# Subsidizing firm entry in open economies

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**Abstract**
Entrepreneurs who decide to start a business are faced with different levels of effective entry costs in different countries. These costs are heavily influenced by economic policy through entry regulation and subsidies. In this paper we present a two-country general equilibrium model with monopolistic competition and heterogeneous firms where entrants pay a sunk cost and randomly draw their productivity level. Governments collect lump-sum taxes and subsidize these sunk entry costs for the domestic entrepreneurs. One motive for this policy, valid already in autarky, is to tighten market selection. This selection effect leads to better firms that produce and sell more output at lower prices. In the open economy there is another, strategic motive for entry subsidies as the tightening of market selection leads to a competitive advantage for domestic producers in international trade. Our analysis shows that entry subsidies in the Nash-equilibrium are first increasing, then decreasing in the level of trade freeness. This implies a U-shaped relationship between trade freeness and effective entry costs. Comparing the non-cooperative and the cooperative policies, we furthermore show that there is first too much and then too little entry subsidization in the course of trade integration.

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# 1. Introduction

An entrepreneur who decides to enter an industry must undergo a number of costly legal procedures in order to start up a firm. The complexity of this process of obtaining all necessary permits, paying all fees and complying with other official requests differs vastly across countries. In a seminal study, Djankov et al. (2002) report that starting a business in Canada requires only two steps and works almost instantaneously, while setting up a firm in the Dominican Republic is much more complicated and requires some 21 different procedures and a waiting time of at least 80 business days. At the same time, governments also often encourage entry by means of start-up grants, guaranteed loans, preferential tax treatments, or other forms of subsidies. Entrepreneurs are thus faced with different levels of *effective entry costs* in different countries. These costs, which are typically sunk for the entrants, are not entirely set by governments as they also include upfront expenses for research and development, marketing etc., but they are heavily influenced by economic policy.

Policymakers have become increasingly aware of the welfare-enhancing effects of business start-ups in recent years. As an example, the Council of Economic Advisers acknowledges in a recent *Economic Report to the President* that the low costs of business entry with relatively few administrative hurdles were key for the superior efficiency gains in the US compared to other countries (Council of Economic Advisers, 2007).[1] Supporting new business is therefore high on policy agendas and public subsidies in support of new business foundation are among the most widespread and frequently used instruments of industrial policy in practice.

An extensive literature addresses a plethora of motivations for such policies which range from curing market failures to increasing competition and to fostering innovation.[2] This literature has not explored the repercussions that emerge in open economies that exploit market entry subsidies, however. In fact, what is not well understood in the literature yet is how international trade affects governments' incentives to impact on effective entry costs for domestic entrepreneurs, and how entry subsidies can be used strategically in open economies. These are the questions that we explore in this paper.

[1] A similar point is made in the EU Commission's statements regarding its Lisbon growth and employment agenda (see EU 2005) and its state aid scoreboard (see EU 2007), as well as in recent reports by the German government (see BuMiFin, 2007) and the German Board of Economic Advisers (see Sachverständigenrat, 2009).

[2] Important issues are the motives to ensure that sellers meet minimum quality standards, to address market failures associated with externalities (e.g., environmental issues or knowledge spillovers), capital market imperfections, policies to restrain the market power of incumbent firms and the fostering of innovation (see, e.g., Bresnahan and Weiss, 1991; European Economic Advisory Group, 2008; Santarelli and Vivarelli, 2007). Another strand of the literature stresses the fact that entry regulation may (partly) be due to less benign political-economy considerations such as the self-interest of bureaucrats who trade entry permits for lobbying contributions (see Djankov et al. 2002 for a discussion).

We build on a model of intra-industry trade with heterogeneous firms á la Melitz (2003), where we assume two (potentially asymmetric) countries and two sectors: a monopolistically competitive manufacturing industry and a perfectly competitive outside sector. That model is well suited as the basis for our analysis, because it explicates the process of firm entry with ex-ante uncertainty in a general equilibrium framework. Entrepreneurs in the manufacturing sector pay a sunk entry cost and randomly draw their productivity level. Only firms with a sufficiently high productivity draw that exceeds some endogenously determined cutoff level remain in the market. Firms with too low productivity immediately exit. When the economy opens up to trade only the most productive firms self-select into export markets and gain market shares. Less productive firms sell only domestically, and the least efficient ones are forced to shut down.

The level of sunk entry costs, which is crucial for the analysis, is purely exogenous in Melitz (2003) and in the subsequent vast literature on firm heterogeneity. In this paper we introduce a government that collects lump-sum taxes in order to finance subsidies which reduce effective entry costs for the domestic entrepreneurs. In autarky such a subsidy quite naturally increases the mass of entrants who decide to start a business. The mass of surviving firms in the market is far less responsive in the autarky equilibrium, because the subsidy encourages competition and thereby raises the toughness of firm selection. Indeed, with our model's specification, the subsidy does not lead to *more* but to *better* firms in the market. These more productive firms produce and sell more output at lower prices to the benefit of consumers.

In the open economy, the increased competition and selection induced by entry subsidies is transmitted to exporters from the other country. Export market entry becomes more difficult for foreign enterprises. This negatively affects expected profits, entry incentives and the quality of foreign firms, and strengthens the market position of domestic firms. Due to these general equilibrium interactions, there is scope for governments to use entry subsidies *strategically* in order to give domestic producers a competitive advantage in trade. This strategic use is particularly interesting, because entry subsidies to local entrepreneurs are mainly perceived as a domestic policy issue and not as a classical trade policy instrument (such as import tariffs or export subsidies) whose abuse is put under scrutiny, e.g., by the WTO or the European Commission. Our analysis reveals that entry subsidization does have strong cross-country repercussions and, hence, is not innocuous in an open economy context.

In the analysis we solve for the entry subsidies in the Nash-equilibrium, which depend on the level of trade freeness. More specifically, we show that gradual trade liberalization first leads to an increase, then to a decrease of the non-cooperatively chosen entry subsidies. Put differently, our model predicts a U-shaped relationship between trade freeness and the level of effective entry costs. These Nash-equilibrium subsidies differ from the level that would be chosen if the two countries coordinated their entry subsidization policies. In fact, comparing the Nash-equilibrium with the cooperative solution, our analysis suggests that there is first too much and then too little entry subsidization in the course of trade integration.

The remainder of this paper is structured as follows. In the rest of this section we review some related literature. Section 2 analyzes the closed economy case. Section 3 turns to the open economy, and in section 4 we analyze entry subsidies for the case of two identical countries. Section 5 deals with the case of size and technology differences across countries. In section 6 we provide a discussion and briefly confront our key theoretical result about the relationship between trade freeness and effective entry costs with real world data.

***Related literature:*** Our paper is firstly related to the literature on firm entry in industrial organization. The contribution by Hopenhayn (1992) is particularly noteworthy here, because that model also explicitly features ex-ante uncertainty of entrants in a general equilibrium setting, yet without analyzing endogenous government subsidies to entry costs. Furthermore, our paper is mainly differentiated from that literature, because we explicitly deal with open economy issues and study the effects of gradual trade liberalization.

Secondly, our paper is related to the large literature on strategic trade policy assuming oligopolistic market structures (see Brander 1995 for a survey). While this literature has extensively studied government interaction for a number of policy instruments (such as export or import subsidies, state aid, tariffs, quotas, etc.) it has remained largely silent on entry regulation, with the paper by Reitzes and Grawe (1999) being one exception. In the older literature on trade with monopolistic competition there is also an extensive discussion on corrective policies (see Helpman and Krugman 1989, Flam and Helpman 1987). Our paper differs from that literature because we introduce firm heterogeneity. This gives rise to several new insights, for example that entry subsidies may not mainly increase the mass but the average productivity of firms in the market.

Thirdly, a recent literature has started to analyze policy issues in the now standard heterogeneous firms frameworks by Melitz (2003) and Melitz and Ottaviano (2008). Demidova and Rodriguez-Clare (2009) conduct a welfare analysis of a small open economy and study various policy instruments that can be used to improve the allocation. They do not address government subsidies to entry costs, however, and they do not analyze a strategic interaction of governments in the setting of a domestic policy like the present paper does.

Baldwin and Forslid (2006) also present a welfare analysis of a one-sector Melitz-type model. Jorgensen and Schröder (2008) study the effects of exogenous tariffs, and Cole and Davies (2009) consider optimal tariffs when firms differ in fixed rather than in variable costs. In Cole and Davies (2009) firms can also choose to engage in FDI rather than in exporting. None of these papers discusses endogenous entry regulation. Chor (2009) analyzes the case where governments subsidize the fixed export costs for foreign firms, but he does not consider subsidies to the effective entry costs of domestic entrepreneurs. Though he identifies a similar pro-selective effect of subsidies, he does not consider a strategic policy game of governments.

Finally, this paper is also broadly related to the literature on international tax competition. In that literature, Davies and Eckel (2009), Baldwin and Okubo (2009) and Krautheim and Schmidt-Eisenlohr (2009) have considered heterogeneous firms, but again none of these papers considers the strategic use of entry regulation.

# 2. Closed economy

We first consider the case of a single country in autarky. Labor is the only factor of production, and there are $L$ workers who supply one unit of labor each. There are two industries, $A$ and $C$. The homogeneous good $A$ is characterized by constant returns to scale and perfect competition. The sector $C$ is the monopolistically competitive manufacturing industry consisting of a continuum of differentiated varieties. Each variety is produced by a single firm under increasing returns, and firms are heterogeneous in their productivity.

### *2.1. Preferences*

Preferences for household $h$ are defined over the homogenous commodity $A$ and the set of differentiated varieties ($\Theta$) according to the following quasi-linear, logarithmic utility function with CES sub-utility:

$$U^h = \beta \ln C^h + A^h \qquad\qquad C^h = \left( \int_{z\in\Theta} q^h(z)^\rho dz \right)^{1/\rho}, \tag{1}$$

where $0 < \rho < 1$, $\beta > 0$. $q^h(z)$ denotes household $h$'s consumption of variety $z$. The elasticity of substitution between any two varieties is given by $\sigma \equiv 1/(1-\rho)$. As is well known from Dixit and Stiglitz (1977), the variable $C^h$ can be understood as the consumption of the manufacturing aggregate with aggregate price

$$P = \left( \int_{z\in\Theta} p(z)^{1-\sigma} dz \right)^{1/(1-\sigma)}. \tag{2}$$

The budget constraint of an individual is $P \cdot C^h + A^h = y^h$, where $y^h$ denotes income. From standard utility maximization it follows that per-capita expenditure on the manufacturing aggregate and the numéraire good are given by $P \cdot C^h = \beta$ and $A^h = y^h - \beta$, respectively, and that indirect utility is of the form $V^h = y^h - \beta \cdot \ln P + \beta(\beta - 1)$. We drop the index $h$ from now on as households are identical. It must be ensured that $\beta < y$, i.e., the preference for varieties relative to the outside commodity must be sufficiently small.[3] Total demand for a single variety $z$ is denoted by $q(z) = \beta L \cdot p(z)^{-\sigma} \cdot P^{\sigma-1}$, and total revenue for that variety is $r(z) = p(z) \cdot q(z) = \beta L \cdot \left(P/p(z)\right)^{\sigma-1}$. Finally, overall manufacturing expenditure equals $\beta L$.

### *2.2. Production and firm behavior*

Firms in the $A$-sector transform one unit of labor into one unit of output. This pins down the wage in the closed economy, which is equal to one. Technology in the manufacturing sector is such that, to produce $q$ units of output, a firm needs $\ell = f + q/\varphi$ units of labor. The fixed overhead production cost $f$ is the same, but the variable labor requirements $(1/\varphi)$ differ across firms. Due to the CES preferences for manufacturing varieties, each firm faces a residual demand curve with constant price elasticity $-\sigma$. As firms have zero mass they cannot affect market aggregates and neglect the impact of their own price on the price index (2). All firms charge prices which are constant mark-ups over the firm-specific level of marginal costs. Specifically, a firm with marginal cost $(1/\varphi)$ charges the price

$$p(\varphi) = \frac{\sigma}{(\sigma - 1)\varphi} = \frac{1}{\rho \cdot \varphi} \tag{3}$$

Revenue and profits of that firm are then, respectively, given by $r(\varphi) = \beta L \cdot (\rho \varphi P)^{\sigma-1}$ and $\pi(\varphi) = r(\varphi)/\sigma - f$. It can be seen that a firm with higher productivity level $\varphi$ charges a lower price, sells a larger quantity and has higher revenue and profits. Furthermore, as all firm-specific variables differ only with respect to $\varphi$, the CES price index (2) can be rewritten in the following form (see Melitz 2003):

$$P = M^{1/(1-\sigma)} \cdot p(\tilde{\varphi}) = M^{1/(1-\sigma)} \cdot \frac{1}{\rho \tilde{\varphi}}, \qquad \text{with } \tilde{\varphi} \equiv \left( \int_0^\infty \varphi^{\sigma-1} \cdot \mu(\varphi) d\varphi \right)^{1/(\sigma-1)}. \tag{4}$$

$M$ denotes the mass of manufacturing firms/varieties in the market, $\mu(\varphi)$ describes the productivity distribution across these active firms (which has positive support over a subset of $(0, \infty)$), and $\tilde{\varphi}$ can be understood as the average productivity level.

