UNIVERSITY OF CAMBRIDGE

Cambridge Working Papers in Economics

Fiscal Policy and Trade Margins: An Educational Channel

Roberto Guadarrama-Baena, Povilas Lastauskas

12 November 2015

CWPE 1533

Fiscal Policy and Trade Margins: An Educational Channel*

Roberto Guadarrama-Baena and Povilas Lastauskas†

Faculty of Economics
University of Cambridge

Abstract

This paper combines current literature on the heterogeneous firms in international trade with the public economics of fiscal policy. We study the nexus between the intensive and extensive margins of trade, and their relationship with fiscal policy. When taxes are collected through the fixed per-period production payments, borne by all active firms, they impact firm partitioning and exporting decisions, but are nevertheless left unmodelled and treated as a pure loss in the literature. Instead, we show theoretically how such taxes can be channelled back into an open economy through spending on education (thereby affecting workers' skill distribution in non-trivial ways), and contrast the result with the standard trade liberalisation exercise and a wasteful channel, which are prevalent in the literature. We estimate the model's predictions using a novel data set covering 40 countries from 1995 to 2011. Employing the instrumental-variable panel techniques, we find support to our main testable predictions: fixed production taxes, used as the source to fund education, create an educational channel on the aggregate expenditure and the extensive margin of trade. A decrease in expenditure and an increase in the extensive margin are both amplified once an educational channel is allowed for.

Keywords: Fiscal policy, intensive and extensive margins of international trade, education, skill distribution

JEL Classification: C26, F12, F16, E62, I28

*We are especially grateful to Toke Aidt, Vasco Carvalho, Tiago Cavalcanti, Meredith Crowley, Giammario Impullitti, Sanjay Jain, and Jose Tavares for their helpful comments and suggestions. We also thank Julius Stakenas for his help with some simulation exercises, as well as thank you to Frederik Toscani, Konstantin Matthies, and Kai Liu for discusions, and participants at various workshops and conferences.

†Corresponding address: Faculty of Economics, University of Cambridge, Sidgwick Avenue, Cam-

1 Introduction

Modern trade literature deals with the firm heterogeneity to analyse trade patterns and explore gains from trade. The seminal contribution by Melitz (2003) has introduced the selection effect when less productive firms are driven out by the more productive survivors after opening the economy to trade. What drives selection effects, as demonstrated by Mrázová and Neary (2012), are fixed costs. Yet, there has been relatively little research digging deeper into the nature of such costs and their effects on wider economic aggregates.

A prominent counterexample is, however, Do and Levchenko (2009), which demonstrate that exporters, being larger firms, are more involved in lobbying activity, and may prefer business regulation, which adversely affect domestic producers. They demonstrate that higher fixed operating costs drive out relatively inefficient domestic producers, creating a more regulated and costly environment for the firms to survive, helping exporters to increase their revenues. Implicitly they are modelling fixed costs as an expression of bad institutions. Empirically, we find examples when high taxes correlate with both good and bad institutions (as proxied by the doing-business costs).[1] We, therefore, propose a channel, which could explain such an empirical regularity: we conjecture that higher production costs can be a pure loss or they can be channelled back into the productive economy. We argue that the expenditure on education (as a share of GDP) affects workers' skill distribution and the entire economy in non-trivial ways.

We conjecture that the assumption of fixed costs proxying bad institutions hinge on another assumption of such costs being a pure loss. Instead, our contribution to the literature is to introduce a channel through which revenues generated from fixed costs are channelled back to the economy in form of public goods. It could be useful to think of revenues generated from fixed costs as the production taxes. These taxes are part of the total fixed costs. Intuitively, higher costs reduce competition in the home economy. This helps exporting firms, which can cover fixed costs by enjoying revenues from the sales abroad. Exporters' profits are discontinuous at the cutoff level of exporting productivity. This creates an additional profit margin and lightens the effect of an increase in fixed costs compared to non-exporters. Additionally, the most productive firms gain because the measure of active firms drops as the needed productivity to break even increases. The standard exercise on trade liberalisation is different from the one on the fixed costs. For any fixed value of trade costs, changes in cutoff productivities due to fixed costs are nonlinear, with the diminishing effect for larger values of production costs. We will argue that production costs, unlike trade

---

bridge, CB3 9DD. *Email*: roberto.guadarrama-baena@cantab.net and pl312@cam.ac.uk.

[1] Doing-business costs are costs of running a company and legal procedures. Data are from Doing Business Report, World Bank. See, in particular, the Appendix 6.3.

costs, do affect firms' decisions not only directly, but also through the educational channel, which changes the distribution of the entire labour force's abilities. This will entail additional and non-trivial adjustments in the labour market, which will be fed back to the production sector.

Our analysis is related to the literature on the political economy of trade policy. The story entertained by this recent literature emphasises the channel through which an increase in fixed costs comes about. As mentioned, one of the first contributions has been done by Do and Levchenko (2009). These authors treat institutional quality as the inverse of fixed cost and analyse a political economy equilibrium within a modified median-voter framework. The major mechanism revolves around politically organised firms with larger ones having exogenous higher political power. Two related papers are Rebeyrol and Vauday (2009) and Abel-Koch (2013). They both deal with the mechanism of trade policy (fixed costs) determination. Rebeyrol and Vauday (2009) analyse a closed-economy and emphasise a discrepancy between the level of lobbies' contributions and their political power. In contrast, Abel-Koch (2013) focuses on border and behind-the-border measures, and the lobbying game based on the framework of Grossman and Helpman (1994) that gives rise to the equilibrium values of the two. Lastauskas (2013) focuses on the structural counterfactual levels of trade, prices and earnings had no excessive obstacles in terms of fixed costs existed. Smeets et al. (2010); Smeets and Creusen (2011) analyse fixed costs empirically. They find that poor institutional quality, such as the quality of regulation or the extent of corruption, can form an important impediment for a firm's export decision.

The emphasis of the literature still rests with the determination of fixed costs and their effects on economy. However, fiscal policy is ignored and the costs are treated as either payments to policy makers or some sort of deadweight loss. What is not considered is the possibility of such costs (production taxes) forming a basis to fund public goods and infrastructure needed for business operation. In such a case, the negative effect on competition could be reversed by the positive effects from a higher quality of the labour force. We focus on education as the recent literature has concentrated on the interaction of labour markets and trade. In this sense, our contribution is closely related to a number of papers on the analysis of the interplay between wage inequality, unemployment, and trade. Some examples are, among others, Cosar et al. (2010), Helpman and Itskhoki (2010), Felbermayr et al. (2013). A prominent paper of introducing a mechanism to improve the quality of the workforce employed by a firm is due to Helpman et al. (2010). Complementarities between workers' abilities and firm productivity lead to the result that exporters end up with better quality labour force. Recently, Bonfiglioli and Gancia (2014) employed the same framework to analyse workers' incentives to invest in higher ability. Lastly, our work also endogenises the changes in the variance of skill distribution, which has recently been shown to be as important source of comparative advantage as the skill abundance (see Bombardini et al., 2012).[2]

We extend the framework of Helpman et al. (2010) to allow for the government's role to channel the collected taxes back to the economy. These collected taxes take the form of production taxes. We cover two subcases. On the one hand, the resources are wasted as in the current literature, whereas on the other hand those resources are invested in education to improve the ability of the existing workforce. This mechanism generates the result that the least productive firms leave the market, but among those firms, which do survive, the proportion of exporters is larger than before such an intervention. The educational channel entails an additional effect, which makes the increase in the share of firms, which export, larger. In both subcases this entails a conflict of interest, where the domestic producers experience their profits reduced, while the exporters gain. Contrary to the first intuition, this implies that the total expenditure in the sector (which is a weighted sum of profits) is being reduced as the measure of surviving firms reduces more than the exporters gain. This effect on expenditure is again more acute for the educational channel subcase.

Our extension preserves the tractability and enables the analysis of the distribution of profits across exporting and non-exporting firms. We contribute to the current literature by analysing government intervention through education expenditure, which affects workers' skill distribution by raising their ability, thereby helping firms to be more productive. Moreover, we derive testable implications, which lend themselves to the empirical analysis on trade, GDP and government expenditure. For this purpose, we construct a novel data base, which quantifies the extensive margin of trade using the world input-output tables. Technically, we use the overlapping variation of the total government's expenditure with that of spending on education. We find support for the theoretically derived propositions.

The rest of the paper is organised as follows. Section 2 presents a theoretical model of trade and lays the foundations for the comparative statics of the equilibrium. This comparative analysis and the results from the simulation exercises are presented in Section 3, where we also state the main testable predictions. Section 4 empirically investigates the relationship between fixed costs (production taxes), the extensive margin of trade and the aggregate expenditure. We conclude with Section 5 including some additional remarks. Finally, the Appendix collects various theoretical derivations and tables containing the empirical results and data sources.[3]

[2]Bombardini et al. (2012) demonstrate that skill dispersion has a comparable effect to skill abundance in shaping comparative advantage. Authors demonstrate that firms in sectors with higher complementarity are relatively more productive in countries with lower skill dispersion. Therefore, we provide a mechanism that can rationalise differences among economies in skill distribution.

[3]There is also an accompanying online Appendix, which reports further robustness checks and simulation results.

2 Theoretical trade model

In this section, we lay down the main theoretical blocks of the extended version of Helpman et al. (2010). To ease comparability, we follow the terminology and notation from Helpman et al. (2010) as closely as possible. The framework is based on Melitz (2003) combined with the search and matching frictions in the labour market approach of Mortensen and Pissarides (1994), and a screening technology. We concentrate on the risk neutral agents who consume goods from homogeneous and heterogeneous sectors. The latter produces a measure of varieties, which are combined into the aggregate basket using a constant elasticity of substitution aggregator. Trade is covered in a two-country setting, which partitions firms into exporters and non-exporters. We derive explicit expressions for a profitability and aggregate expenditure to learn how fixed costs are channelled within the economy.

Effectively, the free entry condition allows us establish a conflict in interest between exporters and non-exporters. In other words, a change in fixed costs affects them in an opposite way: the productivity needed to produce domestically increases, whereas the one for exporting decreases. This change in fixed costs stems from a change in the production taxes. That is to say, we think of production taxes as part of the total fixed costs. Therefore, the extensive margin of trade (i.e., the proportion of firms that export) tends to increase with fixed costs. However, aggregate expenditure suffers, and even more so when there is an educational channel at work. In the educational channel, the government channels back to the economy the receipts from taxing the private sector. These resources are spent on expenditure on education, which increases the ability of workers and due to parametric assumptions, the whole skill distribution. Hence, the total welfare suffers, also confirmed by the increasing aggregate price index.

2.1 Consumers

Let us deal with a model with a single type of worker. In order to determine expected worker income (ω), prices and aggregate income, we embed the sector in a general equilibrium. We assume that preferences, which are defined over an aggregate consumption index ($\mathcal{C}$), exhibit constant relative risk aversion:

$$\mathbb{U} = \frac{1}{1-\eta}\mathbb{E}\mathcal{C}^{1-\eta}, \qquad 0 \leq \eta < 1, \tag{2.1}$$

where $\mathbb{E}$ is the expectations operator. Workers are assumed to be risk neutral, $\eta = 0$.[4] The aggregate consumption index is defined over consumption of a homogeneous good q_0 (the outside good) and a real consumption index Q including differentiated varieties

[4] One of the implications is that the expected indirect utility is given by $\mathbb{V} = \mathbb{E}\left(w/\mathcal{P}\right)$, where $\mathcal{P}$ is the price index of the aggregate consumption index $\mathcal{C}$.

as follows:

$$\mathcal{C} = \left[\vartheta^{1-\zeta} q_0^{\zeta} + (1-\vartheta)^{1-\zeta} Q^{\zeta}\right]^{\frac{1}{\zeta}}, \qquad 0 < \zeta < 1. \tag{2.2}$$

The parameter $\vartheta \geq 0$ determines the relative weight of the homogeneous and the differentiated goods, whereas the parameter ζ governs the degree of substitutability between sectors.[5] As $\mathcal{P}$ is the dual of the aggregate consumption index $\mathcal{C}$, it can be expressed as:

$$\mathcal{P} = \left[\vartheta p_0 + (1-\vartheta) P^{-\frac{\zeta}{1-\zeta}}\right]^{-\frac{1-\zeta}{\zeta}}. \tag{2.3}$$

An indifference condition between sectors is used in order to pin down the expected worker income in the differentiated sector. This condition requires the expected utility of entering any sector to be equal. Since workers are assumed to be risk neutral, the so-called Harris-Todaro condition implies that the expected income in the differentiated sector equals the wage of one in the homogeneous sector:[6]

$$\omega = 1.$$

Given an expected income of one in each sector, aggregate income in the home country, Ω, is equal to its total labour endowment:

$$\Omega = \omega \bar{L} = \bar{L}, \tag{2.4}$$

where $\bar{L} = L_0 + L$ and L_0 is employment in the homogeneous sector; similarly for the foreign country.

Then the price index in the differentiated sector is uniquely determined from the equilibrium choices of consumers and aggregate income (Ω). When both goods are produced, workers in the differentiated sector receive the same expected indirect utility as those in the homogeneous sector, therefore making the indirect utility equal to $1/\mathcal{P}$. Thus, the opening of the economy to trade affects expected welfare only through changes in the aggregate price index ($\mathcal{P}$).

We now solve for the optimal demand choices by the consumers. Using equations (2.1) and (2.2), the problem for maximising the expected utility is

[5] As is standard in this type of models, the product market is assumed to be perfectly competitive in the outside sector and there are no labour market frictions. Moreover, one unit of labour is required to produce one unit of output q_0 in this sector, where, additionally, there are no trade costs. Therefore, after choosing the outside good as the numeraire ($p_0 = 1$), the wage in this sector is equal to unity. This holds for both the home and the foreign countries.

[6] Note that the wage in the homogeneous sector is certain. Moreover, incomplete specialisation (where both goods are produced) can be guaranteed by a suitable choice of labour endowments in the differentiated sector in the home country, L, and in the foreign country $L^{\star}$ (where foreign variables will be denoted with an asterisk), and relative weight of the homogeneous good and the differentiated sector (ϑ).

$$\max_{q_0, q(j)\, j\in J} \mathbb{U} = \mathbb{E}\left[\vartheta^{1-\zeta} q_0^{\zeta} + (1-\vartheta)^{1-\zeta} Q^{\zeta}\right]^{\frac{1}{\zeta}}$$
$$\text{s.t.} \qquad \Omega = q_0 + \int_{j\in J} p(j)q(j)dj. \tag{2.5}$$

The first order conditions of the consumer's problem for good 0 and j are, respectively:

$$\lambda = \mathcal{C}^{1-\zeta}\vartheta^{1-\zeta} q_0^{\zeta-1} \tag{2.6}$$
$$\lambda = \mathcal{C}^{1-\zeta}(1-\vartheta)^{1-\zeta} Q^{\zeta-1}\frac{\partial Q}{\partial q(j)} p(j)^{-1}, \quad \forall j \in J, \tag{2.7}$$

where λ is the Lagrangian multiplier on the budget constraint, and we used the definition of a consumption bundle, $\mathcal{C}^{1-\zeta} = \left[\vartheta^{1-\zeta} q_0^{\zeta} + (1-\vartheta)^{1-\zeta} Q^{\zeta}\right]^{\frac{1}{\zeta}-1}$. Combining equations (2.6) and (2.7), and using the CES aggregator for differentiated goods (refer to the equation (8.1) in Appendix) to solve for $\frac{\partial Q}{\partial q(j)} = \left[\int_{j\in J} q(j)^{\beta} dj\right]^{\frac{1-\beta}{\beta}} q(j)^{\beta-1} = Q^{1-\beta} q(j)^{\beta-1}$, we obtain the demand for homogeneous good:

$$q_0 = \left(\frac{\vartheta}{1-\vartheta}\right) Q P^{\frac{1}{1-\zeta}}, \tag{2.8}$$

where $E = PQ$ is the total expenditure on varieties within the differentiated sector, and the demand for the differentiated good is given by:

$$q(j') = p(j')^{-\frac{1}{1-\beta}} Q P^{\frac{1}{1-\beta}} = \left(\frac{A}{p(j')}\right)^{\frac{1}{1-\beta}} \quad \forall j' \in J. \tag{2.9}$$

The reader is referred to the Appendix 8.1 for all the details regarding demand, including firm and aggregate measures.

2.2 Firms

Firm take consumers' choices from previous subsection as given. Given the specification of sectoral demand from the equation (2.9), the equilibrium revenue of a firm is

$$r(j) = p(j)\, q(j) = A q(j)^{\beta} = p(j)^{-\frac{\beta}{1-\beta}} A^{\frac{1}{1-\beta}}. \tag{2.10}$$

In the product market there is a number of potential firms, which pay an entry cost of $f_e > 0$ to enter the differentiated sector. After a firm pays the sunk entry cost, it observes its productivity θ, which is independently distributed and drawn from a Pareto distribution $G_{\theta}(\theta)$ with $\theta \geq \theta_{min} > 0$ and shape parameter $z > 1$. Once a firm observes its productivity, it chooses whether to exit and whether to produce just for the domestic market or for both the domestic and the export markets. Moreover, a firm incurs the production's fixed cost, $f_d = f'_d + t_d > 0$, which is made of two components. The first component, f'_d, is strictly fixed and can be interpreted as, for example, the cost of building a factory. It could also be thought of as red-tape or corruption-related costs of starting and operating a business. We call the second component, t_d, the production tax. This tax is set by the government and, unlike f'_d, it does generate revenues for the government. The production tax can be interpreted as a payment to the government for a permission or licence to run a firm. This representation will be useful when we introduce the government in the next section.

On the other hand, if the firm exports it also pays a fixed cost of exporting $f_x > 0$. All f'_d, t_d, and f_x are being expressed in terms of units of the numeraire. Additionally, there is an iceberg variable trade cost, $\tau > 1$, in units of a variety, in order for one unit to arrive in the foreign market. The firm's output of each variety, y, is a function of the productivity of the firm θ, the measure of workers that the firm hires h, and the mean ability of these hired workers $\bar{a}$. As a result the output is expressed as

$$y(\theta) = \theta h^{\gamma} \bar{a}, \qquad 0 < \gamma < 1. \tag{2.11}$$

A key feature of this framework is that technology entails complementarities in worker ability. Note that the productivity of each hired worker is increasing in the average ability of the other workers hired. Then the framework closely follows Helpman et al. (2010) – we, thus, describe in detail firm's search strategy, screening costs, and workers' abilities, distributed and drawn from a Pareto distribution with shape parameter k, such that $G_a(a) = 1 - \left(\frac{a_{min}}{a}\right)^k$ for $a \geq a_{min} > 0$ and $k > 1$, in the Appendix 8.1.1.

Despite the rich structure, the recursivity allows solving the model in a simple manner. First, the firm decides whether or not to produce and export depending on its productivity draw. After these decisions have been made, the firm and its hired workers participate in a strategic bargaining game. This game, with equal bargaining weights, is over the division of the revenue from production. This is modelled in the same way as in Stole and Zwiebel (1996a,b). Before the bargaining stage, fixed production, fixed exporting, search and screening costs are all been sunk. As a result all other arguments of the firm revenue are fixed. We now analyse revenue and profit functions in more depth, before solving for the equilibrium.

