

# Subsidies for FDI: Implications from a Model with Heterogeneous Firms\*

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*Comments welcome*

## Abstract

This paper analyzes the welfare effects of subsidies to attract multinational corporations when firms are heterogeneous in their productivity levels. I show that the use of a small subsidy raises welfare in the FDI host country, with the consumption gains from attracting more multinationals exceeding the direct cost of funding the subsidy program through a tax on labor income. This welfare gain stems from a selection effect, whereby the subsidy induces only the most productive exporters to switch to servicing the host's market via FDI. I further show that for the same total subsidy bill, a subsidy to variable costs delivers a larger welfare gain than a subsidy to the fixed cost of conducting FDI, since a variable cost subsidy also raises the inefficiently low output levels stemming from each firm's markup pricing power.

*Keywords:* FDI subsidies; heterogeneous firms; fixed versus variable cost subsidies; import subsidies.

*JEL Classification:* F12, F13, F23, L23

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# 1 Introduction

This paper presents an application of the trade models with heterogeneous firms advanced by Melitz (2003) and Helpman et al. (2004) to an analysis of policy interventions related to foreign direct investment (FDI). It examines the welfare implications of subsidies to attract multinational corporations (MNCs) in a setting where firms in the target industry are heterogeneous in their productivity levels.

FDI subsidies have become increasingly common, with many countries now keen to attract MNCs to their shores for a variety of reasons. At a basic level, there is typically a direct consumption gain: The relocation of production lowers the prices that MNCs charge in the host country's market, due to the savings on cross-border transport costs and possibly also labor costs (if the host country features lower wages). In addition, countries often value the foreign capital or employment creation that MNCs bring. The arguments for FDI have further highlighted other benefits for economic growth, such as industry spillovers and technology transfers, although these have been more difficult to identify empirically.<sup>1</sup>

Not surprisingly, countries that hold such positive views towards FDI have used an array of incentive measures to try to attract a larger share of the FDI pie, including tax holidays, job-creation subsidies, and even the construction of industrial facilities. A recent edition of the *World Investment Report* surmised that “[t]he use of locational incentives to attract FDI has considerably expanded in frequency and value” (UNCTAD, 2003, p.124), resulting in an intense competition among countries for FDI projects.<sup>2</sup> That said, it is not immediately apparent that such policies necessarily raise welfare in the host country, even in the absence of strategic competition for FDI. On net, the fiscal costs of such subsidies have to be weighed against the benefits of an increased multinational presence.

In this paper, I assess this tradeoff formally in a two-country model with heterogeneous firms. I consider a Home country where multinationals are headquartered and a Foreign country seeking to attract FDI. Firms differ in their innate productivity levels, which are independent draws from a pre-existing distribution of technological possibilities. The initial industry equilibrium sees only the most productive Home firms conducting horizontal FDI in Foreign to service that market, since only these firms can afford the high fixed costs of operating an overseas plant. I then examine how welfare in the foreign host country is affected when it offers a FDI subsidy: Focusing on the consumption gains from attracting more MNCs, do these gains to the host country outweigh the direct cost of financing the subsidy scheme through a tax on its workers? Of note, the model that I formulate admits a closed-form expression for consumer welfare, making the analysis of these policy interventions tractable.

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<sup>1</sup>For example, Aitken and Harrison (1999) find only small net effects of FDI on domestic firms in Venezuela. On the other hand, Javorcik (2004) presents evidence of positive spillovers in Lithuania on the productivity of local suppliers. Haskel et al. (2007) find positive effects of a greater foreign presence on domestic plant productivity in the UK, although they argue that the value of the gains from these spillovers is smaller than the quantum of subsidies reportedly extended to MNCs. See also Wells et al. (2001) who contend that tax incentives to attract FDI failed to deliver net gains in Indonesia.

<sup>2</sup>For example, there is brewing unease among some Western European countries over the aggressive use of corporate tax cuts by several Central and Eastern European countries, such as Poland and Slovakia, to attract foreign corporations (*The Economist*, July 24th, 2004). See Hines (1996) and Devereux and Griffith (1998) for evidence that differences in corporate tax rates help to explain the cross-state or cross-country variation in volumes of MNC activity.

Previewing the results in Section 3, I establish that a small FDI subsidy indeed delivers a welfare improvement for the host country. This holds both for a subsidy that reduces MNCs' fixed costs of operation (such as the construction of industrial parks and infrastructure) and for a subsidy that is applied to their variable costs of production (such as corporate tax rate cuts or job-creation subsidies). Importantly, this welfare gain stems from a selection effect that arises when firms are heterogeneous: The subsidy attracts only the most productive Home firms that were initially servicing the Foreign market via exports to switch to horizontal FDI instead. Being relatively productive, this margin of firms already sets lower prices in the initial equilibrium. With the switch to FDI, the consumption gains in Foreign from the savings on transport costs are thus large, since the subsequent price reduction is applied over a large volume of consumption. At the same time, to ensure that these consumption gains actually exceed the funding cost of the policy, one also requires that the mass of MNCs be relatively small, in order to cap the size of the subsidy bill. This translates neatly in the model into an analytic condition governing the degree of firm heterogeneity, specifically that the distribution of firm productivities not display too thick a right-tail; reassuringly, this is a condition found to be readily satisfied in the estimates of firm productivity distributions in Helpman et al. (2004).

The key role played by firm heterogeneity and the selection effect for these welfare results is made clear in Section 3.3, where I show that the scope for a net gain from a FDI subsidy is theoretically ambiguous when all firms are instead identical, as in the antecedent model of Krugman (1980). When all firms share the same productivity level, a subsidy that induces one firm to switch from exports to FDI necessarily induces all Home firms to make the same decision. This generates a large subsidy bill, which can more than negate the consumption gains if the fixed cost of conducting FDI is high or if the productivity level of Home firms is low, so that a large per-firm subsidy is needed. In addition to this selection effect, a varieties effect emerges when we take into account how the subsidy raises the *ex ante* profitability of potential entrants to the Home industry. Section 3.4 shows that this increases the number of Home varieties and amplifies the welfare gain to Foreign in the full industry equilibrium.

I explore quantitatively some properties of the host country welfare function in Section 3.5. In particular, I illustrate how the optimal subsidy varies in response to shifts in the structural parameters of the model, such as the degree of firm heterogeneity and the industry cost parameters. These exercises also highlight a key difference between fixed and variable cost subsidies, namely that the latter have a much larger impact on the host country's welfare. Indeed, I establish formally in Section 3.6 that a variable cost subsidy delivers a greater welfare gain than a fixed cost subsidy that incurs the same total subsidy bill, subject to a mild sufficient condition. Intuitively, a variable cost subsidy further prompts each MNC to raise output levels, delivering an additional kick to consumption by counteracting some of the inefficiency arising from firms' markup pricing power.

This paper contributes to an extensive literature on the welfare effects of FDI subsidies, presenting a first attempt (to the best of my knowledge) at applying a framework with heterogeneous firms to this

policy issue. The model has the advantage that it allows us to be very precise in describing the behavior of individual firms in the industry equilibrium, specifically how each firm's productivity draw and the size of the FDI subsidy jointly pin down whether it can profitably enter the Foreign market, and if so, its optimal mode for servicing that market (exports versus FDI). The comparison of fixed versus variable cost subsidies is a natural question to investigate with this model, yet this is a question that has been under-explored despite the observation that FDI subsidies can assume diverse forms.

Separately, this paper speaks to a broader literature on optimal policy towards foreign investment. The early theoretical contributions here, by MacDougall (1960), Kemp (1966) and Jones (1967), focused on analyzing the jointly optimal levels of commodity tariffs and capital flow taxes in a two-factor world where only one factor (capital) is internationally mobile. In this strand of work however, FDI is viewed as synonymous with capital movements, in contrast to the more recent literature on MNCs which treats FDI more concretely as the production activities of overseas affiliates. Along these latter lines, there has been much work exploring economic settings in which FDI subsidies might lead to a welfare improvement. For example, Haaland and Wooten (1999) examine how FDI subsidies can foster agglomeration effects.<sup>3</sup> Pennings (2005) shows that a subsidy is optimal when foreign investors face uncertainty over demand conditions in the host economy. Others have argued that FDI subsidies can help to alleviate the under-provision of public services (Black and Hoyt, 1989), or improve the allocation of firms' production facilities to countries from the standpoint of aggregate efficiency (Fumagalli, 2003).

In this paper, the welfare improvement stems instead from the reduction of barriers to entry into the host country market, specifically for the most productive Home firms that would have serviced the Foreign market via exports in the absence of the FDI subsidy. I focus on the consumption gains accruing to the host country from attracting more MNCs, namely the benefit from accessing MNCs' products more cheaply due to the savings on transport costs. While this puts aside other potential benefits such as technology spillovers, agglomeration effects, or an increased labor demand, the model nevertheless provides a useful benchmark, since such additional effects would intuitively reinforce the gains from attracting FDI. The results I derive are closely related to recent work by Demidova and Rodriguez-Clare (2008), who demonstrate how a simple consumption subsidy, import tariff, or export tax can offset the markup pricing distortion in a Melitz-type model to achieve the first-best welfare level (although there are key differences between their production setting and that in this paper; see Section 4.1 below).

The paper proceeds as follows. Section 2 describes the building blocks of the model. Section 3 establishes the main propositions on the welfare gain from either a fixed or variable cost subsidy to FDI. Section 4 explores two extensions. A parallel analysis shows that there is a similar scope for improving

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<sup>3</sup>Hauffer and Wooten (1999), Ottaviano and van Ypersele (2005), and Baldwin and Okubo (2006) discuss how market size can confer countries with an advantage in attracting firms or mobile capital. Baldwin and Okubo (2006) in particular introduce firm heterogeneity in a two-country new economic geography model with footloose firms who can choose where to base their headquarter operations after observing their productivity draw. In their model, a subsidy from the smaller Southern country might attract some firms to relocate their Northern headquarters, although the question of the net welfare effect on the South remains to be explored.

welfare in Foreign through an import subsidy (Section 4.1), and I discuss how this result relates to Demidova and Rodriguez-Clare (2008). I also confirm the robustness of the results under an alternative utility specification that incorporates richer income effects (Section 4.2). Section 5 concludes. Detailed proofs are in a supplementary Appendix available on the author’s website, or upon request.

## 2 A Two-Country Model with Heterogeneous Firms

There are two countries, Home and Foreign, indexed by  $H$  and  $F$  respectively. Each economy is made up of two sectors: (i) a homogeneous good sector (the domestic numeraire), and (ii) a (country-specific) differentiated goods sector. Labor is the sole factor of production, assumed to be immobile across borders.