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[3] Note that the quasi-linear preferences eliminate income effects of demand for manufacturing varieties and imply constant marginal utility of income. Upon request we provide a proof that all key results of this paper also hold with Cobb-Douglas upper tier preferences.

### 2.3. Entry and exit

There exists a mass of potential entrepreneurs who can enter the manufacturing industry subject to an effective sunk entry cost $\tilde{f}_e$. At each point in time there is a mass of $M^E$ entrepreneurs who enter. Upon entry they learn about their productivity level $\varphi$, which is drawn from a common and known density function $g(\varphi)$ with support $(0,\infty)$ and cumulative density function $G(\varphi)$. After the productivity level is revealed an entrant can decide to exit immediately or to remain active in the market, in which case that firm earns constant per-period profits $\pi(\varphi)$. It will exit at once if $\pi(\varphi) < 0 \leftrightarrow r(\varphi) < \sigma f$. Only those firms remain active whose productivity draw exceeds some cutoff level $\varphi^* > 0$.

Once in the market, every surviving firm may then be hit by a bad shock which forces it to shut down. Following Melitz (2003) we assume that this event occurs with probability $\delta > 0$ at every point in time, and that this probability is independent of the productivity draw $\varphi$. In a stationary equilibrium without time discounting, on which we focus in this paper, the mass of entrants which successfully make it into the market equals the mass of firms that are forced to shut down. Formally, $p_{in} \cdot M^E = \delta \cdot M$, where $p_{in} = 1 - G(\varphi^*)$ is the survival probability. The endogenous productivity distribution among surviving firms, $\mu(\varphi)$, is then the conditional (left-truncated) ex-ante distribution $g(\varphi)$ on the domain $[\varphi^*, \infty)$.

### 2.4. Government and entry subsidization

The novel focus of this paper is on the role of governments in influencing sunk entry costs. We assume that effective entry costs are given by $\tilde{f}_e = f_e - s$, where $f_e$ denotes exogenous raw costs capturing unavoidable irreversible expenses for research and development and where $s$ is the entry subsidy offered by the government. In practice, governments can reduce effective entry costs also by simplifying legal procedures, reducing red tape or adopting related types of deregulation. Such reforms may reduce bureaucratic rents (which are not the focus of this paper) but do not impose the need for collecting taxes. In this paper we assume that all possibilities for such "costless" reforms are exhausted, and we shall focus on entry subsidies that need to be financed by the government. Specifically, we assume that the government levies a lump-sum tax $t$. As gross per-capita income is equal to one by the choice of the numéraire, individual after-tax income is $y = 1 - t$ and aggregate tax revenue is $t \cdot L$. This money is spent on the non-refundable entry subsidy $s$ that is unconditionally available to all entrants $M^E$ before productivity $\varphi$ is drawn, and that does not have to be paid back by the entrepreneurs if they succeed in the market.[4] The government budget constraint is, therefore, given by $t \cdot L = s \cdot M^E(s)$ where the mass of entrants depends on the entry subsidy $s$.

### *2.5. Equilibrium in the closed economy and parameterization*

To derive the equilibrium within the manufacturing sector we draw on Melitz (2003) who has shown that equilibrium can be characterized by two conditions, the free entry condition (FEC) and the zero cutoff profit condition (ZCPC).

$$\text{(FEC)} \quad \bar{\pi} = \frac{\delta \tilde{f}_e}{1 - G(\varphi^*)} \qquad\qquad \text{(ZCPC)} \quad \bar{\pi} = f\left(\left(\frac{\tilde{\varphi}}{\varphi^*}\right)^{\sigma-1} - 1\right)$$

$\bar{\pi} = \pi(\tilde{\varphi})$ is the ex-ante expected profit conditional on survival, which is equivalent to the profit level of the average surviving firm with productivity level $\tilde{\varphi}$. The (FEC) states that entry occurs until the value of entry, $v^E = E[\sum_{t=0}^{\infty}(1-\delta)^t \cdot \pi(\varphi)] - \tilde{f}_e$, is driven to zero. The (ZCPC) states that the cutoff firm generates revenue $r(\varphi^*) = \sigma f$, which, by using $r(\tilde{\varphi})/r(\varphi^*) = (\tilde{\varphi}/\varphi^*)^{\sigma-1}$ and $\bar{\pi} = r(\tilde{\varphi})/\sigma - f$, implies the expression above. One can substitute the (ZCPC) into the (FEC) to obtain the following equilibrium relationship, $\frac{f}{\delta} \cdot (1 - G(\varphi^*)) \cdot \kappa(\varphi^*) = \tilde{f}_e$, where $\boldsymbol{\kappa(\varphi^*) = [(\tilde{\varphi}/\varphi^*)^{\sigma-1} - 1]}$. Melitz (2003) proves that the left-hand side of this equation is monotonically decreasing in $\varphi^*$ over the range $(0,\infty)$ and crosses $\tilde{f}_e$ only once from above. This equilibrium determination is illustrated in figure 1, where the initial level of effective entry costs is depicted by the thick horizontal curve.

**[FIGURE 1 HERE]**

Hence, there exists a unique solution for $\varphi^*$ and, upon substitution, for the equilibrium level of ex-ante expected profits $\bar{\pi}$. Once these equilibrium values are obtained, the equilibrium mass of entrants $M^E$ and of surviving firms $M$ can be derived as follows: The consumers' budget constraints imply that aggregate expenditure for manufacturing varieties, $\beta L$, must equal the aggregate revenue of the surviving firms, $R = M \cdot \bar{r}$, where the average revenue conditional on survival is given by $\bar{r} = r(\tilde{\varphi}) = \sigma(\bar{\pi} + f)$. Moreover, market clearing in the $A$-sector commands that the value of consumption must equal the value of production, $(1 - t - \beta)L = (1 - \gamma)L$, where $\gamma$ denotes the share of the workforce that is employed in the manufacturing sector. Hence, $\gamma = \beta + t$ holds, i.e., higher taxes increase the manufacturing

[4] In appendix A we discuss profit taxes for surviving firms as an alternative financing mode for the entry subsidies. That discussion is also related to the observation that start-up grants in practise may not always be designed as pure subsidy programs for the firms, but that the government may require a financial contribution by the former subsidy recipients if they succeed in the market.

share in this economy, because consumption of the numéraire commodity (where all income effects of demand accrue) is reduced by lump-sum taxes, and the entire tax revenue is directed towards the manufacturing sector in the form of entry subsidies. Combining these results it follows that $M = \beta L / \sigma(\bar{\pi} + f) = (\gamma - t) L / \sigma(\bar{\pi} + f)$ and $M^E = \delta M / (1 - G(\varphi^*))$.

We assume that firms draw their productivities from a Pareto-distribution, such that $G(\varphi) = 1 - (\varphi^{\min}/\varphi)^k$ and $g(\varphi) = k(\varphi^{\min})^k \cdot \varphi^{-k-1}$, where $\varphi^{\min} > 0$ is the lower bound for productivity draws and $k > 1$ is the shape parameter.[5] Using this parameterization in (4), and assuming $k > \sigma - 1$, we find that average productivity is proportional to the cutoff productivity, $\tilde{\varphi} = \left(\frac{k}{k+1-\sigma}\right)^{1/(\sigma-1)} \varphi^* > \varphi^*$. Furthermore, under the Pareto-distribution the (FEC) and the (ZCPC) read as $\bar{\pi} = \delta \tilde{f}_e (\varphi^{\min})^{-k} (\varphi^*)^k$ and $\bar{\pi} = (f(\sigma-1))/(k+1-\sigma)$, respectively, which imply the following closed-form solutions for the cutoff, mass of entrants, and mass of surviving firms in autarky (indicated with subscript "*aut*"):

$$\varphi^*_{aut} = \left( \frac{(\sigma-1) f (\varphi^{\min})^k}{\delta(k+1-\sigma)\tilde{f}_e} \right)^{1/k}, \qquad M^E_{aut} = \left( \frac{\sigma-1}{\sigma k \tilde{f}_e} \right) \cdot \beta L, \qquad M_{aut} = \left( \frac{k+1-\sigma}{\sigma f k} \right) \cdot \beta L \quad (5)$$

Notice that $M = \beta L / \bar{r}(\tilde{\varphi})$ and $\bar{r}(\tilde{\varphi}) = (\tilde{\varphi}/\varphi^*)^{\sigma-1} \cdot \sigma f$ also imply $M = (\beta L / \sigma f)(\tilde{\varphi}/\varphi^*)^{1-\sigma}$. Using this in (4), and recalling that $V = y - \beta \ln P + \beta(\ln \beta - 1)$ holds, we obtain the following expression for indirect utility in autarky:

$$V_{aut} = y - \beta \cdot \ln\left( \left( \frac{\beta L}{\sigma f} \right)^{\frac{1}{1-\sigma}} \cdot \frac{1}{\rho \cdot \varphi^*_{aut}} \right) + \beta(\ln \beta - 1) \quad (6)$$

Hence, countries with higher labor endowment $L$ and/or higher cutoff $\varphi^*_{aut}$ are better off.

### *2.6. Endogenous policy determination in the closed economy*

Observe that a decrease in the effective entry costs $\tilde{f}_e$ shifts the horizontal curve in figure 1 downwards, which implies a higher cutoff and, ceteris paribus, higher welfare. The government in the closed economy sets the entry subsidy $s$ so as to maximize total welfare $W_{aut} = L \cdot V_{aut}$. It has to take into account the budget constraint, which commands that total expenditure for subsidies must equal total tax revenue. Using (5) this constraint is given by

$$t \cdot L = s \cdot M^E_{aut} = s \cdot \left( \frac{\sigma - 1}{\sigma k (f_e - s)} \right) \beta L \quad \rightarrow \quad t = \frac{\beta(\sigma-1)s}{\sigma k (f_e - s)} \quad (7)$$

[5] The Pareto distribution has been extensively used in the previous literature on heterogeneous firms (see, e.g., Bernard et al. 2003; Helpman et al. 2008; Melitz and Ottaviano 2008; Behrens et al. 2009).

Equation (7) implies $dt/ds > 0$ and $d^2t/d\,s^2 > 0$: An increase of the entry subsidy $s$ requires an over-proportional tax increase, because a higher subsidy induces an increase in the mass of entrants ($dM_{aut}^{E}/ds > 0$) among which tax revenue has to be shared. Using (5), (6) and (7) the welfare maximization problem in the closed economy can be formulated as follows:

$$\underset{\{s\}}{Max} \quad W_{aut} = L\left[1 - t(s) + \beta \cdot \ln \varphi_{aut}^{*}(s) + \tfrac{\beta}{\sigma - 1} \cdot \ln L + b\right] ,$$

where $t(s)$ is the budget constraint (7) and where $b \equiv \beta\left(\ln(\beta/\rho) - 1\right) + \frac{\beta}{\sigma-1} \cdot \ln\left(\beta/\sigma f\right)$ is a constant. This problem gives rise to the following first-order condition for a maximum:

$$\beta \cdot \hat{\varphi}_{aut}^{*} , \qquad \text{where} \quad \hat{\varphi}_{aut}^{*} \equiv \frac{1}{\varphi_{aut}^{*}} \cdot \frac{d\varphi_{aut}^{*}}{ds} \tag{8}$$

The right-hand side of (8) represents the marginal cost of the entry subsidy, in terms of the required lump-sum tax and the associated decrease of disposable income and numéraire consumption. The left-hand side is the marginal benefit, in terms of the welfare-enhancing reduction of effective entry costs that the subsidy generates. Government balances cost and benefit at the margin, and this leads to the following subsidy-tax scheme in autarky:

**Proposition 1** *Consider a government that subsidizes entry costs and finances the expenses through lump-sum taxes. In autarky the government sets the following entry subsidy and tax:*

$$s_{aut}^{*} = f_e/\sigma \qquad\qquad t_{aut}^{*} = \beta/(\sigma k) \tag{9}$$

Proof: See Appendix B □

What is the rationale for entry subsidies in this model, and what are the associated effects? It is apparent from eq. (5) that the subsidy $s$ induces a greater mass of entrepreneurs to enter the manufacturing industry. In principle, restoring the stationary equilibrium condition, $p_{in} \cdot M_{aut}^{E} = \delta \cdot M_{aut}$, requires either a decreasing survival probability $p_{in} = 1 - G\left(\varphi_{aut}^{*}\right)$, or an increasing mass of surviving firms in the market $M_{aut}$, or a combination of the two.