2.2.1 Revenues

A firm, which sells to the foreign market, will always serve the domestic market, too. This is because of consumers' love of variety and the existence of a fixed production cost. If exporting, a firm distributes its output $y(\theta)$ between the domestic market $y_d(\theta)$ and the export market $y_x(\theta)$ in order to equate its marginal revenues in the two markets. This implies, from the equation (2.10), that $\left(\frac{y_x(\theta)}{y_d(\theta)}\right)^{1-\beta} = \tau^{-\beta}\left(\frac{A^\star}{A}\right)$. Hence, we can express total revenues of a firm as follows:

$$r(\theta) \equiv r_d(\theta) + r_x(\theta) = \Upsilon(\theta)^{1-\beta} A y(\theta)^{\beta}, \tag{2.12}$$

where $r_d(\theta) \equiv Ay_d(\theta)^\beta$ are revenues from serving the domestic market, while $r_x(\theta) \equiv A^\star\left(\frac{y_x(\theta)}{\tau}\right)^\beta$ are those from serving the foreign market.[7] The variable $\Upsilon(\theta)$ – capturing the market access by a firm – is determined by the decision to sell to both the home and foreign markets or solely to the home market:

$$\Upsilon(\theta) \equiv 1 + I_x(\theta)\,\tau^{-\frac{\beta}{1-\beta}}\left(\frac{A^\star}{A}\right)^{\frac{1}{1-\beta}} \geq 1, \tag{2.13}$$

where $I_x(\theta)$ is an indicator variable equal to one (zero) if the firm chooses (not) to export. Note that the intensive margin of trade, $\Upsilon(\theta) = \frac{y(\theta)}{y_d(\theta)}$, is constant across firms since $\Upsilon(\theta) = 1 + I_x(\theta)\left[\tau^{-\beta}\left(\frac{A^\star}{A}\right)\right]^{\frac{1}{1-\beta}}$ is just a function of aggregate (per sector) variables. That is, from $\Upsilon_x(\theta) = 1 + \frac{y_x(\theta)}{y_d(\theta)}$, for any $\theta > \theta_x$ a firm exports a constant share of its total production. Moreover, from equation the (2.11), note that $\Upsilon(\theta) = \frac{\theta h^\gamma \bar{a}}{\theta h_d^\gamma \bar{a}_d}$, a useful expression for a few yet to be derived results.

2.2.2 Profits

Anticipating the outcome of the bargaining game, the firm chooses to maximise its net profits. Using the production technology with Pareto-based worker's ability and hiring rate with revenues equation (2.12), and using the equation (2.13), the profit maximisation problem of a firm is the following:

$$\pi(\theta) = \max_{\substack{n \geq 0 \\ a_c \geq a_{min} \\ I_x \in \{0,\,1\}}} \left\{ \frac{1}{1+\beta\gamma}\left[1 + I_x(\theta)\,\tau^{-\frac{\beta}{1-\beta}}\left(\frac{A^\star}{A}\right)^{\frac{1}{1-\beta}}\right]^{1-\beta} \cdot A\left(\kappa_y \theta n^\gamma a_c^{1-\gamma k}\right)^\beta - bn - \frac{c}{\delta}a_c^\delta - f_d - I_x f_x \right\}. \tag{2.14}$$

We concentrate on the parameter space such that $\theta_x > \theta_d > \theta_{min}$. This is done by appropriate choice of trade costs.[8]

It is important to find out the threshold level of screening ability, which follows from the first order condition with respect to a_c of the profit function equation (2.14):

$$\tfrac{\beta(1-\gamma k)}{1+\beta\gamma} r(\theta) = c a_c^\delta(\theta),$$

where $r(\theta) = \Upsilon(\theta)^{1-\beta} A\left(\kappa_y \theta n^\gamma a_c^{1-\gamma k}\right)^\beta$. The first order condition with respect to the measure of workers sampled, n, of the profit function equation (2.14) is as follows:

[7] Note that $\left(\frac{y_x(\theta)}{y_d(\theta)}\right)^{1-\beta} = \tau^{-\beta}\left(\frac{A^\star}{A}\right)$ together with $y_d(\theta) + y_x(\theta) = y(\theta)$ imply $y_d(\theta) = \frac{y(\theta)}{\Upsilon(\theta)}$ and $y_x(\theta) = \frac{y(\theta)}{\Upsilon(\theta)}(\Upsilon(\theta) - 1)$, and hence $r_d(\theta) = \frac{r(\theta)}{\Upsilon(\theta)}$ and $r_x(\theta) = \frac{r(\theta)}{\Upsilon(\theta)}(\Upsilon(\theta) - 1)$.

[8] This is line with the empirical literature showing evidence of selection into export markets, where

$$\tfrac{\beta\gamma}{1+\beta\gamma}r(\theta) = bn(\theta).$$

Notice that screening depends on the productivity of the firm, so there is a clear mapping between the two:

$$(1-\gamma k)\, bn(\theta) = \gamma c a_c^{\delta}(\theta).$$

Using $r(\theta)$, we can now solve explicitly for both $a_c(\theta)$ and $n(\theta)$:

$$a_c(\theta) = \phi_{a_c}\left[\Upsilon(\theta)^{1-\beta} A\theta^{\beta} c^{\beta\gamma-1} b^{-\beta\gamma}\right]^{\frac{1}{\delta\Gamma}}, \tag{2.15a}$$

$$n(\theta) = \phi_n\left[\Upsilon(\theta)^{1-\beta} A\theta^{\beta} c^{-\frac{\beta(1-\gamma k)}{\delta}} b^{-(\beta\gamma+\Gamma)}\right]^{\frac{1}{\Gamma}}, \tag{2.15b}$$

where $\phi_{a_c} \equiv \left[\frac{\beta\gamma}{1+\beta\gamma}\left(\frac{1-\gamma k}{\gamma}\right)^{1-\beta\gamma}\kappa_y^{\beta}\right]^{\frac{1}{\delta\Gamma}}$ and $\phi_n \equiv \phi_{a_c}^{\delta}\frac{\gamma}{1-\gamma k} = \left[\frac{\beta\gamma}{1+\beta\gamma}\left(\frac{1-\gamma k}{\gamma}\right)^{1-\beta\gamma-\Gamma}\kappa_y^{\beta}\right]^{\frac{1}{\Gamma}}$. Note that $1>\gamma k>0$ has to hold for the firm to have an incentive to screen. Recall that $1>\gamma>0$, and that $\delta>k>1$ must hold in order to admit an employer-size wage premium. Moreover, knowing that $\frac{\beta\gamma}{1+\beta\gamma}r(\theta) = bn(\theta)$, firm revenue, equation (2.12), can be solved explicitly for $r(\theta)$ as a function of sectoral variables (A, b), parameters, and the firm productivity θ:

$$r(\theta) = \left(\frac{\beta\gamma}{1+\beta\gamma}\right)^{-1}\phi_n\left[\Upsilon(\theta)^{1-\beta} A\theta^{\beta} c^{-\frac{\beta(1-\gamma k)}{\delta}} b^{-\beta\gamma}\right]^{\frac{1}{\Gamma}}, \tag{2.16}$$

where $\Gamma \equiv 1-\frac{\beta}{\delta}(1-\gamma k)-\beta\gamma>0$. Finally, using the two first-order conditions in the firm's problem equation (2.14), profits for each firm drawing productivity θ can be expressed in terms of the firm revenue and the fixed production and exporting costs as follows:[9]

$$\pi(\theta) = \frac{\Gamma}{1+\beta\gamma}r(\theta) - f_d - I_x(\theta) f_x. \tag{2.17}$$

2.2.3 Other firm-specific variables

We can explicitly write firm-level variables as functions solely dependent on the sectoral variable b, the firm productivity θ and consequently the firm market access $\Upsilon(\theta)$, the zero-profit productivity cutoff θ_d, and parameters. For this purpose, we consider the threshold domestic producer, which makes a zero profit. By using the equation (2.16) and imposing $\pi(\theta)=0$ from the equation (2.17), we obtain that

$$f_d = \frac{\Gamma}{1+\beta\gamma}r(\theta_d) = \frac{\Gamma}{\beta\gamma}\phi_n\left[Ac^{-\frac{\beta(1-\gamma k)}{\delta}} b^{-\gamma\beta}\right]^{\frac{1}{\Gamma}}\theta_d^{\frac{\beta}{\Gamma}}. \tag{2.18}$$

only the most productive firms are able to serve the foreign market.

[9] Note that $\pi(\theta)$ should be thought of as the per-period net profit, whereas the average long-run net profit is equal to the sunk entry cost f_e in order for the free-entry condition to hold.

As a result, the firm-specific revenue function is as follows:

$$r(\theta) = \left(\frac{1+\beta\gamma}{\Gamma}\right) \Upsilon(\theta)^{\frac{1-\beta}{\Gamma}} f_d \left(\frac{\theta}{\theta_d}\right)^{\frac{\beta}{\Gamma}}, \tag{2.19}$$

where we substituted $\left[Ac^{-\frac{\beta(1-\gamma k)}{\delta}} b^{-\gamma\beta}\right]^{\frac{1}{\Gamma}}$ from the equation (2.18). Similarly, we obtain the firm-specific ability threshold and the measure of workers sampled, respectively:

$$a_c(\theta) = \left[\frac{\beta(1-\gamma k)}{\Gamma}\right]^{\frac{1}{\delta}} \left[\Upsilon(\theta)^{\frac{1-\beta}{\Gamma}} f_d \left(\frac{\theta}{\theta_d}\right)^{\frac{\beta}{\Gamma}}\right]^{\frac{1}{\delta}} c^{-\frac{1}{\delta}} \quad, \tag{2.20}$$

$$n(\theta) = \left(\frac{\beta\gamma}{\Gamma}\right) \Upsilon(\theta)^{\frac{1-\beta}{\Gamma}} f_d \left(\frac{\theta}{\theta_d}\right)^{\frac{\beta}{\Gamma}} b^{-1} \quad. \tag{2.21}$$

Considering the first order conditions from the firm's problem, we can express wage bill as

$$w(\theta) = \left[\Upsilon(\theta)^{\frac{1-\beta}{\Gamma}} f_d \left(\frac{\theta}{\theta_d}\right)^{\frac{\beta}{\Gamma}}\right]^{\frac{k}{\delta}} \phi_w, \tag{2.22}$$

where $\phi_w \equiv b\left[\frac{\beta(1-\gamma k)}{\Gamma}\frac{1}{a_{min}^{\delta}}\right]^{\frac{k}{\delta}} c^{-\frac{k}{\delta}}$, and the measure of workers hired as

$$h(\theta) = \left(\frac{\beta\gamma}{\Gamma}\right) \phi_w^{-1} \left[\Upsilon(\theta)^{\frac{1-\beta}{\Gamma}} f_d \left(\frac{\theta}{\theta_d}\right)^{\frac{\beta}{\Gamma}}\right]^{1-\frac{k}{\delta}} . \tag{2.23}$$

Finally, the optimal supply of variety j with productivity θ is

$$\begin{aligned} y(\theta) =& \kappa_y n^{\gamma} a_c^{1-\gamma k}\theta \\ =& \phi_p^{\frac{1}{\beta}} \left(\frac{1+\beta\gamma}{\Gamma}\right) \left[c^{\gamma-\frac{1-\Gamma}{\beta}} b^{-\gamma}\right] f_d^{\frac{1-\Gamma}{\beta}} \theta_d^{-\frac{1-\Gamma}{\Gamma}} \Upsilon(\theta)^{\frac{1-\beta}{\Gamma}\left(\frac{1-\Gamma}{\beta}\right)} \theta^{\frac{1}{\Gamma}}, \end{aligned} \tag{2.24}$$

where $\phi_p \equiv \left(\frac{\Gamma}{\beta\gamma}\phi_n\right)^{\Gamma} \left(\frac{1+\beta\gamma}{\Gamma}\right)^{1-\beta}$.

2.3 Equilibrium

As already mentioned, the model is solved exploiting its recursive structure. We first analyse labour market outcomes, then feed them into the production side of the economy, and uncover cut-off productivities. They are then essential to uncover aggregate variables, and explore welfare implications and conduct comparative statics.

2.3.1 Labour market details

The strategic bargaining game determines that the total wage bill is a constant share of revenue. This further implies that firm wages are monotonically increasing in the screening ability cut-off. Hence, dividing the latter first order condition by the measure of hired workers, $h(\theta)$, we obtain that

$$w(\theta) = \frac{\beta\gamma}{1+\beta\gamma}\frac{r(\theta)}{h(\theta)} = b\frac{n(\theta)}{h(\theta)} = b\left[\frac{a_c(\theta)}{a_{min}}\right]^k. \tag{2.25}$$

As a result, firms with larger revenues have higher screening ability cut-offs. They also pay higher wages, however, the expected wage for a worker given that it has been sampled is the same across firms in the sector. Then we obtain that

$$\frac{w(\theta)\,h(\theta)}{n(\theta)} = b. \tag{2.26}$$

Note that this implies that workers have no incentive to direct their search. To pin down b, recall that the standard Diamond–Mortensen–Pissarides assumption implies that the search cost b is increasing in the labour market tightness:

$$b = \alpha_0 x^{\alpha_1}, \quad \alpha_0 > 1,\ \alpha_1 > 0.$$

Labour market tightness is defined as a ratio of workers sampled, N, to workers searching for employment, L, that is $x \equiv N/L$. Given identical expected income in two sectors, $\omega = xb$, it follows that

$$b = \alpha_0^{1/(1+\alpha_1)}\omega^{\alpha_1/(1+\alpha_1)}.$$

2.3.2 Cutoff productivities

By using the equation (2.16), the zero profit condition for the domestic producer $r(\theta_d)$ from the equation (2.17) yields:

$$\begin{aligned} f_d =& \frac{\Gamma}{1+\beta\gamma} r(\theta_d) \\ =& \frac{\Gamma}{\beta\gamma}\phi_n\left[Ac^{-\frac{\beta(1-\gamma k)}{\delta}} b^{-\beta\gamma}\right]^{\frac{1}{\Gamma}} \theta_d^{\frac{\beta}{\Gamma}}, \end{aligned} \tag{2.27}$$

which solves θ_d as a function of parameters, screening technology c, search cost b, and fixed cost f_d, for a given value of demand shifter A.

On the other hand, by considering the equation (2.16) and the zero profit condition for the exporter $r(\theta_x)$ from the equation (2.17), we obtain the export productivity threshold θ_x as a function of parameters, technology and the various costs, for a given demand shifter A. Hence,

$$\begin{aligned} f_x =& \frac{\Gamma}{1+\beta\gamma} r(\theta_x) - f_d \\ =& \frac{\Gamma}{\beta\gamma}\phi_n\left[Ac^{-\frac{\beta(1-\gamma k)}{\delta}} b^{-\beta\gamma}\right]^{\frac{1}{\Gamma}} \theta_x^{\frac{\beta}{\Gamma}}\left(\Upsilon_x^{\frac{1-\beta}{\Gamma}} - 1\right), \end{aligned} \tag{2.28}$$

where we substituted f_d from the equation (2.27) evaluated at θ_x. Dividing equation (2.28) by the equation (2.27), we obtain θ_x as a function of θ_d:

$$\overbrace{\left(\Upsilon_x^{\frac{1-\beta}{\Gamma}}-1\right)}^{>0}\left(\frac{\theta_x\left(\theta_d\left(f_d\right)\right)}{\theta_d\left(f_d\right)}\right)^{\frac{\beta}{\Gamma}}=\frac{f_x}{f_d}. \tag{2.29}$$

Note that θ_d is itself a function of f_d, where f_d is taken as given by firms. Moreover, $\rho\equiv\frac{\theta_d}{\theta_x}\in[0,\,1]$ can be interpreted as an *extensive margin* of trade openness as it determines the fraction of exporting firms, $\frac{[1-G_\theta(\theta_x)]}{[1-G_\theta(\theta_d)]}=\rho^z$.

The intuition about the cut-off productivities is visualised in Figure 2.1. A standard exercise in the trade literature focuses on trade liberalisation, usually modelled as a reduction in variable trade costs. It is clear, however, that fixed costs f_d affect domestic firms' and exporters' productivities (θ_d and θ_x, respectively) differently from a change in variable trade costs. For any fixed value of trade costs, changes in cutoff productivities due to fixed costs are nonlinear, with diminishing effect for larger values of f_d. We will argue in the following sections that production costs, unlike trade costs, do affect firms' decisions not only directly but also through the educational channel, which changes the distribution of the entire labour force's abilities. This will entail adjustments in the labour market, which will be fed back to the production sector.

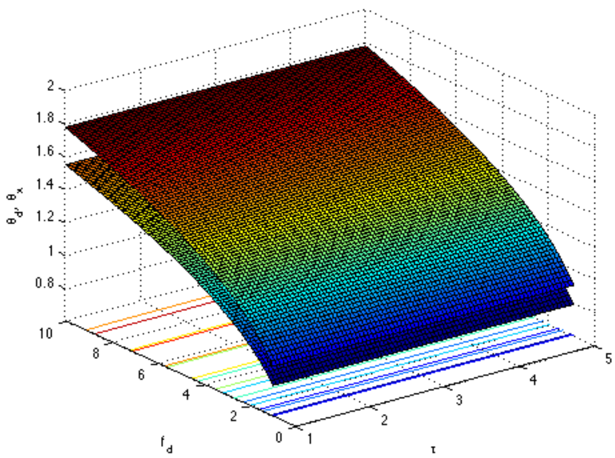

Figure 2.1: The production taxes, trade costs, and cut-off productivities for non-exporter (lower surface) and exporter (upper surface)

The *intensive margin* of trade openness, as captured by the market access variable, $\Upsilon_x>1$, determines the ratio of revenues from domestic sales and exporting. These two dimensions of trade openness are linked through the relationship between the productivity cut-offs, as reported in the equation (2.29). Moreover, we must equate the expected value of entry to the sunk entry cost, which is required for the free entry condition to hold:

$$f_e=\bar{\pi}-f_d\left[1-G(\theta_d)\right]-f_x\left[1-G(\theta_x)\right],$$

where $\bar{\pi} \equiv \int_{\theta_d}^{\infty} \frac{\Gamma}{1+\beta\gamma} r(\theta) g_\theta(\theta) d\theta$ is the average operating profit (before fixed costs) for all the firms in the economy. We can further partition this profit for the whole economy into its part, where only the non-exporter is considered. Hence, we express $\bar{\pi}_d \equiv \int_{\theta_d}^{\theta_x} \frac{\Gamma}{1+\beta\gamma} r(\theta) g_\theta(\theta) d\theta$ as the average operating profit for the non-exporter. Making use of these definitions, in the following statement, we re-express these profits in terms of the fixed costs and the extensive margin of trade ρ, the variables of utmost interest to us.