**Utility:** The utility of the representative consumer in country  $i$  is given by:

$$U_i = x_i^0 + \sum_{c=H,F} \frac{1}{\mu} (X_i^c)^\mu \quad (1)$$

Here,  $x_i^0$  denotes consumption of the homogeneous (background) good.  $X_i^c$  is the familiar Dixit-Stiglitz aggregator of consumption over products,  $x_i^c$ , from country  $c$ ’s differentiated goods sector, given by:  $X_i^c = \left[ \int_{\Omega_i^c} x_i^c(a)^\alpha dG^c(a) \right]^{\frac{1}{\alpha}}$ , where  $\Omega_i^c$  is the set of products from country- $c$  firms available to consumers in country  $i$ . (For example, when  $c = H$  and  $i = F$ ,  $\Omega_F^H$  is the union of the set of goods exported from Home to Foreign and the set of goods produced in Foreign by Home MNCs.) I assume that  $0 < \mu < \alpha < 1$ , so the differentiated products are pairwise substitutes; moreover, products from the same country are closer substitutes than products drawn from different countries. Differentiated products are indexed by  $a$ , which is the amount of labor required to produce one unit of output.  $1/a$  is thus the firm’s labor productivity. Upon paying the fixed cost of entry into the industry, each firm draws its  $a$  from a pre-existing technological distribution,  $G^c(a)$ . The resulting productivity differences are the key dimension along which firms in this sector are heterogeneous.

The utility function in (1) is maximized with respect to the budget constraint:

$$x_i^0 + \sum_{c=H,F} \int_{\Omega_i^c} p_i^c(a) x_i^c(a) dG^c(a) = w_i \quad (2)$$

where  $w_i$  is the wage income of a representative consumer in country  $i$ , and  $p_i^c(a)$  is the unit price of product  $x_i^c(a)$ . The background good  $x_i^0$  is produced with a constant returns to scale technology and its price is normalized to 1. Solving the consumer maximization problem yields a demand function for each product with constant elasticity,  $\varepsilon = \frac{1}{1-\alpha} > 1$ , given by:  $x_i^c(a) = (X_i^c)^{\frac{\mu-\alpha}{1-\alpha}} p_i^c(a)^{-\varepsilon}$ . Note that I have focused the analysis here on equilibria in which there is a strictly positive amount of production and consumption of the background good in each country ( $x_i^0 > 0$ ); this holds for example when the labor force in each country is sufficiently large. I will show in the numerical exercises in Section 3.5 that this positive employment condition for the background sector is not particularly restrictive, in that there are reasonable parameterizations of the model for which the condition is readily satisfied. The nominal wage,

$w_i$ , is then equal to the marginal product of labor in this background sector. While a more general model would allow the wage to respond to an increased demand for labor by MNCs, this would tend to raise welfare in the host country further if wages rise as a consequence, as long as the increase in  $w_F$  were not so large as to erode the original incentives for MNCs to locate production in Foreign.<sup>4</sup>

Substituting  $x_i^c(a) = (X_i^c)^{\frac{\mu-\alpha}{1-\alpha}} p_i^c(a)^{-\varepsilon}$  into the definition of  $X_i^c$  delivers the following expression for the CES consumption aggregates in terms of goods prices that is useful for future computations:

$$X_i^c = \left[ \int_{\Omega_i^c} p_i^c(a)^{1-\varepsilon} dG^c(a) \right]^{\frac{1}{\varepsilon-1} \frac{1}{1-\mu}} \quad (3)$$

Intuitively, the overall consumption of differentiated goods decreases as individual goods prices rise.<sup>5</sup>

**Welfare:** As a measure of welfare for the subsequent analysis, I derive the indirect utility function,  $W_i$ , for a representative consumer. The demand function for differentiated products,  $x_i^c(a)$ , and the budget constraint (2) together imply a level of demand for the homogeneous good,  $x_i^0$ . Substituting this expression for  $x_i^0$  (when  $x_i^0 > 0$ ) into the utility function (1) and simplifying, one obtains:

$$W_i = w_i + \left( \frac{1-\mu}{\mu} \right) \sum_{c=H,F} (X_i^c)^\mu \quad (4)$$

Naturally, welfare is increasing in labor income, as well as in the consumption aggregates.

The analysis focuses on the industry equilibrium for the Home differentiated goods sector, namely  $c = H$ , and the effects of a subsidy extended by Foreign on FDI from this sector. The model does formally include a Foreign heterogeneous firms sector (denoted by  $c = F$ ), which shares the same structure as the Home sector, the purpose being to demonstrate that I do not need to appeal to asymmetries in the structure of production across the countries (such as between a developed and developing country) to establish the efficacy of FDI subsidies. In practice, this Foreign sector does not affect the analysis of FDI subsidies substantively, due to the additive separability of utility from Home and Foreign goods in (1), and it suffices to focus on the Home sector.<sup>6</sup> I thus suppress the  $c$  superscript, taking it to refer to  $c = H$ , unless there is cause for ambiguity. (Note that the extension in Section 4.2 relaxes this additive separability in the baseline model, without loss of the welfare results.)

**Production and profits:** The structure of production in the differentiated goods sector follows that in Helpman et al. (2004). Upon entering the industry, each Home firm takes an independent productivity draw,  $1/a$ , from the distribution  $G^H(a)$ . Production for the Home domestic economy requires a fixed cost of  $f_D$  units of Home labor in each period, while the marginal cost of each unit of output is  $aw_H$ . Under profit-maximization, prices are set at a constant markup,  $\frac{1}{\alpha}$ , over marginal costs.

<sup>4</sup>For the nominal wage to differ across the two countries, we require that the homogeneous good be a non-tradable, or alternatively, a country-specific good for which there is no cross-border demand.

<sup>5</sup>This is also evident from the fact that  $X_i^c$  is the ideal price index for Home products raised to the power of  $-1/(1-\mu)$ .

<sup>6</sup>This additive separability implies that actions taken by Foreign firms do not affect the demand functions and profit levels of Home firms. This feature is relaxed with the more general utility function considered in Section 4.2. See also Levy and Nolan (1992) for an analysis of FDI policy when domestic firms and MNCs are oligopolistic competitors.

Home firms may service the Foreign market through one of two means, namely exports or horizontal FDI. Firms that export incur two additional costs: (i) a per-period fixed cost of exporting, equal to  $f_X$  units of Home labor; and (ii) the conventional iceberg transport costs, which raise unit production costs by a factor  $\tau > 1$ . Alternatively, Home firms may decide to operate an additional manufacturing plant in Foreign, employing labor there at wage cost  $w_F$ , while saving on transport costs. However, FDI entails a higher per-period fixed cost,  $f_I > f_X$ , than exporting. (For simplicity,  $f_I$  is also incurred in units of Home labor.)

Denote the number of workers in country  $i$  by  $M_i$  ( $i = H, F$ ). For a Home firm with productivity  $1/a$ , the per-period profits from sales to the domestic economy, from exporting, and from FDI are given respectively by  $\pi_D(a)$ ,  $\pi_X(a)$  and  $\pi_I(a)$ :

$$\pi_D(a) = \left(\frac{aw_H}{\alpha}\right) M_H x_H(a) - aw_H M_H x_H(a) - f_D w_H = (1 - \alpha) A_H \left(\frac{aw_H}{\alpha}\right)^{1-\varepsilon} - f_D w_H \quad (5)$$

$$\pi_X(a) = \left(\frac{\tau aw_H}{\alpha}\right) M_F x_F(a) - \tau aw_H M_F x_F(a) - f_X w_H = (1 - \alpha) A_F \left(\frac{\tau aw_H}{\alpha}\right)^{1-\varepsilon} - f_X w_H \quad (6)$$

$$\pi_I(a) = \left(\frac{aw_F}{\alpha}\right) M_F x_F(a) - aw_F M_F x_F(a) - f_I w_H = (1 - \alpha) A_F \left(\frac{aw_F}{\alpha}\right)^{1-\varepsilon} - f_I w_H \quad (7)$$

where  $A_i = M_i (X_i)^{\frac{\mu-\alpha}{1-\alpha}}$  ( $i = H, F$ ) is the level of demand in country  $i$ . With a continuum of firms, individual firms take these aggregate demand levels as given.

**Productivity cutoffs:** Firms engage in production for the domestic market if profits from (5) are positive. Solving  $\pi_D(a) = 0$ , this establishes a cutoff value,  $a_D$ , which is the maximum labor input coefficient at which production for the Home market is profitable. Firms for which  $\pi_X(a) \geq 0$  export to Foreign. This implies a cutoff value,  $a_X$ , such that exporting is profitable for all firms with  $a < a_X$ . However, Home firms service the Foreign market via FDI instead if  $\pi_I(a) \geq \pi_X(a)$ ; solving for the value of  $a$  that equates (6) and (7) yields a third cutoff,  $a_I$ , such that the Home firm opts for FDI over exporting if  $a < a_I$ . The expressions for these three cutoffs are:

$$(a_D)^{1-\varepsilon} = \frac{f_D w_H}{(1 - \alpha) A_H (w_H/\alpha)^{1-\varepsilon}} \quad (8)$$

$$(a_X)^{1-\varepsilon} = \frac{f_X w_H}{(1 - \alpha) A_F (\tau w_H/\alpha)^{1-\varepsilon}} \quad (9)$$

$$(a_I)^{1-\varepsilon} = \frac{(f_I - f_X) w_H}{(1 - \alpha) A_F [(w_F/\alpha)^{1-\varepsilon} - (\tau w_H/\alpha)^{1-\varepsilon}]} \quad (10)$$

I assume that the underlying model parameters induce a natural sorting pattern of firms to the various modes of servicing the two markets, namely that  $a_D > a_X > a_I$ . This implies that only the most productive firms (with  $a < a_I$ ) are able to conduct FDI, while firms with an intermediate level of productivity (with  $a_X > a > a_I$ ) export to Foreign. Firms with  $a_D > a > a_X$  serve only the Home market, while firms that draw an  $a$  larger than  $a_D$  have labor input requirements that are too high and thus exit the industry immediately.<sup>7</sup> Figure 1 illustrates this sorting pattern of firms according to  $a^{1-\varepsilon}$ ,

<sup>7</sup>In terms of the underlying model parameters, the condition  $a_X > a_I$  simplifies to:  $f_I > \left(\frac{\tau w_H}{w_F}\right)^{\varepsilon-1} f_X$ . Intuitively, the

which is a proxy for a firm's productivity level (since  $1 - \varepsilon < 0$ ). Note from (10) that we further require  $w_F < \tau w_H$  for the FDI cutoff to be well-defined ( $a_I > 0$ ). Thus, Foreign wages must be lower than the marginal cost of the exporting option, to make FDI feasible at some positive productivity levels.