Figure 1 shows that the entry subsidy clearly leads to a higher cutoff productivity $\varphi_{aut}^{*}$, i.e., to a lower survival probability. Whether the mass of surviving firms (and thereby consumption diversity) is also affected depends on the properties of the density function $g(\varphi)$. With the Pareto-distribution that is assumed in this paper, the mass of surviving firms $M_{aut}$ remains constant, as can be seen from eq. (5). The surviving firms become more productive on average, however, as the increase of $\varphi_{aut}^{*}$ directly implies an increase of $\tilde{\varphi}_{aut}$. The entry subsidy does therefore not lead to *more* but just to *better* firms in the market.[6] This higher average productivity means that the average consumer price for a variety, $1/(\rho\tilde{\varphi}_{aut})$, decreases. Aggregate manufacturing revenue remains constant on the other hand, since neither the mass of firms nor the average revenue $\bar{r} = r(\tilde{\varphi}) = \sigma k f/(k+1-\sigma)$ changes. There is, hence, an increase in average (physical) output per firm, and higher consumption of each variety. In other words, the better firms now produce and sell more output at lower prices; the CES price index (4) decreases.

The government trades off this welfare-enhancing selection effect of the entry subsidy with the income and welfare reduction associated with the lump-sum tax. Proposition 1 characterizes the welfare-maximizing policy, and an inspection of $s^*_{aut}$ and $t^*_{aut}$ yields several important insights. Firstly, the subsidy and tax are both inversely related to the elasticity of substitution. The reason is that a higher $\sigma$ leads to a higher marginal cost $dt/ds$ at a constant marginal benefit $\beta \cdot \hat{\varphi}^*_{aut}$ of this policy, thus, to a smaller subsidy $s^*_{aut}$ (see eqs. (B1) and (B2) in Appendix B). Intuitively, the entry subsidy decreases manufacturing prices by tightening selection. It can be thought of as an indirect policy instrument to target the market imperfections in the manufacturing sector, namely the monopolistic mark-up pricing and the associated under-consumption of varieties.[7] A higher value of $\sigma$ reduces this distortion and, hence, the incentive for entry subsidization.

Secondly, the lower is the raw entry cost $f_e$, the higher is the marginal benefit of the subsidy, but the higher is also the marginal cost $dt/ds$ because the directly positive effect on the mass of entrants requires a higher tax to sustain the same subsidy per entrant. This latter effect is relatively stronger, hence we find that a decrease in $f_e$ would lead to a lower optimal subsidy $s^*_{aut}$. Intuitively, the entry subsidy does not target the monopoly distortion directly, but rather indirectly through the process of market entry. A reduction in the *raw* entry costs already tightens the welfare-enhancing selection, so that a smaller entry subsidy is sufficient.

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[6] With the class of density functions mentioned in Melitz (2003, footnote 15), expected profits $\bar{\pi}$ would decrease and consumption variety $M_{aut}$ increase. The entry subsidy would then lead to *more* and *better* firms in the market. This results from the fact that the (ZCPC) is decreasing in $(\tilde{\varphi}/\varphi^*)$, the ratio of average-to-cutoff productivity, since the (ZCPC) is then monotonically decreasing in $(\varphi^*, \bar{\pi})$-space for the class of density functions considered there. In the case of a Pareto-distribution the (ZCPC) is horizontal in $(\varphi^*, \bar{\pi})$-space.

[7] A more direct way of approaching this distortion would be to subsidize consumption of manufacturing varieties directly. In fact, upon request we provide a proof that if the government had two instruments at its disposal, a consumption subsidy and an entry subsidy, then the optimal (first-best) policy would be to subsidize consumption at the rate (1/σ) and not to use the entry subsidy. A direct production subsidy to surviving firms at the rate (1/σ) has analogous effects as the consumption subsidy and would also lead to the first-best allocation. However, as we have highlighted in the introductory section of this article, policies targeted at the entry of *new* businesses are highly pervasive in practice. It is therefore important to study the positive impacts of this widely used policy instrument, in order to gain a better understanding of its effects in an open economy setting. The observation that real-world policies often deviate from first-best schemes is also quite common and usually seen as the result of political economy mechanisms (see Corden 1997), which are beyond the scope of this paper.

Finally, $t_{aut}^*$ is decreasing in the shape parameter $k$ and increasing in per-capita manufacturing expenditure $\beta$, whereas $s_{aut}^*$ is independent of both parameters. The higher $k$, the more concentrated is the distribution $g(\varphi)$ at low productivity levels. Entry subsidies then have a lower marginal benefit, but the marginal cost is also lower since a higher $k$ per se induces less entry. It turns out that the two effects just offset each other, hence there is no net effect on $s_{aut}^*$, but since a higher $k$ leads to fewer entrants the tax $t_{aut}^*$ can be lower. A similar intuition applies for the comparative statics of decrease in $\beta$.

# 3. The open economy

We now explore an open economy setting with two countries $i = H, F$. The two countries may differ along two exogenous characteristics: population size $L_i$ and technology. Specifically, we assume that entrants in country $i$ draw their productivity from a country-specific Pareto-distribution with common shape parameter $k$ but potentially different lower bounds $\varphi_i^{\min}$.[8] Furthermore, in the two countries there may be different levels of effective sunk entry costs, $\tilde{f}_{e,i} = f_e - s_i$. We assume that the raw entry cost $f_e$ is the same in both countries, so that differences in $\tilde{f}_{e,i}$ are due to the subsidy-tax schemes that are implemented by the respective government. Ultimately we are interested in the endogenous determination of these policy schemes, see sections 4 and 5 below, but in this section we first analyze the open economy equilibrium when the policy parameters $\{s_H, t_H, s_F, t_F\}$ are given.

### *3.1. Domestic and export cutoffs*

There are both fixed and variable trade costs in the manufacturing sector. Firstly, if a firm from country $i$ decides (after learning its $\varphi$) to become an exporter and to sell to country $j$ it must pay an additional fixed cost $f_x$ on top of the fixed cost $f$ that accrues irrespective of export status. Secondly, for one unit of output to arrive in $j$ the firm in $i$ must ship $\tau > 1$ units, where $\tau$ denotes the variable iceberg trade costs. Trade in the outside sector $A_i$ is costless, which ensures factor price equalization (FPE) provided both countries produce both types of goods. If a firm from country $j$ sells to country $i$, its exporting profits are $\pi_{xj}(\varphi) = r_{xj}(\varphi)/\sigma - f_x$. There is a threshold level $\varphi_{xj}^*$ where such a firm just breaks even abroad, i.e., $r_{xj}(\varphi_{xj}^*) = r_i(\varphi_{xj}^*/\tau) = \sigma f_x$. Similarly, for the domestic cutoff firm which just

[8] Note that if $H$ and $F$ are identical in all respects, except for $\varphi_H^{\min} > \varphi_F^{\min}$, there is a hazard rate stochastic dominance of the productivity distribution in country $H$ in the definition of Demidova (2008). We therefore say that country $H$ has a "better technology" if $\varphi_H^{\min} > \varphi_F^{\min}$.

breaks even in its local market, we have $r_i\left(\varphi_i^*\right)=\sigma f$. Since $r_i(\varphi)=\left(\rho\varphi P_i\right)^{\sigma-1}\beta L_i$ the following link between domestic and export cutoff exists: $\varphi_{xj}^*=\Lambda\cdot\varphi_i^*$, where $\Lambda\equiv[\tau\cdot\left(f_x/f\right)^{1/(\sigma-1)}]$. Throughout this paper we shall assume $f_x>f$ which is a sufficient condition to ensure that $\Lambda>1$, i.e., that it is easier for a domestic firm than for a foreign exporter to break even in the domestic market.[9]

To solve for the domestic cutoff productivities $\varphi_H^*$ and $\varphi_F^*$ (which inter alia pin down the export cutoffs) we again make use of the (FEC) and the (ZCPC).[10] The (FEC) remains unchanged compared to the autarky case, and reads as follows for country $i$:

$$\text{(FEC)}\qquad \left(1-G_i\left(\varphi_i^*\right)\right)\frac{\overline{\pi}_i}{\delta}=f_e-s_i \qquad\Leftrightarrow\qquad \overline{\pi}_i=\delta\left(f_e-s_i\right)\left(\varphi_i^{\min}\right)^{-k}\left(\varphi_i^*\right)^k$$

As for the (ZCPC), ex-ante expected profits are now given by $\overline{\pi}_i=\pi_i\left(\tilde{\varphi}_i\right)+p_{xi}\cdot\pi_{xi}\left(\tilde{\varphi}_{xi}\right)$ where $\tilde{\varphi}_i$ and $\tilde{\varphi}_{xi}$ are the average productivities among all active and, respectively, among all exporting firms from country $i$. The exporting probability conditional on survival is given by $p_{xi}=\left(\varphi_i^*/\varphi_{xi}^*\right)^k=\left(\varphi_i^*/\Lambda\varphi_j^*\right)^k$. Using this together with $\tilde{\varphi}_i/\varphi_i^*=\tilde{\varphi}_{xi}/\varphi_{xi}^*=\left(\frac{k}{k+1-\sigma}\right)^{1/(\sigma-1)}$ we can rewrite the (ZCPC) as follows:

$$\text{(ZCPC)}\quad \overline{\pi}_i=f\cdot\left(\left(\frac{\tilde{\varphi}_i}{\varphi_i^*}\right)^{\sigma-1}-1\right)+p_{xi}\cdot f_x\cdot\left(\left(\frac{\tilde{\varphi}_{xi}}{\varphi_{xi}^*}\right)^{\sigma-1}-1\right)\quad\Leftrightarrow\quad \overline{\pi}_i=\frac{f\left(\sigma-1\right)}{k+1-\sigma}\cdot\left(1+\phi\left(\frac{\varphi_i^*}{\varphi_j^*}\right)^k\right),$$

where $\phi\equiv\tau^{-k}\cdot\left(f/f_x\right)^{\frac{k+1-\sigma}{\sigma-1}}$ can be understood as a measure of trade freeness which is higher the lower the variable or fixed trade costs are. Note that $0<\phi<1$ due to $f_x>f$. Substituting the (ZCPC) into the (FEC) for countries $i,j=\left\{H,F\right\}$ we obtain a system of equations,

$$\frac{\delta\left(k+1-\sigma\right)}{f\left(\sigma-1\right)}=\frac{\left(\varphi_H^{\min}\right)^k}{f_e-s_H}\left[\left(\varphi_H^*\right)^{-k}+\phi\left(\varphi_F^*\right)^{-k}\right],\qquad \frac{\delta\left(k+1-\sigma\right)}{f\left(\sigma-1\right)}=\frac{\left(\varphi_F^{\min}\right)^k}{f_e-s_F}\left[\left(\varphi_F^*\right)^{-k}+\phi\left(\varphi_H^*\right)^{-k}\right]$$

which gives rise to the following closed-form solutions for the equilibrium domestic cutoffs:

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[9] The necessary condition $f_x>\tau^{1-\sigma}f$ is weaker. None of our key results hinges crucially on the assumption of the stricter condition $f_x>f$, however. See Appendix C for a further discussion.

[10] See Demidova (2008) for a lucid exposition of the cutoff determination with asymmetric countries, where (FEC) and (ZCPC) are interdependent. Compared to that paper we consider further asymmetries across countries (size and effective entry costs) but work with a specific functional form for the productivity distribution.

$$\varphi_H^* = \left(\frac{\zeta\,\chi\left(1-\phi^2\right)}{\zeta\,\chi-\phi}\right)^{\frac{1}{k}}\left(\frac{f\left(\sigma-1\right)(\varphi_H^{\min})^k}{\delta\left(f_e-s_H\right)\left(k+1-\sigma\right)}\right)^{\frac{1}{k}},\quad \varphi_F^* = \left(\frac{1-\phi^2}{1-\phi\zeta\,\chi}\right)^{\frac{1}{k}}\left(\frac{f\left(\sigma-1\right)(\varphi_F^{\min})^k}{\delta\left(f_e-s_F\right)\left(k+1-\sigma\right)}\right)^{\frac{1}{k}} \quad (10)$$

The parameters $\zeta \equiv \left(f_e - s_H\right)/\left(f_e - s_F\right)$ and $\chi \equiv \left(\varphi_F^{\min}/\varphi_H^{\min}\right)^k$ measure the countries' relative effective entry costs and technology, respectively. Note that the cutoff expressions in (10) converge against the autarky cutoff levels given in (5) if exporting becomes prohibitively costly (if $\phi \to 0$). If countries are symmetric ($\varsigma = \chi = 1$) we can verify the selection effect of opening up to trade by noting that $\varphi_i^* = \left(1+\phi\right)^{1/k} \cdot \varphi_{i,aut}^* > \varphi_{i,aut}^*$. That is, trade integration per se raises the average productivity in the two symmetric countries by forcing less efficient firms to exit and by reallocating market shares towards more efficient producers.

In the asymmetric case, assuming that $F$ is the laggard country in terms of effective entry costs and/or technology, we have $\varsigma \le 1$ and $\chi \le 1$. We then need to impose the condition that these asymmetries are modest relative to the trade freeness, namely $\varsigma \cdot \chi > \phi$, to ensure that $\varphi_i^* > 0$ for $i = H, F$. In this case we obtain $\varphi_{xF}^* > \varphi_{xH}^* > \varphi_H^* > \varphi_F^*$: The firms from the country with the better technology and/or lower effective entry costs have higher average productivity.