Lemma 1. *The average operating profit in the economy is proportional to the weighted sum of fixed costs, adjusted for the probability of survival, $(\theta_{min}/\theta_d)^z \equiv 1 - G_\theta(\theta_d)$. The average operating profit for the non-exporter, in turn, is proportional to the fixed production costs only, adjusted for the probability of survival.*

Proof. Re-expressing $\bar{\pi}$ by using $r(\theta)$ from equation (2.19) yields:

$$\begin{aligned}\bar{\pi} &= \int_{\theta_d}^{\infty} \frac{\Gamma}{1+\beta\gamma} \left(\frac{\Gamma}{1+\beta\gamma}\right)^{-1} \Upsilon(\theta)^{\frac{1-\beta}{\Gamma}} f_d \left(\frac{\theta}{\theta_d}\right)^{\frac{\beta}{\Gamma}} g_\theta(\theta) d\theta \\ &= \left(\frac{\theta_{min}}{\theta_d}\right)^z (f_d + f_x \rho^z) \left(\frac{z\Gamma}{z\Gamma - \beta}\right) > 0, \end{aligned} \tag{2.30}$$

where we used the fact that $\int_{\theta_d}^{\theta_x} I_x(\theta) = 0$, which implies $\Upsilon(\theta) = 1$ for this range, and that $\int_{\theta_x}^{\infty} I_x(\theta) = 1$, which implies $\Upsilon(\theta) = \Upsilon_x$ for this other range. We also imposed $\frac{\beta}{\Gamma} - z < 0$ in order for the integral to be well defined. Similarly, the average operating profit for the non-exporter, $\bar{\pi}_d$, can be also re-expressed as:

$$\bar{\pi}_d = \left(\frac{\theta_{min}}{\theta_d}\right)^z f_d \left(1 - \rho^{z-\frac{\beta}{\Gamma}}\right) \left(\frac{z\Gamma}{z\Gamma - \beta}\right) > 0, \tag{2.31}$$

where the procedure to obtain this follows the same logic used in obtaining $\bar{\pi}$ but for the range $\theta \in [\theta_d, \theta_x)$. □

In words, the average operating profit in the economy entails fixed production and exporting costs, the latter adjusted for the fraction of exporting firms, ρ^z. It also adjusts for the parameters from the consumer and technology sides (Γ and β). In contrast, the domestic profit, since a domestic producer does not incur in the fixed cost f_x, considers fixed cost of production further adjusted by a factor (smaller than one), which entails the extensive margin of trade. With these definitions in hand, the free entry condition is seen as equating the free entry cost f_e to the probability of survival multiplied by fixed costs of production and exporting. As a result, using $\bar{\pi}$ from the equation (2.30), we re-express the free entry condition as:

$$f_e = \left(\frac{\theta_{min}}{\theta_d}\right)^z (f_d + f_x \rho^z) \left(\frac{\beta}{z\Gamma - \beta}\right), \tag{2.32}$$

where we used $[1-G(\theta_d)] = \left(\frac{\theta_{min}}{\theta_d}\right)^z$ and $[1-G(\theta_x)] = \left(\frac{\theta_{min}}{\theta_x}\right)^z$ from the Pareto distribution. With this entry condition at hand, we can have a useful expression for the average and non-exporter operating profits as functions of parameters, the extensive margin of trade, and the free entry sunk cost f_e. For this purpose we state the following lemma:

Lemma 2. *The average operating profit in the economy is proportional to the entry cost. On the other hand, the average operating profit for the non-exporter is proportional to the economy-wide average profit $\bar{\pi}$, adjusted for the weighted sum of fixed costs.*

Proof. Re-expressing $\bar{\pi}$ and $\bar{\pi}_d$ by using f_e from equation (2.32) yields, respectively:

$$\bar{\pi} = \frac{z\Gamma}{\beta} \cdot f_e, \qquad \text{and} \tag{2.33}$$

$$\bar{\pi}_d = \frac{z\Gamma}{\beta} \cdot f_e \cdot \frac{f_d\left(1-\rho^{z-\frac{\beta}{\Gamma}}\right)}{f_d + f_x\rho^z}. \tag{2.34}$$

In words, the free entry condition implies that the sunk cost to obtain a productivity draw is equal to the sum of weighted fixed costs, borne every period when the firm is active. Note also that the entry cost is equal to $\bar{\pi}$ scaled by a factor of $\frac{\beta}{z\Gamma} < 1$. That is, this factor accounts for Γ, for the elasticity of substitution entailed in β, and for the mean and variance of the productivities of the firms through z. Recall that z is a sufficient statistic for both moments as the firm productivity is drawn from a Pareto distribution. By contrast, $\bar{\pi}_d$ has also the same proportionality factor as $\bar{\pi}$, but is further adjusted by $f_d\left(1-\rho^{z-\frac{\beta}{\Gamma}}\right)/f_d+f_x\rho^z < 1$. □

The average operating profit of the economy is itself the sum of the average operating profits of the domestic producer and the exporter. Thus the average operating profit for the exporter only is $\bar{\pi}_x \equiv \int_{\theta_x}^{\infty} \frac{\Gamma}{1+\beta\gamma} r(\theta)\, g_\theta(\theta)\, d\theta$, and is also a function of parameters, the entry cost and ρ as follows:

$$\begin{aligned}\bar{\pi}_x &= \bar{\pi} - \bar{\pi}_d \\ &= \frac{z\Gamma}{\beta} \cdot f_e \cdot \left(\frac{f_d\rho^{z-\frac{\beta}{\Gamma}} + f_x\rho^z}{f_d + f_x\rho^z}\right).\end{aligned} \tag{2.35}$$

Evidently, when there is no trade, $\rho = 0$, there is no difference between the two profits. In case when the economy is fully open (all firms engage in trade), $\bar{\pi} - \bar{\pi}_d = \frac{z\Gamma}{\beta} \cdot f_e$, the difference is just equal to the profit of an average firm as purely domestic firms are absent in the economy.

Now we can solve for θ_d, θ_x, and A by substituting θ_d from the equation (2.27) to the equation (2.32):

$$f_e = \frac{\theta_{min}^z \left(\frac{\Gamma}{\beta\gamma}\phi_n\right)^{z\frac{\Gamma}{\beta}}}{\left(c^{\frac{(1-\gamma k)}{\delta}} b^\gamma\right)^z} \left(\frac{\beta}{z\Gamma - \beta}\right) \left[f_d^{1-z\frac{\Gamma}{\beta}} + f_x \left(\frac{\Upsilon_x(A, A^*)^{\frac{1-\beta}{\Gamma}} - 1}{f_x}\right)^{z\frac{\Gamma}{\beta}}\right] A^{\frac{z}{\beta}}. \tag{2.36}$$

This equation solves for the demand-shifter of the sector, A, as a function of parameters, screening technology, fixed, sunk, and search costs, for given values of foreign demand shifter A^*, which affects the solution only through the intensive margin of trade Υ_x. This solution can then be used to solve for P (refer to the Appendix and use the equation (8.5)). Recall that $z - \frac{\beta}{\Gamma} > 0$, and note that the equation (2.36) is non-linear in A because of $\Upsilon_x(A, A^*)$. However, in a symmetric equilibrium $A = A^*$, thus implying $\Upsilon_x = 1 + \tau^{-\frac{\beta}{1-\beta}}$. Hence, in a symmetric equilibrium, equation (2.36) can be solved analytically for A as a function of parameters, fixed, sunk, and search costs.

2.3.3 Aggregate variables

Consider now the utility maximisation problem by the consumers (refer to the equation (2.5)). Optimising across sectors and varieties, the sectoral price index for the differentiated sector P is a function of the demand shifter A and the aggregate income Ω (see equation (8.5) in the Appendix). In Subsection 2.3.2 above, A has already been solved for by the equation (2.36). Moreover, by using the solution for P, one can solve for the optimal real consumption index of the differentiated sector Q.

To determine the mass of firms within the sector M, we make use of the market clearing condition. This condition states that the total expenditure on the differentiated sector, $E = PQ$, equals total revenues of domestic and foreign firms that sell differentiated goods to the domestic market. As a result,

$$\begin{aligned} E =& M \int_{\theta_d}^{\infty} r_d(\theta)\, g_\theta(\theta)\, d\theta + M^* \int_{\theta_x^*}^{\infty} r_x^*(\theta)\, g_\theta(\theta)\, d\theta \\ =& M \int_{\theta_d}^{\infty} \frac{r(\theta)}{\Upsilon(\theta)} g_\theta(\theta)\, d\theta + M^* \int_{\theta_x^*}^{\infty} \left(\frac{\Upsilon(\theta)^* - 1}{\Upsilon(\theta)^*}\right) r(\theta)^* g_\theta(\theta)\, d\theta \\ =& \frac{1+\beta\gamma}{\Gamma}\left[\left(\frac{\Upsilon_x - 1}{\Upsilon_x}\right)\left(\bar{\pi}_d + \frac{\bar{\pi}}{\Upsilon_x - 1}\right) M + \left(\frac{\Upsilon_x^* - 1}{\Upsilon_x^*}\right)\left(\bar{\pi}^* - \bar{\pi}_d^*\right) M^*\right], \end{aligned} \tag{2.37}$$

where we used the fact that $\int_{\theta_x}^{\infty} \frac{\Gamma}{1+\beta\gamma} r(\theta)\, g_\theta(\theta)\, d\theta = \bar{\pi} - \bar{\pi}_d$. Equation (2.37), together with a similar equation for the foreign country, can then be used to solve for M and M^*. For the balanced trade condition to hold, total imports ($M^* \int_{\theta_x^*}^{\infty} r_x^*(\theta)\, g_\theta(\theta)\, d\theta$) must equal total exports ($M \int_{\theta_x}^{\infty} r_x(\theta)\, g_\theta(\theta)\, d\theta$). As a result, equation (2.37) becomes

$$\begin{aligned} PQ = E =& M \int_{\theta_d}^{\infty} \frac{r(\theta)}{\Upsilon(\theta)} g_\theta(\theta)\, d\theta + M \int_{\theta_x}^{\infty} \left(\frac{\Upsilon(\theta) - 1}{\Upsilon(\theta)}\right) r(\theta)\, g_\theta(\theta)\, d\theta \\ =& \frac{1+\beta\gamma}{\Gamma} M \bar{\pi}. \end{aligned} \tag{2.38}$$

Total expenditure is just a weighted sum of all the profits made by firms in the economy, both purely domestic ones and exporters.

First, we determine the mass of workers searching for employment in the differentiated sector, L, from the requirement that the sector's total wage bill equals L, which ensures that the ex ante expected wage for every worker searching for employment in the differentiated sector equals one. That is,

$$\begin{aligned} L = & M\int_{\theta_d}^{\infty} w(\theta)\, h(\theta)\, g_\theta(\theta)\, d\theta = M\int_{\theta_d}^{\infty} \frac{\beta\gamma}{1+\beta\gamma} r(\theta) g_\theta(\theta)\, d\theta \\ = & \frac{\beta\gamma}{\Gamma} M\bar{\pi}, \end{aligned} \tag{2.39}$$

where the second equality follows from the equation (2.25) manipulations of $\bar{\pi} \equiv \int_{\theta_d}^{\infty} \frac{\Gamma}{1+\beta\gamma} r(\theta)\, g_\theta(\theta)\, d\theta$.

Since in the monopolistic competition each variety j is produced by just one firm, we replaced the variety symbol j with the firm's productivity θ. We then re-express the inverse demand function equation (2.9), after using the market clearing condition $q(\theta) = y(\theta)$, as

$$p(\theta)^{-\frac{\beta}{1-\beta}} = A^{-\frac{\beta}{1-\beta}} y(\theta)^{\beta}. \tag{2.40}$$

Thus, substituting the optimal supply of a firm with the productivity θ from the equation (2.24) to the equation (2.40) yields the optimal price relation:

$$\begin{aligned} p(\theta)^{-\frac{\beta}{1-\beta}} = & A^{-\frac{\beta}{1-\beta}} \left(\frac{1+\beta\gamma}{\Gamma}\right)^{\beta} \phi_p \left[c^{\gamma-\frac{1-\Gamma}{\beta}} b^{-\gamma}\right]^{\beta} f_d^{1-\Gamma} \theta_d^{-\beta\frac{1-\Gamma}{\Gamma}} \Upsilon(\theta)^{\frac{1-\beta}{\Gamma}(1-\Gamma)} \theta^{\frac{\beta}{\Gamma}} \\ = & \left(\frac{1+\beta\gamma}{\Gamma}\right) A^{-\frac{\beta}{1-\beta}} A^{-1} f_d \theta_d^{-\frac{\beta}{\Gamma}} \Upsilon(\theta)^{\frac{1-\beta}{\Gamma}(1-\Gamma)} \theta^{\frac{\beta}{\Gamma}}, \end{aligned} \tag{2.41}$$

where the second equality, which will be useful below, substitutes A for the search and screening cost b and c. Moreover, the real consumption index for the differentiated sector, Q, equation (8.1), can be re-expressed as

$$\begin{aligned} Q = & \left[\int_{j\in J} q(j)^{\beta}\, dj\right]^{\frac{1}{\beta}} = \left[\int_{j\in J} \left(\frac{A}{p(j)}\right)^{\frac{\beta}{1-\beta}} dj\right]^{\frac{1}{\beta}} \\ = & \left[\int_{j\in J} p(j)^{-\frac{\beta}{1-\beta}}\, dj\right]^{\frac{1}{\beta}} A^{\frac{1}{1-\beta}}. \end{aligned} \tag{2.42}$$

Thus, by using $A \equiv E^{1-\beta}P^{\beta}$ and $E = PQ$, we can solve for Q as function of the demand shifter and the ideal price index P, $Q = A^{\frac{1}{1-\beta}} P^{-\frac{1}{1-\beta}}$. As a result, the ideal price level P can be expressed as

$$P = \left[\int_{j\in J} p(j)^{-\frac{\beta}{1-\beta}}\, dj\right]^{-\frac{1-\beta}{\beta}}. \tag{2.43}$$

Note that, unlike models with one sector only, the price index P though dual to Q is not defined up to a single normalisation. In the Appendix (see Subsection 8.4), we show that the very existence of the outside sector (the homogeneous sector) makes P^{-1} and Q not homogeneous of degree zero.

Consider now the optimal pricing rule by each firm with productivity θ and integrate according to the optimal price index P. This procedure leads us to establish the optimal price index as a function of parameters, the demand shifter A, and the profits from domestic producer and the economy as a whole. This result is important when it comes to measuring welfare and learning how production costs are channeled into the price index.

Lemma 3. *The ideal price index P is proportional to the demand shifter A and a weighted average of the operating profit for the whole economy and the non-exporters.*

Proof. Substitute equation (2.41) into the price index, equation (2.43). Then, consider all active firms in the economy, which actually produce, i.e., those with $\theta \geq \theta_d$. Recalling that firms draw their productivity from the cumulative distribution $G_\theta(\theta) = 1 - \left(\frac{\theta_{min}}{\theta}\right)^z$, the probability density function is $g_\theta(\theta) = z\theta_{min}^z\theta^{-z-1}$. As a result, the optimal price index is the following:

$$P = \left[\int_{\theta_d}^{\infty} A^{-\frac{\beta}{1-\beta}} A^{-1} \left(\frac{1+\beta\gamma}{\Gamma}\right) f_d \theta_d^{-\frac{\beta}{\Gamma}} \Upsilon(\theta)^{\frac{1-\beta}{\Gamma}(1-\Gamma)} \theta^{\frac{\beta}{\Gamma}} g_\theta(\theta) d\theta\right]^{-\frac{1-\beta}{\beta}}$$
$$= A^{\frac{1}{\beta}} \left(\frac{\Gamma}{1+\beta\gamma}\right)^{\frac{1-\beta}{\beta}} \left[\bar{\pi}_d\left(1 - \Upsilon_x^{\beta-1}\right) + \bar{\pi}\Upsilon_x^{\beta-1}\right]^{-\frac{1-\beta}{\beta}}, \tag{2.44}$$

where $z - \frac{\beta}{\Gamma} > 0$ must hold in order for the integral to be well defined. We also used equations (2.30) and (2.31) to express the object in the square brackets. See the Appendix for the whole derivation.

□

Note that the price level entails a relationship between the interest of the domestic only producers and the exporters (contained in $\bar{\pi}$). This relationship is adjusted by the intensive margin of trade Υ and the elasticity of substitution between varieties. With this representation, one can easily extract various components from the price level. This manipulation helps to establish the following lemma, which will be useful for constructing the testable prediction, covered in the next section.

Lemma 4. *Total expenditure in the sector E is a weighted sum of operating profits for the whole economy and the non-exporters, being adjusted by a factor $^{1+\beta\gamma}/_{\Gamma} > 1$.*

Proof. By using the demand shifter definition in equation (8.5), note that, since $A^{\frac{1}{\beta}} E^{\frac{\beta-1}{\beta}} = P$, the following holds:

$$E = \left(\frac{1+\beta\gamma}{\Gamma}\right) \left[\bar{\pi}_d\left(1 - \Upsilon_x^{\beta-1}\right) + \bar{\pi}\Upsilon_x^{\beta-1}\right]$$
$$= \left(\frac{1+\beta\gamma}{\beta}\right) z \cdot f_e \left[\frac{f_d\left(1 - \rho^{z-\frac{\beta}{\Gamma}}\right)}{f_d + f_x\rho^z}\left(1 - \Upsilon_x^{\beta-1}\right) + \Upsilon_x^{\beta-1}\right], \tag{2.45}$$

where P is from the equation (2.44) . □

The expenditure function combines the firms' productivity heterogeneity parameter z, fixed costs of production and exporting, f_d and f_x, sunk costs f_e, and interaction between the intensive, Υ_x, and extensive, ρ, trade margins. Note that under no trade, expenditure is given by $E = \left(\frac{1+\beta\gamma}{\beta}\right) z f_e$, whereas a fully open economy implies $E = \left(\frac{1+\beta\gamma}{\beta}\right) z f_e \Upsilon_x^{\beta-1}$. The ratio of these two counter-factual expenditure levels is simply an intensive trade margin, adjusted for the elasticity of substitution, $\Upsilon_x^{\beta-1} < 1$. Note that the weighted sum of operating profits can be expressed explicitly in terms of $\bar{\pi}_x$ by using equation (2.35), thus $E = \left(\frac{1+\beta\gamma}{\Gamma}\right) \left[\bar{\pi}_d + \bar{\pi}_x \Upsilon_x^{\beta-1}\right]$.

Considering the market clearing condition from the equation (2.38) and the equation (2.45), we can express the mass of firms within the sector as a weighted average of operating profits $\bar{\pi}$ and $\bar{\pi}_d$ per unit of $\bar{\pi}$:

$$M = \frac{\bar{\pi}_d \left(1 - \Upsilon_x^{\beta-1}\right) + \bar{\pi} \Upsilon_x^{\beta-1}}{\bar{\pi}}.$$

Note that from the consumers optimisation problem in equation (8.4), we can obtain that $E = PQ = \Omega \left[\left(\frac{\vartheta}{1-\vartheta}\right) P^{\frac{1}{1-\varsigma}} + P\right]^{-1} P$, which, after using equation (2.45), solves for another representation for P:

$$P = \left(\frac{\Omega - E}{E}\right)^{\frac{1-\varsigma}{\varsigma}} \left(\frac{1-\vartheta}{\vartheta}\right)^{\frac{1-\varsigma}{\varsigma}}. \tag{2.46}$$

We can, alternatively, express the price level as an explicit function of sectoral variables, parameters, technology, f_d and θ_d. Then P is as follows:

$$P = \left[\phi_p^{-1} c^{-\Gamma+1-\beta\gamma} b^{\gamma\beta} \theta_d^{-\beta} f_d^{\Gamma}\right]^{\frac{1}{\beta}} \left[\bar{\pi}_d \left(1 - \Upsilon_x^{\beta-1}\right) + \bar{\pi} \Upsilon_x^{\beta-1}\right]^{-\frac{1-\beta}{\beta}}. \tag{2.47}$$

This representation might prove useful when allowing for the government to play a role in manipulating the production tax t_d, where recall that $f_d = f_d' + t_d$. Since the revenues generated from t_d are spent on providing public goods, this will affect aggregate variables. In the next section, we argue that the public good is in the form of expenditure affecting the average ability of the workers hired. Moreover, the expression (2.47) makes the channels, through which t_d payments affect equilibrium outcomes, very explicit. They are important to appreciate changes in welfare. First, there is a direct effect that makes per period survival of firms more difficult. Second, there is an indirect effect that makes survival easier through an increase in the average ability of the workers, through $\Gamma\left(k(t_d)\right)$. Third, there are reallocation effects, which influence productivity thresholds θ_d and, through them, average domestic profits, and the intensive margin of trade. However, to learn what the effect of a change in fixed costs is, we first have to embed the private sector into a framework with a government.

Before proceeding, we solve for a symmetric-countries case, which allows us to clearly show the conflict of interest between exporters and non-exporters. This insight will prove useful in guiding us to the next section of comparative statics, and show the mechanism behind the policy intervention by the government.