[Figure 1 about here]

**Technology:** Firm productivity levels,  $1/a$ , are independent draws from a Pareto distribution with shape parameter  $k$  and support  $[1/a_U, \infty)$ , a parametrization commonly adopted in the industrial organization literature. The shape parameter conveniently summarizes several key features of this distribution, with both the mean and variance decreasing in  $k$ .<sup>8</sup> Thus, a larger  $k$  corresponds to a distribution that places less weight on its right-tail, or equivalently, on obtaining high productivity draws. It is useful to define  $V^H(a) = \int_0^a \tilde{a}^{1-\varepsilon} dG^H(\tilde{a})$ , as this expression will show up repeatedly. The Pareto distribution facilitates an analytical solution, since both  $G^H(a)$  and  $V^H(a)$  are polynomials in  $a$ , given by:

$$G^H(a) = \left(\frac{a}{a_U}\right)^k, \quad 0 < a < a_U \quad (11)$$

$$V^H(a) = \frac{k}{k - \varepsilon + 1} \left(\frac{a}{a_U}\right)^k a^{1-\varepsilon}, \quad 0 < a < a_U \quad (12)$$

Helpman et al. (2004) show that if the underlying productivity distribution is Pareto with shape parameter  $k$ , then the distribution of firm sales will be Pareto with shape parameter  $k - \varepsilon + 1$ . Their estimation based on European firm-level data establishes the goodness of fit of the Pareto distribution for firm sales, while yielding estimates for  $k - \varepsilon + 1$  that are always significantly greater than 0 across manufacturing industries. This empirical evidence motivates a key assumption:  $k > \varepsilon - 1$ . This means that the distribution of productivity levels does not place too much weight on obtaining very high productivity draws.<sup>9</sup> To ensure that the cutoff for domestic entry is relevant, I further assume that  $a_U > a_D$ , so that some prospective entrants fail to obtain a good enough productivity draw to engage in production for the Home market, and thus exit the industry immediately.

**Equilibrium consumption of differentiated goods:** We now solve for the equilibrium levels of  $X_H$  and  $X_F$ , which are the CES aggregates for Home differentiated products consumed in the Home and Foreign markets respectively. These will be important for evaluating welfare based on the indirect utility function, (4). From (3) and applying the sorting pattern within the heterogeneous firms sector, these

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fixed cost of FDI must be large, so that FDI is more profitable than exporting only for the most productive firms. Similarly, the condition  $a_D > a_X$  simplifies to:  $\tau^{\varepsilon-1} \left(\frac{f_X}{A_F}\right) > \frac{f_D}{A_H}$ . The fixed cost of exporting must be large relative to that for domestic production, so that exporting will only be pursued by sufficiently productive firms.

<sup>8</sup>The mean of this Pareto distribution is  $\frac{k}{k-1} \left(\frac{1}{a_U}\right)$  for  $k > 1$ ; when  $k \leq 1$ , the mean is infinite. The variance of this distribution is  $\frac{k}{(k-1)^2(k-2)} \left(\frac{1}{a_U}\right)^2$  for  $k > 2$ ; when  $k \leq 2$ , the variance is infinite. It is straightforward to check that when both the mean and variance are finite, both are decreasing functions in  $k$ .

<sup>9</sup>It should be stressed that the condition  $k - \varepsilon + 1 > 0$  is a mild assumption regarding the extent of firm heterogeneity: For the variance of firm sales to be finite, we would in fact require the even more stringent condition that  $k - \varepsilon + 1 > 2$ .



CES aggregates can be re-written as:

$$X_H = \left[ N \int_0^{a_D} \left( \frac{aw_H}{\alpha} \right)^{1-\varepsilon} dG^H(a) \right]^{\frac{1}{\varepsilon-1} \frac{1}{1-\mu}} = \left[ N \frac{k}{\alpha} \Lambda_H (A_H)^{\frac{k-\varepsilon+1}{\varepsilon-1}} \right]^{\frac{1}{\varepsilon-1} \frac{1}{1-\mu}} \quad (13)$$

$$\begin{aligned} X_F &= \left[ N \left( \int_{a_I}^{a_X} \left( \frac{\tau aw_H}{\alpha} \right)^{1-\varepsilon} dG^H(a) + \int_0^{a_I} \left( \frac{aw_F}{\alpha} \right)^{1-\varepsilon} dG^H(a) \right) \right]^{\frac{1}{\varepsilon-1} \frac{1}{1-\mu}} \\ &= \left[ N \frac{k}{\alpha} \Lambda_F (A_F)^{\frac{k-\varepsilon+1}{\varepsilon-1}} \right]^{\frac{1}{\varepsilon-1} \frac{1}{1-\mu}} \end{aligned} \quad (14)$$

where  $N$  is the number (measure) of Home varieties. Note that I have used the expressions for the productivity cutoffs from (8), (9) and (10), as well as for the Pareto distribution from (11), in evaluating the integrals above. The terms  $\Lambda_H$  and  $\Lambda_F$  are given explicitly by:

$$\begin{aligned} \Lambda_H &= \frac{\varepsilon-1}{k-\varepsilon+1} \left( \frac{\alpha}{a_U} \right)^k \left( \frac{1-\alpha}{w_H} \right)^{\frac{k}{\varepsilon-1}} \frac{(f_D)^{\frac{k}{1-\varepsilon}+1} w_H}{(w_H)^k} \\ \Lambda_F &= \frac{\varepsilon-1}{k-\varepsilon+1} \left( \frac{\alpha}{a_U} \right)^k \left( \frac{1-\alpha}{w_H} \right)^{\frac{k}{\varepsilon-1}} \left[ \frac{(f_X)^{\frac{k}{1-\varepsilon}+1} w_H}{(\tau w_H)^k} + \frac{(f_I - f_X)^{\frac{k}{1-\varepsilon}+1} w_H}{((w_F)^{1-\varepsilon} - (\tau w_H)^{1-\varepsilon})^{\frac{k}{1-\varepsilon}}} \right] \end{aligned}$$

In words,  $\Lambda_H$  and  $\Lambda_F$  are equal to the *ex ante* profits that a prospective entrant firm in the Home sector would obtain in expectation (before observing its productivity draw) from sales in Home and Foreign respectively, if the market demand levels  $A_H$  and  $A_F$  were normalized to 1. I therefore refer to  $\Lambda_H$  and  $\Lambda_F$  as the normalized profit levels in these respective markets.

Recall that  $A_i = M_i (X_i)^{\frac{\mu-\alpha}{1-\alpha}}$  (for  $i = H, F$ ), which is a definition I now substitute into (13) and (14). Some algebra then leads to the following compact expression for the consumption aggregates:

$$(X_i)^\mu = \left( N \frac{k}{\alpha} \right)^{\frac{\mu\alpha}{\mu\alpha-k(\mu-\alpha)}} \frac{\tilde{M}_i}{M_i} \tilde{\Lambda}_i, \quad i = H, F \quad (15)$$

where  $\tilde{\Lambda}_i = (\Lambda_i)^{\frac{\mu\alpha}{\mu\alpha-k(\mu-\alpha)}}$  and  $\tilde{M}_i = (M_i)^{\frac{k\alpha(1-\mu)}{\mu\alpha-k(\mu-\alpha)}}$ . (15) is a very useful expression for computing country welfare, since based on (4),  $\frac{1-\mu}{\mu} (X_F)^\mu$  is the quantum of utility derived by Foreign from the consumption of Home differentiated products. Not surprisingly,  $(X_F)^\mu$  and hence Foreign welfare are both increasing in  $N$ , so that there is the usual “love of varieties” effect. In addition,  $(X_F)^\mu$  rises with  $\tilde{\Lambda}_F$ , and hence with  $\Lambda_F$  too ( $\frac{\mu\alpha}{\mu\alpha-k(\mu-\alpha)} > 0$ , since  $\mu < \alpha$ ); a higher normalized profit level from sales in Foreign implies that a larger set of Home firms can service the Foreign market profitably, thus raising consumer welfare in Foreign. Finally, we have a market size effect, whereby  $(X_F)^\mu$  increases with  $M_F$  (the exponent of  $M_F$  in (15) is  $\frac{k\alpha(1-\mu)}{\mu\alpha-k(\mu-\alpha)} - 1 = \frac{\mu(k-k\alpha-\alpha)}{\mu\alpha-k(\mu-\alpha)} > 0$ , since  $k > \frac{\alpha}{1-\alpha} = \varepsilon - 1$ ).

To close the model fully, one needs to pin down the number of Home varieties,  $N$ , with a free-entry condition for the Home sector. I defer this step to Section 3.4, since (15) already facilitates a closed-form expression for Foreign welfare that corresponds to a situation where the Foreign market has a negligible effect on the *ex ante* profitability of prospective entrants to the Home sector, and hence does not affect the number of Home varieties. Analyzing this case where  $N$  is exogenous isolates the selection effect of

FDI subsidies, by focusing attention on the set of existing Home firms that switch their mode of servicing Foreign from exports to FDI. It will turn out later in the endogenous  $N$  case that the additional varieties effect reinforces this selection effect, so that the welfare implications are qualitatively identical. I therefore turn first to the analysis when the number of Home varieties is fixed.

### 3 The Welfare Implications of FDI Subsidies

#### 3.1 FDI subsidy to fixed costs

We now analyze the effects of FDI subsidies to attract more Home firms to locate in Foreign, focusing on the welfare implications for the host economy. Consider first the use of a subsidy by the Foreign government that reduces the per-period fixed costs of FDI for multinationals headquartered in Home by the amount:  $s_f(f_I - f_X)w_H$ , where  $s_f < 1$ . For example, this subsidy could take the form of the construction of infrastructure such as roads or factories, or the reduction of lump-sum regulatory fees that need to be paid on a recurrent basis.

Throughout the analysis, I restrict myself to policies that are “budget-neutral”, in that the subsidy bill is exactly paid for by revenues raised from a tax on Foreign labor. With a fixed cost subsidy, the income tax rate,  $t_f$ , must therefore satisfy the following equation to balance Foreign’s state budget:

$$t_f w_F M_F = s_f (f_I - f_X) w_H N G^H(a_I) \quad (16)$$

The right-hand side of this balanced-budget constraint is the total fiscal bill from subsidizing each Home firm with  $a < a_I$  by the amount  $s_f(f_I - f_X)w_H$ . Firms continue to pay  $w_F$  for each unit of Foreign labor they employ, but Foreign workers now maximize utility subject to the budget constraint (2) with their income  $w_F$  replaced by  $(1 - t_f)w_F$ . ( $t_f$  is thus the minimum tax rate that needs to be levied on workers to cover the cost of funding the FDI subsidy.)

To evaluate the net impact on welfare, it suffices to examine what happens to the terms,  $W_{Ff} \equiv (1 - t_f)w_F + \frac{1-\mu}{\mu}(X_F^H)^\mu$ , in the formula for indirect utility in (4). This expression for  $W_{Ff}$  highlights the tradeoff facing Foreign: The FDI subsidy lowers the productivity cutoff,  $a_I^{1-\varepsilon}$ , allowing some Home firms that were previously exporting to turn to FDI as their mode of servicing the Foreign market. There is thus a margin of goods previously exported at price  $\frac{\tau a w_H}{\alpha}$  that are now priced more cheaply at  $\frac{a w_F}{\alpha}$  when produced at the MNC’s Foreign facility (since  $\tau w_H > w_F$ ). While this boosts the consumption aggregate,  $X_F^\mu$ , this consumption gain must be weighed against the direct cost of the tax,  $-t_f w_F$ .

The following proposition formally establishes that the net effect from a “small” positive subsidy to the fixed costs of FDI is indeed a welfare improvement:

**Proposition 1 [Fixed Cost Subsidy]:** *Consider the family of fixed cost FDI subsidies characterized by  $s_f$  that: (i) satisfy the balanced-budget constraint (16); and (ii) preserve the sorting pattern of organizational forms within the industry, namely  $a_U > a_D > a_X > a_I$ . Then the optimal policy,  $s_f^*$ , that*

maximizes welfare in Foreign is a strictly positive subsidy, namely  $s_f^* \in (0, 1)$ .

