} = 0$) *in both countries.*

3.4 Low Trade Costs: Cooperative Policy

In the foregoing Sections 3.2 and 3.3 we found that there exists a unilateral incentive to marginally lower the fixed costs of FDI. The strategic Nash-equilibrium policy is zero fixed costs of FDI. In this section we study the cooperative policy that maximizes joint welfare to determine whether there are gains from supra national coordination. The qualitative results for $P \equiv P_H = P_F$ are given in Figure 6. Similar to Section 3.1, lower fixed costs of FDI lead to softer competition and less entrants. Concerning foreign market entry firms face less competition in each market. Therefore the export as well as the FDI cutoff increase.

[11] To provide some numerical reading examples, consider for example a 20% decrease in FDI costs as given in Table 2. The relative wage $\omega = w_F/w_H$ decreases only 0.42% while there is a strong effect on the FDI cutoff for country F with 27.81%, compared to a small increase of 1.79% in country H. Welfare in country H (F) increases (decreases) 0.57% (2.64%).

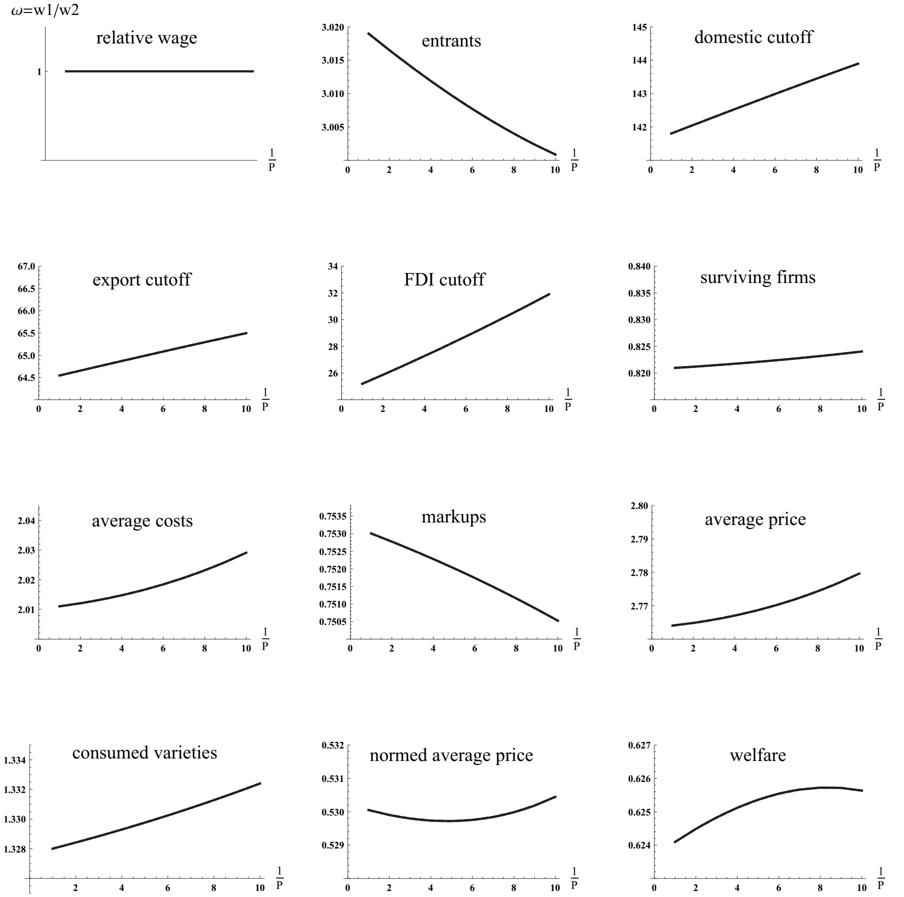

Figure 6: Comparative statics, lower fixed costs in both countries. We start with $P_H = P_F = 0.55$. Parameters: $L_H = L_F = 10$, $\tau_{HH} = \tau_{FF} = 1$, $\tau_{HF} = \tau_{FH} = 1.3$, $F_H = F_F = 1$,$\alpha = 1$, $k = 2$, $m_H^{max} = m_F^{max} = 10$. Note that the productivity cutoffs are monotonically transformed to m^{k+1}.