### *3.2. Trade balance condition and equilibrium allocation*

To complete the description of the open economy equilibrium we first need to derive the allocation of labor $\gamma_i$ in both countries. We use the aggregate trade balance for country $H$:

$$M_H\, p_{xH}\, r_{xH}\left(\tilde{\varphi}_{xH}\right) = M_F\, p_{xF}\, r_{xF}\left(\tilde{\varphi}_{xF}\right) + \left(1 - t_H - \beta\right)L_H - \left(1-\gamma_H\right)L_H \quad (11)$$

The left-hand side of (11) denotes the value of country $H$'s manufacturing exports, and the first term on the right-hand side are the respective manufacturing imports from country $F$. If manufacturing trade is not balanced between $H$ and $F$, the overall trade balance is closed by net exports of the numéraire good (the sum of the second and third term on the right). Using this trade balance condition we can state the following result which is proven in appendix C:

***Lemma 1*** *In the open economy equilibrium the labor share allocated to manufacturing production in country $i = H, F$ is given by*

$$\gamma_H = \beta\left(\frac{1-\phi\varsigma\chi(1+\lambda)}{1-\phi\varsigma\chi} + \frac{\phi}{\varsigma\chi-\phi}\right) + t_H, \qquad \gamma_F = \beta\left(\frac{1}{1-\phi\varsigma\chi} - \frac{\phi}{\lambda\left(\varsigma\chi-\phi\right)}\right) + t_F \quad (12)$$

*where $\lambda \equiv L_F/L_H$ denotes relative country size.*

Note that a higher tax rate in country $i$ increases the manufacturing share in that country, as numéraire consumption is squeezed and entry costs are lowered. Furthermore, recall that due to identical preferences across countries the per-capita manufacturing expenditure of every household is given by $\beta$. It immediately follows from (12) that $\gamma_H = \gamma_F = \beta + t$ if countries are identical ($\lambda = \varsigma = \chi = 1$), and $\gamma_i = \beta + t_i$ if trade costs are prohibitive ($\phi \to 0$). To ensure that the outside sector is active after trade in both countries in the asymmetric case, we need to impose parameter restrictions such that $0 < \gamma_i < 1$ for $i = H, F$. These conditions, spelled out in appendix C, require that the degree of asymmetry is modest relative to trade freeness, and that the per-capita manufacturing expenditure $\beta$ is sufficiently small. Under these conditions, the country that is larger and/or technologically leading and/or has lower effective entry costs produces the bulk of manufacturing varieties and has a trade surplus in that sector.

Using $\gamma_H$ and $\gamma_F$ as given in (12), it is straightforward to derive the equilibrium masses of entrants $M_i^E$, surviving firms $M_i$, exporters $M_{xi}$, and the available consumption variety ($M_{ti} = M_i + M_{xj}$) for both countries. Finally, the CES price index is $P_i = M_{ti}^{1/(1-\sigma)} \cdot \left(\rho \cdot \tilde{\varphi}_{ti}\right)^{-1}$, where $\tilde{\varphi}_{ti}$ denotes the average productivity among all (domestic and foreign) firms active in country $i$. Using the fact that $M_{ti} = \beta L_i \big/ r_i\left(\tilde{\varphi}_{ti}\right)$ in equilibrium, and substituting $r_i\left(\tilde{\varphi}_{ti}\right) = \left(\tilde{\varphi}_{ti} / \varphi_i{}^*\right)^{\sigma-1} \sigma f$, this leads to the following expression for total welfare in $i$:

$$W_i = L_i\left[y_i - \beta \cdot \ln P_i + b\right] = L_i\left[1 - t_i + \beta\left(\ln \varphi_i^*(\cdot) + \tfrac{1}{\sigma-1} \cdot \ln L_i\right) + b\right] \tag{13}$$

Welfare in country $i$ is increasing in the domestic cutoff productivity and in the population size $L_i$. Using eqs. (10), (13) and the conditions for non-specialization, we show in appendix C that if countries H and F differ in technology or size, the leading country has – everything else equal – more entrants, more surviving firms, higher consumption diversity, lower CES price index and higher welfare than the laggard country.

The effective entry costs are, ultimately, endogenous in our model. The welfare implications of country differences are therefore not obvious, because lower entry costs require higher taxes to finance subsidies. Before turning to the endogenous determination of the subsidy-tax schedule it is useful, however, to briefly consider how an *exogenous* change in effective entry costs affects the steady-state equilibrium while neglecting the implied changes in tax rates. Recall that in the autarky case a decrease of sunk entry cost leads to an increase in the mass of entrants and the cutoff productivity, but ex-ante expected profits and the mass of surviving firms remain constant (see section 2). In the open economy, matters are more complex. Suppose that effective entry costs in country $F$ decrease, which implies an increase in the parameter $\varsigma$. It follows from (10) and the expressions reported in appendix C, that we not only have more entrants $M_F^E$ and higher cutoff productivity $\varphi_F^*$ in country $F$, but also a rise in the mass of surviving firms $M_F$. In contrast, equilibrium values of $M_H^E$, $\varphi_H^*$ and $M_H$ are decreasing in $\varsigma$. The reason is the following: The lower effective entry costs trigger entry and induce tougher selection in $F$, similarly as in autarky, but the higher domestic cutoff $\varphi_F^*$ now also implies a rising export cutoff $\varphi_{xH}^*$. It becomes more difficult for firms from $H$ to break into the more competitive market in $F$. This puts downward pressure on expected profits $\bar{\pi}_H$ and reduces the incentive for entry ($M_H^E$ decreases). The stationary equilibrium in $H$ is restored by a combination of higher survival probability (lower $\varphi_H^*$) and a lower mass of firms $M_H$. This in turn facilitates entry of firms from $F$ into their export market ($\varphi_{xF}^*$ decreases), which further boosts ex-ante expected profits $\bar{\pi}_F$. Restoring the stationary equilibrium in $F$ now implies a combination of tougher selection and more surviving firms. Put differently, country $F$'s entry cost reduction induces tougher selection in $F$, which in turn makes export market entry more difficult for firms from $H$ and easier for firms from $F$.

# 4. Taxes and entry subsidies: Identical open economies

We now turn to the endogenous determination of the subsidy-tax schemes, and thus the levels of effective entry costs in the two countries. The analysis in this section assumes that countries $H$ and $F$ are identical in terms of size and technology, which allows for closed-form solutions. First we deal with the Nash-equilibrium that results when $H$ and $F$ behave non-cooperatively (section 4.1) before addressing the case where $H$ and $F$ cooperate (section 4.2). In section 4.3 we compare these scenarios and discuss the economic intuition.

### *4.1. Nash equilibrium policy*

The government in country $i$ maximizes total welfare $W_i$ as given in (13) with respect to the subsidy $s_i$, taking into account the government budget constraint, and taking the policy parameters of the other country $\left(t_j, s_j\right)$ as given. Recall that welfare $W_i$ is proportional to the domestic cutoff productivity $\varphi_i^*$. In the case of identical technologies ($\chi = 1$, $\varphi_H^{\min} = \varphi_F^{\min} = 1$ for convenience) this cutoff stated in eq. (10) simplifies to

$$\varphi_i^*\left(s_i, s_j\right) = \left(\frac{f\left(\sigma-1\right)}{\delta\left(k+1-\sigma\right)} \cdot \frac{1-\phi^2}{\left(f_e(1-\phi)-s_i+\phi s_j\right)}\right)^{1/k}, \tag{14}$$

which depends positively on the own, and negatively on the other country's entry subsidy. Furthermore, using $\lambda = 1$ ($L_H = L_F = L$) and the expressions for $M_i^E$ stated in eq. (C5) in

Appendix C, the government budget constraint for country $i, j = \{H, F\}$, $i \neq j$, can be written in implicit form as follows: $g_i(t_i, s_i, s_j) = t_i L_i - s_i M_i^E(s_i, s_j) = 0$, where the mass of entrants $M_i^E$ depends positively on the subsidy in the own country $i$ and negatively on the subsidy in the other country $j$. See Appendix D for the analytical expression of this budget constraint. Using (13), the first-order condition for a welfare maximum commands that the marginal cost ($dt_i/ds_i$) equals the marginal benefit ($\beta \cdot \hat{\varphi}_i^*$) of the entry subsidy in country $i$,

$$\beta \cdot \hat{\varphi}_i^* = \frac{dt_i}{ds_i}, \qquad \text{where} \quad \hat{\varphi}_i^* \equiv \frac{1}{\varphi_i^*} \cdot \frac{d\varphi_i^*}{ds_i} \tag{15}$$

The analytical expressions for these terms are also reported in Appendix D. In the present case with equally large and productive countries ($\lambda = \chi = 1$) it is clear that the Nash equilibrium subsidy must be identical in the two countries ($s_H{}^* = s_F{}^* = s^*$). Exploiting this symmetry property we can state the following result:

**Proposition 2** *Consider two identical open economies. The government in each country collects income taxes and subsidizes sunk entry costs for domestic entrepreneurs. The entry subsidy and the tax rate in the non-cooperative Nash-equilibrium are given by*

$$s^* = \frac{f_e(1-\phi)(1+\phi(\sigma-1))}{\sigma+\phi(\sigma-2)} \qquad \textit{and} \qquad t^* = \frac{\beta}{\sigma k}\frac{(1-\phi)(1+\phi(\sigma-1))}{(1+\phi^2)}. \tag{16}$$

<u>*Proof:*</u> See Appendix D □

### *4.2. Cooperative entry subsidization policy*

We now turn to the case where the governments in $H$ and $F$ cooperatively determine their entry subsidization policies in order to maximize their joint welfare. Due to the quasi-linearity of preferences, which imply constant marginal utility of income equal to one in both countries, the utilitarian social welfare function $\Omega = W_H + W_F$ is a valid measure for joint welfare. This social welfare function can be written as:

$$\Omega = W_H + W_F = L\left[1 - t_H + \beta \ln \varphi_H^*(\cdot) + 1 - t_F + \beta \ln \varphi_F^*(\cdot) + b'\right], \tag{17}$$

where $b' \equiv 2b + \frac{2\beta}{\sigma-1}\ln L$ is a constant. This objective function is maximized while taking into account the overall budget constraint of the two countries,

$$g = L(t_H + t_F) - s_H M_H^E(s_H, s_F) - s_F M_F^E(s_H, s_F) = 0 \;\leftrightarrow\; t_F = \tfrac{1}{L}\left(s_H M_H^E(\cdot) + s_F M_F^E(\cdot)\right) - t_H \tag{18}$$

Substituting (18) into (17) we can express joint welfare solely as a function of $s_H$ and $s_F$, $\Omega(s_H, s_F)$. The optimal cooperative policy can then be obtained by imposing the standard first-order conditions. We can state the following result:

**Proposition 3** *Consider two identical open economies where governments cooperatively set entry subsidies and finance the expenses with lump-sum taxes. The cooperative policy is equivalent to the tax and entry subsidy in autarky characterized in eq. (9).*

Proof: See Appendix D □

When the two symmetric countries coordinate their entry subsidies, they behave as a single country in autarky.[11] The cooperative entry subsidization policy is thus unaffected by the level of trade freeness $\phi$. This point is discussed in greater detail in the next sub-section.

### *4.3 Entry subsidies: Nash equilibrium versus cooperative policy*

Using propositions 1, 2 and 3 we can single out some important observations about the Nash-equilibrium and the cooperative entry subsidization policy for the case of two identical open economies in the course of trade integration. These insights, which follow directly from (9) and (16), can be summarized as follows:

**Proposition 4** *a) With prohibitively high trade costs, the Nash-equilibrium coincides with the autarkic (=coordinated) policy, i.e.,* $s^* = s^*_{aut}$ and $t^* = t^*_{aut}$ for $\phi = 0$.

*b) With free trade the Nash-equilibrium policy implies a tax rate of zero and no entry subsidies (* $s^* = 0$ *and* $t^* = 0$ *at* $\phi = 1$*).*

*c) With intermediate trade freeness, the entry subsidy and the tax rate in the Nash-equilibrium are hump-shaped. Specifically, we have {* $s^* > s^*_{aut}$, $t^* > t^*_{aut}$ *} and thus over-subsidization for low levels of trade freeness (for* $0 < \phi < (\sigma - 2)/\sigma$*), and {* $s^* < s^*_{aut}$, $t^* < t^*_{aut}$ *} and thus under-subsidization for high levels of trade freeness (for* $(\sigma - 2)/\sigma < \phi < 1$*).*

[11] Similar as in autarky, the cooperative entry subsidization policy characterized in proposition 3 leads to a constrained maximum for joint welfare. It can be shown that the first-best allocation in the open economy can be achieved with a consumption subsidy at the rate $1/\sigma$. Moreover, it can be shown that the non-cooperative and the cooperative choice of consumption subsidies coincide. This parallels the result by Haufler and Pflüger (2004) for the Dixit-Stiglitz model without firm heterogeneity. We provide a detailed analysis on request.