**Proof.** Substituting from (10) and (11) into (16), one can express  $t_f$  in terms of  $s_f$  and the model parameters. Using this expression for  $t_f$  and the expression for  $(X_F)^\mu$  from (15) in the definition of  $W_{Ff}$ , one obtains:

$$W_{Ff} = w_F + \left( N \frac{k}{\alpha} \right)^{\frac{\mu\alpha}{\mu\alpha - k(\mu - \alpha)}} \frac{\tilde{M}_F}{M_F} \left[ \frac{1 - \mu}{\mu} \tilde{\Lambda}_{Ff} - s_f \left( \frac{\alpha}{k} \right) \frac{\tilde{\Lambda}_{Ff}}{\Lambda_{Ff}} \frac{\partial \Lambda_{Ff}}{\partial s_f} \right] \quad (17)$$

where  $\Lambda_{Ff}$  and  $\tilde{\Lambda}_{Ff}$  are  $\Lambda_F$  and  $\tilde{\Lambda}_F$  respectively with  $f_I - f_X$  replaced by  $(1 - s_f)(f_I - f_X)$ . (The term  $\frac{\partial \Lambda_{Ff}}{\partial s_f}$  appears in (17) purely through an algebraic substitution; no first-order conditions have been taken yet.) Now, differentiating (17) with respect to  $s_f$  and simplifying gives:

$$\begin{aligned} \frac{\partial W_{Ff}}{\partial s_f} = & \left( N \frac{k}{\alpha} \right)^{\frac{\mu\alpha}{\mu\alpha - k(\mu - \alpha)}} \frac{\tilde{M}_F}{M_F} \frac{\tilde{\Lambda}_{Ff}}{\Lambda_{Ff}} \left[ \frac{\alpha(1 - \mu)}{\mu\alpha - k(\mu - \alpha)} \frac{\partial \Lambda_{Ff}}{\partial s_f} - \frac{\alpha}{k} \frac{\partial \Lambda_{Ff}}{\partial s_f} \dots \right. \\ & \left. \dots - s_f \frac{\alpha(\mu - \alpha)}{\mu\alpha - k(\mu - \alpha)} \frac{1}{\Lambda_{Ff}} \left( \frac{\partial \Lambda_{Ff}}{\partial s_f} \right)^2 - s_f \frac{\alpha}{k} \frac{\partial^2 \Lambda_{Ff}}{\partial s_f^2} \right] \end{aligned} \quad (18)$$

Since  $\tilde{\Lambda}_F > 0$  whenever  $s_f < 1$ , it suffices to examine the terms in the square brackets in (18) to deduce how Foreign welfare varies with the level of the fixed cost subsidy.

To determine the effect of a small subsidy, set  $s_f = 0$ . The key tradeoff is now the following: Does the consumption gain from a marginal increase in  $s_f$  (captured by the  $\frac{\alpha(1 - \mu)}{\mu\alpha - k(\mu - \alpha)} \frac{\partial \Lambda_{Ff}}{\partial s_f}$  term) exceed the increased fiscal cost of the subsidy scheme? At  $s_f = 0$ , this increased fiscal cost (captured by the  $-\frac{\alpha}{k} \frac{\partial \Lambda_{Ff}}{\partial s_f}$  term) is equal to the cost of transferring a marginal dollar to each of the multinationals already operating in the host economy (the infra-marginal MNCs). Observe that:

$$\frac{\alpha(1 - \mu)}{\mu\alpha - k(\mu - \alpha)} - \frac{\alpha}{k} = \frac{\alpha}{k} \left( \frac{k(1 - \alpha) - \mu\alpha}{\mu\alpha - k(\mu - \alpha)} \right) = \frac{\alpha}{k} \frac{(1 - \alpha)(k - \mu(\varepsilon - 1))}{\mu\alpha - k(\mu - \alpha)} > 0$$

This last inequality holds because: (i)  $k - \mu(\varepsilon - 1) > k - (\varepsilon - 1) > 0$ ; and (ii)  $\mu < \alpha$ . Since  $\frac{\partial \Lambda_{Ff}}{\partial s_f} > 0$ , we have that  $\frac{\partial W_{Ff}}{\partial s_f} > 0$  in a neighborhood of  $s_f = 0$ . One can show moreover that  $\frac{\partial W_{Ff}}{\partial s_f} > 0$  for all  $s_f < 0$  (so a tax on FDI is never beneficial), and that  $W_{Ff} \rightarrow -\infty$  as  $s_f \rightarrow 1^-$ . (The details of these proofs are not particularly illuminating, and are relegated to the separate Appendix.)  $W_{Ff}$  therefore increases with  $s_f$  for small values of the subsidy, but has at least one turning point in the interval  $(0, 1)$ , so welfare in Foreign achieves its maximum at a strictly positive subsidy level. ■

There is a small complication here: As  $s_f$  is raised towards 1, the FDI cutoff  $a_I^{1 - \varepsilon}$  decreases monotonically and eventually overshoots  $a_X^{1 - \varepsilon}$  ( $a_I \rightarrow \infty$  as  $s_f \rightarrow 1^-$ ). Thus, the subsidy level cannot be too large if we are to retain the order of the productivity cutoffs. (Formally, we need  $s_f < \tilde{s}_f$ , where  $\tilde{s}_f \in (0, 1)$  is the subsidy that equates the FDI and exporting cutoffs,  $a_I = a_X$ .) Notwithstanding this, a small subsidy still improves welfare in Foreign, so the optimal policy remains a strictly positive subsidy level.

It is useful to dissect the intuition behind this welfare improvement. The fixed cost,  $f_I$ , prevents a segment of Home firms from servicing the Foreign market directly through FDI. By reducing this cost

barrier, the subsidy enables the most productive Home exporters – those firms just left of the original  $a_I^{1-\varepsilon}$  cutoff – to switch into FDI, as illustrated in Figure 1. What then ensures that the subsequent consumption gains to Foreign outweigh the fiscal cost of the subsidy scheme? First, the consumption gains are large because the firms newly attracted to FDI form a sufficiently productive margin: The more productive a firm, the lower the unit price it sets, and hence the larger the increase in consumption when this price falls from  $\frac{\tau aw_H}{\alpha}$  (under exporting) to  $\frac{aw_F}{\alpha}$  (under FDI). Firm heterogeneity is therefore a key ingredient for this selection effect, since it is the underlying productivity differences that allows the FDI subsidy to attract precisely just this productive margin of Home firms. (There is moreover a secondary consumption effect of the FDI subsidy not illustrated in Figure 1. The lowering of prices by Home exporters who switch to FDI spurs an increase in Foreign’s aggregate demand for Home products,  $A_F^H$ . This in turn lowers the  $a_X^{1-\varepsilon}$  cutoff also, as more Home firms find it profitable to export, adding to the consumption gains for Foreign.)

On the other hand, the subsidy scheme cannot be too costly. For this, the mass of MNCs cannot be too large, which means that the distribution of Home firm productivities cannot have a very thick right-tail. This is precisely the role of the condition  $k - \mu(\varepsilon - 1) > 0$  in the above proof: Higher values of  $k$  imply Pareto distributions with thinner right-tails, and hence a smaller mass of Home firms productive enough to become MNCs. To ensure that the funding cost of the subsidy scheme is not excessive,  $k$  must therefore be sufficiently large. Reassuringly, this condition on the extent of firm heterogeneity is a mild one, consistent with the estimates from Helpman et al. (2004) showing that  $k > \varepsilon - 1$ .<sup>10</sup>

Interestingly, this result can help to rationalize a situation in which two countries extend FDI subsidies to attract each others’ multinationals. To see this, suppose that the Foreign differentiated goods sector shares the same structure as the Home sector; in particular, this Foreign sector also features fixed costs to domestic production, exporting and FDI which generate a sequence of productivity cutoffs that sort the Foreign firms into the various modes of operation. In the absence of a subsidy, the most productive firms in Foreign would choose to service Home’s market via horizontal FDI so long as  $\tau w_F > w_H$ , namely that the variable cost of exporting from Foreign exceeds the unit cost of locating production in Home itself.<sup>11</sup> Proposition 1 then implies that it would also be optimal for Home to extend a positive FDI subsidy to attract even more Foreign MNCs.

### 3.2 FDI subsidy to variable costs

What happens if the financial incentives are targeted towards MNCs’ variable costs of production instead? Many of the incentive schemes offered in practice, such as job-creation subsidies or corporate tax rate cuts, fall into this category. I show below that the welfare implications of such variable cost subsidies are

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<sup>10</sup>Naturally, if the Foreign government could discriminate between new and existing MNC activity, and extend the subsidy only to new FDI projects, the welfare gains would be even larger.

<sup>11</sup>Together with the earlier condition  $\tau w_H > w_F$ , this implies the necessary condition  $\frac{1}{\tau} < \frac{w_H}{w_F} < \tau$ . Thus, wages cannot differ too much between the two countries if horizontal FDI is to take place in both directions.

similar to what we have seen for a fixed cost subsidy.

Consider a subsidy to the variable costs of Home MNCs' production in Foreign that reduces their effective unit wage costs from  $w_F$  to  $(1 - s_v)w_F$ , where  $s_v < 1$ . As before, suppose that these subsidies are financed by levying a tax,  $t_v$ , on each worker. If this scheme is to be budget-neutral, then:

$$t_v w_F M_F = s_v w_F N A_F \left( \frac{(1 - s_v) w_F}{\alpha} \right)^{-\varepsilon} V^H(a_I) \quad (19)$$

where the right-hand side of (19) is the total amount paid out as production subsidies to the multinationals. Note that a higher demand for Home final goods,  $A_F$ , will now raise the total subsidy bill directly under a variable cost subsidy scheme. We have the following parallel result concerning the welfare improvement from a subsidy to MNCs' variable costs of production:

**Proposition 2 [Variable Cost Subsidy]:** *Consider the family of variable cost FDI subsidies characterized by  $s_v$  that: (i) satisfy the balanced-budget constraint (19); and (ii) preserve the sorting pattern of organizational forms within the industry, namely  $a_U > a_D > a_X > a_I$ . Then the optimal policy,  $s_v^*$ , that maximizes welfare in Foreign is a strictly positive subsidy level, namely  $s_v^* \in (0, 1)$ .*

As with a fixed cost subsidy, a variable cost subsidy exhibits the same selection effect of drawing in the most productive Home exporters who were just shy of the  $a_I^{1-\varepsilon}$  cutoff for FDI. Over and above the selection effect, there is now also a production effect at play, as the variable cost subsidy raises output levels at all overseas affiliates, further increasing the consumption gains to the host country. Put otherwise, the variable cost subsidy helps to partially counteract the inefficiency stemming from the firms' monopoly pricing power, by reducing the effective price markup of MNCs from  $\frac{1}{\alpha}$  to  $\frac{1-s_v}{\alpha}$ . Note also that the proof of Proposition 2 once again requires that  $k > \mu(\varepsilon - 1)$ , to ensure a reasonably small mass of infra-marginal MNCs and hence a small total subsidy bill in the neighborhood of  $s_v = 0$ .