2.4 Symmetric-countries case

In this part, we solve for closed form solutions. We do this only for the expositional purposes as this shows a clear mechanism when modifying the production tax t_d and hence fixed costs f_d. We obtain this by analysing the symmetric-countries case. We will show the full derivations for the general case in the next section. As a result, equation (2.36) becomes

$$A = \left[\left(\frac{z\Gamma - \beta}{\beta} \right) f_e \right]^{\frac{\beta}{z}} \frac{c^{\frac{\beta(1-\gamma k)}{\delta}} b^{\beta\gamma}}{\theta_{min}^{\beta} \left(\frac{\Gamma}{\beta\gamma} \phi_n \right)^{\Gamma}} f_d^{\Gamma} \left(f_d + f_x \rho^z \right)^{-\frac{\beta}{z}}, \tag{2.48}$$

where we used the fact that $\rho = f_d^{\frac{\Gamma}{\beta}} \left(\frac{\Upsilon_x^{\frac{1-\beta}{\Gamma}} - 1}{f_x} \right)^{\frac{\Gamma}{\beta}}$. Moreover, θ_d can be solved directly from the equation (2.32) as follows:

$$\begin{aligned}
\theta_d =& \theta_{min} \left[\left(\frac{z\Gamma - \beta}{\beta} \right) f_e \right]^{-\frac{1}{z}} \left(f_d + f_x \rho^z \right)^{\frac{1}{z}} \\
=& \theta_{min} \left[\left(\frac{z\Gamma - \beta}{\beta} \right) f_e \right]^{-\frac{1}{z}} \left(f_d + f_d^{z\frac{\Gamma}{\beta}} f_x \left(\frac{\left(1 + \tau^{-\frac{\beta}{1-\beta}} \right)^{\frac{1-\beta}{\Gamma}} - 1}{f_x} \right)^{z\frac{\Gamma}{\beta}} \right)^{\frac{1}{z}},
\end{aligned} \tag{2.49}$$

while

$$\theta_x = \theta_{min} \left[\left(\frac{z\Gamma - \beta}{\beta} \right) f_e \right]^{-\frac{1}{z}} \left(f_d^{1 - z\frac{\Gamma}{\beta}} \left(\frac{\left(1 + \tau^{-\frac{\beta}{1-\beta}} \right)^{\frac{1-\beta}{\Gamma}} - 1}{f_x} \right)^{-z\frac{\Gamma}{\beta}} + f_x \right)^{\frac{1}{z}}. \tag{2.50}$$

Further, for the symmetric-countries case, the explicit solution for M comes from the following equation:

$$E = \frac{1 + \beta\gamma}{\Gamma} M \bar{\pi}. \tag{2.51}$$

Remark 1. The free entry condition generates a conflict in interest, embedded in the cutoff productivity levels. Having the expressions only in parameters and fixed costs, we can explore comparative statics of marginally changing t_d, where $f_d = f_d' + t_d$. Evidently, in this symmetric-country case $\partial\theta_d/\partial t_d > 0$, which makes it harder for the domestic producer to survive, but $\partial\theta_x/\partial t_d < 0$, thereby increasing the share of exporters. In the next section, we will notice that this also holds in a richer environment, where the government, through its provision of public goods, affects the surviving firms and the share of exporting firms.

3 Comparative statics

In this section, we derive the main testable implications by comparing exporters and domestic producers behaviour to changes in t_d. For this purpose, we focus on the effects of fixed cost (of which one components is the production tax t_d) on the extensive margin of trade and total expenditure in the differentiated sector. Having established a conflict of interest over the choice of per-period fixed costs for enterprises, we can introduce politico-economic setting, and explore what the effects of changing the level of t_d are. This explains the rationale for the existence of a government. Notice that the very existence of the government is motivated by the resource reallocation: from charging firms for operating each period to making the hiring of more able workers more profitable.

The introduction of the possibility to channel the revenues generated from production taxes in terms of increased average ability creates additional effects. First, the extensive margin reacts more strongly – hence, the economy, which invests the collected fixed costs into education, tends to be more open. However, an increase in the ability level also creates effects, which are amplified on other variables such as expenditure. A decrease in expenditure tends to be larger in absolute value due to both competition and education effects, which make survival for relatively inefficient firms harder. The price increases, whereas the quantity drops by more, so that the product decreases.

The main predictions of our model relate to the conflict of interest generated by the fixed cost of production. Our approach differs from Do and Levchenko (2009), which demonstrate that exporters, being larger firms, are more involved in lobbying activity, and may prefer business regulation, which adversely affect domestic producers. They analyse the relationship between international trade and the quality of economic institutions. They model fixed costs as a reflection of bad institutional framework. They demonstrate that a more regulated and costly environment in the form of higher fixed operating costs drives out relatively inefficient domestic producers. This harsher environment makes the less productive firms more difficult to survive, while, on the other hand, helps exporters (the more productive) to increase their profits.[10] However, they do not channel the resources collected by the government back into the economic system. In this paper, we do not link fixed costs and bad institutions *a priori*. We, instead, hypothesise that the fixed costs could lead to either bad or good institutions. That is, we do not assume that fixed costs are a pure loss in the system. We introduce a channel through which part of the fixed costs could be reverted back

[10] For an exporter, a higher fixed cost has three effects. One, it lowers the total profits one-to-one on the costs side. Second, a higher fixed cost increases profits because it implies fewer surviving firms. This effects is larger the more productive the firm is. Third, higher costs imply fewer producers, which lead to fewer varieties in the sector and, thus, a higher price level.

to the economy in the form of public goods.[11]

3.1 Channels through cut-offs and the extensive margin of trade

In this section, we embed the private sector equilibrium decisions into a framework, where there exists a government who taxes the private sector and provides public goods. We focus on the mechanism affecting productivity cut-offs and the extensive margin of trade. Comparative statics on Q and A are shown in the Appendix as they do not show relevant mechanism for the current purpose. We establish the government budget constraint and the public goods technology. For this purpose, we first build the channel, denominated *wasteful.* In this case, the government just extracts resources from the private sector in the form of taxes, known as production taxes t_d. The receipts from t_d are then wasted. One can think of this as a case when policy makers (or their corresponding revenues officers) extract rents or receive money from bribes but do not feedback these resources into the economic system. We also model a second case, in which government receipts are used in providing public goods. We model this as resources spent on education. Specifically, expenditure in education is such that it positively affects workers' ability. We call this the *educational channel.*

The government follows a balanced budget rule, where total revenues $t_d\left[1-G(\theta_d)\right]$ equal total government expenditure $\mathcal{G}$:

$$\mathcal{G} = t_d\left[1-G(\theta_d)\right]. \tag{3.1}$$

The balancedness is assumed as our model is static, and can be thought of as the steady state version of a dynamic extension.[12] The running of deficits or surpluses would require to complicate the model by introducing financial markets, and this is not the aspect we want to emphasise or focus on.

We assume throughout that the ratio of the demand shifters (the aggregates $A(t_d)$ and $A^{\star}(t_d^{\star})$) entailed in $\Upsilon_x = 1+\tau^{-\frac{\beta}{1-\beta}}\left(\frac{A^{\star}}{A}\right)^{\frac{1}{1-\beta}}$ do not vary. This implicitly assumes that the impact of the policy intervention (changes in t_d) on A in the home country is similar in proportional terms to the impact of the corresponding policy intervention on $A^{\star}$ in the foreign country. This is because both A and $A^{\star}$ change equiproportionally. Note that a particular case for this is the symmetric-countries case (which is usually assumed in the literature). We now start with the wasteful channel.

[11] There are many issues to be considered, such as commitment problem between a lobby and a policy maker, as well as inside a lobby. See Magee (2002) on the modelling strategy to account for the endogenous trade policy and lobby formation. We omit all these complications.

[12] See Helpman and Itskhoki (2009) for the extension of the basic trade and unemployment model to the dynamic setting.

3.1.1 The wasteful channel

Reconsider equation (2.29), which establishes the relative productivity cut-off requirement condition. This determines that

$$\frac{f_x}{f_d} = \left(\Upsilon_x^{\frac{1-\beta}{\Gamma}} - 1\right)\left[\frac{\theta_x\left(\theta_d\left(t_d\right)\right)}{\left(\theta_d\left(t_d\right)\right)}\right]^{\frac{\beta}{\Gamma}}, \tag{3.2}$$

where the extensive margin of trade, $\rho \equiv \frac{\theta_d}{\theta_x}$, is related to the fixed costs of production and fixed cost of exporting, and to the intensive margin of trade. Note that, since $f_d = f_d' + t_d$, the extensive trade margin is a function of the production tax t_d. Now take the derivative with respect to t_d. As a result, we obtain that:

$$\frac{\beta}{\Gamma}\epsilon_{\theta_d,t_d}\left(\epsilon_{\theta_x,\theta_d} - 1\right) = -\,\epsilon_{f_d,t_d} = -\frac{t_d}{f_d}. \tag{3.3}$$

Given the parameter values from the consumer preferences and the technology side, $\beta, \Gamma > 0$, the following cases exist:

$$\epsilon_{\theta_d,t_d} = \begin{cases} < 0 & \text{if} \quad \epsilon_{\theta_x,\theta_d} > 1, \\ > 0 & \text{if} \quad 1 > \epsilon_{\theta_x,\theta_d}. \end{cases} \tag{3.4}$$

As can be noted, the revenues do not feedback positively to the system. That is, the production tax increases without compensating the private sector directly through the public provision of goods. This observation allows us establishing the following lemma, which will be tested empirically.

Lemma 5. *The extensive margin reacts positively to changes in the production tax* t_d.

Proof. Using the properties of elasticities, i.e., $\epsilon_{\theta_x,\theta_d} = \frac{\epsilon_{\theta_x,t_d}}{\epsilon_{\theta_d,t_d}}$, we obtain the elasticity of the extensive margin of trade, ρ, with respect to the production tax, t_d, as follows:

$$\epsilon_{\rho,t_d} \equiv \epsilon_{\theta_d,t_d} - \epsilon_{\theta_x,t_d} = \frac{\Gamma}{\beta} \cdot \frac{t_d}{f_d}. \tag{3.5}$$

□

For the case when there is no feedback to the system, as the above lemma shows, the proportion of exporting firms is increasing in the production tax. Moreover, the marginal change in the extensive margin is constant, and equal to Γ/β. This, however, does not determine, for a given productivity distribution, if the proportion of surviving firms actually increases, that is, those firms above the productivity threshold θ_d. For this purpose, we need to clarify the mechanism through which the conflict of interest between domestic producers and exporters affects the extensive margin of trade.

In order to obtain ϵ_{θ_d,t_d}, consider the free entry condition.[13] After implicitly differentiating equation (2.32) with respect to t_d, noting that f_e is a fixed sunk cost, we obtain that:

$$
\begin{aligned}
z\epsilon_{\theta_d,t_d} =& \frac{t_d}{f_d} + \frac{f_x\rho^z}{(f_d + f_x\rho^z)}\left(z\epsilon_{\rho,t_d} - \frac{t_d}{f_d}\right) \\
=& \frac{t_d}{f_d} + \left(\frac{z\Gamma - \beta}{\beta}\right)\frac{f_x\rho^z}{(f_d + f_x\rho^z)}\frac{t_d}{f_d} > \frac{t_d}{f_d},
\end{aligned} \tag{3.6}
$$

since $z\frac{\Gamma}{\beta} > 1$. This also implies that $\frac{\Gamma}{\beta}\frac{t_d}{f_d} > \epsilon_{\theta_d,t_d}$. Finally, using the fact that $\frac{\epsilon_{\theta_x,t_d}}{\epsilon_{\theta_d,t_d}} = \epsilon_{\theta_x,\theta_d}$, and employing equation (3.6) yield:

$$
\begin{aligned}
z\epsilon_{\theta_x,t_d} =& z\epsilon_{\theta_d,t_d} - z\frac{\Gamma}{\beta}\frac{t_d}{f_d} \\
=& -\left(\frac{z\Gamma - \beta}{\beta}\right)\frac{t_d}{f_d} + \left(\frac{z\Gamma - \beta}{\beta}\right)\frac{f_x\rho^z}{(f_d + f_x\rho^z)}\frac{t_d}{f_d} < 0.
\end{aligned} \tag{3.7}
$$

As mentioned before, the free entry condition generates a conflict of interest, which is embedded in the relative cut-off productivity levels (also refer to the Remark 1). As a result of the above equations, there is a negative relationship between two productivity cut-offs. Keeping sunk costs constant, any shock that affects an active domestic firm in the economy must be offset by the effect of opposite sign on the exporting firm, and vice versa. With this idea in mind, we now relate the mechanism behind the cut-off productivity levels to the average operating profits. We can show explicitly how the profits for the whole economy and the non-exporter get affected.

Taking the derivative of equation (2.33) with respect to t_d we obtain that

$$
\frac{\partial \bar{\pi}}{\partial t_d} = \frac{\partial z \cdot \frac{\Gamma}{\beta} \cdot f_e}{\partial t_d} = 0. \tag{3.8}
$$

Note that this is the result of the envelope theorem in which the derivative of the average operating profit in the economy as a whole, $\bar{\pi}$, should be zero in the optimum. Whereas the derivative of $\bar{\pi}_d$ equation (2.34) with respect to t_d, yields:

$$
\frac{\partial \bar{\pi}_d}{\partial t_d} = -\left(\frac{z\Gamma - \beta}{\beta}\right)\frac{\bar{\pi}_x}{(f_d + f_x\rho^z)} < 0, \tag{3.9}
$$

where we used the fact that $\epsilon_{\rho,t_d} = \frac{\Gamma}{\beta}\frac{t_d}{f_d}$, from the equation (3.5). Note that, since by definition $\bar{\pi}_d \leq \bar{\pi}$ and that $\beta < z\Gamma$, the following holds:

$$
\frac{\partial \bar{\pi}_x}{\partial t_d} = \frac{\partial \bar{\pi}}{\partial t_d} - \frac{\partial \bar{\pi}_d}{\partial t_d} > 0.
$$

The above relations confirm the intuition regarding the conflict of interest between exporters (the winners) and non-exporters (the losers). This is because a gain (loss)

[13] Recall that $1 > \Gamma > 0$.

in the average profit of a domestic producer must be compensated by a loss (gain) in the average profit for the exporting firm to keep an average profit for all firms constant (refer to the equation (2.33), which demonstrates that an average profit is just a fixed proportion of sunk costs). The share of exporters and, therefore, the openness level is affected, but the average active firm is left unchanged.

Further, using this explicit mechanism of conflict of interest, we can determine what the effect on the total expenditure in the sector is. From the previous section, we know that E is the weighted sum of operating profits for the whole economy and non-exporters.[14] Taking the derivative of E (from the equation (2.45)) with respect to t_d allows us to establish the following testable proposition.

Proposition 1. *Total expenditure E is decreasing in the production tax t_d. The effect of t_d on expenditure is the average profit of exporters per unit of total costs adjusted for the intensive margin of trade.*

Proof. Partially differentiate equation for the equilibrium expenditure, leading to

$$\frac{\partial E}{\partial t_d} = -\left(1 - \Upsilon_x^{\beta-1}\right)\left(\frac{1+\beta\gamma}{\Gamma}\right)\left(\frac{z\Gamma - \beta}{\beta}\right)\frac{\bar{\pi}_x}{(f_d + f_x\rho^z)} < 0. \tag{3.10}$$

□

This proposition establishes that by extracting resource from the private sector in the form of production taxes t_d, the total expenditure in the differentiated sector reduces. This negative effect stems from the fact that the price index P increased (this can be clearly seen from the equation (2.46)). On the other hand, consumption index, Q, must decrease. The decrease in the latter has to be more than proportional to the increase in the former for the above proposition to hold (since $E = PQ$). Note that this proposition clearly shows the dependence of E on the exporters' profit. For an exporter, a higher cost in the form of t_d has three effects. One, it lowers the total profits one-to-one on the costs side. Second, a higher cost increases profits because it implies fewer surviving firms (and less competition). This effects is larger the more productive the firm is. Third, higher costs imply fewer producers, which lead to fewer varieties in the sector and, thus, a higher price level. This can be seen more clearly from the effect suffered by the counter part of the exporter, the domestic producer. From the equation (2.31) we know that $\bar{\pi}_d = f_d\left(\frac{\theta_{min}}{\theta_d}\right)^z\left(1-\rho^{z-\frac{\beta}{\Gamma}}\right)\left(\frac{z\Gamma}{z\Gamma-\beta}\right)$, where the first factor contains the first effect. The second factor is the probability of survival (the second effect) and the third factor is the composition effect and its impact on varieties.

We concentrate on aggregate expenditure as it can be mapped into an empirical setting. However, it is of interest to explore how the general price index behaves, as

[14] This is further adjusted by a factor $1+\beta\gamma/\Gamma > 1$, which is not affected in the current subsection

it relates to the welfare in our economy. We demonstrate in the Appendix that the equilibrium price can be expressed in two ways:

$$\begin{aligned} P = & \quad A^{\frac{1}{\beta}}\left(\frac{\Gamma}{1+\beta\gamma}\right)^{\frac{1-\beta}{\beta}}\left[\bar{\pi}_d\left(1-\Upsilon_x^{\beta-1}\right)+\bar{\pi}\Upsilon_x^{\beta-1}\right]^{-\frac{1-\beta}{\beta}} \\ = & \quad \left\{\phi_p^{-1}c^{-\Gamma+1-\beta\gamma}b^{\gamma\beta}\theta_d^{-\beta}f_d^{\Gamma}\right\}^{\frac{1}{\beta}}\left[\bar{\pi}_d\left(1-\Upsilon_x^{\beta-1}\right)+\bar{\pi}\Upsilon_x^{\beta-1}\right]^{-\frac{1-\beta}{\beta}}. \end{aligned}$$

The second equality considers prices as a function of sectoral variables, parameters, technology, f_d and a cut-off productivity θ_d. Combining all the channels, it turns out that the effect on a general price index is related to the expenditure:

$$\begin{aligned} \epsilon_{E,t_d} = & \quad -\frac{q_0}{\Omega}\left(\frac{\zeta}{1-\zeta}\right)\cdot\epsilon_{P,t_d} \\ = & \quad -\left(\frac{\zeta}{1-\zeta}\right)\left(\frac{\frac{\vartheta}{1-\vartheta}P^{\frac{\zeta}{1-\zeta}}}{\frac{\vartheta}{1-\vartheta}P^{\frac{\zeta}{1-\zeta}}+1}\right)\cdot\epsilon_{P,t_d} < 0, \end{aligned}$$

where ϵ denotes an elasticity. Therefore, an increase in production costs makes expenditure suffer and the price index rise. This confirms the intuition about a reduction in a welfare for the agents in the differentiated sector.

3.1.2 The educational channel

In this subsection, we proceed to analyse the effects of the government decision to channel the receipts from taxing the private sector. We assume that these resources are channelled back into the economic system, where in the previous subsection they were just wasted outside the system. We consider the feedback of public resources into the educational system. We choose this particular channel as it affects all the modelled parts of the economy. Skill distribution is crucial for the labour market outcomes, which feed into the structure of exporters. This, in turn, affects all the aggregate measures, including the size of differentiated sector, prices, and general welfare. A simple alternative would have been to model investment into (transport) infrastructure, which is proxied, at least partly, by trade costs τ. As is demonstrated in the Remark 2, it is a straightforward extension for which the rich model's structure is not needed.