Figure 2 illustrates the entry subsidy and the tax in the open economy Nash-equilibrium (thick solid lines), and with cooperative policy determination (broken lines).

**[FIGURE 2 HERE]**

Starting from an autarkic situation, gradual trade liberalization first leads to increasing entry subsidies and taxes in the Nash-equilibrium, and thus to excessive subsidization relative to the cooperative solution. Then, at a certain stage of trade freeness, entry subsidies and taxes start to decrease with further integration, until they eventually fall short of the cooperative levels and ultimately converge to zero when trade becomes completely free.

What is the intuition for this non-monotonic effect of trade liberalization on the Nash-equilibrium policy? To understand this point, it is useful to consider first how the marginal benefit and cost of entry subsidies in country $i$ are affected by the level of trade freeness $\phi$. Using the expressions reported in Appendix D we obtain:

$$\left.\frac{\partial\left(\beta\cdot\hat{\varphi}_i^*\right)}{\partial\phi}\right|_{s_i=s_j=s}=\frac{\beta}{k\left(f_e-s\right)\left(1-\phi\right)^2}>0\,,\qquad \left.\frac{\partial}{\partial\phi}\left(\frac{dt_i}{ds_i}\right)\right|_{s_i=s_j=s}=\frac{2\beta s(\sigma-1)\left(1+\phi\right)}{\sigma k\left(f_e-s\right)^2\left(1-\phi\right)^3}>0$$

That is, an additional € worth of entry subsidies has a higher marginal benefit in country $i$ the higher $\phi$ is, because the induced selection effect is stronger and cutoff productivity $\hat{\varphi}_i^*$ increases more substantially. Yet, the required tax increase to finance this additional subsidy-€ is also larger the higher $\phi$ is. A marginal increase in $s_i$ for a given $s_j$ motivates further entry in country $i$, and this effect is stronger the freer trade is. As the tax revenue has to be divided up among all domestic entrants, this consequently requires a relatively stronger tax increase at higher levels of trade freeness. In the limit with prohibitive trade costs, we have

$$\lim_{\phi\to 0}\left(\beta\cdot\hat{\varphi}_i^*\right)=\frac{\beta}{k\left(f_e-s_i\right)}>0\,,\quad \lim_{\phi\to 0}\left(\frac{dt_i}{ds_i}\right)=\frac{\beta f_e\left(\sigma-1\right)}{\sigma k\left(f_e-s_i\right)^2}>0\,,\quad \lim_{\phi\to 0}\left(\beta\cdot\hat{\varphi}_i^*-\frac{dt_i}{ds_i}\right)=\frac{\beta\left(f_e-\sigma s_i\right)}{\sigma k\left(f_e-s_i\right)^2}\,,$$

which leads to the Nash-equilibrium $s^*=s_{aut}^*$ and $t^*=t_{aut}^*$ at $\phi=0$. Initially, at low trade freeness levels, the marginal benefit is increasing faster in $\phi$ than the marginal cost, which in turn implies the initially upward-sloping ranges of the curves in figure 2. Eventually, the relative strength of the two effects changes and at maximum trade freeness we obtain

$$\lim_{\phi\to 1}\left(\beta\cdot\hat{\varphi}_i^*\right)=+\infty\,,\qquad \lim_{\phi\to 1}\left(\frac{dt_i}{ds_i}\right)=+\infty\,,\qquad \lim_{\phi\to 1}\left(\beta\cdot\hat{\varphi}_i^*-\frac{dt_i}{ds_i}\right)=-\infty\,.$$

In other words, at high trade freeness, the entry subsidies would be very effective in bringing up the cutoff productivity, but also very expensive in terms of the required taxes as there are many subsidy recipients who decide to enter. This latter effect is, in fact, stronger at high levels of $\phi$, so that the equilibrium subsidy at maximum freeness is equal to zero.

Another way to intuitively approach these different forces at work is in terms of the *net externality* that the policy choice exerts on the other country. In the open economy one can think of *two* motives for governments to subsidize firm entry. The first one is that entry subsidies lead to better firms with lower marginal costs, so this policy implies lower manufacturing prices and thus indirectly targets the monopoly distortion (mark-up pricing) due to imperfect competition. The second motive arises from the fact that entry subsidies have cross-country externalities which can be exploited strategically in an open economy setting.

The cooperative solution internalizes all cross-country externalities and thereby only follows the first motivation. Proposition 3 shows that this cooperative policy is independent of the trade freeness level $\phi$ and is equivalent to the optimal entry subsidy in autarky. This is intuitive, because all firms (regardless of trade freeness and the productivity level) apply the same mark-up in our model because of the assumption of constant substitution elasticity. The monopoly distortion in the manufacturing sector therefore does not depend on $\phi$, hence the same optimal entry subsidization policy results both in autarky and with trade.

The second motive, the strategic exploitation of externalities, comes into play in the non-cooperative solution. The behavior of the Nash-equilibrium subsidies and taxes, and the results of over- and under-subsidization stated in proposition 4 imply that the direction and the size of the *net externality* are trade-cost dependent. To shed more light on this issue, we derive the net externality of subsidy $s_i$ on country $j$'s welfare as follows:

$$\frac{dW_j}{ds_i} = \beta \cdot \frac{1}{\varphi_j^*} \cdot \frac{d\varphi_j^*}{ds_i} - \frac{dt_j}{ds_i} \qquad \text{where} \quad \frac{dt_j}{ds_i} = -\frac{\partial g_j / \partial s_i}{\partial g_j / \partial t_j} = -\frac{\partial M_j^E / \partial s_i}{L} \tag{19}$$

The first term in (19) is negative. As explained in section 3, an increase in the subsidy $s_i$ leads to tougher selection in country $i$. This reduces entry incentives in country $j$ and leads to a lower cutoff productivity there, i.e., $d\varphi_j^* / ds_i < 0$. The second term in (19) is positive, however, and represents a fiscal externality. Since $s_i$ negatively affects $M_j^E$, country $j$ can sustain the same subsidy level $s_j$ with a lower tax rate $t_j$ and, thus, with higher consumption of the numéraire commodity. Evaluating expression (19) at the cooperative solution, $s_{aut}^* = f_e / \sigma$, allows rewriting the net externality in the following form:

$$\left.\frac{dW_j}{ds_i}\right|_{s_i=s_j=s^*_{aut}} = \frac{\beta\phi}{k(\sigma-1)f_e(1-\phi)}\left[-\sigma+\frac{2}{(1-\phi)}\right] \tag{20}$$

The first term in the square brackets on the right-hand side ($-\sigma$) reflects the negative externality associated with the selection effect while the second term reflects the positive fiscal externality ($2/(1-\phi)$), both pre-multiplied by a common factor. Since $\sigma > 2$ must hold due to the aforementioned parameter restriction $k > \sigma - 1$, it follows directly from (20) that the net externality is negative for low levels, $\phi < (\sigma-2)/\sigma$, and positive for high levels of trade freeness, $\phi > (\sigma-2)/\sigma$. This implies first too much and then too little entry subsidies in the course of trade integration, as shown by the hump-shaped curve in figure 2.

## 5. Country differences in size or technology

In this section we analyze the Nash-equilibrium for the case of two countries that differ in size or technology. Analytical solutions for the equilibrium subsidies and taxes can no longer be obtained when allowing for such asymmetries. However, it is possible to derive explicit expressions for the government reaction functions (see appendix E for further details), and to solve for the Nash-equilibrium numerically.

In table 1 we illustrate the Nash-equilibrium subsidies for various parameter constellations. The left half refers to cases where country $H$ is technologically ahead of country $F$, whereas the right half refers to cases where $H$ is larger than $F$. In the first line on both halves we still report the benchmark case with identical countries. In the second and third line we consider cases with a disparity (in technology or, respectively, in size) between countries $H$ and $F$, where the magnitude of the disparity is stronger in the third than in the second line. For each constellation of the country disparity we then report the Nash-equilibrium subsidy that would result with low, medium and high trade freeness, respectively.[12]

**[TABLE 1 HERE]**

Table 1 yields three main insights. Firstly, if country $H$ is technologically ahead, it has a lower equilibrium entry subsidy than the laggard country $F$. This can be seen by comparing $s^*_H$ and $s^*_F$ in the left half of the table for any given constellation of trade freeness and strength of the technological gap. Intuitively, entrants in country $H$ draw from a more favorable distribution and, thus, have a higher ex-ante probability to succeed in the market

[12] We have assumed the same value for $f$ and $f_x$ in all examples. Different levels of $\phi$ thus result from different iceberg trade costs $\tau$. Furthermore, we focus on the subsidies and neglect the corresponding tax rates that satisfy the balanced budget constraint. In the examples the tax rates follow a similar pattern as the subsidies.

than entrants in country $F$. Put differently, surviving firms in $H$ are on average more productive and successful as exporters than firms from country $F$ and, hence, households in $H$ have higher welfare. Our numerical results indicate that this reduces the incentive to subsidize entry in order to give domestic firms a competitive advantage in trade.

Secondly, the examples in the right half of table 1 suggest that subsidies are also lower in the larger country. What is the intuition for this result? Recall from above that, neglecting entry subsidies, there are more entrants and more surviving firms as well as greater consumption diversity in the larger country. Due to these market size effects, the welfare of country $H$ is therefore less strongly affected by exporting firms from country $F$ than vice versa. Hence, the incentive to subsidize the market entry of domestic firms to foster their competitive position is smaller for the domestic government.

Thirdly, our numerical examples suggest that there is still a hump-shaped relationship between subsidies and trade freeness, similarly as in the case with identical countries. For each constellation reported in the table, it can be seen that the subsidy in both countries first increases and then decreases as trade gradually comes freer, in a similar way as depicted in figure 2. Notice that this implies a U-shaped relationship between trade freeness and the level of effective entry costs in the Nash equilibrium, $\tilde{f}_{e,i}^{*} = f_e - s_i^{*}$.

# 6. Discussion

### *6.1. Summary*

In this paper we have a developed a two-country model with heterogeneous firms where governments subsidize entry of domestic entrepreneurs. One motive for this policy, valid already in autarky, is to induce tougher selection in the manufacturing industry. This leads to better firms in the market and, thus, to a lower average price of varieties. In open economies this pro-selective effect, which improves the average productivity of domestic firms, makes export market entry more difficult for foreign rivals. Put differently, even though entry subsidies have – at first glance – no direct implications for exporting decisions of domestic or foreign firms, as they do not affect fixed or variable trade costs directly, there are still distinct general equilibrium implications for market entry and exporting considerations. Governments can therefore use entry subsidies strategically in open economies. This policy tool may be particularly interesting for governments, because entry regulation for new firms is typically conceived as a purely domestic policy issue. Unlike classical tools of trade policy, such as export subsidies or import tariffs, these entry subsidies are typically not scrutinized by organizations like the WTO. Our analysis shows, however, that this "domestic" policy has cross-country externalities, so that there are potential gains from policy coordination.

### *6.2. A brief look into the data*

Our model predicts a U-shaped relationship between trade freeness and effective entry costs in the non-cooperative Nash-equilibrium. If trade freeness is low, trade integration first leads to higher entry subsidies and, thus, to lower effective entry costs. Later on, at higher levels of trade freeness, integration leads to less subsidization and thus to higher effective entry costs. This theoretical result immediately raises the question: on which side of the U-shaped curve are we? While this question is surely difficult to answer in general, we close this paper with a rough but hopefully suggestive look into real world data. Specifically, in figure 3 we plot effective entry costs for 81 countries in the year 1999 against a basic openness index. Specifically we use the standard trade intensity for country $i$, which is defined as the sum of total exports and imports over GDP in that year, i.e., $TI_i = \left(Exp_i + Imp_i\right) / GDP_i$ .[13]

**[FIGURE 3 HERE]**

This figure suggests a negative correlation, although not necessarily a linear relationship. In fact, when fitting a curve of the type $\tilde{f}_{e,i} = \alpha + \beta_1 \cdot TI_i + \beta_2 \cdot \left(TI_i\right)^2 + \varepsilon_i$ to this scatter plot, we receive significant coefficients $\beta_1 < 0$ and $\beta_2 > 0$ which actually suggests that a U-shaped curve seems to fit the data.[14] This result is driven, however, by the countries with the highest openness levels. The estimated coefficients imply that the curve has its minimum at a quite high trade intensity level equal to 184.4%. Only 3 out of 81 countries exhibit $TI$-based openness beyond such a level (Hong Kong, Singapore and Malaysia). The remaining 78 countries, which include all OECD members, are located in the downward-sloping range of the U-shaped curve according to this simple back-of-the-envelope-calculation.

### *6.3. Outlook*

What can be learned from figure 3? In the light of our model, this figure suggests that strategic entry regulation might become an even more important policy issue in the future as

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[13] Dozens of openness indices have been proposed in the literature, all with specific advantages and disadvantages (Rodriguez and Rodrik, 2000). Trade intensity is the most basic one, and data are easily available for a variety of countries from the Penn World Tables. The entry cost data are taken from Djankov et al. (2002). In appendix F we provide some additional information about the data.