Section 3.6 will make a more careful comparison of the relative efficacy of fixed versus variable cost subsidies. But first, it is useful to isolate the role played by firm heterogeneity in the welfare results, by contrasting what happens when all Home firms have identical productivity levels.

### 3.3 Comparison to a model with homogeneous firms

Consider the case where all firms in Home's differentiated goods sector share the same unit labor input coefficient,  $\bar{a}$ , as in Krugman (1980). This corresponds to a situation where  $G^H(a)$  has its entire mass concentrated at a single point. For simplicity, I continue to treat  $N$  as exogenous.

Suppose that all the Home firms initially service Foreign via exports instead of via FDI, namely  $\bar{a}$  satisfies  $\pi_D(\bar{a}), \pi_X(\bar{a}) > 0$ , but  $\pi_X(\bar{a}) > \pi_I(\bar{a})$ , where the profit functions come from (5)-(7). The question of interest would then be whether a subsidy to the Home firms inducing a switch to FDI improves welfare in Foreign. It turns out that when firms have identical productivity levels, the scope for welfare improvement from a subsidy to FDI is **not** guaranteed.

For the purpose of illustration, let us examine the case of a fixed cost subsidy. Consider a subsidy,  $s_f$ , that would make the Home firms exactly indifferent between exports and FDI as their mode of servicing the Foreign market. This is the smallest subsidy that would induce Home firms to switch to FDI. Setting  $\pi_X(\bar{a}) = \pi_I(\bar{a})$ ,  $s_f$  therefore satisfies:

$$(1 - \alpha)A_{F,I} \left( \frac{\bar{a}w_F}{\alpha} \right)^{1-\varepsilon} - (1 - \alpha)A_{F,X} \left( \frac{\tau\bar{a}w_H}{\alpha} \right)^{1-\varepsilon} = (1 - s_f)(f_I - f_X)w_H \quad (20)$$

where  $A_{F,X}$  and  $A_{F,I}$  are respectively the Foreign aggregate demand levels in the old equilibrium where all Home firms export and in the new equilibrium where all Home firms conduct FDI. Now, the expression for  $X_F^c$  in (3) implies that  $(X_{F,X})^\mu = N^{\frac{1-\alpha}{\alpha}} \frac{\mu}{1-\mu} \left( \frac{\tau\bar{a}w_H}{\alpha} \right)^{-\frac{\mu}{1-\mu}}$  when Home firms export, and  $(X_{F,I})^\mu = N^{\frac{1-\alpha}{\alpha}} \frac{\mu}{1-\mu} \left( \frac{\bar{a}w_F}{\alpha} \right)^{-\frac{\mu}{1-\mu}}$  when Home firms undertake FDI (the  $X$  and  $I$  subscripts distinguish between these two scenarios). One can then obtain expressions for  $A_{F,X}$  and  $A_{F,I}$  from:  $A_F = M_F(X_F)^{\frac{\mu-\alpha}{1-\alpha}}$ .

As before, let the fixed cost subsidy be paid for by revenues from a tax,  $t_f$ , on workers, that satisfies a balanced-budget constraint:  $t_f w_F M_F = s_f (f_I - f_X) w_H N$ . I now substitute the expression for  $s_f$  implied by (20) into this budget constraint to obtain an expression for  $t_f$ . Recalling that the relevant welfare measure is:  $(1 - t_f)w_F + \frac{1-\mu}{\mu}(X_F^H)^\mu$ , one can show that the change in welfare for Foreign,  $\Delta W_{Ff}$ , from this fixed cost subsidy to Home multinationals is:

$$\Delta W_{Ff} = N^{\frac{1-\alpha}{\alpha}} \frac{\mu}{1-\mu} \left( \frac{1}{\mu} - \alpha \right) \left[ \left( \frac{\bar{a}w_F}{\alpha} \right)^{-\frac{\mu}{1-\mu}} - \left( \frac{\tau\bar{a}w_H}{\alpha} \right)^{-\frac{\mu}{1-\mu}} \right] - \frac{s_f (f_I - f_X) w_H N}{M_F} \quad (21)$$

The first summand in (21) represents the consumption gains from a lower price of Home products; this is positive since  $\frac{1}{\mu} > 1 > \alpha$  and  $\tau w_H > w_F$ . The second term is the funding cost of the FDI subsidy program. Observe that  $\Delta W_{Ff}$  can be negative: The higher the fixed cost of FDI,  $f_I$ , the larger the total subsidy bill, which could overwhelm the consumption gains from this policy action. Likewise, the less productive the Home firms are (the higher is  $\bar{a}$ ), the smaller the price decrease in Foreign when Home firms switch from exporting to FDI, so the resulting consumption gains may not be sufficient to generate a welfare increase. (Note that the model does not constrain how large  $f_I$  or  $\bar{a}$  can be: The condition  $\pi_X(\bar{a}) > \pi_I(\bar{a})$  implies lower bounds on  $f_I$  and  $\bar{a}$ , and not an upper bound.)

This discussion highlights the key role played by firm heterogeneity and the selection effect for the results of Sections 3.1 and 3.2. When firms are instead identical in their productivity levels, any subsidy that successfully attracts some Home MNCs necessarily also induces all Home exporters to switch to FDI. This can imply a large subsidy burden if the fixed cost of conducting FDI is very high. Also, the consumption gain may be too small to justify attracting all Home firms to undertake FDI if these firms are not particularly productive to begin with. In contrast, in the model with firm heterogeneity, the continuous distribution of firm productivity levels regulates the amount of FDI induced by the subsidy by attracting only the most productive Home exporters, a selection mechanism that is crucial for delivering a welfare improvement.

### 3.4 Endogenizing the number of varieties

To this point, the number of Home varieties,  $N$ , has been treated as exogenous in order to focus on the shift in the FDI cutoff,  $a_I^{1-\varepsilon}$ , that a FDI subsidy induces. However, the subsidy also increases the *ex ante* profitability of potential entrants to the Home differentiated goods sector, particularly when the host country is a big market. I endogenize  $N$  in this subsection to solve for the full industry equilibrium. The model remains highly tractable, with the subsequent increase in the number of Home varieties reinforcing the gains that accrue to Foreign consumers.

**Free-entry:**  $N$  is pinned down by a free-entry condition, which closes the industry equilibrium in Section 2. Potential entrants do not observe their productivity draw  $1/a$  until after they have started paying a per-period fixed cost of entry equal to  $f_E$  units of Home labor. These prospective firms weigh their expected profits against this fixed cost, with zero *ex ante* profits prevailing in equilibrium. This free-entry condition is:

$$\begin{aligned} f_E w_H &= (1-\alpha)A_H \left(\frac{w_H}{\alpha}\right)^{1-\varepsilon} V^H(a_D) + (1-\alpha)A_F \left(\frac{\tau w_H}{\alpha}\right)^{1-\varepsilon} (V^H(a_X) - V^H(a_I)) \dots \\ &\quad \dots + (1-\alpha)A_F \left(\frac{w_F}{\alpha}\right)^{1-\varepsilon} V^H(a_I) - f_D w_H G^H(a_D) \dots \\ &\quad \dots - f_X w_H (G^H(a_X) - G^H(a_I)) - f_I w_H G^H(a_I) \end{aligned} \quad (22)$$

$$= \Lambda_H (A_H)^{\frac{k}{\varepsilon-1}} + \Lambda_F (A_F)^{\frac{k}{\varepsilon-1}} \quad (23)$$

where the right-hand side of (22) comes from integrating over the productivity distribution,  $G^H(a)$ , to compute expected profits prior to entry. The compact expression in (23) comes from a further substitution and simplification, using the productivity cutoffs in (8)-(10) and the Pareto distribution expressions in (11)-(12). Equation (23) has an intuitive interpretation:  $\Lambda_H (A_H)^{\frac{k}{\varepsilon-1}}$  captures the normalized profits from sales in Home weighted by a measure of the demand level in the Home market, with  $\Lambda_F (A_F)^{\frac{k}{\varepsilon-1}}$  being the analogous term for the Foreign market. The free-entry condition thus equates the fixed cost of entry with the sum of expected profits from both markets.

Substituting now from (13) and (14) into the definition:  $A_i = M_i (X_i)^{\frac{\mu-\alpha}{1-\alpha}}$ , yields:

$$(A_i)^{\frac{k}{\varepsilon-1}} = \left( N \frac{k}{\alpha} \right)^{\frac{k(\mu-\alpha)}{\mu\alpha-k(\mu-\alpha)}} \frac{\tilde{\Lambda}_i}{\Lambda_i} \tilde{M}_i, \quad i = H, F \quad (24)$$

The aggregate demand level in market  $i$  facing each firm is thus increasing in the size of that market,  $M_i$ , while decreasing in the number of competing varieties,  $N$  (since  $\mu < \alpha$ ).

The free-entry condition (23) and the two equations in (24) comprise a system of three equations in three unknowns,  $N$ ,  $A_H$  and  $A_F$ , that can be solved for the equilibrium in the Home sector. Substituting from (24) into (23) and re-arranging yields:

$$N = \frac{\alpha}{k} \left[ \frac{\tilde{M}_H \tilde{\Lambda}_H + \tilde{M}_F \tilde{\Lambda}_F}{f_E w_H} \right]^{\frac{\mu\alpha-k(\mu-\alpha)}{k(\alpha-\mu)}} \quad (25)$$

Not surprisingly, an increase in entry costs,  $f_E$ , decreases the number of Home varieties. Similarly, a rise in Home wages,  $w_H$ , decreases expected normalized profits (both  $\Lambda_H$  and  $\Lambda_F$ ), while also raising entry costs,  $f_E w_H$ , and hence reduces  $N$ . This expression for  $N$  can be substituted into (15) to solve for the consumption aggregate  $(X_F)^\mu$ , and hence welfare, as a function of model parameters only. Note that both  $N$  and  $(X_F)^\mu$  exhibit similar comparative statics, with both variables rising as the market size,  $M_i$ , or normalized profit levels,  $\Lambda_i$ , in either country increases.

Allowing  $N$  to be endogenous introduces an additional varieties effect from the use of a FDI subsidy. Denoting  $N_{Ff}$  (respectively  $N_{Fv}$ ) to be the number of Home varieties in the equilibrium with a fixed cost subsidy  $s_f$  (respectively, a variable cost subsidy  $s_v$ ), we have:

**Lemma 1:**  $\frac{\partial N_{Ff}}{\partial s_f}, \frac{\partial N_{Fv}}{\partial s_v} > 0$  for all  $s_f, s_v < 1$ .