Concerning the welfare analysis, FDI-liberalization unambiguously leads to a larger mass of consumed varieties while the change in the normed average price is ambiguous as in Section 3.1. The normed average price only decreases and leads to an unambiguous welfare decrease if the fixed costs of FDI are high. Further FDI-liberalization below a fixed cost threshold now attracts relatively underproductive multinationals that increase the normed average price. As a result, FDI-liberalization can lead to a welfare decrease, if too many multinationals are attracted. A cooperative policy would therefore set a strictly positive level for the fixed costs of FDI.[12]

Proposition 4 *The cooperative FDI policy sets a strictly positive fixed costs of FDI ($P_H^{Coop} = P_F^{Coop} > 0$) in both countries.*

4 Conclusion

We extended the Behrens et al. (2009) framework by horizontal FDI. This allows to assess the welfare consequences of FDI-liberalization in two, commonly not studied, channels: FDI-liberalization changes the relative wage and the price markup. Although both channels are commonly not studied in theoretical models they are present in the political discussion. As our model highlights, both channels are also important in a theoretical discussion. Wage differentials are important since they deepen our understanding of the classical "proximity-concentration" trade-off. We find that the unilateral attraction of FDI rises the relative wage in the attracting country, which in turn dampens the reallocation of production. As a result, foreign exporters benefit while domestic exporters suffer from relatively higher labor costs. Price markups are important since we can confirm the argument given by policy makers that FDI-liberalization can lead to trade cost savings. Those trade cost savings can lead to lower average marginal costs, markups, average prices and quite naturally might increase welfare in turn.

Compared to the existing theoretical literature, in particular Chor (2009), we consider strategic competition and collaboration among countries for FDI. This new element brings our model closer to the political discussion, where the dynamic aspects of competition for FDI are vividly discussed. In that context the comparison between the strategic FDI policy

[12] After having discussed the qualitative results, we again provide some numerical reading examples. Consider for example a 20% decrease in FDI costs as given in Table 3. Although the effect on FDI cutoff is strong (increases 29.23%) welfare in both countries decreases by 0.43%.

and the cooperative solution can be relevant for policy makers. Our model predicts that there a potential welfare gains from supranational coordination. However, since coordination is difficult to achieve, it is likely that countries over attract FDI. For policy makers this is an important result since it indicates that besides the indisputable positive aspects of FDI there are also potential welfare losses. However, our simple model relies on various critical assumptions. In reality, decreasing fixed costs of FDI involves some sort of subsidy that needs to be refinanced or implies a tax loss. With the assumption of a balanced budget the over attraction of FDI in the Nash-equilibrium will likely be dampened. Other simplifying assumptions like identical country size and technology potentials keep the analysis short, but are left for further research. As always, reality is much more complex but our simple model still clearly illustrates the potential welfare losses of FDI. Furthermore, our model also identifies a clear difference between trade- and FDI-liberalization that implies different policy recommendations. Jointly decreasing variable trade costs unambiguously increase welfare while our model predicts that for fixed costs of FDI countries should rather commit for a strictly positive level.

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Appendix

Equilibrium conditions: In Section 2.3 we state the equilibrium conditions (20)-(22) assuming a Pareto distribution for the productivity distribution. Without assuming this specific distribution the zero expected profit condition for each firm in a country s is given by

$$\begin{aligned} F_s w_s &= \int_0^{m_s^D} L_s \left[p_{ss}(m) - \tau_{ss} w_s m\right] q_{ss}(m)\, \mathrm{d}G_s(m) \\ &+ \int_{m_s^T}^{m_s^X} L_r \left[p_{sr}(m) - \tau_{sr} w_s m\right] q_{sr}(m)\, \mathrm{d}G_s(m) \\ &+ \int_0^{m_s^T} \left(L_r \left[p_{rr}(m) - \tau_{rr} w_r m\right] q_{rr}(m) - P_r w_r m\right) \mathrm{d}G_s(m), \end{aligned}$$

where F_s is the country-specific fixed labor requirement. The first term are domestic profits, the second term are export profits and the third term are FDI profits. Furthermore, each country's labor market clears in equilibrium, which requires that in each country s