[14] More specifically, this simple OLS estimation yields $\beta_1$=-0.0953** (std.error 0.044) and $\beta_2$=0.0019* (std.error 0.001) with $R^2$=0.08. When using cross-country data from the International Labor Office (ILO) to additionally control for population size and labor productivity (GDP/employment) as a proxy for "technology", we receive $\beta_1$=-0.1328*** (std.error 0.047) and $\beta_2$=0.0036*** (std.error 0.001) with $R^2$=0.23.

the general trend of international trade integration continues. According to the numbers discussed above, most countries still seem to be located on the downward-sloping part of the U-shaped curve. That is, freer trade seems to go hand in hand with *lower* effective entry costs. To the extent that lower entry costs are due to higher entry subsidies of the governments, this suggests that most countries – being exposed to further trade integration – would at least at the moment still respond by increasing their efforts to engage in strategic entry subsidization. This conclusion is, of course, suggestive at best, especially since figure 3 makes no pretense of capturing any causal relationship between trade freeness and effective entry costs, as emphasized by our model, but simply depicts a correlation between these two variables. A more detailed empirical analysis of these issues seems to be an interesting avenue for future research.

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## Appendix A: Profit taxes

<u>Preliminaries</u>: In the main text we have considered the case that the entire subsidization program is financed by taxing the consumers. That is, the financial resources for the entry subsidies are external to the manufacturing sector. In this appendix we consider the other extreme, where the entire subsidization program is sustained internally within the manufacturing sector by raising profit taxes for successful firms. We assume that the government adjusts the profit tax rate $t_\pi$ such that aggregate tax revenue equals the aggregate expenditure for entry subsidies.

<u>Market equilibrium</u>: Net profits of a firm with draw $\varphi$ are now $\pi(\varphi)=\left(1-t_\pi\right)\cdot[r(\varphi)/\sigma-f]$, where $0<t_\pi<1$ is the profit tax rate. The value of entry, $v^E=E[\sum_{t=0}^{\infty}\left(1-\delta\right)^t\cdot\pi(\varphi)]-\tilde{f}_e$, is driven to zero which implies the following (FEC):

$$\text{(FEC)}\qquad \bar{\pi}=\frac{\delta\tilde{f}_e}{\left(1-t_\pi\right)\left(1-G(\varphi^*)\right)}=\frac{\delta\tilde{f}_e}{\left(1-t_\pi\right)}\cdot\left(\varphi^*_{aut}\right)^k$$

where we have normalized the lower bound $\varphi_{\min}=1$ to save notation. Turning to the (ZCPC), the cutoff firm with zero (gross and net) profits generates revenue equal to $r(\varphi^*)=\sigma f$. The relationship $r(\tilde{\varphi})/r(\varphi^*)=\left(\tilde{\varphi}/\varphi^*\right)^{\sigma-1}$ still holds. Thus, since $\bar{\pi}=\left(1-t_\pi\right)\left(r(\tilde{\varphi})/\sigma-f\right)$ we get

$$\text{(ZCPC)}\qquad \bar{\pi}=\left(1-t_\pi\right)f\left[\left(\frac{\tilde{\varphi}}{\varphi^*}\right)^{\sigma-1}-1\right]=\frac{\left(1-t_\pi\right)f\left(\sigma-1\right)}{k+1-\sigma}$$

Solving the (FEC) and the (ZCPC) we obtain the following equilibrium cutoff productivity:

$$\varphi^*_{aut}=\left(\frac{\left(1-t_\pi\right)^2 f\left(\sigma-1\right)}{\delta\left(k+1-\sigma\right)\left(f_e-s\right)}\right)^{1/k}\qquad\text{(A1)}$$

where we have used $\tilde{f}_e=f_e-s$. Using $\bar{\pi}$ from the (ZCPC) we can compute directly:

$$M_{aut}=\frac{\beta L}{\sigma\left(\bar{\pi}+f\right)}=\frac{\beta L\left(k+1-\sigma\right)}{f\sigma\left(k-t_\pi\left(\sigma-1\right)\right)}\qquad M^E_{aut}=\delta\left(\varphi^*_{aut}\right)^k M_{aut}=\frac{\beta L\left(\sigma-1\right)\left(1-t_\pi\right)^2}{\sigma\left(k-t_\pi\left(\sigma-1\right)\right)\left(f_e-s\right)}\ \text{(A2)}$$

Note that an increase in the profit tax rate, ceteris paribus, lowers the mass of entrants (who anticipate lower profits) and the mass of surviving firms. An increase in the entry subsidy $s$ naturally increases the mass of entrants and implies a higher cutoff productivity.

<u>Endogenous policy determination</u>: The government budget constraint is now given by

$$s\cdot M^E\ =\ t_\pi\cdot M\cdot\bar{\pi}\ =\ t_\pi\cdot\frac{\beta L\left(1-t_\pi\right)\left(\sigma-1\right)}{\sigma\left(k-t_\pi\left(\sigma-1\right)\right)}\qquad\text{(A3)}$$

where $M\cdot\bar{\pi}$ denotes aggregate profits of surviving firms. Using (A2) in (A3) it is straightforward to see that $s=t_\pi\left(f_e-s\right)/\left(1-t_\pi\right)\Leftrightarrow s=t_\pi\cdot f_e$, i.e., there is now a linear relationship between the tax and the subsidy rate. This, in turn, implies $f_e-s=f_e\left(1-t_\pi\right)$, which we substitute into (A1) to obtain:

$$\varphi_{aut}^{*}=\left(\frac{\left(1-t_{\pi}\right)f\left(\sigma-1\right)}{\delta\left(k+1-\sigma\right)f_{e}}\right)^{1/k} \tag{A4}$$

<u>Result and discussion</u>: Equation (A4) shows that the cutoff $\varphi_{aut}^{*}$ is monotonically decreasing in the profit tax rate $t_{\pi}$. Since welfare is proportional to the cutoff productivity, see (6), this implies that the government has no incentive to run a program where entry subsidies are financed by profit taxes for surviving firms. The intuition is that profit taxes are anticipated by the potential entrants, and the taxes thus partly offset the intention of the entry subsidy.

This result also has a different implication, namely that the government has no incentive to initiate a program where it obtains a claim on firms' profits in exchange for the initial start-up grant. Suppose that the government does not offer a free entry *subsidy* but a refundable entry *loan* to the entrepreneurs. This is subject to two sources of uncertainty. Firstly, some loans go to failing businesses (with $\varphi<\varphi^{*}$) which fully default. Secondly, even successful firms (with $\varphi>\varphi^{*}$) can be hit by the terminal shock before they have fully recovered the loan. The government has to take both types of default risk into account and raise respective financial sources to balance the public budget.[15] If the subsidy program shall be sustained purely within the manufacturing sector, this gap has to be closed by requiring some firms to repay more than what they have initially received. This would be the case if the government has a permanent claim on $t_{\pi}$ per cent of the firms' profits. However, as shown above, such a policy regime would not be welfare-improving, as entrants anticipate the lower net profits.

One can also analyze intermediate cases where the government uses a combination of profit and income (lump-sum) taxes to finance the start-up grants, which is equivalent to saying that the aggregate default risk in the system is covered by taxing the consumers. However, it is intuitively clear that there is no reason to resort to such alternative schemes from an efficiency perspective. That is, the lump-sum taxes that are considered in the main text are the preferred mode of financing the entry subsidies for a welfare-maximizing government.

## Appendix B: Proof of proposition 1

To prove this proposition we rewrite the expression for the cutoff productivity from eq. (5):

$$\varphi_{aut}^{*}=\left(\frac{f\left(\sigma-1\right)(\varphi^{\min})^{k}}{\delta\left(k+1-\sigma\right)\left(f_{e}-s\right)}\right)^{1/k}$$

This implies the following marginal benefit of entry subsidies:

$$\beta\cdot\hat{\varphi}_{aut}^{*}=\frac{\beta}{k\left(f_{e}-s\right)}. \tag{B1}$$

From (7) we obtain the following marginal cost,

$$\frac{dt}{ds}=\frac{\beta(\sigma-1)f_{e}}{\sigma k\left(f_{e}-s\right)^{2}}. \tag{B2}$$

Solving $\beta\cdot\hat{\varphi}_{aut}^{*}=dt/ds$ by using (B1) and (B2) yields the entry subsidy $s_{aut}^{*}$, which we substitute into (7) to obtain $t_{aut}^{*}$.

[15] Recall that there is no time discounting in the model, hence all considerations apply also in net present values.

## Appendix C: The open economy equilibrium

*Proof of Lemma 1:* We have $\gamma_i L_i = M_i \cdot \overline{r}_i + t_i L_i$, where $\overline{r}_i = r_i\left(\tilde{\varphi}_i\right) + p_{xi}\ r_{xi}\left(\tilde{\varphi}_{xi}\right)$, which states that aggregate earnings in manufacturing come from government spending and the revenue of manufacturing firms. Hence, $M_i = \left(\gamma_i - t_i\right) L_i / \overline{r}_i$ for $i = H, F$. Substituting these terms into (11), using the analogous trade balance for country $F$ and $\lambda \equiv L_F / L_H$, we obtain

$$\frac{\gamma_H - t_H}{1 + b_H} = \frac{\lambda\left(\gamma_F - t_F\right)}{1 + b_F} + \gamma_H - \beta - t_H \qquad \frac{\gamma_F - t_F}{1 + b_F} = \frac{\gamma_H - t_H}{\lambda\left(1 + b_H\right)} + \gamma_F - \beta - t_F \tag{C1}$$

where
$$b_H = \frac{r_H\left(\tilde{\varphi}_H\right)}{p_{xH} \cdot r_{xH}\left(\tilde{\varphi}_{xH}\right)} = \frac{\tau^{\sigma-1}}{p_{xH}}\left(\frac{\tilde{\varphi}_H}{\varphi_H^*}\frac{\varphi_F^*}{\tilde{\varphi}_{xH}}\right)^{\sigma-1} = \frac{1}{\phi}\left(\frac{\varphi_F{}^*}{\varphi_H{}^*}\right)^k = \frac{1}{\phi}\left(\frac{\zeta\,\chi - \phi}{1 - \phi\zeta\,\chi}\right)$$
$$b_F = \frac{r_F\left(\tilde{\varphi}_F\right)}{p_{xF} \cdot r_{xF}\left(\tilde{\varphi}_{xF}\right)} = \frac{\tau^{\sigma-1}}{p_{xF}}\left(\frac{\tilde{\varphi}_F}{\varphi_F^*}\frac{\varphi_H^*}{\tilde{\varphi}_{xF}}\right)^{\sigma-1} = \frac{1}{\phi}\left(\frac{\varphi_F{}^*}{\varphi_H{}^*}\right)^k = \frac{1}{\phi}\left(\frac{1 - \phi\zeta\,\chi}{\zeta\,\chi - \phi}\right)$$

Solving the equation system in (C1) for $\gamma_H$ and $\gamma_F$ yields

$$\gamma_H = \beta \cdot \frac{\left(1 + b_H\right)\left(\lambda - b_F\right)}{1 - b_H b_F} + t_H \qquad \gamma_F = \beta \cdot \frac{\left(1 + b_F\right)\left(\frac{1}{\lambda} - b_H\right)}{1 - b_H b_F} + t_F \tag{C2}$$

Plugging in the expressions for $b_H$ and $b_F$ then yields $\gamma_H$ and $\gamma_F$ as given in lemma 1. □

*Parameter restrictions to ensure $0<\gamma_i<1$ for $i=H,F$:* We firstly impose restrictions to ensure that $0 < \beta_i \equiv \gamma_i - t_i < 1$ for $i = H, F$. Assuming without loss of generality that country $F$ lags behind country $H$ in terms of size *and/or* effective sunk entry costs *and/or* technology, we have $0 < \iota \leq 1$ for $\iota = \{\phi, \lambda, \varsigma, \chi\}$. We then need to impose the following conditions:

$$0 < \phi < \phi_{\max} \equiv \frac{1 + \lambda - \varsigma\sqrt{(1+\lambda)^2/\varsigma^2\chi^2 - 4\lambda}}{2\varsigma\chi}, \qquad 0 < \beta < \beta_{\max} \equiv \frac{\left(1 - \phi\zeta\,\chi\right)\left(\zeta\,\chi - \phi\right)}{\zeta\,\chi\left(\phi\zeta\,\chi(1+\lambda) - \lambda\phi^2 - 1\right)} \tag{C3}$$

If the conditions in (C3) hold we have $0 < \beta_F < \beta_H < 1$, with $\partial\beta_H/\partial\iota < 0$ and $\partial\beta_F/\partial\iota > 0$ for $\iota = \{\lambda, \varsigma, \chi\}$ and $\partial\beta_H/\partial\phi > 0$, $\partial\beta_H/\partial\phi < 0$. We then need to assume $t_i < \gamma_i$ and $\left|t_F - t_H\right| < \left|\gamma_H - \gamma_F\right|$ so that results for $\beta_i$ carry over to $\gamma_i$. In words, (C3) requires that country asymmetries are small relative to trade freeness, and that per-capita manufacturing expenditure $\beta$ and tax rates $t_i$ are sufficiently small. Under these conditions the leading country $H$ is specialized in manufacturing, and trade integration reinforces this pattern.