The subsidy to FDI raises the profitability of Home entrants, and so the thickness of the supply side of this sector (namely,  $N$ ) has to increase in equilibrium to continue to ensure that firms earn zero *ex ante* profits. Since the utility function exhibits a “love of variety”, this increase in  $N$  amplifies the consumption gains from the subsidy. For the net effect on Foreign welfare, one must weigh this against the higher subsidy bill to be paid to the larger number of Home firms. It turns out nevertheless that the functions  $W_{Ff}$  and  $W_{Fv}$  inherit the same shape as in the baseline case where  $N$  is fixed: Welfare is an increasing function of  $s_f$  (or  $s_v$ ) when the subsidy level is negative, has a positive slope when the subsidy level is zero, but hits a negative asymptote as the subsidy approaches 1. I summarize this result as follows (see the Appendix for a sketch of the proof):

**Proposition 3** [*N endogenous*]: *For both fixed and variable cost subsidy schemes, the optimal policy that maximizes welfare in Foreign when  $N$  is endogenous continues to be a strictly positive subsidy level that lies in the interior of the interval  $(0, 1)$ .*

In fact, it is straightforward to show that the slope of the welfare function when the subsidy level is 0 is larger in the endogenous  $N$  case compared to the baseline exogenous  $N$  case in both the fixed and variable cost subsidies (see the Appendix). Thus, for small subsidy levels, the increase in the number of Home varieties amplifies the welfare gains accruing to Foreign. The FDI subsidy in fact generates an improvement for both countries, since Home consumers also benefit from the expansion of varieties.

### 3.5 Some Numerical Exercises

It is instructive at this point to examine some numerical examples. This will facilitate a better understanding of how welfare in the host country varies with the chosen subsidy level, as well as how the optimal subsidy shifts with the magnitudes of the underlying model parameters. For these exercises, I consider a setting in which Home and Foreign are completely symmetric in the absence of policy interventions. This means not only that the Home and Foreign heterogeneous firms sectors share the same



structure, but additionally that the two sectors share identical parameter values, including the Pareto shape parameter,  $k$ , and the industry cost parameters.<sup>12</sup> (For the analytical results derived previously in Sections 3.1-3.4, I only require that the Home and Foreign sectors share the same structure, but do not need to assume that they share identical parameter values.)

Figure 2 plots the Foreign welfare functions,  $W_{Ff}$  and  $W_{Fv}$ , using a set of illustrative parameter values. Following Ghironi and Melitz (2005), I set the demand elasticity to  $\varepsilon = 3.8$  (which implies  $\alpha = 0.74$ ), the key productivity spread parameter to  $k = 3.4$ , and the iceberg cost to  $\tau = 1.3$ .<sup>13</sup> There is less precedent in the literature for the remaining parameters, although the conditions  $\mu < \alpha$ ,  $\tau w_H > w_F$ , and  $a_U > a_D > a_X > a_I$  impose some discipline on the values they can take. As a baseline, Figure 2 uses:  $\mu = 0.5$ ,  $f_D = 20$ ,  $f_X = 40$ ,  $f_I = 250$ ,  $f_E = 100$ ,  $a_U = 25$ ,  $w_H = w_F = 1$ , and  $M_H = M_F = 100,000$ .<sup>14</sup> Together, these imply the required productivity cutoff ordering in the heterogeneous firms sector, as well as reasonable summary statistics for key features of the initial industry equilibrium in the absence of a subsidy. 57% of potential entrants survive and engage in production for the domestic market. Of these, 21% of firms are productive enough to export – approximately equal to the fraction of US plants that export reported in Bernard et al. (2003) – while only 4% of firms successfully undertake FDI. Exporting firms are on average 58% more productive than firms that produce solely for the domestic market, while the MNCs are on average 102% more productive than exporting firms. About half (47%) of the labor force in each country is employed in the homogeneous good sector, with the remaining workers employed either in local differentiated goods firms or in MNC affiliates operating locally.<sup>15</sup> The number of varieties in each differentiated goods sector is  $N_H = N_F = 117.2$ .

**[Figure 2 about here]**

Several observations emerge from Figure 2. First, the optimal subsidy is indeed unique (the welfare functions each have a single turning point), both in the fixed and variable cost cases. In general, we cannot actually solve for the optimal subsidy in closed-form from the first-order conditions, nor is it easy to establish analytically that the optimal subsidy is unique; there are for example parameters, albeit

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<sup>12</sup>For the CES consumption aggregates, this symmetry implies that  $X_H^H = X_F^F$  and  $X_H^F = X_F^H$ . However, the use of a FDI subsidy by Foreign only will introduce asymmetries between the two economies. In the exogenous  $N$  case, the consumption of Home differentiated products in the Foreign country,  $X_F^H$ , will increase, but  $X_H^H$ ,  $X_F^F$  and  $X_H^F$  stay constant, due to the additive separability in the country utility function, so long as the productivity cutoff ordering in the heterogeneous firms sector and the positive employment condition in the homogeneous good sector continue to be satisfied.

<sup>13</sup>Ghironi and Melitz (2005) adopt  $\varepsilon = 3.8$  from Bernard et al. (2003). Bernard et al. (2003) also estimate the log standard deviation of US plant sales to be 1.67; since this moment is equal to  $1/(k - \varepsilon + 1)$  in the model, this implies a value of  $k = 3.4$ . The choice of  $\tau = 1.3$  follows from Obstfeld and Rogoff's (2001) deductions on the size of the iceberg transport cost parameter needed to reconcile several empirical puzzles in international macroeconomics.

<sup>14</sup>The welfare functions are invariant to scaling  $f_E$ ,  $f_D$ ,  $f_X$ ,  $f_I$ ,  $M_H$  and  $M_F$  by a positive multiplicative constant. The choice of  $w_H$  and  $w_F$  is in effect a normalization which sets the labor requirement in the homogeneous good sector to one unit of labor per unit output, since the price of this background good is 1.

<sup>15</sup>To obtain this statistic, I calculate the share of the Foreign workforce employed outside its homogeneous good sector (53%) by summing up the shares of Foreign labor that are: (i) producing Foreign differentiated products for domestic consumption and export to Home; (ii) producing Home products for Home MNC affiliates located in Foreign; and (iii) servicing the fixed costs of domestic production, exporting, FDI, and entry for the Foreign heterogeneous firms sector.

very extreme ones, for which the welfare functions are not globally concave.<sup>16</sup> For all practical purposes though,  $W_{Ff}$  and  $W_{Fv}$  do exhibit a unique maximum for a wide range of parameter values. (For a more formal treatment, the Appendix derives a sufficient condition for the uniqueness of the optimal fixed cost subsidy in the exogenous  $N$  case:  $2(\varepsilon - 1) > k$ , which is satisfied by our baseline parameters.) Second, allowing the number of varieties,  $N$ , to respond to the subsidy accentuates the welfare functions without altering their general shape, as was asserted in Proposition 3. For the positive subsidy levels in Figure 2, the case with  $N$  endogenous (dashed-line graphs) has welfare levels raised above that where  $N$  is held fixed (solid-line graphs).<sup>17</sup> Note that while there are other parameter configurations that also respect the key structural assumptions of the model, namely that in both countries: (i) some labor be employed in the background sector, and (ii) the desired ordering of the productivity cutoffs be preserved ( $a_U > a_D > a_X > a_I$ ), the shape of the welfare functions and the qualitative features of the equilibria are nevertheless very similar under these alternative parameterizations. I have moreover checked that these two structural assumptions hold over the range of subsidy values plotted for each welfare function in Figure 2, and in particular at the optimal subsidy.<sup>18</sup>

Figure 3 explores some comparative statics of the optimal subsidy. I graph these for the case of a variable cost subsidy; the behavior of the optimal fixed cost subsidy against each parameter is similar, but quantitatively smaller. I examine first the effect of adjusting the parameters that relate to the cost of exporting, namely  $\tau$  and  $f_X$ . *Ceteris paribus*, as  $\tau$  is raised from 1.05 to 1.4 in panel A, the share of exporting firms decreases steadily from 43% to 14%, similar to the range for this summary statistic (15%-45%) considered in Costantini and Melitz (2007). Likewise, in panel B, as  $f_X$  is increased from 20 to 55 units of labor, the share of exporting firms decreases from 50% to 13%. Both panels show that a larger exporting cost is associated with a higher optimal subsidy. Intuitively, the larger the barriers faced by exporters, the greater the gains to the host country from attracting firms to switch into FDI, and hence the higher the optimal subsidy. Conversely, a higher fixed cost of FDI,  $f_I$ , lowers the optimal subsidy (panel C), since a given FDI subsidy will be less effective at inducing firms to go multinational when  $f_I$  is high. The optimal subsidy is not particularly sensitive to the fixed cost of domestic production  $f_D$  (panel D), since the FDI subsidy affects a margin of firms that is much more productive than those that produce solely for the domestic market. In fact, in the exogenous  $N$  case,  $f_D$  does not alter the optimal subsidy at all ( $f_D$  does not appear in the first-order conditions that pin down  $s_F^*$  or  $s_v^*$ ).

Panel E focuses on the Pareto shape parameter  $k$ . There is an interplay between two effects as  $k$  increases: As less mass is placed on the right-tail of the productivity distribution, fewer firms can potentially become multinationals, which reduces both the consumption gain and the total subsidy bill

<sup>16</sup>When  $k$  is large (for example,  $k = 25$ ) and  $\mu$  is raised closer to the value of  $\alpha$  (for example,  $\mu = 0.6$  and  $\alpha = 0.74$ ),  $W_{Fv}$  ceases to be globally concave in the interval  $(0, 1)$ .

<sup>17</sup>For the exogenous  $N$  graphs, the value of  $N$  used is given by (25) with the subsidy level set to 0.

<sup>18</sup>In Figure 2, it takes a large subsidy ( $s_f = 0.79$  or  $s_v = 0.32$  respectively) to lower the FDI cutoff,  $a_I^{1-\varepsilon}$ , down to the exporting cutoff,  $a_X^{1-\varepsilon}$ . The welfare functions reach their turning points before these respective upper bounds on the permissible subsidy level, ensuring that  $a_X > a_I$  at the optimal subsidy.

from a given FDI subsidy. The reduced consumption gain tends to lower the optimal subsidy, whereas the smaller fiscal cost tends to raise the optimal subsidy instead. For the exogenous  $N$  case, the latter effect is more salient for smaller values of  $k$ . However, the former effect dominates as  $k$  increases, and the optimal subsidy appears to asymptote towards zero. This is consistent with the idea that as we approach the Krugman (1980) case with homogeneous firms ( $k \rightarrow \infty$ ), the scope for a FDI subsidy to generate a welfare gain becomes more limited. There is a caveat here, namely that as  $k$  increases, the productivity distribution becomes more concentrated at a point mass. In particular, the domestic cutoff  $a_D$  increases and eventually overshoots  $a_U$ , so that the condition  $a_U > a_D$  can no longer be satisfied. What is plotted as the optimal subsidy in panel E is the value of  $s_v$  at which the welfare function  $W_{Fv}$  reaches its maximum, but one should bear in mind that one cannot increase  $k$  indefinitely without violating the required ordering of productivity cutoffs in the industry equilibrium.<sup>19</sup>

[Figure 3 about here]

Last but not least, an increase in the demand elasticity,  $\varepsilon$ , lowers the optimal subsidy (panel F). The consumption gains from a FDI subsidy are intuitively smaller if there is more scope for substitution between differentiated products.<sup>20</sup> Finally, note that throughout Figure 3, the optimal subsidy when  $N$  is endogenous (solid-line graphs) exceeds that when  $N$  is exogenous (dashed-line graphs). This is not surprising since the host country stands to gain more when the number of Home varieties is allowed to increase in response to the subsidy (Proposition 3).