$$\begin{aligned} L_s &= N_s^E \left(L_s \int_0^{m_s^D} m \tau_{ss} q_{ss}(m)\, \mathrm{d}G_s(m) + F_s \right) \\ &+ N_s^E L_r \int_{m_s^T}^{m_s^X} m \tau_{sr} q_{sr}(m)\, \mathrm{d}G_s(m) \\ &+ N_r^E \left(\int_0^{m_r^T} \left(L_s m \tau_{ss} q_{ss}(m) + P_s m\right) \mathrm{d}G_r(m) \right) \end{aligned}$$

holds. The first term is "firms from country s serve their domestic country s", the second term is "firms from country s that serve foreign country r via exporting" and the third term is "firms from country r that serve country s via FDI". Last, the current account is balanced for each country if $CA_{sr} = CA_{rs}$ with

$$\begin{aligned} CA_{sr} &= N_s^E L_r \int_{m_s^T}^{m_s^X} p_{sr}(m)\, q_{sr}(m)\, \mathrm{d}G_s(m) \\ &+ N_r^E \int_0^{m_r^T} \left(L_s \left[p_{ss}(m) - \tau_{ss} w_s m\right] q_{ss}(m) - P_s w_s m\right) \mathrm{d}G_s(m). \end{aligned}$$

The first term is "exports from the domestic country s to the foreign country r" and the second term is "transfer of FDI profits from the foreign country s back to the domestic country r". To derive the equilibrium conditions (20)-(22) we separate integrals, use (12)-(14) and assume a Pareto distribution. Then we use the change in variables as proposed by Behrens et al. (2009): $z = W\left(\mathrm{e}\frac{m}{I}\right)$, $\mathrm{e}\frac{m}{I} = ze^z$, $m = Ize^{z-1}$ and $\mathrm{d}m =$

$(1+z)\, e^{z-1} I \mathrm{d}z$. We use the following abbreviations $\kappa_1 = \mathrm{e}^{-(k+1)} k \int_0^1 \left(1-z^2\right) z^k \mathrm{e}^{zk} \mathrm{e}^{z} \mathrm{d}z$, $\kappa_2 = \mathrm{e}^{-(k+1)} k \int_0^1 z^k \left(z^{-1}+z-2\right)(1+z)\, \mathrm{e}^{zk} \mathrm{e}^{z} \mathrm{d}z$, $\kappa_3 = \mathrm{e}^{-(k+1)} k \int_0^1 z^k \left(z^{-1}-z\right) \mathrm{e}^{zk} \mathrm{e}^{z} \mathrm{d}z$ and $\kappa_4 = \mathrm{e}^{-(k+1)} k \int_0^1 z^k (1+z)\, \mathrm{e}^{zk} \mathrm{e}^{z} \mathrm{d}z$, to further simplify the expressions. Note that $\kappa_1 - \kappa_4$ are constants and only depend on the shape parameter k of the Pareto distribution. This directly yields to (20)-(22).

Algorithm: In Sections 3.2-3.4 we discuss various numerical simulations. We solve numerical by using the following algorithm: Let ω denote the relative wage. The zero expected profit conditions (21) only depend on the cutoffs and the relative wage, so we can solve for the cutoffs $m_r^D\left(\omega, m_r^T, m_s^T\right)$ with $r \neq s$. Then, using the labor market clearing conditions (20) we can solve for the mass of entrants $N_r^E\left(\omega, m_r^D, m_s^D, m_r^T, m_s^T\right)$. In the next step we use the cutoffs $m_r^D\left(\omega, m_r^T, m_s^T\right)$ in $N_r^E\left(\omega, m_r^D, m_s^D, m_r^T, m_s^T\right)$ to eliminate the domestic cutoffs. The mass of entrants simplifies to $N_r^E\left(\omega, m_r^T, m_s^T\right)$. Using the expression in the current account balance (22) and the two indifference conditions $Z_r \equiv \pi_r^F\left(\omega, m_r^T, m_s^T\right) - \pi_r^X\left(\omega, m_r^T, m_s^T\right) = 0$ we can solve for the equilibrium allocation numerically. We secure uniqueness of our allocation since we start in a symmetric scenario with $P_r = P_s$ where $\omega = 1$ and $m_r^T = m_s^T$ must hold.