*Equilibrium firm masses:* Using (10) and (12) we obtain the following expressions

$$M_H = \frac{\left(\gamma_H - t_H\right)L_H}{\sigma\left(\overline{\pi}_H + f + p_{xH} \cdot f_x\right)} = \frac{\left(k + 1 - \sigma\right)\beta L_H}{\sigma k f} \cdot \frac{\left(1 + \phi^2\lambda - (1+\lambda)\phi\zeta\,\chi\right)}{\left(1 - \phi^2\right)\left(1 - \phi\zeta\,\chi\right)} \tag{C4}$$
$$M_F = \frac{\left(\gamma_F - t_F\right)L_F}{\sigma\left(\overline{\pi}_F + f + p_{xF} \cdot f_x\right)} = \frac{\left(k + 1 - \sigma\right)\beta L_F}{\sigma k f} \cdot \frac{\left(\zeta\chi(\lambda + \phi^2) - \phi(1+\lambda)\right)}{\lambda\left(1 - \phi^2\right)\left(\zeta\chi - \phi\right)}$$

$$M_H^E = \frac{\delta M_H}{\left(\varphi_H^{\min}/\varphi_H^*\right)^k} = \frac{(\sigma-1)\beta L_H}{\sigma k\left(f_e - s_H\right)} \cdot \frac{\zeta\chi\left(1+\phi^2\lambda-\phi\zeta\chi(1+\lambda)\right)}{(\zeta\chi-\phi)(1-\phi\zeta\chi)} \tag{C5}$$

$$M_F^E = \frac{\delta M_F}{\left(\varphi_F^{\min}/\varphi_F^*\right)^k} = \frac{(\sigma-1)\beta L_F}{\sigma k\left(f_e - s_F\right)} \cdot \frac{\left(\zeta\chi(\lambda+\phi^2)-\phi(1+\lambda)\right)}{\lambda(\zeta\chi-\phi)(1-\phi\zeta\chi)},$$

$$M_{xH} = \left(\frac{\varphi_H *}{\Lambda\varphi_F *}\right)^k M_H = \frac{(k+1-\sigma)\beta L_H}{\sigma k f_x} \cdot \frac{\phi\left(1+\phi^2\lambda-\phi\zeta\chi(1+\lambda)\right)}{\left(1-\phi^2\right)(\zeta\chi-\phi)} \tag{C6}$$

$$M_{xF} = \left(\frac{\varphi_F *}{\Lambda\varphi_H *}\right)^k M_F = \frac{(k+1-\sigma)\beta L_F}{\sigma k f_x} \cdot \frac{\phi\left(\zeta\chi(\lambda+\phi^2)-\phi(1+\lambda)\right)}{\lambda\left(1-\phi^2\right)(1-\phi\zeta\chi)}$$

The mass of firms active in country $i$, $M_{ti} = M_i + M_{xj}$ (i.e., consumption variety), is then readily obtained. From these expressions it follows that

$$\frac{M_H}{M_F} = \frac{L_H\lambda(\zeta\chi-\phi)\left(1+\phi^2\lambda-\phi\zeta\chi(1+\lambda)\right)}{L_F(1-\phi\zeta\chi)\left(\zeta\chi(\lambda+\phi^2)-\phi(1+\lambda)\right)} > 1$$

$$\frac{M_H^E}{M_F^E} = \frac{L_H\left(f_e-s_F\right)\lambda\zeta\chi\left(1+\lambda\phi^2-\phi\zeta\chi(1+\lambda)\right)}{L_F\left(f_e-s_H\right)\left(\zeta\chi(\lambda+\phi^2)-\phi(1+\lambda)\right)} > 1$$

$$\frac{M_{tH}}{M_{tF}} = \frac{(\zeta\chi-\phi)\left[L_H\lambda f_x\left(1+\phi^2\lambda-\phi\zeta\chi(1+\lambda)\right)+\phi L_F f\left(\zeta\chi(\lambda+\phi^2)-\phi(1+\lambda)\right)\right]}{(1-\phi\zeta\chi)\left[\phi L_H\lambda f\left(1+\phi^2\lambda-\phi\zeta\chi(1+\lambda)\right)+L_F f_x\left(\zeta\chi(\lambda+\phi^2)-\phi(1+\lambda)\right)\right]} > 1$$

as $0<\lambda\le 1$, $0<\chi\le 1$, $0<\varsigma\le 1$, $L_H \ge L_F > 0$, $0<\left(f_e-s_H\right)\le\left(f_e-s_F\right)$ and $f_x > f > 0$ imply $(\zeta\chi-\phi)>(1-\phi\zeta\chi)$ and $\lambda\zeta\chi\left(1+\phi^2\lambda-\phi\zeta\chi(1+\lambda)\right)>\left(\zeta\chi(\lambda+\phi^2)-\phi(1+\lambda)\right)$. That is, the leading country has more entrants, more surviving firms and greater consumption diversity. As the cutoff productivity is also higher (or at most equal) in the leading country, the CES price index must therefore be lower and welfare must be higher there than in the laggard country.

*Identical open economies:* With $\lambda=\varsigma=\chi=1$, eqs. (C4)-(C6) simplify to the following expressions in the case with identical countries

$$M^E = \frac{(\sigma-1)\beta L}{\sigma k\left(f_e-s\right)} = M_{aut}^E, \qquad M = \frac{(k+1-\sigma)\beta L}{\sigma k f}\cdot\frac{1}{1+\phi} < M_{aut}$$

$$M_x = \frac{(k+1-\sigma)\beta L}{\sigma k f_x}\cdot\frac{\phi}{1+\phi} \qquad \rightarrow M_t = \frac{(k+1-\sigma)\beta L}{\sigma k f}\cdot\frac{1+\frac{f}{f_x}\phi}{1+\phi} < M_{aut}$$

These expressions show that the move from autarky to trade among identical countries causes exit of domestic firms but per se does not affect the mass of entrants under the Pareto-distribution. Our assumption $f_x > f$, which was made for analytical simplicity and to avoid undue case distinctions, implies that the move from autarky to trade causes a reduction of consumption diversity (also see Baldwin/Forslid 2006; Arkolakis et al. 2008 on this). However, this anti-variety effect is not crucial for our analysis, since the introduction of trade still implies a welfare gain for both countries as $\varphi^* > \varphi_{aut}^*$ holds.

## Appendix D: Taxes and entry subsidies: Identical open economies

*Derivations*: The government budget constraint for country $i$ can be written as follows:

$$g_i\left(t_i,s_i,s_j\right)=t_i\cdot L_i-s_i\cdot M_i^E\left(s_i,s_j\right)=t_i\cdot L_i-s_i\cdot\frac{(\sigma-1)\beta L}{\sigma k\xi}\left(f_e\left(1-\phi\right)^2+2\phi s_i-s_j\left(1+\phi^2\right)\right) \quad \text{(D1)}$$

where $\xi\equiv\left(f_e(1-\phi)-s_H+\phi s_F\right)\left(f_e(1-\phi)-s_F+\phi s_H\right)$. Furthermore, using (14) and (D1), we can calculate the following expressions for the marginal benefit and cost of entry subsidies:

$$\frac{1}{\varphi_i *}\cdot\frac{d\varphi_i *}{ds_i}=\frac{1}{k\left(f_e-s_i-\phi\left(f_e-s_j\right)\right)} \qquad \text{and} \qquad \frac{dt_i}{ds_i}=-\frac{\partial g_i/\partial s_i}{\partial g_i/\partial t_i}=\frac{\beta(\sigma-1)}{k\sigma\xi^2}\cdot\tilde{\xi}_i, \quad \text{(D2)}$$

where the term $\tilde{\xi}_i$ for $i,j=\{H,F\}, i\neq j$ is given by $\tilde{\xi}_i=\phi s_j\left(s_i^2+s_j^2-4\phi s_i s_j+\phi^2\left(s_i^2+s_j^2\right)\right)$ $+f_e^3\left(1-\phi\right)^4-2f_e^2\left(1-\phi\right)^2\left(s_j(1-\phi+\phi^2)-2\phi s_i\right)+f_e\left(1-\phi\right)^2\left(s_j^2(1-\phi+\phi^2)-4\phi s_i s_j-\phi s_i^2\right)$.

*Proof of proposition 2*: Imposing symmetry $s_i=s_j=s$, the expressions in (D2) simplify and we obtain the following marginal benefit and cost of the entry subsidy:

$$\beta\cdot\hat{\varphi}_i *=\beta\cdot\frac{1}{\varphi *}\cdot\frac{d\varphi *}{ds}=\frac{1}{k\left(f_e-s\right)\left(1-\phi\right)} \qquad \text{and} \qquad \frac{dt}{ds}=\frac{\beta(\sigma-1)\left(f_e\left(1-\phi\right)^2+2\phi s\right)}{\sigma k\left(f_e-s\right)^2\left(1-\phi\right)^2}.$$

Solving $\beta\cdot\hat{\varphi}*=dt/ds$ for $s$ yields the Nash equilibrium subsidy $s*$ as given in (16). With identical countries the budget constraint (D1) furthermore simplifies to

$$g\left(t,s\right)=t\cdot L-s\cdot\frac{\beta L\left(\sigma-1\right)\left(1+\phi^2\right)}{\sigma k\left(f_e-s\right)^2\left(1-\phi^2\right)}=0.$$

Plugging in $s*$ and solving for $t$ then yields the equilibrium tax rate $t*$ as given in (16).

*Proof of proposition 3*: Differentiating $d\Omega/ds_i$ and imposing $s_i=s_j=s$ for $i,j=\{H,F\}$, $i\neq j$ yields $d\Omega/ds=\beta L\left(f_e-\sigma s\right)/\sigma k\left(f_e-s\right)^2=0$. Solving this first-order condition we obtain $s=f_e/\sigma$ which is equivalent to $s_{aut}^*$. Using $t_H=t_F=t$ and $s_H=s_F=s=f_e/\sigma$ in (18) we obtain $g=2L\left(\frac{\beta}{\sigma k}-t\right)=0$, hence $t=\beta/\sigma k$, which is equivalent to $t_{aut}^*$.

## Appendix E: Country differences in size or technology

Using the cutoff productivity as given in (10), we obtain the following expressions for the marginal benefit of the entry subsidy in countries *H* and *F*, respectively.

$$\frac{1}{\varphi_H *}\cdot\frac{d\varphi_H *}{ds_H}=\frac{\chi}{k\left(\chi\left(f_e-s_H\right)-\phi\left(f_e-s_F\right)\right)}\ , \quad \frac{1}{\varphi_F *}\cdot\frac{d\varphi_F *}{ds_F}=\frac{1}{k\left(f_e-s_F-\phi\chi\left(f_e-s_H\right)\right)} \quad \text{(E1)}$$

The budget constraints of the two countries can be written as follows

$$
\begin{aligned}
g_H &= \hat{\xi} \cdot \left[ s_H L_H \chi \left( \left( f_e - s_F \right) \left( 1 + \phi^2 (2\lambda - 1) \right) - 2\phi \lambda \chi \left( f_e - s_H \right) \right) \right] - t_H L_H = 0 \\
g_F &= \hat{\xi} \cdot \left[ s_F L_F \cdot \left( \chi \left( f_e - s_H \right) \left( 1 + \phi^2 \right) - 2\phi \left( f_e - s_F \right) \right) \right] - t_F L_F = 0
\end{aligned} \tag{E2}
$$

where $\hat{\xi} \equiv \frac{\beta(\sigma-1)}{\sigma k \left( \chi \left( f_e - s_H \right) - \phi \left( f_e - s_H \right) \right) \left( f_e - s_F - \phi \lambda \chi \left( f_e - s_H \right) \right)}$. These expressions can be used to derive the marginal costs of entry subsidies, $dt_i / ds_i = -\left( \partial g_i / \partial s_i \right) / L_i$ for $i = \{H, F\}$.

The first-order conditions are analogous as for the case of two identical countries, see eq.(15), and from these conditions we can obtain the government reaction functions for the two countries *H* and *F*,

$$
RF_i \left( s_i, s_j, t_i, \chi, \lambda \right) = \beta \cdot \hat{\varphi}_i^* - dt_i / ds_i = 0 \text{ for } i, j = \{H, F\}, j \neq i . \tag{E3}
$$

As stated before, this equation system in (E3) cannot be solved explicitly for closed-form solutions $s_H^*, s_F^*$ which satisfy $RF_i = 0$ and $s_i^* \geq 0$. However, table 1 in the main text provides some intuition on the effects of technology and size differences by means of numerical examples.

## Appendix F: Data

<u>Data sources:</u>

$\tilde{f}_{e,i}$ Cost+time measure provided in Djankov et al. (2002), Table III, measured as % of country GDP per capita in US-$ for 1999. We lose 4 observations (Mali, Mongolia, Taiwan, Vietnam) because of missing trade openness data.