### 3.6 Fixed versus Variable Cost Subsidies

How does the welfare level at the optimal fixed cost subsidy,  $s_f^*$ , compare to that at the optimal variable cost subsidy,  $s_v^*$ ? Figure 2 points to a *prima facie* case in favor of variable cost subsidies from the perspective of Foreign welfare levels, since these appear to generate much larger gains than fixed cost subsidies. As argued earlier, a variable cost subsidy delivers a greater kick to welfare by raising each firm's output from its inefficiently low level. This production effect is absent with a fixed cost subsidy, which only affects a Home firm's decision on exporting versus FDI.

Formally, we can derive the following result to compare the efficacy of the two types of subsidy schemes (see the Appendix for a proof):

**Proposition 4 [Fixed versus variable cost subsidy]:** *Suppose that  $\varepsilon > 2$  and that the number of Home varieties is fixed. Consider only those subsidies with  $s_f, s_v \in (0, 1)$  that: (i) satisfy a balanced-budget constraint; and (ii) preserve the sorting pattern of organizational forms within the industry, namely*

<sup>19</sup>I do not encounter this problem with the other model parameters. For the range over which the other parameters are graphed in Figure 3, the productivity ordering in the heterogeneous firms sector and the positive employment condition for the homogeneous good sector are satisfied in both countries.

<sup>20</sup>As I vary  $\varepsilon$  in panel F, I have held the log standard deviation of plant sales constant at 1.67 (from Bernard et al., 2003). Since this moment is equal to  $1/(k - \varepsilon + 1)$  in the model, this means that the value of  $k$  adjusts to keep the log standard deviation constant. The graph looks similar if I instead fix  $k$  at its initial value of  $k = 3.4$  as I vary  $\varepsilon$ .

$a_U > a_D > a_X > a_I$ . Then, a variable cost subsidy that incurs the same total subsidy bill as a fixed cost subsidy delivers greater consumption gains to Foreign.

A variable cost subsidy therefore has more bang for the buck, delivering a greater increase in utility than a corresponding fixed cost subsidy with the same amount of public spending. It follows that the welfare level achieved by the optimal variable cost subsidy,  $s_v^*$ , will be higher than that reached by the optimal fixed cost subsidy,  $s_f^*$ . The requirement that  $\varepsilon > 2$  also has an intuitive interpretation: Consumer demand needs to be sufficiently elastic, so that a given price decrease with the introduction of a variable cost subsidy will generate a large increase in consumption. (Note that this condition is satisfied by the baseline parameter values used in the numerical exercises.)

It is important however to highlight a key caveat. As it stands, the only motive in the model for a Home firm to open a plant in Foreign is to service that market, so that FDI is of a purely horizontal nature. In practice, much of the foreign affiliate activity that takes place services more than just the local market, with some output from the foreign assembly plant being shipped back to the home or third-country markets (Eckholm et al., 2003, Grossman et al., 2006). The scope for welfare improvement from a variable cost subsidy is potentially fragile to incorporating such an export-platform motive, since re-exports represent subsidized production for which the consumption gains accrue purely to other countries. If the third-country market that the affiliate is servicing is large, re-exports would raise the total subsidy bill without generating corresponding gains to domestic consumers, potentially negating the scope for a welfare improvement. To avoid this outcome, the subsidy would have to be administered as a domestic sales or retail credit (a rebate to local consumption), instead of as a direct subsidy to production. In contrast, this caveat does not apply to a fixed cost subsidy, since that alters only firms' mode of servicing the Foreign market, but does not affect firms' choice of output levels.

## 4 Some Extensions

I briefly discuss two extensions. The first examines a similar policy intervention, namely import subsidies to promote more exporting by Home firms to the Foreign market. The second explores the robustness of the results under an alternative utility function that builds in richer income effects.

### 4.1 Import subsidies

The above model lends itself naturally to an analysis of trade policy. It is well-established that the optimal policy for a country with a downward-sloping import demand curve is to levy a tariff, since the tariff revenue outstrips the loss in consumer surplus when the tariff is small (see Helpman and Krugman, 1989). In view of this result, previous arguments advanced for the opposite policy of an import subsidy have raised the possibility of dynamic gains. Dasgupta and Stiglitz (1988) posit that when learning-by-doing effects are large, it may be optimal to subsidize imports to promote learning by foreign producers,

which lowers prices in the long run.

The framework with heterogeneous firms suggests another mechanism through which import subsidies might be beneficial, by increasing the set of products that is exported to the Foreign market. In this case, however, the intuition is less neat: An import subsidy will induce some Home firms to start exporting to Foreign, delivering positive consumption gains (from a leftward shift of the  $a_X^{1-\varepsilon}$  cutoff in Figure 1), but it will also prompt some Home MNCs to switch from horizontal FDI back to exporting, raising prices for Foreign consumers for this margin of goods (as the  $a_I^{1-\varepsilon}$  cutoff shifts to the right). It is nevertheless straightforward to analyze the welfare impact of either a fixed or variable cost subsidy to imports, following steps analogous to Sections 3.1 and 3.2. For this alternative policy intervention, it turns out that a small subsidy is once again welfare-improving:

**Proposition 5 [Import Subsidies]:** *Consider the family of fixed cost (respectively variable cost) import subsidies that: (i) satisfy a balanced-budget constraint; and (ii) preserve the sorting pattern of organizational forms within the industry, namely  $a_U > a_D > a_X > a_I$ . Then the optimal policy that maximizes welfare in Foreign is a strictly positive subsidy level.*

The proof is similar to that for Propositions 1 and 2, as it hinges on showing that the welfare function has a positive slope in the neighborhood where the subsidy level is zero. (Details are in the supplementary Appendix.) Thus, the consumption gains from drawing in more firms at the  $a_X^{1-\varepsilon}$  cutoff outweigh the loss of MNCs at the  $a_I^{1-\varepsilon}$  margin, with the intuition being that there is a greater density of firms at the exporting cutoff than the FDI cutoff. The proof also relies on the inequality:  $k > \varepsilon - 1$ , to ensure that the mass of firms to be subsidized is not too large. Naturally, when  $N$  is allowed to be endogenous, the subsequent increase in the number of varieties in the Home sector reinforces the welfare gains from a small subsidy, akin to the varieties effect in Proposition 3.

It is useful to highlight how this result can be reconciled with Demidova and Rodriguez-Clare (2008), who find instead that the optimal policy is an import tariff when the domestic economy is composed solely of a heterogeneous firms sector. Their model identifies two welfare distortions, both of which are also present in this paper. There is first a markup distortion, by which markup pricing by domestic firms leads to an under-consumption of domestic varieties (imports are purchased at opportunity cost from the perspective of the domestic economy). Second, there is a consumer surplus distortion, by which the failure of Foreign consumers to internalize the effects of their purchases on the entry of Home firms leads to an under-consumption of import varieties (which gives rise to what I term the selection effect). In Demidova and Rodriguez-Clare (2008), it turns out that the former effect dominates the latter, so that it is optimal to impose an import tariff to raise consumption of domestic varieties. Intuitively, in the absence of a homogeneous good sector, the domestic wage is endogenous, so an import tariff raises the demand for domestic varieties and hence wages. This direct boost to income turns out to be sufficient to offset the loss due to the decrease in import varieties. This is however no longer the case when a

constant returns-to-scale homogeneous good sector (such as the  $x_i^0$  sector) is included in the model. An import tariff would now introduce a further distortion, by increasing consumption of the homogeneous good above its optimal level. Achieving the first-best instead requires an import subsidy together with a consumption subsidy for domestic varieties, to correct the consumer surplus and markup distortions respectively. In particular, an import tariff alone cannot achieve the first-best, and an import subsidy is now welfare-improving. In sum, the divergence in results in the two papers can be traced to the distinct production structures considered in each model.<sup>21</sup>

## 4.2 Robustness to specification of utility function

The quasilinear utility function (1) has facilitated the analysis by providing a closed-form expression for country welfare. One relevant concern is that this function carries the restriction that any exogenous change in labor income,  $w_F$ , affects only the consumption level of the homogeneous good. If instead the demand for differentiated products were also to exhibit a positive income elasticity, then the decrease in disposable income from the labor tax could dampen the welfare gains from a FDI subsidy.

A natural way to incorporate more general income effects is with the following country  $i$  utility function:

$$U_i = \left( (x_i^0)^\rho + \left( \sum_{c=H,F} \frac{1}{\mu} (X_i^c)^\mu \right)^{\frac{\rho}{\mu}} \right)^{\frac{1}{\rho}}, \quad 0 < \rho < \mu < \alpha < 1$$

This introduces a constant elasticity of substitution (equal to  $\frac{1}{1-\rho}$ ) between the demand for the homogeneous good,  $x_i^0$ , and the differentiated varieties aggregate,  $\sum_{c=H,F} \frac{1}{\mu} (X_i^c)^\mu$ . (We require  $\rho < \mu$ , so that differentiated products are always better substitutes for each other than the homogeneous good.) With utility no longer quasilinear in  $x_i^0$ , the demand for differentiated products now depends directly on disposable income,  $(1 - t_f)w_F$ , as well as on the demand for varieties from the other country. Also, the utility derived from consumption of the Home and Foreign differentiated goods will no longer be additively separable. This more general specification does however sacrifice some tractability, as welfare can no longer be written down in a convenient closed-form, so the subsidy analysis requires us to perform comparative statics on the system of equations that defines the industry equilibrium.

It turns out that our welfare results continue to hold with this alternative utility function, with the optimal policy being a small subsidy to MNCs. (The proof is in the Appendix.) Of note, the condition  $k > \varepsilon - 1$  once again ensures a relatively small mass of MNCs, and hence a small total funding cost for the subsidy scheme. This further implies a small per worker tax burden,  $t_f$ , so that the negative income effect of this tax on the consumption of differentiated products fails to wipe out the overall welfare gain. It is thus reassuring that the welfare implications for FDI subsidies carry through when some allowance is made for the demand for differentiated products to be subject to income effects.

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<sup>21</sup>Demidova and Rodriguez-Clare (2008) also recognize this point, and briefly mention in their Conclusion how their results would change if a constant returns-to-scale sector where prices are set at marginal cost were included in the model.

## 5 Conclusion

This paper builds on a growing literature on firm heterogeneity in international trade by extending it to a policy analysis of FDI subsidies. The paper developed a two-country version of the Helpman et al. (2004) model that admits a closed-form expression for welfare. Focusing on the consumption gains from attracting FDI (the lowered prices at which MNCs' products are sold in the host country), I showed that a small subsidy to either MNCs' fixed or variable costs of operation leads to a rise in welfare in the FDI host country, after accounting for the cost of financing this policy through a tax on workers' income. Of note, these consumption gains already generate a welfare improvement for the host economy, even while putting aside other potential gains from such further considerations as technological spillovers, agglomeration economies, or an increased demand for local labor.