Remark 2. Suppose government decides to channel funds into a better and more efficient infrastructure, which reduces trade costs, τ. This is a standard exercise of trade liberalisation. Consider the closed-form solution for the domestic productivity cut-off, reported in (2.49). Obviously, moving from infinite trade costs (autarky) or reducing any bounded level of trade costs increases the cut-off productivity level (also see the export cut-off in (2.50)). This affects aggregate variables and labour market only through the standard Melitz-type reallocations, where more firms afford to engage in trade. The economy is better off and experiences gains from trade,

on the wasteful channel, whereas this factor will be affected in the next subsection.

despite the nonlinearities of the model. However, the distribution of skills/abilities is intact, and there is no channel from the labour market to trade, unlike our chosen approach.

As a result, we look at the case, where t_d, as government expenditure on education, affects positively workers' ability. That is, an increase in t_d affects the shape parameter k of the worker ability Pareto distribution $G_a(a) = 1 - ({}^{a_{min}}/_{a})^k$. It affects the average ability directly through the sufficient statistic k,[15] as the mean ability across workers is $\frac{k}{k-1} \cdot a_{min}$. Though it might seem intuitive to expect a necessarily positive effect, however, it is quite unexpected after accounting for all the channels. To be more precise, we assume an education technology as follows:

$$\begin{aligned} k(\mathcal{G}) =& c_1 \cdot \mathcal{G}^{-\varepsilon} \\ =& c_1 \cdot \{t_d [1 - G(\theta_d)]\}^{-\varepsilon}, \qquad \varepsilon, c_1 > 0, \end{aligned} \tag{3.11}$$

where, as before, the government runs a balance budget, i.e., $\mathcal{G} = t_d [1 - G(\theta_d)]$ and c_1 is a scaling factor.[16] Recall that $\Gamma(k(\mathcal{G})) \equiv 1 - \beta\gamma - \beta\frac{(1-\gamma k(\mathcal{G}))}{\delta}$ – its marginal change with respect to the production tax determines how variables of interest move. These facts help establishing the following testable lemma.

Lemma 6. *The extensive margin tends to react more strongly to changes in production taxes, once the educational channel is allowed for.*

Proof. Taking the derivative of equation (3.2) with respect to t_d and considering $\Gamma(k(\mathcal{G}))$ yield:

$$\epsilon^B_{\rho,t_d} \equiv \epsilon^B_{\theta_d,t_d} - \epsilon^B_{\theta_x,t_d} = \frac{\Gamma}{\beta}\frac{t_d}{f_d} - \mathcal{D} \cdot \epsilon_{\Gamma,t_d} > 0, \tag{3.12}$$

where $\mathcal{D} \equiv \ln\left(\Upsilon_x^{\left(\frac{1-\beta}{\beta}\right)\Psi}/\rho\right) > 0$, $\Psi \equiv \Upsilon_x^{\frac{1-\beta}{\Gamma}}/\left(\Upsilon_x^{\frac{1-\beta}{\Gamma}}-1\right) > 0$, $\frac{t_d}{f_d} = \epsilon_{f_d,t_d}$, and $\epsilon_{\Gamma,t_d} < 0$, provided $z \cdot \epsilon^B_{\theta_d,t_d} < f_d/t_d$. The latter condition is sufficient (but not necessary) for the positive sign.[17] See the Appendix for the full derivation. □

We use the superscript B to denote the educational channel. Note that $\epsilon^B_{\rho,t_d} > \epsilon_{\rho,t_d}$ where ϵ_{ρ,t_d} is from the equation (3.5).[18] This is because of an additional *educational* effect on ρ that arrives from the term $-\mathcal{D} \cdot \epsilon_{\Gamma,t_d} > 0$ for sufficiently bounded $z \cdot \epsilon^B_{\theta_d,t_d}$.[19]

[15] Consider that k is a sufficient statistic for both the mean and the variance since workers' ability is drawn from a Pareto distribution.

[16] Note that c_1 ensures that k remains in the admissible parameter space.

[17] The elasticity of the domestic productivity threshold should be not too large, i.e., bounded by $z \cdot \epsilon^B_{\theta_d,t_d} < \frac{f_d}{t_d} + \frac{(\Gamma/\beta)^2}{\mathcal{D} \cdot \frac{\gamma}{\delta} k \cdot \varepsilon}$. Clearly, this condition is easier met for small t_d relative to f_d.

[18] This also implies that, since $z\frac{\Gamma}{\beta} > 1$, $z\epsilon^B_{\rho,t_d} > z\epsilon_{\rho,t_d} > \epsilon_{f_d,t_d} = \frac{t_d}{f_d}$ holds.

[19] Note that $\epsilon_{\Gamma,t_d} = -\frac{\beta}{\Gamma}\frac{\gamma}{\delta}k \cdot \varepsilon \left(\frac{f_d}{t_d} - z \cdot \epsilon^B_{\theta_d,t_d}\right)\frac{t_d}{f_d}$ is itself a function of parameters, f_d, t_d, and $\epsilon^B_{\theta_d,t_d}$. We do not explicitly solve ϵ_{Γ,t_d}, as in this section we are solely interested in the signs of the derivatives.

That is, among those firms that survive, the proportion of exporting firms increases after an increase in the production taxes. The reason for this is rooted in the fact that exporters, which have higher productivities, are benefiting relatively more from the effects stemming from higher ability workers. Although all firms benefit from the increase in ability, some of them do compensate the increase in t_d in terms of both more production and higher prices. We again proceed to clarify the mechanism through which a change in production taxes operates on the productivity thresholds (refer to Figure 3.1, where elasticities for cases of wasteful and educational channels have been simulated, with t_d approaching f_d in 10 steps; refer to the Appendix and online materials for technical details on simulations).

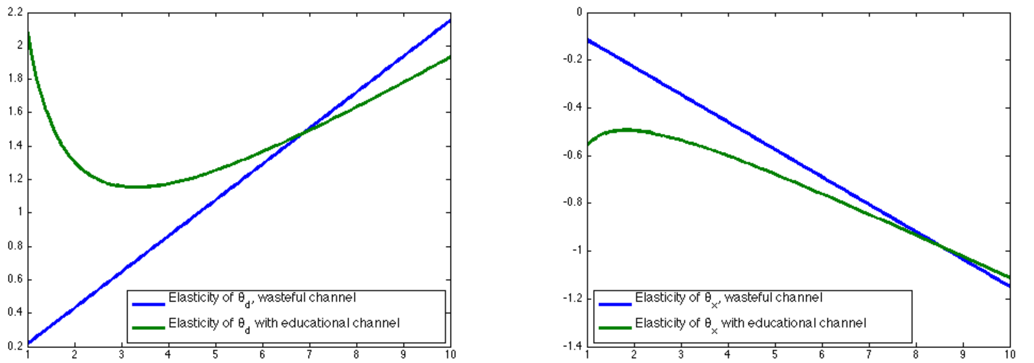

Figure 3.1: Elasticities of threshold productivities with and without educational channel

In order to obtain ϵ_{θ_d,t_d}, consider the free entry condition. Hence, implicitly differentiate equation (2.32) with respect to t_d, recalling that f_e is a fixed sunk cost, obtaining:

$$z\epsilon^B_{\theta_d,t_d} = z\epsilon_{\theta_d,t_d} - \left(\frac{f_x\rho^z}{(f_d + f_x\rho^z)}\mathcal{D} + \frac{\Gamma}{(z\Gamma - \beta)}\right) z \cdot \epsilon_{\Gamma,t_d} > 0, \tag{3.13}$$

provided that $\epsilon_{\Gamma,t_d} < 0$. It is worth noting that the last term entails the additional educational channel (compared to $z\epsilon_{\theta_d,t_d}$ from the subsection on the wasteful channel). Using the fact that $\left(1 - \epsilon^B_{\theta_x,\theta_d}\right) = \epsilon^B_{\rho,t_d}/\epsilon^B_{\theta_d,t_d} > 0$ and equations (3.12) and (3.13), we obtain that

$$z\epsilon^B_{\theta_x,t_d} = z\epsilon_{\theta_x,t_d} - \left(-\mathcal{D} + \frac{f_x\rho^z}{(f_d + f_x\rho^z)}\mathcal{D} + \frac{\Gamma}{(z\Gamma - \beta)}\right) z \cdot \epsilon_{\Gamma,t_d} < 0, \tag{3.14}$$

However, we analytically solve for $\epsilon^B_{\theta_d,t_d}$in the Appendix. Importantly, $\epsilon_{\Gamma,t_d} < 0 \iff \frac{f_d}{t_d} > z \cdot \epsilon^B_{\theta_d,t_d}$. Additionally, this condition is equivalent to the total government expenditure being increasing in t_d, implying that we are on the increasing (left) side of the Laffer curve. This condition holds if and only if $\frac{f_d}{t_d} > z \cdot \epsilon_{\theta_d,t_d} = 1 + \left(\frac{z\Gamma - \beta}{\beta}\right) \frac{f_x\rho^z}{(f_d + f_x\rho^z)} > 1$. As t_d is only a fraction of total fixed cost f_d, in principle this condition can hold. We consider the parameter values commonly used in the literature where the last term is a new element, compared to the subsection on the wasteful channel, $z\epsilon_{\theta_x,t_d}$.[20]

As mentioned in the subsection on the wasteful channel above, the conflict of interest operates through the free entry condition. As before, there is a negative relationship between productivity cut-offs of domestic producer and exporters. However, the educational channel generates an extra effect entailed in the last term of the above equation. We now show explicitly how the profits are affected.

Taking the derivative of equation (2.33) with respect to t_d:

$$\begin{aligned}\frac{\partial \bar{\pi}^B}{\partial t_d} =& \frac{\partial z \cdot \frac{\Gamma}{\beta} \cdot f_e}{\partial t_d} \\ =& \frac{\bar{\pi}}{t_d}\epsilon_{\Gamma,t_d} < 0. \end{aligned} \tag{3.15}$$

Differently to the subsection on the wasteful channel, here the average operating profit does decrease when t_d increases. On the other hand, the derivative of $\bar{\pi}_d$ in equation (2.34) with respect to t_d yields:

$$\frac{\partial \bar{\pi}_d^B}{\partial t_d} = \frac{\partial \bar{\pi}_d}{\partial t_d} + \left(\bar{\pi} - \bar{\pi}_x - \frac{\partial \bar{\pi}_d}{\partial t_d}\mathcal{A} \cdot t_d\right)\frac{1}{t_d}\epsilon_{\Gamma,t_d} < 0, \tag{3.16}$$

where $\mathcal{A} > 0$, and we used ϵ^B_{ρ,t_d} from the equation (3.12).[21] Moreover, the first term, which is negative, is from the subsection on the wasteful channel. The second term is also negative as $\epsilon_{\Gamma,t_d} < 0$. Using the fact that $\bar{\pi} = \bar{\pi}_d + \bar{\pi}_x$, and noting that, given the properties of $\Upsilon_x > 1$, and by definition $\bar{\pi}_d \leq \bar{\pi}$, the following holds:[22]

$$\frac{\partial \bar{\pi}_x^B}{\partial t_d} = \frac{\partial \bar{\pi}^B}{\partial t_d} - \frac{\partial \bar{\pi}_d^B}{\partial t_d} > 0. \tag{3.17}$$

This relation further confirms the findings from the subsection on the wasteful channel above, in that it shows the conflict of interest between non-exporters and exporters (the winners of this government policy). Now, in contrast, the average profit for all firms does change (it decreases, as equation (3.15) shows). For this reason, the sign of the marginal benefit for the exporter from the educational channel compared to

(see Section 8.6 in the Appendix and Helpman et al., 2008a). As a result, $\frac{f_d}{t_d} > z \cdot \epsilon_{\theta_d,t_d} \approx \frac{4}{3}$, which implies that the production tax must be less than 75% of total fixed cost of production.

[20] Note that a sufficient condition for $\epsilon^B_{\theta_x,t_d} < 0$ is the brackets to be negative:

$$\frac{\Gamma}{(z\Gamma - \beta)} < \mathcal{D} - \frac{f_x\rho^z}{(f_d + f_x\rho^z)}\mathcal{D} = \mathcal{D}\frac{f_d}{(f_d + f_x\rho^z)},$$

which holds for the admissible parameter space in our theoretical model and those used in the literature. See Helpman et al. (2008a) and Figure 8.1 in the Appendix which graphically confirms this.

[21] $\mathcal{A} \equiv \left(\frac{\beta}{z\Gamma - \beta}\right)\frac{f_d}{t_d}\left[z\mathcal{D} - \frac{\bar{\pi}}{\bar{\pi}_x}\rho^{z-\frac{\beta}{\Gamma}}\frac{\beta}{\Gamma}(\ln\rho + \mathcal{D})\right] > 0$ as $z\mathcal{D} > \rho^{z-\frac{\beta}{\Gamma}}\frac{\beta}{\Gamma}(\ln\rho + \mathcal{D})$. The last inequality follows after using $\frac{\bar{\pi}}{\bar{\pi}_x}$ and a few algebraical manipulations.

[22] See Figure 8.2 in the Appendix for a graphical representation of the necessary and sufficient

the wasteful channel ($\frac{\partial \bar{\pi}_x^B}{\partial t_d} - \frac{\partial \bar{\pi}_x}{\partial t_d}$) is not clear *a priori*. However, for the admissible parameter space in our model and in related literature, the marginal benefit is positive (see footnote 20). For this case, the loss in the average profit of a domestic producer is more than compensated by the gain in the average profit for the exporting firm. This is a result from a decreasing average profit for all firms. Another feature behind this mechanism is the fact that the openness level (i.e., the share of exporters ρ^z) increases more in the *educational* channel compared to the *wasteful* channel, i.e., $\epsilon^B_{\rho,t_d} > \epsilon_{\rho,t_d}$.

The observation that E is the weighted average of profits of domestic producers and exporters, and that the existence of the *educational* channel makes the conflict of interest in the economy more acute, leads us to establish the following proposition. This proposition, as well as the corresponding one from the wasteful channel, is testable, and we consider it in the empirical section below.

Proposition 2. *The reaction of expenditure to a shock in the production taxes is more pronounced when there is an educational channel. Its effect on expenditure, as compared to a wasteful channel, is equal to* $-\mathcal{A} \cdot \epsilon_{\Gamma,t_d} > 0$.

Proof.

$$\frac{\partial E^B}{\partial t_d} = \frac{\partial E}{\partial t_d}\left(1 - \mathcal{A} \cdot \epsilon_{\Gamma,t_d}\right) < 0, \tag{3.18}$$

where $\frac{\partial E}{\partial t_d}$ is from the equation (3.10) and $\mathcal{A} > 0$. □

Note that $|\frac{\partial E^B}{\partial t_d}| > |\frac{\partial E}{\partial t_d}|$, provided $\epsilon_{\Gamma,t_d} < 0$. That is, total expenditure in the differentiated sector, E, is more sensitive when t_d is channelled through the education expenditure into the ability of workers. This is because of the existence of an additional *educational* effect entailed in the term $-\mathcal{A} \cdot \epsilon_{\Gamma,t_d} > 0$. This term is larger the larger the elasticity of the statistic k with respect to expenditure on education, ε. This is because $-\epsilon_{\Gamma,t_d}$ is increasing in ε. The rationale for this is that the conflict of interest was intensified by the educational channel. To be more precise, the direct effect works through the extensive margin, ρ. However, there is also an indirect channel working through the intensive margin of trade. Notice that the interaction of the extensive and intensive margins determines the effect on expenditure. The change in k affects the power of an extensive margin ($\rho^{z-\frac{\beta}{\Gamma}}$), thereby creating another effect when the very interaction (the functional form) of two margins changes.[23] Figure 3.2 illustrates how the production taxes affect total expenditure, with and without accounting for the educational channel.

condition for $\frac{\partial \bar{\pi}_x^B}{\partial t_d} > 0$.

[23]In principle, however, the effect can be dampened by the educational channel if $\epsilon_{\Gamma,t_d} > 0$. This happens when the production tax is relatively large to f_d. We explore this case in simulations and report results in the online Appendix. However, our preferred case is the one supported by data. The values used for simulations and their sources can be found reported in the Appendix 9.

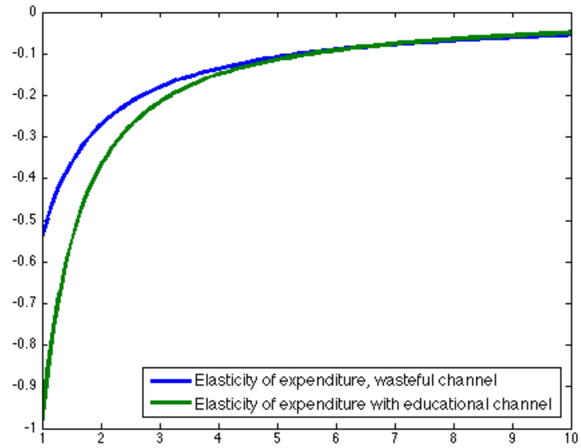

Figure 3.2: Change in expenditure due to production tax

The main testable predictions of our model relate to the conflict of interest between exporters and domestic producers. As noted before, an exporter benefits disproportionately from the higher fixed cost. This is because fewer surviving firms and, hence, less competition increase profits (in terms of more production and higher prices). Relatively more firms drop out the market and the most productive firms make the most out of this at the expenses of the low productivity firms. However, the increase in output (from those firms that survive) does not compensate the fall in output from those exiting the sector: total expenditure E decreases as a result.

4 Empirical Evidence

Having provided insight into the theoretical nexus of the openness and government's role through collecting and channelling production taxes, we aim at establishing empirical support. First, notice that, unlike Do and Levchenko (2009), we do not impose *a priori* an adverse relationship between fixed costs and institutional setting in the economy. High per period costs could either proxy poor institutional environment (ineffective judicial system, high expropriation risk, prohibitive cost of external finance) but could also be a sign of business conducive environment, where government actively engages in channelling taxes to improve human capital, reduce frictions in labour market or provide state-of-the-art public infrastructure. The differences in results once we use the traditional infrastructure variables (trade liberalisation) instead of the educational channel, as emphasised by our theory, can be found in the online Appendix.

4.1 Data

We construct a data set, which covers the period from 1995 until 2011 in annual figures. The countries considered can be seen in Table 6.1. One of the main variables in our theoretical model is the extensive margin of trade, ρ. Due to the country level analysis, we self construct this variable from the World Input-Output Database (WIOD), as otherwise the trade network would have been full if considered aggregatively. Note that our model admits multi-sectoral analysis, and can be mapped to our empirical strategy. The database covers 27 European Union countries and 13 other major countries in the world. It indicates the use of products, either intermediate use (domestic use and exports) or final use (domestic use and exports). It also indicates the supply of products (imported or domestically produced). Moreover, the WIOD database shows the country of origin and destination of products at the industry level. It disaggregates the economy into 35 different industries with over 40 million observations. This data give us time series of the extensive margin of trade for these 40 countries. We construct this variable as the ratio of all non-zero trade links and all the possible trade links by the domestic industries with industries abroad. A link is defined as non-zero (i.e., active) as long as a given industry exports to any other foreign country.[24] The total possible links by all domestic industries with foreign market is $35 \cdot 35 \cdot 39$, where 35 corresponds to the number of industries and 39 to all the countries except for the domestic country. See Dietzenbacher et al. (2013) for the construction of the world input-output tables.

The remaining variables are from the World Development Indicators from the World Bank. We consider the intensive margin of trade Υ_x as a trade openness indicator, which is defined as the ratio between trade flows and GDP. We use GDP as a total expenditure in the sector. We use this variable as a proxy for E from the theoretical model. In our theoretical economy, the production tax (t_d) constitutes the only source of taxes, collected each period from active firms. Recall that we model balanced government's budget, summarised in equation (3.1). Therefore, we account for the government's expenditure using data on general government's expenditure, divided by the country's GDP, to enable multi-country comparison. As for the instrumental variable approach, we instrument government expenditure with spending on education (as a share of GDP) and adjusted savings on education (as a share of GNI). Because of the availability of data, we end up with a panel covering 37 countries with a total of 629 observations. For all the data and definitions of the variables see Table 6.2 in the Appendix. The descriptive statistics for all the variables are shown in Table 6.3.