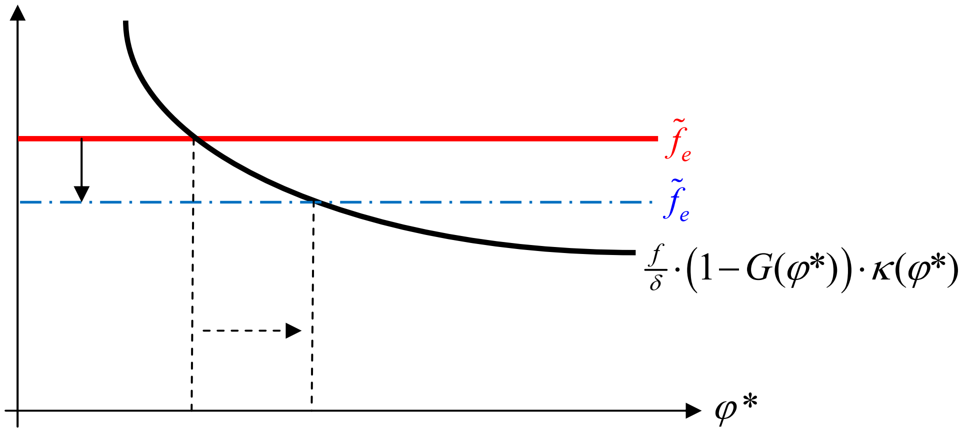
<u>Note</u>*:* This data does not directly include government subsidies, but focuses on the legal procedures that are officially required for starting a business in the respective country. The variable $\tilde{f}_e{}^*$ ranges from 2.5% of Canadian GDP per capita (483 $) to 495% of GDP per capita (945 $) in the Dominican Republic. The absolute effective entry costs range from 42.38$ in Mongolia (12% of GDP per capita) to 10,928.18$ in Austria (42% of GDP per capita). As in Djankov et al. (2002) we measure entry costs relative to GDP per capita.

$TI_i$ TI-based trade openness measures for the year 2000, Penn World Tables

*Population$_i$* Total population size (in 1,000) for 1999, World Bank, World Development Indicators (for additional control variable, see footnote 14)

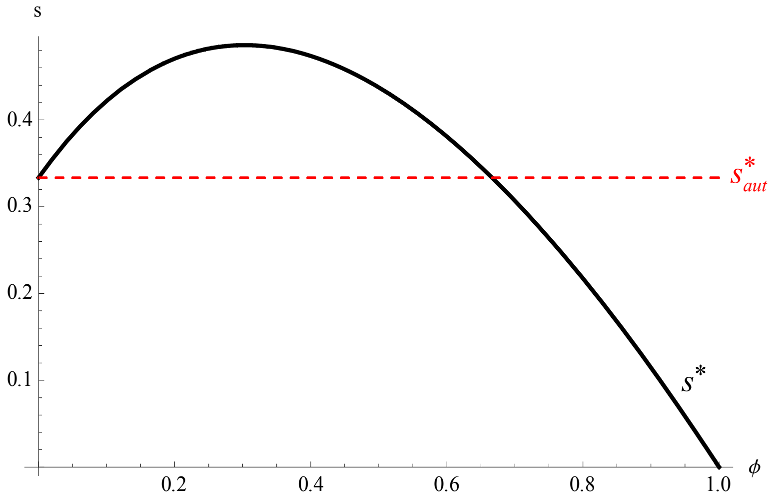
*Employment$_i$* Total employment level for 1999 (in 1,000), International Labour Office (ILO), LABORSTA – data base for labor statistics (see footnote 14)

**Figure 1: Equilibrium cutoff determination**

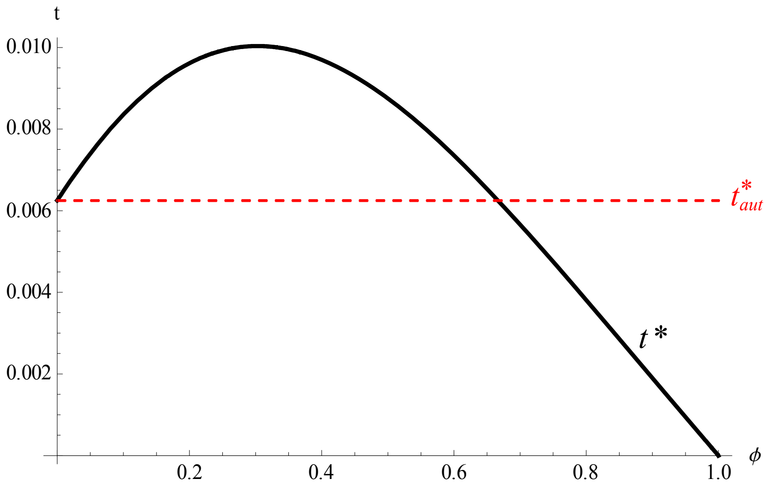


## Figure 2: Tax rate and entry subsidy – Symmetric case

a) Subsidy

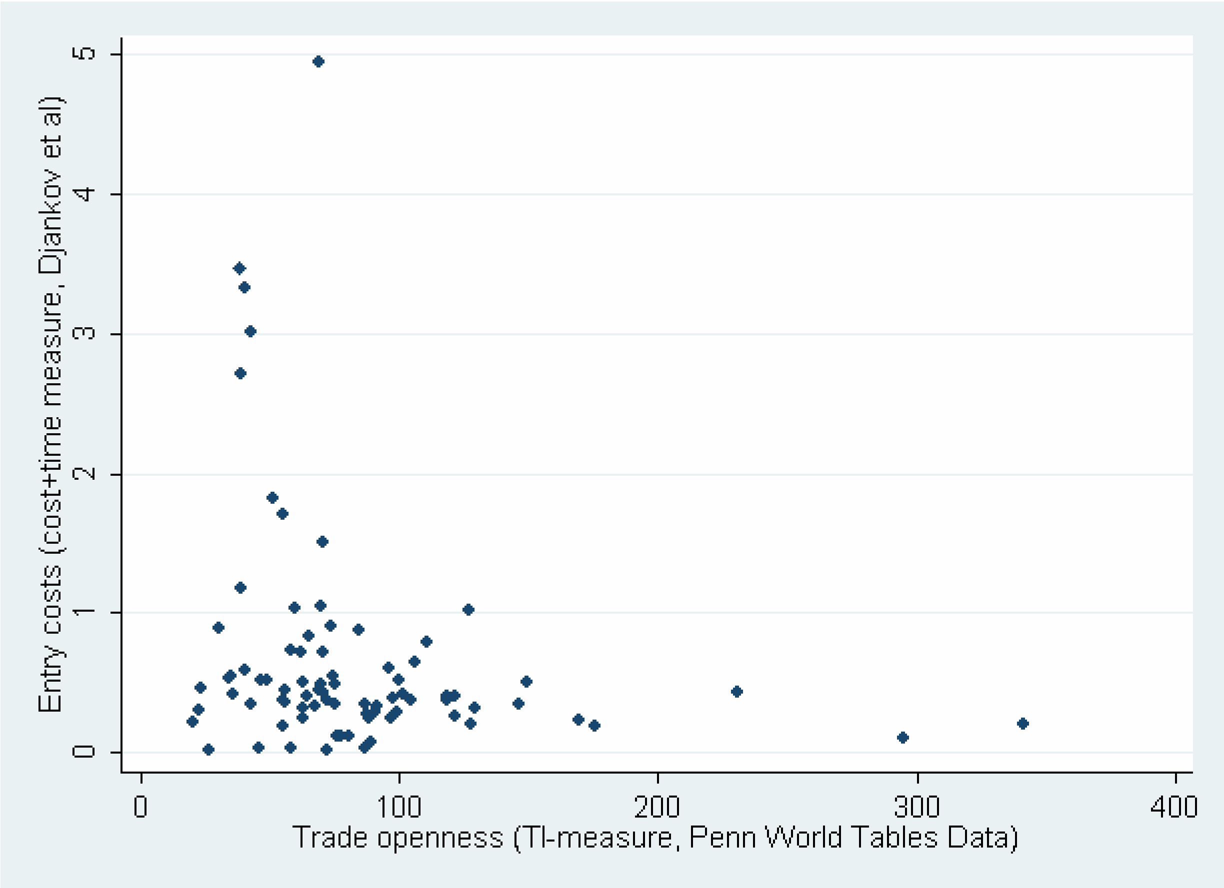



b) Tax




*Parameters:* $k = 8, \sigma = 6, \beta = 0.3, f_e = 2$

**Figure 3: Trade intensity and effective entry costs across 81 countries in 1999**




List of countries included in figure 3 (N=81)U: Argentina, Armenia, Australia, Austria, Belgium, Bolivia, Brazil, Bulgaria, Burkina Faso, Canada, Chile, China, Colombia, Croatia, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, Arab Rep., Finland, France, Georgia, Germany, Ghana, Greece, Hong Kong, Hungary, India, Indonesia, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Korea, Rep, Kyrgyz Republic, Latvia, Lebanon, Lithuania, Madagascar, Malawi, Malaysia, Mexico, Morocco, Mozambique, Netherlands, New Zealand, Nigeria, Norway, Pakistan, Panama, Peru, Philippines, Poland, Portugal, Romania, Russian Federation, Senegal, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Tanzania, Thailand, Tunisia, Turkey, Uganda, Ukraine, United Kingdom, United States, Uruguay, Venezuela, Zambia, Zimbabwe.

**Table 1: Entry subsidies - The case of asymmetric countries, Numerical simulation results**

| | | Country H technologically advanced | | | | Country H larger | | |
|---|---|---|---|---|---|---|---|---|
| | | *Trade freeness* | $s_H^*$ | $s_F^*$ | | *Trade freeness* | $s_H^*$ | $s_F^*$ |
| **Identical countries** | **λ=1, χ=1** | $Low\,\phi \quad (\tau = 1.4)$ | $s_H^* = 0.394$ | $s_F^* = 0.394$ | **λ=1, χ=1** | $Low\,\phi \quad (\tau = 1.4)$ | $s_H^* = 0.394$ | $s_F^* = 0.394$ |
| | | $Medium\,\phi\,(\tau = 1.2)$ | $s_H^* = 0.476$ | $s_F^* = 0.476$ | | $Medium\,\phi\,(\tau = 1.2)$ | $s_H^* = 0.476$ | $s_F^* = 0.476$ |
| | | $High\,\phi \quad (\tau = 1.05)$ | $s_H^* = 0.353$ | $s_F^* = 0.353$ | | $High\,\phi \quad (\tau = 1.05)$ | $s_H^* = 0.353$ | $s_F^* = 0.353$ |
| **Small gap** | **λ=1, χ=0.9** | $Low\,\phi \quad (\tau = 1.4)$ | $s_H^* = 0.385$ | $s_F^* = 0.405$ | **λ=0.97, χ=1** | $Low\,\phi \quad (\tau = 1.4)$ | $s_H^* = 0.393$ | $s_F^* = 0.398$ |
| | | $Medium\,\phi\,(\tau = 1.2)$ | $s_H^* = 0.451$ | $s_F^* = 0.501$ | | $Medium\,\phi\,(\tau = 1.2)$ | $s_H^* = 0.474$ | $s_F^* = 0.484$ |
| | | $High\,\phi \quad (\tau = 1.05)$ | $s_H^* = 0.306$ | $s_F^* = 0.388$ | | $High\,\phi \quad (\tau = 1.05)$ | $s_H^* = 0.367$ | $s_F^* = 0.376$ |
| **Large Gap** | **λ=1, χ=0.85** | $Low\,\phi \quad (\tau = 1.4)$ | $s_H^* = 0.380$ | $s_F^* = 0.411$ | **λ=0.94, χ=1** | $Low\,\phi \quad (\tau = 1.4)$ | $s_H^* = 0.391$ | $s_F^* = 0.401$ |
| | | $Medium\,\phi\,(\tau = 1.2)$ | $s_H^* = 0.438$ | $s_F^* = 0.515$ | | $Medium\,\phi\,(\tau = 1.2)$ | $s_H^* = 0.473$ | $s_F^* = 0.493$ |
| | | $High\,\phi \quad (\tau = 1.05)$ | $s_H^* = 0.276$ | $s_F^* = 0.400$ | | $High\,\phi \quad (\tau = 1.05)$ | $s_H^* = 0.381$ | $s_F^* = 0.399$ |

*Common parameters:* $k = 8, \sigma = 6, \beta = 0.3, f_e = 2, \delta = 0.1, f = 1, f_x = 2 - L_H = 100, \varphi_H^{\min} = 1$

Legend: These examples show that the Nash equilibrium subsidies display a hump-shaped pattern with respect to trade freeness also in the case of *asymmetric* countries. In the examples on the left country H has the better technology and, thus, the lower equilibrium subsidy than F. As trade gradually becomes freer, the subsidies in both countries first increase then decrease. In the examples on the right country H is larger and, thus, has the lower equilibrium subsidy than F. As trade gradually becomes freer, the subsidies in both countries first increase then decrease.