This welfare improvement is driven by a selection effect, highlighting the key role played by firm heterogeneity in these results. The FDI subsidy enables the host country to attract those Home exporters that previously fell just shy of the FDI cutoff to switch to servicing the Foreign market via horizontal FDI. Being from a relatively productive margin, these firms set lower prices and their products are demanded in relatively high quantities, so the resulting savings on cross-border transport costs from the switch to FDI delivers substantial consumption gains to Foreign. At the same time, for these consumption gains to exceed the funding cost of the subsidy scheme, one also needs the mass of MNCs to be subsidized to be relatively small. This translates into a requirement that the firm distribution not place too large a mass on high productivity levels. What is particularly neat is that the implied formal condition on the heterogeneity parameter of firm productivities is one that empirical research has shown is readily satisfied in practice (Helpman et al. 2004). The model also concludes that in general, a variable cost subsidy delivers a larger welfare improvement than a fixed cost subsidy: A reduction in MNCs' variable costs of operation has an additional production effect that partially corrects the inefficiently low output levels stemming from firms' monopoly pricing power.

As a cautionary concluding remark, it has to be stressed that this paper should not be read as a *carte blanche* endorsement of generous subsidies to FDI. Naturally, the actual implementation and governance of any such schemes will have to be carried out carefully, in order to determine what the appropriate subsidy level should be. Moreover, while the model does establish sharp benchmark results, it abstracts from such issues as strategic competition among countries for FDI or political economy forces (the presence of lobbies) that could qualify and alter the conclusions on the efficacy of FDI subsidies.<sup>22</sup> These are all relevant issues for future work to consider within this setting with heterogeneous firms.

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<sup>22</sup>See for example Janeba (2004), where FDI subsidies generate a redistributive effect from workers to firms, which limits the scope for large subsidies if workers have sufficient political clout. Also, Janeba (2002) considers a model where the host government is unable to make credible long-term commitments to its announced tax or subsidy policies.

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**Figure 1: The Sorting Pattern within Home's Differentiated Goods Sector**  
 (drawn holding the aggregate demand level  $A_F$  fixed)

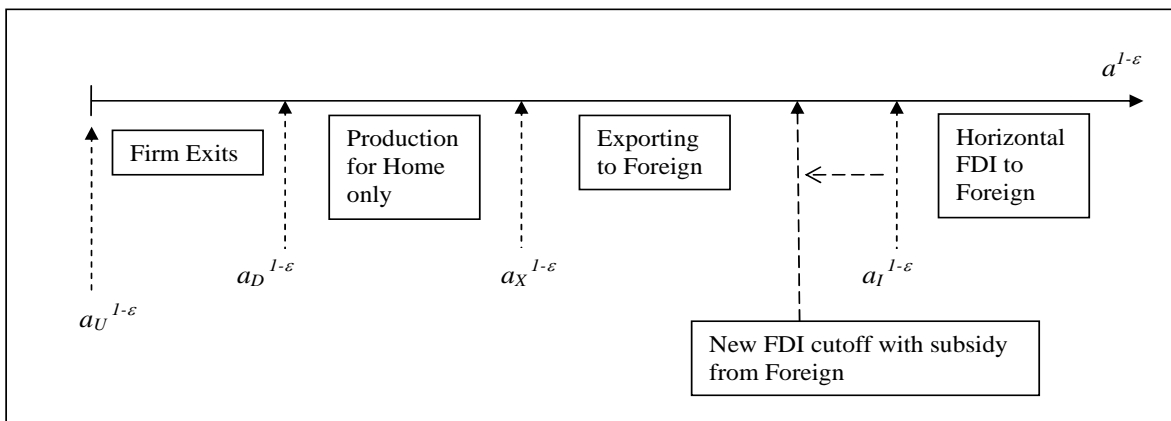
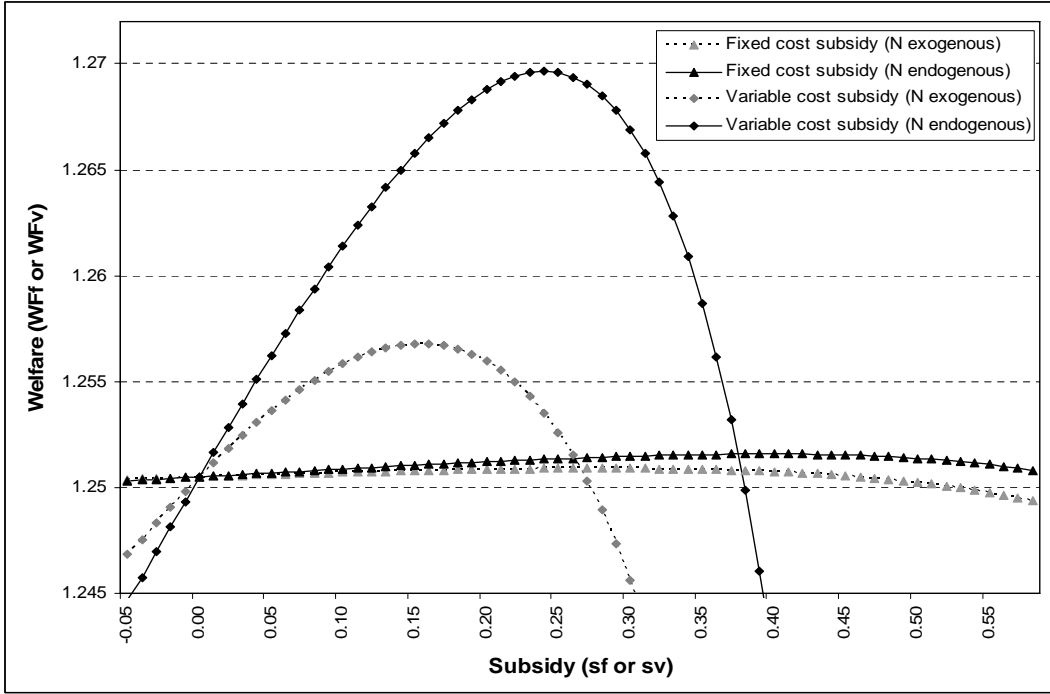
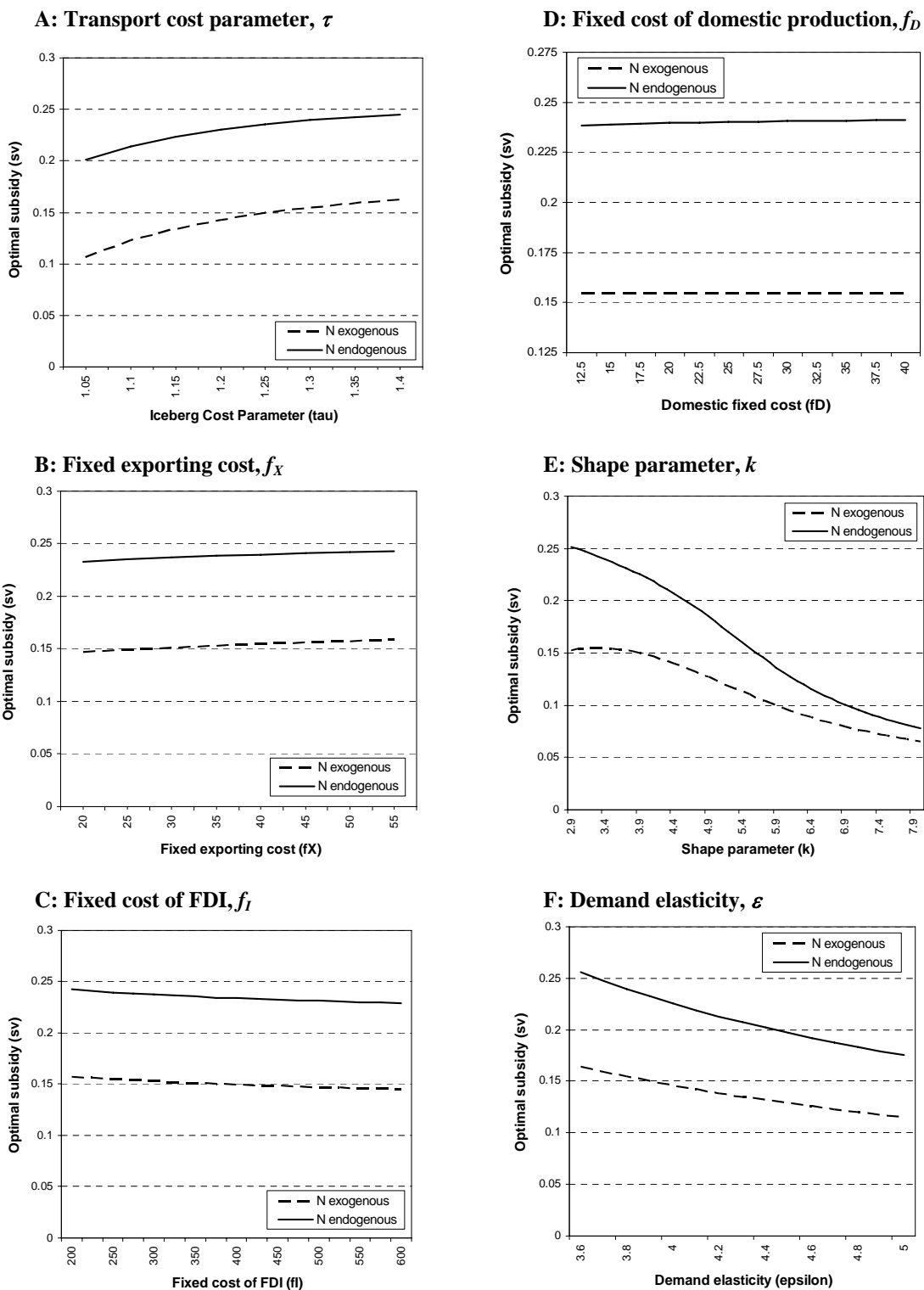


Figure 2: Welfare as a Function of the Subsidy Level



**Notes:** Parameter values are:  $k = 3.4$ ,  $\varepsilon = 3.8$  (which implies  $\alpha = 0.74$ ),  $\mu = 0.5$ ,  $\tau = 1.3$ ,  $f_D = 20$ ,  $f_X = 40$ ,  $f_I = 250$ ,  $f_E = 100$ ,  $a_U = 25$ ,  $w_H = w_F = 1$ , and  $M_H = M_F = 100,000$ . These parameter choices imply the order of productivity cutoffs imposed in the model, namely  $a_U > a_D > a_X > a_I$ . For the graphs where the measure of Home firms is exogenous, the value of  $N$  used is that obtained when setting the subsidy level to 0 in equation (25).

**Figure 3: Some Properties of the Optimal Subsidy Level**  
(illustrated for a variable cost subsidy to FDI)



**Notes:** In each panel, the optimal subsidy is plotted against the parameter of interest that is being varied, holding the other model parameters fixed at their baseline values (see notes to Figure 2).