[24] Note that we abstract from considerations relating to the size of firms as we do not have disaggregated data on the number of firms that export for multiple countries. That is to say, our data cannot reflect the fact that a large number of small firms might not export, whereas a few large firms might export.

4.2 Estimation strategy

Our approach allows evaluating whether open economies behave as predicted by the theory. We employ panel techniques to exploit variation both in spatial and time dimensions. Our modelling strategy somewhat resembles that of trade gravity as developed by Anderson and van Wincoop (2003). Though our main variable of interest is expenditure (and also trade extensive margin), gravity modellers are mainly interested in trade flows. They relate bilateral trade (which can be expressed as trade share over GDP), to economic size of trade partners proxied by their GDPs, bilateral trade barriers, and multilateral resistance variables. The latter, as popularised by Feenstra (2004), are being modelled using fixed effects. They should capture the general equilibrium (trade network) effects because any change in the bilateral trade flows create an effect on the entire trade network. Therefore, instead of analysing trade values, we can see our estimating equation as an 'inverted' gravity model: GDP becomes a function of trade variables (intensive and extensive margins), multilateral and bilateral terms (two-way fixed effects), and deterministic time effects to capture dynamics of, say, technology improvements. To illustrate, the traditional gravity model purports that trade openness (the ratio between trade flow and GDP) is equal to the trade costs, including bilateral and multilateral ones, and income shares of trading partners. Recently, Helpman et al. (2008b) demonstrated that trade flows contain substantial amount of zero values, and that the extensive margin of trade must be accounted for even if one is solely interested in the trade intensity.

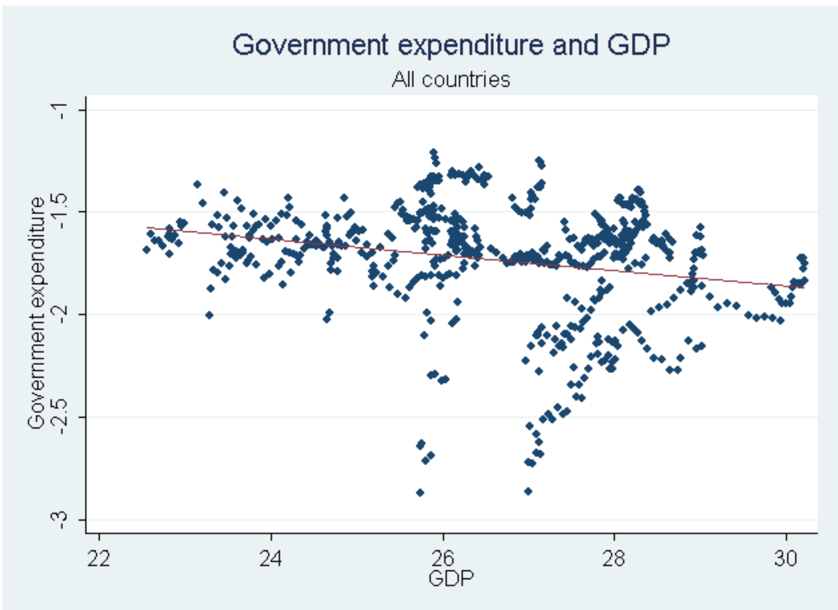

Figure 4.1: Government expenditure and GDP

Before continuing with our regression specification, we first show some graphic evidence in Figure 4.1 for the relationship between total production taxes and total expenditure. In that figure, we see a clear negative relation between our proxy for t_d

and our proxy for E. This negative relationship is broadly consistent with the testable implications of our theoretical model. We now proceed to establish whether this also holds when we test it econometrically.

In our case, equation (2.45) can be rewritten, after taking logs and using expression (2.36), as

$$\ln E = \ln \Delta + \frac{z}{\beta} \ln A + \ln \left[\frac{f_d \left(1 - \rho^{z - \frac{\beta}{\Gamma}}\right)}{f_d + f_x \rho^z} \left(1 - \Upsilon_x^{\beta - 1}\right) + \Upsilon_x^{\beta - 1} \right] + \ln \left[f_d^{1 - z\frac{\Gamma}{\beta}} + f_x \left(\frac{\Upsilon_x{}^{\frac{1-\beta}{\Gamma}} - 1}{f_x} \right)^{z\frac{\Gamma}{\beta}} \right], \tag{4.1}$$

where Δ collects parameters and variables not responding to fixed costs.[25] Hence, expenditure is a non-linear function of t_d through f_d (recall that $f_d = f_d' + t_d$). Expenditure is also a function of the extensive margin ρ^z, the intensive margin Υ_x, and a demand shifter A. The latter is unobservable but can be proxied by a population to reflect the size of the market. Since it is insignificant, we leave expressions with population for robustness checks. The intensive margin is measured as a share of trade over GDP and mimics a ratio of export revenue in total revenue, as shown in the equation (2.13). To control for trade network effects, we will employ fixed effects methodology.

We, therefore, test our prediction by first running regressions using government expenditure as a proxy for total t_d payments. Total production tax payments could be either considered as a loss – as is done in heterogeneous firms trade literature – or channelled back into economy – as is done in this paper. Then we employ an instrumental variable (IV) approach, and explore the effect of the *educational* channel. Technically, we use the overlapping variation of the total government's expenditure with that of spending on education. The larger the common variation, the more consumption is channelled back through education. Specifically, we instrument the government's expenditure with spending on education (as a share of GDP) and adjusted savings on education (as a share of GNI). In other words, we extract the variation in total expenditure, which is contributable to education. This is done to be consistent with the theory, which postulated that the latter part of government spending (not all of it) matters for our described mechanisms to be at work. Proposition 2 predicts that the reaction in expenditure will be more pronounced and of negative sign (compare equations (3.10) and (3.18)). We interpret the difference in two parameters as the education effect on E, once channels of trade have been accounted for. We run fixed effects panel regression, augmented with time effects to control for technology

[25] We let $\ln \Delta \equiv \ln \left(\frac{1+\beta\gamma}{\beta}\right) z\theta_{min}^z \frac{\left(\frac{\Gamma}{\beta\gamma}\phi_n\right)^{z\frac{\Gamma}{\beta}}}{\left(c^{\frac{(1-\gamma k)}{\delta}} b^\gamma\right)^z} \frac{\beta}{z\Gamma - \beta}$; note that for the wasteful channel this expressions does not vary with t_d. However, for the educational channel, the last multiplicand does change.

advancements and multilateral terms.

Facing data limitations, we cannot address all the surrounding issues of statistical nature, namely testing for different channels, using larger set of conditioning variables, and be fully confident of the validity of exclusion restrictions of the chosen variables. The essence is to model the role of government's expenditure on aggregate income. The IVs should correlate with the government expenditure – and they obviously do – but should not correlate with the residuals from the regression of government consumption on aggregate income once excluded variables have been conditioned on. Our model hints that if the educational channel is to be believed, this should be the case. In other words, once we condition on trade margins, the proxy for t_d through expenditure on education should capture the required variation. However, it would be sensible to argue that, as economies get richer, they tend to spend more resource in the education system. Thus, there could be reasons to consider the natural case of an effect of GDP (aggregate income) on expenditure on education. As a result, one can expect one category of government expenditure, namely education, to be correlated with outcome variables. In other words, it seems reasonable to expect that the exclusion restriction might be violated.[26]

Empirical studies have subjected Wagner's law to various empirical tests. This law states that there exists a positive long term relationship between income and the relative size of the government.[27] Interestingly, recent studies have subjected the aforementioned law to more thorough empirical tests. A recent study by Bruckner et al. (2012), using instrumental variable approach, has found that the elasticity of government expenditures with respect to national income to be less than unity. However, among government expenditure subcategories like expenditure on education, the results are different. Specifically, they estimate the income elasticity of government expenditure on education to be small and not statistically different from zero (coefficient 0.32, standard errors 0.31). This empirical finding argues in favour of the validity of the exclusion restriction, however, the usual caveats with respect to instrumental variables should be considered.

Graphic evidence for the link between the extensive margin of trade and government expenditure is presented in Figure 4.2. This visual inspection shows a clear positive correlation between the extensive margin and total production taxes t_d (government expenditure). This relationship is broadly consistent with the testable implications of the theoretical model. We now examine whether this relationship is

[26]We have also considered using the "outcome" variables such as a share of population with advanced training, stock of human capital, etc. However, drawing from an endogenous growth theory, we would face the same issue of instruments exogeneity. Rather, we proceed with the most direct mapping from the theory to empirics.

[27]However, not much consensus with respect to aggregate government expenditure has been achieved as to whether Wagner's law holds in the data. It can be seen in Durevall and Henrekson (2011) that there still exists controversy on the empirical findings.

present when exposed to a more thorough empirical analysis.

To learn the effect on the extensive margin, we first recall that it can be expressed as $\rho = f_d^{\frac{\Gamma}{\beta}} \left(\frac{\Upsilon_x^{\frac{1-\beta}{\Gamma}} - 1}{f_x} \right)^{\frac{\Gamma}{\beta}}$, or

$$\ln \rho = \frac{\Gamma}{\beta} \ln f_d + \frac{\Gamma}{\beta} \ln \left(\frac{\Upsilon_x^{\frac{1-\beta}{\Gamma}} - 1}{f_x} \right).$$

Therefore, the extensive margin is a function of fixed costs (of which one component is t_d) and the intensive margin of trade. We test the implication whether, once educational channel is allowed for, the effect on the extensive margin is positive and larger (refer to Lemma 6). As mentioned in the data section above, we construct ρ to uncover extensive margins. A positive difference between the coefficient on t_d of the IV versus the OLS regressions would be interpreted as a positive effect stemming from education.

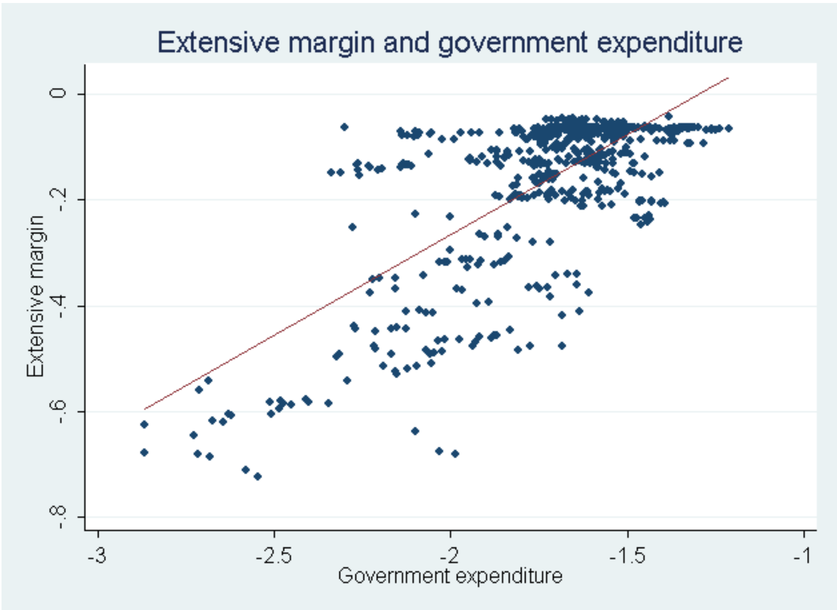

Figure 4.2: Extensive margin and government expenditure

4.3 Results

The results of testing Proposition 1 are shown in Table 4.1. This shows the results for the OLS estimator. We can see in column one the impact of a positive change in government spending on expenditure. There we estimate a coefficient equal to -0.17, which is statistically significant at the 1% level and consistent with our theory. We also note that there is no direct effect of the extensive margin of trade on expenditure. The second column shows a similar regression, but it additionally accounts for the intensive margin of trade. In this case, the coefficient on government spending is also negative and equal to -0.16 (statistically significant at the 1% level).

Table 4.1: Expenditure (GDP) and the role of government
Ordinary Least Squares

	(1)	(2)
$SPENDING$	-0.174***	-0.168***
	(0.042)	(0.042)
$EXTENSIVE$	0.129	0.164
	(0.135)	(0.139)
$INTENSIVE$		0.040
		(0.037)
N	618	618
R^2	0.773	0.774

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Standard errors, clustered by country, in parentheses.

Table 4.2: Expenditure (GDP) and the role of government
Instrumental Variables

	(1)	(2)	(3)	(4)
$SPENDING$		-0.387***		-0.434***
		(0.118)		(0.123)
$EXTENSIVE$	0.220	0.412**	0.181	0.353**
	(0.151)	(0.167)	(0.153)	(0.167)
$INTENSIVE$			-0.051	-0.086**
			(0.035)	(0.039)
$EDUCA$	0.488***		0.476***	
	(0.070)		(0.070)	
$EDUCA_{noK}$	-0.202***		-0.198***	
	(0.058)		(0.058)	
Stock–Yogo F		64.91		63.57
Stock–Yogo F critical value		11.59		11.59
OID p–value		0.532		0.495
N	463	463	463	463
R^2	0.363		0.366	

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Standard errors, clustered by country, in parentheses.
Columns (2) and (4) are the 2nd stage regressions.
The Stock and Yogo (2005) critical values for the weak instrument test are based on the 2SLS size at 0.15 for the 5% level test for Excluded instruments.
OID= overidentification test of all instruments (Hansen J statistic).

The results for the IV regression are shown in Table 4.2. Here we aim essentially at testing whether the Proposition 2 holds in the data. We report the first stage regression results in columns 1 and 3, the latter being the case when the intensive margin of trade is considered as a regressor. In those columns, we note that expenditure on education is positively and statistically related to government spending (so relevance condition is met, though will be tested more formally). Columns 2 and 4 show the second stage regressions. There, we can note that the total production taxes (government spending) is negatively related to expenditure. This holds for both whether we consider or not the intensive margin of trade as a regressor. The former has a coefficient larger in absolute value. That is, the intensive margin of trade intensifies the impact of fixed costs on expenditure. Moreover, the IV regressions tell us that once we account for the effect of education, the impact of a change in government spending increases in absolute value, from -0.16 to -0.43, where the latter is significant at the 1% level. This confirms the existence of the *educational* channel and the initial hypothesis that higher production taxes embedded in t_d might lead to quite different results compared to the wasteful channel. We run the test for weak instrument by Stock and Yogo (2005) and note that the F values are well above the critical values.[28] This does not cast doubt on the strength of our instruments. We conducted Sargan-Hansen statistic of over-identifying restrictions and the null has never been rejected indicating that instruments are valid (statistically exogenous, with no effect on outcomes other than through the first stage channel).

Table 4.3: Extensive margin and the role of government Ordinary Least Squares

	(1)	(2)
$SPENDING$	0.069***	0.055***
	(0.013)	(0.013)
$INTENSIVE$		-0.061***
		(0.011)
N	618	618
R^2	0.211	0.253

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Standard errors, clustered by country, in parentheses.

With regard to the results of the effects of production taxes on the extensive margin, see Table 4.3. This collects evidence on the OLS case. It shows a positive impact of government spending on the extensive margin of trade with a magnitude of the coefficient of 0.055, which is significant at the 1% level. Table 4.4, instead, shows the result on the instrumental variable approach. It confirms that, once the *educational* channel is allowed for, the effect on the extensive margin is positive and substantially larger (also refer to Lemma 6). The elasticity almost quadruples from

[28] See also Stock et al. (2002) for a related discussion.

0.055 (from the OLS estimate) to 0.203, the latter being significant at the 1% level. The difference between the OLS and the IV estimates is being interpreted as a positive effect stemming from education. We also test for the strength of the instruments and again F values are well above the critical values by Stock and Yogo (2005). However, the OID test does reject the null, which casts some doubt over the validity of the instruments and calls for caution when interpreting this set of results.

Table 4.4: Extensive margin and the role of government Instrumental Variables

	(1)	(2)	(3)	(4)
$SPENDING$		0.227***		0.203***
		(0.039)		(0.040)
$INTENSIVE$			-0.058*	-0.031**
			(0.034)	(0.014)
$EDUCA$	0.495***		0.480***	
	(0.070)		(0.070)	
$EDUCA_{noK}$	-0.192***		-0.190***	
	(0.058)		(0.058)	
Stock–Yogo F		77.62		76.56
Stock–Yogo F critical value		11.59		11.59
OID p–value		0.00		0.00
N	463	463	463	463
R^2	0.359		0.364	

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Standard errors, clustered by country, in parentheses.
Columns (2) and (4) are the 2nd stage regressions.
The Stock and Yogo (2005) critical values for the weak instrument test are based on the 2SLS size at 0.15 for the 5% level test for Excluded instruments.
OID= overidentification test of all instruments (Hansen J statistic).

Further, we run some robustness checks (refer to the Appendix for the relevant tables). We first start by dropping one country each at a time. We do this for both the OLS and IV cases. The country we drop corresponds to the column's number (see Table (6.1)). We start with the OLS case with corresponding Tables 7.1 and 7.2. There we note that the coefficients on $SPENDING$ range from a lowest of 0.045 (dropping Romania or Turkey) to a largest of 0.63 (dropping Hungary). The vast majority of these coefficient are statistically significant at the 1% level. Recall that for the benchmark case, where all countries are considered, this value is 0.055. On the other hand, the coefficient on $INTENSIVE$ for the benchmark case was -0.061. When dropping one country each at a time, this coefficient ranges from a lowest of -0.069 (dropping Canada) to a largest of -0.042 (dropping India), and are statistically significant at the 5% level. We continue with the IV case with corresponding Tables 7.3 and 7.4. They report the second stage regressions. For the benchmark case (all countries), we had a coefficient on $SPENDING$ of 0.203. When dropping one country each at a time, this coefficient ranges from a minimum of 0.133 (dropping Indonesia) to a maximum of 0.228, when we drop Latvia. For the coefficient on $INTENSIVE$ we had value of -0.031 in our benchmark estimation. When dropping one country each at a time, the coefficient on $INTENSIVE$ ranges from a minimum of -0.040 (dropping Canada) to a maximum value of -0.018, when dropping India. Given these results, we can only conclude that there is some consistency of the coefficient on the variable $INTENSIVE$ across estimators as those countries, which are dropped, make this coefficient the lowest (Canada) and the highest (India) for both the OLS and the IV estimators. With respect to the test of overidentifying restrictions (not presented in the tables), we reject the null hypothesis, which casts some doubt on the validity of the instruments. However, for the weak instrument by Stock and Yogo (2005) (not presented in the tables), the F values are well above the critical values and, hence, does not cast doubt on the strength of our instruments.

We also analyse the effect of splitting the sample into two subsets. One subset, where countries have an extensive margin (average across time) larger than the median, and those, which are below the median. We run the regressions relating expenditure to production taxes and other regressors. We show these in Tables 7.6 and 7.5. Table 7.6 shows the OLS estimates. There it can be noted that for those countries, which are below the median extensive margin, ρ, (see column 1), the effect of government spending on expenditure is negative (-0.057), as in the benchmark case, but smaller in absolute value than for those countries, which are above the median (column 2), where the coefficient is now -0.382. The former coefficient being statistically undistinguishable from zero, whereas the latter being significant at the 1% level. When instrumenting government spending, we see in the second column of Table 7.5 that those countries below the median ρ now have a larger (in absolute terms) coefficient on spending (-0.582), compared to those countries, which are above the median extensive margin of trade (-0.368) in column 4, where both coefficients are significant at conventional levels. A number of further robustness checks can be also found in the accompanying online Appendix. It is worthwhile mentioning that using a number of infrastructure components, we could not establish consistent evidence of the educational channel, attributable to other (more trade related) variables.

5 Conclusion

International trade literature has enjoyed a revival after an introduction of firm heterogeneity into a monopolistic competition model with the love of variety. However, it is only recently that more interest has been documented with regard to the fixed costs, which produce firm partitioning into exporters and non-exporters. This enables to uncover new gains from trade, selection effects, when less productive firms are driven out from the open economy by more productive ones.

A few contributions, which analysed fixed costs, mainly focused on their determination and treated them as either payments to policy makers or a pure loss. Motivated by the empirical fact that higher business operation costs can be related to both larger and smaller government sector, we introduce fiscal policy into the model due to Helpman et al. (2010). Instead of a simple trade liberalisation idea when taxes are reverted back to the economy through decreased trade costs, we propose an educational channel, which is contrasted to the standard result when fixed costs are treated as a pure loss. Contributing to literatures on the political economy and trade, and trade and labour markets outcomes, we demonstrate that fixed costs, and particularly one of its components, the production tax, paid by all active firms and redistributed back through the educational channel, change the structure of active firms and, thus, affect the entire macroeconomy. The ability level of the workforce increases and this helps to make a country more open than without such a channel. We, therefore, contribute to the emerging literature on the importance of the skill distribution on trade patterns. However, aggregate expenditure level drops and prices increase, therefore, reducing general welfare. Three major effects for the trading firm include a drop in the profit due to payments in terms of a fixed cost, an increase in the profit due to lesser measure of remaining competitors, and, lastly, lower measure of available varieties and, consequently, higher price.

We also mapped our theoretical framework to test the predictions on the extensive margin and expenditure using a dataset on 40 countries from 1995-2011. Employing education variables (expenditure and savings) to instrument for the aggregate government expenditure, we find our predictions largely confirmed. Of course, it would be desirable to have richer data to explore the robustness of our results. In particular, we see our framework to be tested using micro level data, and certified, whether the variation across the countries mimics the behaviour within a country. Both theoretically and empirically, it remains unexplored how adjustments in the differentiated sector are being transmitted to the homogeneous sector. In a static environment with the fixed aggregate income, any change in one sector causes adjustments in the other one. Treating homogeneous sector as an informal economy opens new vistas to explore how government intervention affects economy's openness, sectoral shifts, relative share of exporters to non-exporters, and formality. Another area worth exploring is the creation of a political economy model that fully endogenises the determination of production taxes t_d. This framework could provide additional insights into how the government optimally sets the equilibrium level of production taxes in a game, where net profits of both exporters and non-exporters are being considered. A research on the educational channel and the comparative advantage at a sectoral level, which helps to account for varying degrees of complementarity, can be pursued along the lines of Bombardini et al. (2012). These are exciting avenues for future research.

Appendices

6 Data

6.1 List of countries

Table 6.1: List of countries

Country	Nr.	Country	Nr.	Country	Nr.
Australia	1	Greece	14	Poland	27
Austria	2	Hungary	15	Portugal	28
Brazil	3	India	16	Romania	29
Bulgaria	4	Indonesia	17	Russia	30
Canada	5	Ireland	18	Slovak Republic	31
China	6	Italy	19	Slovenia	32
Cyprus	7	Japan	20	Spain	33
Czech Republic	8	Korea	21	Sweden	34
Denmark	9	Latvia	22	Turkey	35
Estonia	10	Lithuania	23	United Kingdom	36
Finland	11	Malta	24	United States	37
France	12	Mexico	25		
Germany	13	Netherlands	26		

6.2 Data description and source

Table 6.2: Variables and sources

Variable	Sources and description
$SPENDING$	Natural logarithm (henceforth, ln) of general government final consumption expenditure (% of GDP, NE.CON.GOVT.ZS) by WDI, the World Bank.
$EXTENSIVE$ (ρ)	Ratio of all non-zero trade links and all the possible trade links by domestic industries with industries abroad. The database covers 40 countries from 1995 to 2011 and 35 different industries. Self constructed with data from WIOD. See Dietzenbacher et al. (2013) and http://www.wiod.org.
$INTENSIVE$ (Υ_x)	Ln of export plus imports (% of GDP, NE.TRD.GNFS.ZS) by WDI.
$EDUCA$	Ln of public spending on education, total (% of GDP, SE.XPD.TOTL.GD.ZS), WDI.
$EDUCA_{noK}$	Ln of current education expenditure (% of GNI, NY.ADJ.AEDU.GN.ZS), WDI.
Population	Population total ($SP.POP.TOTL$), WDI.
GDP	Ln of GDP, PPP (constant 2005 international $, NY.GDP.MKTP.PP.KD), WDI. We use this variable as a proxy for E from the theoretical model.
doing business	Costs of doing-business and legal procedures (% of GNI per capita, IC.REG.COST.PC.ZS), Doing Business, World Bank.

6.2.1 Descriptive statistics

Table 6.3: Descriptive Statistics[a]

	mean	min	max	sd	cv
GDP	26.57	22.71	30.21	1.65	0.06
$SPENDING$	-1.70	-2.71	-1.21	0.27	-0.16
$EXTENSIVE$	-0.15	-0.72	-0.04	0.14	-0.94
$INTENSIVE$	4.30	2.76	5.21	0.54	0.12
$EDUCA$	1.56	0.00	2.17	0.28	0.18
$EDUC_{noK}$	1.51	-0.57	2.11	0.32	0.21

a) All countries from Table 6.1 pooled together.

cv= coefficient of variation.

6.3 Data evidence

As stated in the main text, empirically, we find examples when high taxes and, therefore, high government consumption correlate with worse institutions (as proxied by high doing-business costs).[29] Bulgaria is a prominent example. Figure 6.1 (left pane) demonstrates exactly such a pattern: though higher regulation and doing-business costs are associated with higher government's consumption (which must be financed from taxes), there are also counter examples, as mentioned. The positive association is in line with previous research. However, the right pane shows the example of the Netherlands, which demonstrates that high government consumption can be associated with high quality institutions (as proxied by low doing-business costs). We, therefore, see our contribution as proposing a channel, which could explain such a diverging phenomenon among a set of trading and, as a result, interdependent economies.

[29] Doing-business costs are costs of running a company and legal procedures. Data are from Doing Business Report, World Bank. See the Appendix.

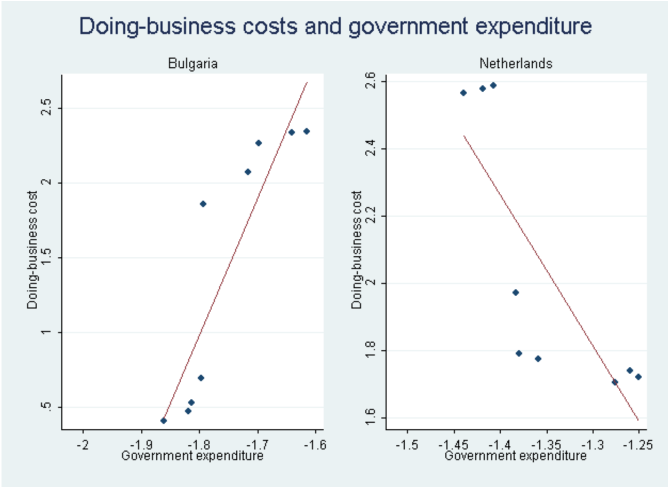

Figure 6.1: Heterogeneity in government expenditure and doing-business costs

7 Robustness Checks

7.1 Dropping one country each at a time

Table 7.1: Extensive margin and the role of government
Dropping country (Block 1)
Ordinary least squares

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$SPENDING$	0.053***	0.054***	0.055***	0.060***	0.053***	0.055***	0.056***	0.056***	0.056***	0.051***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.019)	(0.019)	(0.018)	(0.018)	(0.018)
$INTENSIVE$	-0.064**	-0.060**	-0.063**	-0.063**	-0.069**	-0.066**	-0.064**	-0.060**	-0.060**	-0.063**
	(0.028)	(0.027)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.027)	(0.027)	(0.028)
N	601	601	601	601	601	601	602	601	601	601
R^2	0.260	0.254	0.254	0.262	0.264	0.252	0.256	0.257	0.255	0.256
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
$SPENDING$	0.055***	0.055***	0.055***	0.055***	0.063***	0.056***	0.053***	0.055***	0.057***	0.058***
	(0.018)	(0.018)	(0.018)	(0.019)	(0.018)	(0.018)	(0.019)	(0.018)	(0.018)	(0.019)
$INTENSIVE$	-0.061**	-0.061**	-0.061**	-0.060**	-0.060**	-0.042*	-0.057*	-0.057**	-0.061**	-0.060**
	(0.027)	(0.028)	(0.028)	(0.028)	(0.027)	(0.024)	(0.031)	(0.028)	(0.027)	(0.028)
N	601	601	601	601	601	601	601	601	601	601
R^2	0.246	0.258	0.253	0.245	0.257	0.275	0.222	0.237	0.259	0.257

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Standard errors, clustered by country, in parentheses.

The country excluded corresponds to column's number (see Table 6.1).

Table 7.2: Extensive margin and the role of government
Dropping country (Block 2)
Ordinary least squares

	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)
SPENDING	0.050**	0.054***	0.060***	0.056***	0.056***	0.057***	0.055***	0.058***	0.045*	0.056***
	(0.019)	(0.019)	(0.017)	(0.018)	(0.019)	(0.018)	(0.018)	(0.018)	(0.027)	(0.018)
INTENSIVE	-0.066**	-0.063**	-0.060**	-0.047*	-0.064**	-0.061**	-0.063**	-0.062**	-0.063**	-0.062**
	(0.027)	(0.028)	(0.028)	(0.024)	(0.028)	(0.027)	(0.028)	(0.027)	(0.027)	(0.028)
N	601	601	601	601	601	601	602	601	601	610
R^2	0.247	0.258	0.246	0.229	0.258	0.261	0.252	0.263	0.229	0.251
	(31)	(32)	(33)	(34)	(35)	(36)	(37)			
SPENDING	0.055***	0.056***	0.057***	0.054***	0.045***	0.059***	0.057***			
	(0.018)	(0.018)	(0.018)	(0.018)	(0.016)	(0.018)	(0.018)			
INTENSIVE	-0.060**	-0.060**	-0.061**	-0.061**	-0.050*	-0.063**	-0.061**			
	(0.027)	(0.027)	(0.027)	(0.027)	(0.026)	(0.028)	(0.027)			
N	601	601	601	601	601	601	601			
R^2	0.254	0.257	0.260	0.260	0.241	0.268	0.258			

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Standard errors, clustered by country, in parentheses.

The country excluded corresponds to column's number (see Table 6.1).

Table 7.3: Extensive margin and the role of government
Dropping country (Block 1)
Instrumental variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$SPENDING$	0.201***	0.205***	0.199***	0.205***	0.190***	0.201***	0.218***	0.195***	0.203***	0.222***
	(0.041)	(0.042)	(0.039)	(0.038)	(0.041)	(0.040)	(0.043)	(0.040)	(0.041)	(0.049)
$INTENSIVE$	-0.032**	-0.031**	-0.034**	-0.036***	-0.040***	-0.031**	-0.034**	-0.031**	-0.030**	-0.026*
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.015)
N	454	448	450	450	451	459	450	448	449	448
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
$SPENDING$	0.207***	0.203***	0.203***	0.206***	0.208***	0.221***	0.133***	0.214***	0.199***	0.210***
	(0.041)	(0.041)	(0.041)	(0.041)	(0.042)	(0.042)	(0.035)	(0.043)	(0.040)	(0.042)
$INTENSIVE$	-0.031**	-0.030**	-0.032**	-0.030**	-0.030**	-0.018	-0.035***	-0.023*	-0.033**	-0.027*
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.013)	(0.014)	(0.014)	(0.015)
N	449	448	455	455	448	452	450	448	448	449

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Standard errors, clustered by country, in parentheses. The country excluded corresponds to column's number (see Table 6.1).

The Stock and Yogo (2005) weak instrument test and the overidentification test are not reported here but commented in the main text.

Table 7.4: Extensive margin and the role of government
Dropping country (Block 2)
Instrumental variables

	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)
$SPENDING$	0.198***	0.228***	0.223***	0.193***	0.191***	0.199***	0.204***	0.193***	0.218***	0.203***
	(0.043)	(0.047)	(0.043)	(0.038)	(0.038)	(0.041)	(0.041)	(0.039)	(0.043)	(0.041)
$INTENSIVE$	-0.032**	-0.028*	-0.026*	-0.029**	-0.034**	-0.032**	-0.035**	-0.035***	-0.032**	-0.032**
	(0.014)	(0.015)	(0.014)	(0.013)	(0.014)	(0.014)	(0.014)	(0.013)	(0.013)	(0.014)
N	451	449	449	456	449	447	448	449	454	458
	(31)	(32)	(33)	(34)	(35)	(36)	(37)			
$SPENDING$	0.216***	0.205***	0.202***	0.198***	0.173***	0.223***	0.205***			
	(0.044)	(0.041)	(0.041)	(0.041)	(0.035)	(0.043)	(0.041)			
$INTENSIVE$	-0.031**	-0.031**	-0.033**	-0.031**	-0.029**	-0.033**	-0.030**			
	(0.014)	(0.014)	(0.014)	(0.014)	(0.012)	(0.014)	(0.014)			
N	448	452	448	448	455	448	450			

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Standard errors, clustered by country, in parentheses. The country excluded corresponds to column's number (see Table 6.1).
The Stock and Yogo (2005) weak instrument test and the overidentification test are not reported here but commented in the main text.

7.2 Median split (by the extensive margin)

Table 7.5: Expenditure (GDP) and the role of government
Instrumental Variables
By extensive margin

	(1)	(2)	(3)	(4)
$SPENDING$		-0.582***		-0.368**
		(0.198)		(0.151)
$EXTENSIVE$	0.406*	0.145	-0.313	0.973*
	(0.210)	(0.257)	(0.519)	(0.508)
$INTENSIVE$	-0.037	-0.000	-0.068*	-0.180***
	(0.061)	(0.070)	(0.039)	(0.040)
$EDUCA$	0.467***		0.487***	
	(0.113)		(0.088)	
$EDUCA_{noK}$	-0.190**		-0.205**	
	(0.089)		(0.083)	
Stock–Yogo F		25.046		39.956
Stock–Yogo F critical value		11.59		11.59
OID p–value		0.6455		0.9988
N	211	211	252	252
R^2	0.400		0.408	

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Standard errors, clustered by country, in parentheses.
Columns 1 and 2 (3 and 4) include countries with ρ below (above) median.
Columns 2 and 4 are the 2nd stage regressions.
The Stock and Yogo (2005) critical values for the weak instrument test are based on the 2SLS size at 0.15 for the 5% level test for Excluded instruments.
OID= overidentification test of all instruments (Hansen J statistic).

Table 7.6: Expenditure (GDP) and the role of government
Ordinary Least Squares
By extensive margin

	(1)	(2)
$SPENDING$	-0.057	-0.382***
	(0.058)	(0.046)
$EXTENSIVE$	-0.318*	1.120**
	(0.173)	(0.525)
$INTENSIVE$	0.172***	-0.209***
	(0.050)	(0.040)
N	313	305
R^2	0.811	0.856

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Standard errors, clustered by country, in parentheses.
Column 1 (2) includes countries with ρ below (above) median.

8 Theoretical model

8.1 Setting

The real consumption index for the sector (Q) is defined as follows:

$$Q = \left[\int_{j\in J} q\left(j\right)^{\beta} dj\right]^{\frac{1}{\beta}}, \qquad \zeta < \beta < 1, \tag{8.1}$$

where j indexes varieties; J is the set of varieties within the sector; $q\left(j\right)$ denotes consumption of variety j; and β governs the elasticity of substitution between varieties. Moreover, the price index for the differentiated sector (P), which is dual to Q, is

$$P = \left[\int_{j\in J} p\left(j\right)^{-\frac{\beta}{1-\beta}} dj\right]^{-\frac{1-\beta}{\beta}}. \tag{8.2}$$

As is reported in the main text (see equation (2.8)), the demand function for homogenous good is given by

$$q_0 = \left(\frac{\vartheta}{1-\vartheta}\right) QP^{\frac{1}{1-\zeta}}.$$

Moreover, combining equations (2.7) for j and j' yields $q\left(j\right) = q\left(j'\right)\left(\frac{p(j)}{p(j')}\right)^{\frac{1}{\beta-1}}$ $\forall j \neq j'$. After integrating over all varieties $j \in J$ and manipulating it, we obtain the CES demand curved for variety j' as a function of sector aggregates (P, Q) and its own price $p(j')$:

$$q\left(j'\right) = p(j')^{-\frac{1}{1-\beta}} QP^{\frac{1}{1-\beta}} = \left(\frac{A}{p\left(j'\right)}\right)^{\frac{1}{1-\beta}} \qquad \forall j' \in J, \tag{8.3}$$

where $A \equiv E^{1-\beta}P^{\beta} = Q^{1-\beta}P$ is a demand-shifter for the sector.

Substituting equations (2.8) and (8.3) in the budget constraint, and using $\int_{j\in J} p(j)^{-\frac{\beta}{1-\beta}} dj = P^{-\frac{\beta}{1-\beta}}$ yield the optimal real consumption index of the differentiated sector,

$$Q = \Omega \left[\left(\frac{\vartheta}{1-\vartheta} \right) P^{\frac{1}{1-\varsigma}} + P \right]^{-1}, \tag{8.4}$$

and the demand-shifter for that same sector

$$A^{\frac{1}{1-\beta}} \equiv E P^{\frac{\beta}{1-\beta}} = \Omega \left[\left(\frac{\vartheta}{1-\vartheta} \right) P^{\frac{\varsigma-\beta}{(1-\varsigma)(1-\beta)}} + P^{-\frac{\beta}{1-\beta}} \right]^{-1}, \tag{8.5}$$

both as functions of aggregate income Ω and sectoral prices.

8.1.1 Details of labour market

Worker ability is assumed to be independently distributed and drawn from a Pareto distribution with a shape parameter k, such that $G_a(a) = 1 - \left(\frac{a_{min}}{a}\right)^k$ for $a \geq a_{min} > 0$ and $k > 1$. After a firm pays a search cost of bn units of the numeraire (to be specified when dealing with the equilibrium), it is randomly matched with a measure of n workers. The search cost b per unit of matching workers is endogenously determined in the labour market. The labour market tightness and its characteristics are essentially based on the Diamond-Mortensen-Pissarides approach. For simplicity, we assume that after paying a screening cost of $\frac{ca_c^{\delta}}{\delta}$, where $c > 0$ and $\delta > 0$, a firm can determine which workers have an ability above a_c, where $a_c > a_{min}$, which guarantees an interior equilibrium. Then, a firm only hires workers with abilities larger than a_c. By doing so, a firm reduces its output by decreasing workers hired, h. On the other hand, a firm raises output (thus revenue and profits increase) by increasing the average ability of the workers $\bar{a}$. Therefore, a firm, choosing a_c, hires a measure $h = n\left(\frac{a_{min}}{a_c}\right)^k$ of workers who have an average ability $\bar{a} = \frac{k}{k-1}a_c$. As a result, the output of each variety can be rewritten as

$$y = \kappa_y \theta n^{\gamma} a_c^{1-\gamma k}, \tag{8.6}$$

where $\kappa_y \equiv \frac{k}{k-1}(a_{min})^{\gamma k}$.

8.2 Equilibrium

$$\begin{aligned}
\bar{\pi} =& \int_{\theta_d}^{\infty} \frac{\Gamma}{1+\beta\gamma}\left(\frac{\Gamma}{1+\beta\gamma}\right)^{-1} \Upsilon(\theta)^{\frac{1-\beta}{\Gamma}} f_d \left(\frac{\theta}{\theta_d}\right)^{\frac{\beta}{\Gamma}} g_\theta(\theta)\, d\theta \\
=& z\cdot\theta_{min}^z f_d \left(\frac{1}{\theta_d}\right)^{\frac{\beta}{\Gamma}} \left\{\int_{\theta_d}^{\infty} \Upsilon(\theta)^{\frac{(1-\beta)}{\Gamma}} \theta^{\frac{\beta}{\Gamma}-z-1} d\theta\right\} \\
=& z\cdot\theta_{min}^z f_d \left(\frac{1}{\theta_d}\right)^{\frac{\beta}{\Gamma}} \left\{\int_{\theta_d}^{\theta_x} \Upsilon(\theta)^{\frac{(1-\beta)}{\Gamma}} \theta^{\frac{\beta}{\Gamma}-z-1} d\theta + \int_{\theta_x}^{\infty} \Upsilon(\theta)^{\frac{(1-\beta)}{\Gamma}} \theta^{\frac{\beta}{\Gamma}-z-1} d\theta\right\} \\
=& z\cdot\theta_{min}^z f_d \left(\frac{1}{\theta_d}\right)^{\frac{\beta}{\Gamma}} \left\{\int_{\theta_d}^{\theta_x} \theta^{\frac{\beta}{\Gamma}-z-1} d\theta + \Upsilon_x^{\frac{1-\beta}{\Gamma}} \int_{\theta_x}^{\infty} \theta^{\frac{\beta}{\Gamma}-z-1} d\theta\right\} \\
=& z\cdot\theta_{min}^z f_d \left(\frac{1}{\theta_d}\right)^{\frac{\beta}{\Gamma}} \left\{\frac{1}{\frac{\beta}{\Gamma}-z}\left(\theta_x^{\frac{\beta}{\Gamma}-z} - \theta_d^{\frac{\beta}{\Gamma}-z}\right) + \Upsilon_x^{\frac{1-\beta}{\Gamma}} \frac{1}{\frac{\beta}{\Gamma}-z}\left(\lim_{\theta\to\infty} \theta^{\frac{\beta}{\Gamma}-z} - \theta_x^{\frac{\beta}{\Gamma}-z}\right)\right\} \\
=& z\cdot\theta_{min}^z f_d \left(\frac{1}{\theta_d}\right)^{\frac{\beta}{\Gamma}} \frac{1}{z-\frac{\beta}{\Gamma}}\left[\theta_d^{\frac{\beta}{\Gamma}-z} + \left(\Upsilon_x^{\frac{1-\beta}{\Gamma}} - 1\right)\theta_x^{\frac{\beta}{\Gamma}-z}\right] \\
=& f_d \left(\frac{\theta_{min}}{\theta_d}\right)^z \left[1 + \left(\frac{f_d}{f_x}\right)^{\frac{z\Gamma-\beta}{\beta}} \left(\Upsilon_x^{\frac{1-\beta}{\Gamma}} - 1\right)^{z\frac{\Gamma}{\beta}}\right] \frac{z\Gamma}{z\Gamma-\beta} > 0. \\
=& \left(\frac{\theta_{min}}{\theta_d}\right)^z (f_d + f_x\rho^z) \left(\frac{z\Gamma}{z\Gamma-\beta}\right) > 0. \qquad (8.7)
\end{aligned}$$

The second line follows from noting that aggregates are functions of θ_d and not θ, hence, we can factor the elements, which are functions of θ in the integral. The fourth line follows the same logic as well as from using the fact that $\int_{\theta_d}^{\theta_x} I_x(\theta) = 0$, which implies $\Upsilon(\theta) = 1$ for this range, and that $\int_{\theta_x}^{\infty} I_x(\theta) = 1$, which implies $\Upsilon(\theta) = \Upsilon_x$ for this range. The sixth line follows from imposing $\frac{\beta}{\Gamma} - z < 0$ in order for the integral to be well defined. The seventh line uses (2.29), where $\rho = f_d^{\frac{\Gamma}{\beta}} \left(\frac{\Upsilon_x^{\frac{1-\beta}{\Gamma}}-1}{f_x}\right)^{\frac{\Gamma}{\beta}}$. Similarly, the average operating profit for the non-exporter, $\bar{\pi}_d \equiv \int_{\theta_d}^{\theta_x} \frac{\Gamma}{1+\beta\gamma} r(\theta)\, g_\theta(\theta)\, d\theta$, can be also re-expressed as:

$$\begin{aligned}
\bar{\pi}_d =& f_d \left(\frac{\theta_{min}}{\theta_d}\right)^z \left[1 - \left(\frac{f_d}{f_x}\right)^{\frac{z\Gamma-\beta}{\beta}} \left(\Upsilon_x^{\frac{1-\beta}{\Gamma}} - 1\right)^{\frac{z\Gamma-\beta}{\beta}}\right] \left(\frac{z\Gamma}{z\Gamma-\beta}\right) > 0, \\
=& \left(\frac{\theta_{min}}{\theta_d}\right)^z \left[f_d - f_d^{\frac{z\Gamma}{\beta}} \left(\frac{\Upsilon_x^{\frac{1-\beta}{\Gamma}}-1}{f_x}\right)^{\frac{z\Gamma}{\beta}} \left(\frac{\Upsilon_x^{\frac{1-\beta}{\Gamma}}-1}{f_x}\right)^{-1}\right] \left(\frac{z\Gamma}{z\Gamma-\beta}\right) \\
=& \left(\frac{\theta_{min}}{\theta_d}\right)^z \left(f_d + f_x\rho^z \frac{1}{1-\Upsilon_x^{\frac{1-\beta}{\Gamma}}}\right) \left(\frac{z\Gamma}{z\Gamma-\beta}\right) \\
=& \left(\frac{\theta_{min}}{\theta_d}\right)^z f_d \left(1 - \rho^{z-\frac{\beta}{\Gamma}}\right) \left(\frac{z\Gamma}{z\Gamma-\beta}\right) > 0, \qquad (8.8)
\end{aligned}$$

where the procedure to obtain this follows the same logic used in obtaining $\bar{\pi}$ but for the range $\theta \in [\theta_d, \theta_x)$. Using $\bar{\pi}$ from the equation (2.30), we re-express the free entry condition as:

$$
\begin{aligned}
f_e =& \bar{\pi} - f_d\left[1 - G(\theta_d)\right] - f_x\left[1 - G(\theta_x)\right] \\
=& \left(\frac{\theta_{min}}{\theta_d}\right)^z (f_d + f_x\rho^z)\left(\frac{z\Gamma}{z\Gamma - \beta}\right) - f_d\left(\frac{\theta_{min}}{\theta_d}\right)^z - f_x\left(\frac{\theta_{min}}{\theta_x}\right)^z \\
=& \left(\frac{\theta_{min}}{\theta_d}\right)^z \left[(f_d + f_x\rho^z)\left(\frac{z\Gamma}{z\Gamma - \beta}\right) - f_d - f_x\rho^z\right] \\
=& \left(\frac{\theta_{min}}{\theta_d}\right)^z (f_d + f_x\rho^z)\left(\frac{\beta}{z\Gamma - \beta}\right),
\end{aligned} \tag{8.9}
$$

where we used $[1 - G(\theta_d)] = \left(\frac{\theta_{min}}{\theta_d}\right)^z$ and $[1 - G(\theta_x)] = \left(\frac{\theta_{min}}{\theta_x}\right)^z$ from the Pareto distribution.

8.2.1 Computing the price index $(P,\, P^\star)$, the real consumption index $(Q,\, Q^\star)$, the mass of firms $(M,\, M^\star)$, and the size of the labour force $(L,\, L^\star)$

Substitute equation (2.41) in the price index, equation (2.43). Consider then all active firms in the economy, which actually produce, i.e., those with $\theta \geq \theta_d$. Recalling that firms draw their productivity from the cumulative distribution $G_\theta(\theta) = 1 - \left(\frac{\theta_{min}}{\theta}\right)^z$, hence, the probability density function is $g_\theta(\theta) = z\theta_{min}^z\theta^{-z-1}$. As a result, the equilibrium price index is the following:

$$
\begin{aligned}
P =& \left\{A^{-\frac{\beta}{1-\beta}} A^{-1}\left(\frac{1+\beta\gamma}{\Gamma}\right) f_d\theta_d^{-\frac{\beta}{\Gamma}} \int_{\theta_d}^{\infty} \Upsilon(\theta)^{\frac{1-\beta}{\Gamma}(1-\Gamma)} \theta^{\frac{\beta}{\Gamma}} g_\theta(\theta) d\theta\right\}^{-\frac{1-\beta}{\beta}} \\
=& A^{\frac{1}{\beta}}\left(\frac{\Gamma}{1+\beta\gamma}\right)^{\frac{1-\beta}{\beta}} \left\{\theta_d^{-\frac{\beta}{\Gamma}} f_d\theta_{min}^z z\left[\int_{\theta_d}^{\theta_x} \theta^{\frac{\beta}{\Gamma}-z-1} d\theta + \Upsilon_x^{\frac{1-\beta}{\Gamma}(1-\Gamma)} \int_{\theta_x}^{\infty} \theta^{\frac{\beta}{\Gamma}-z-1} d\theta\right]\right\}^{-\frac{1-\beta}{\beta}} \\
=& A^{\frac{1}{\beta}}\left(\frac{\Gamma}{1+\beta\gamma}\right)^{\frac{1-\beta}{\beta}} \left\{\bar{\pi}_d + \Upsilon_x^{\beta-1}\left(\frac{z\Gamma}{z\Gamma-\beta}\right)\left(\frac{\theta_{min}}{\theta_d}\right)^z \left[f_d - f_d + f_x\rho^z\left(\frac{\Upsilon_x^{\frac{1-\beta}{\Gamma}} - 1 + 1}{\Upsilon_x^{\frac{1-\beta}{\Gamma}} - 1}\right)\right]\right\}^{-\frac{1-\beta}{\beta}} \\
=& A^{\frac{1}{\beta}}\left(\frac{\Gamma}{1+\beta\gamma}\right)^{\frac{1-\beta}{\beta}} \left\{\bar{\pi}_d + \Upsilon_x^{\beta-1}\left(\frac{z\Gamma}{z\Gamma-\beta}\right)\left(\frac{\theta_{min}}{\theta_d}\right)^z \left[f_d + f_x\rho^z + f_d\left(-1 + \rho^z\rho^{-\frac{\beta}{\Gamma}}\right)\right]\right\}^{-\frac{1-\beta}{\beta}} \\
=& A^{\frac{1}{\beta}}\left(\frac{\Gamma}{1+\beta\gamma}\right)^{\frac{1-\beta}{\beta}} \left[\bar{\pi}_d\left(1 - \Upsilon_x^{\beta-1}\right) + \bar{\pi}\Upsilon_x^{\beta-1}\right]^{-\frac{1-\beta}{\beta}}.
\end{aligned} \tag{8.10}
$$

Recall that $z - \frac{\beta}{\Gamma} > 0$ must hold in order for $\bar{\pi}$ to be well defined (see equation (8.7)). From the equation (2.41), we split $f_d^{1-\Gamma}$ into $f_d^{-\Gamma}$ and f_d, where the former was used to re-express in terms of A^{-1}. Finally, using equations (2.31) and (2.30), we obtained P as a function of $A^{\frac{1}{\beta}}$, and a weighted average of operating profit for the whole economy and the non-exporters.

We can, alternatively, express the price level as a function of sectoral variables, parameters, technology, f_d and θ_d. Then P is as follows:

$$
P = \left\{\phi_p^{-1} c^{-\Gamma+1-\beta\gamma} b^{\gamma\beta} \theta_d^{-\beta} f_d^{\Gamma}\right\}^{\frac{1}{\beta}} \left[\bar{\pi}_d\left(1 - \Upsilon_x^{\beta-1}\right) + \bar{\pi}\Upsilon_x^{\beta-1}\right]^{-\frac{1-\beta}{\beta}}. \tag{8.11}
$$

Note also that $\frac{1-\beta\gamma-\Gamma}{\beta}=\frac{1-\gamma k}{\delta}>0$ and $1-\beta-\Gamma=\frac{\beta}{\delta}\left[1-\delta+\gamma\left(\delta-k\right)\right]=\frac{\beta}{\delta}\left[1-\gamma k-\delta\left(1-\gamma\right)\right]\lesseqgtr 0$, recalling that $1>\gamma k>0$ for a firm to have an incentive to screen. Now look at the exponent of f_d, which has that sign. Hence, looking at (2.24), one can notice that y is increasing in f_d, and thus p must be decreasing in f_d. As P is like a weighted average of the variety prices p, P must also be decreasing in f_d, which then means that $1-\beta-\Gamma>0$ must hold. Furthermore, P is increasing in A (for a given A^*) since $\Upsilon_x{}^{\frac{1-\beta}{\Gamma}(1-\Gamma)}$ is decreasing in A (for a given A^*), where $\frac{1-\beta}{\Gamma}\left(1-\Gamma\right)>0$ (since $1>\Gamma>0$).

8.3 Symmetric-countries case

The symmetric-countries case implies that $\Upsilon_x=1+\tau^{-\frac{\beta}{1-\beta}}$. Hence the Price level for the differentiated sector can be expressed as the various costs and technology, and parameters.

$$
\begin{aligned}
P=&\left\{\frac{c^{\frac{\beta(1-\gamma k)}{\delta}}b^{\beta\gamma}}{\theta_{min}^{\beta}\left(\frac{\Gamma}{\beta\gamma}\phi_n\right)^{\Gamma}}f_d^{\Gamma}\left(f_d+f_x\rho^z\right)^{-\frac{\beta}{z}}\left(\frac{z\Gamma-\beta}{\beta}\right)^{\frac{\beta}{z}}f_e^{\frac{\beta}{z}}\right\}^{\frac{1}{\beta}}\left(\frac{\Gamma}{1+\beta\gamma}\right)^{\frac{1-\beta}{\beta}}\left(\frac{z\Gamma}{\beta}\cdot f_e\right)^{-\frac{1-\beta}{\beta}}\cdot\\
&\left[\frac{f_d\left(1-\rho^{z-\frac{\beta}{\Gamma}}\right)}{f_d+f_x\rho^z}\left(1-\Upsilon_x^{\beta-1}\right)+\Upsilon_x^{\beta-1}\right]^{-\frac{1-\beta}{\beta}}\\
=&\frac{c^{\frac{(1-\gamma k)}{\delta}}b^{\gamma}}{\theta_{min}}\Gamma^{-\frac{\Gamma}{\beta}}\beta^{\frac{\Gamma-\beta}{\beta}-\frac{1}{z}}\gamma^{-\gamma}\frac{k-1}{k}a_{min}^{-\gamma k}\left(1-\gamma k\right)^{-\frac{(1-\gamma k)}{\delta}}\left(1+\beta\gamma\right)f_d^{\Gamma\frac{1}{\beta}-\frac{1-\beta}{\beta}}\cdot\\
&\left(f_d+f_x\rho^z\right)^{-\frac{1}{z}+\frac{1-\beta}{\beta}}\left(z\Gamma-\beta\right)^{\frac{1}{z}}f_e^{\frac{1}{z}-\frac{1-\beta}{\beta}}z^{-\frac{1-\beta}{\beta}}\left[1+\left(\Upsilon_x{}^{\frac{1-\beta}{\Gamma}(1-\Gamma)}-1\right)\rho^{z-\frac{\beta}{\Gamma}}\right]^{-\frac{1-\beta}{\beta}}
\end{aligned}
\tag{8.12}
$$

8.4 Comparative statics on aggregate prices and quantities

In this section, we analyse how the changes in the composition of firms in the differentiated sector affect the sectorial aggregate variables. These variables are the ideal price index P, its dual bundle Q, and the demand shifter A. We build on the previous section in order to sign some of the expressions to follows. Since we employ sectoral data to infer variation in the extensive margin of trade, our modelling framework incorporates two sectors, differentiated and homogenous. However, this introduced additional complexities. One difference compared to the one-sector model is that Q^{-1} and P are not substitutable one-to-one. In other words, the elasticity between aggregate price index and consumption basket in the differentiated sector is not one in absolute terms. Let us see if this is true given that we know from equation (8.4) that $Q=\Omega\left[\left(\frac{\vartheta}{1-\vartheta}\right)P^{\frac{1}{1-\varsigma}}+P\right]^{-1}$. As a result

$$
\frac{d\ln Q}{d\ln P}\equiv\epsilon_{Q,P}=-\frac{1}{1-\zeta}\leq-\frac{1}{1-\zeta}+\frac{\zeta}{1-\zeta}\frac{PQ}{\Omega}\leq-1. \tag{8.13}
$$

Note that when $\vartheta = 0$ (no homogeneous sector) then $P = \mathcal{P}$ (or equivalently $PQ = \Omega$) implying $\epsilon_{Q,P} = -1$. On the other hand, the elasticity of demand shifter, A, with respect to the price level P is as follows:

$$\begin{aligned}\epsilon_{A,P} \equiv& \frac{d \ln A}{d \ln P} = (1-\beta)\frac{d \ln Q}{d \ln P} + 1\\ =&(1-\beta)\left(-\frac{1}{1-\zeta} + \frac{\zeta}{1-\zeta}\frac{PQ}{\Omega}\right) + 1\\ =&\beta\left[1 - \frac{\zeta}{\zeta-1}\frac{\vartheta}{\vartheta + (1-\vartheta)\, P^{-\frac{\zeta}{1-\zeta}}}\right] + \frac{\zeta}{\zeta-1}\frac{\vartheta}{\vartheta + (1-\vartheta)\, P^{-\frac{\zeta}{1-\zeta}}}\\ =&\mathcal{B} > 0,\end{aligned} \tag{8.14}$$

where we let $\mathcal{B} \equiv \beta\left[1 - \frac{\zeta}{\zeta-1}\frac{\vartheta}{\vartheta+(1-\vartheta)P^{-\frac{\zeta}{1-\zeta}}}\right] + \frac{\zeta}{\zeta-1}\frac{\vartheta}{\vartheta+(1-\vartheta)P^{-\frac{\zeta}{1-\zeta}}}$ and note that $\frac{\beta-\zeta}{1-\zeta} \leq \mathcal{B} \leq \beta$. The first inequality follows from noting $0 < \zeta < \beta$. Knowing how E is affected by the government policy, we can also analyse the effects on the price level in an indirect manner. Hence, consider the fact that $E = PQ = \Omega\left[\left(\frac{\vartheta}{1-\vartheta}\right) P^{\frac{1}{1-\zeta}} + P\right]^{-1} P$. Note that this expression allows us to divide the effect of varying t_d into its two parts: the effect on quantitative Q and the effect on the ideal price index P. We obtain the latter by differentiating this expression E with respect to t_d. As a result, we obtain that:

$$\begin{aligned}\epsilon_{E,t_d} =& -\frac{q_0}{\Omega}\left(\frac{\zeta}{1-\zeta}\right)\cdot \epsilon_{P,t_d}\\ =& -\left(\frac{\zeta}{1-\zeta}\right)\left(\frac{\frac{\vartheta}{1-\vartheta}P^{\frac{\zeta}{1-\zeta}}}{\frac{\vartheta}{1-\vartheta}P^{\frac{\zeta}{1-\zeta}} + 1}\right)\cdot \epsilon_{P,t_d} < 0,\end{aligned} \tag{8.15}$$

where the sign follows from either the *wasteful* or the *educational* channels from equations (3.10) and (3.18), respectively. Note that for both cases the sign is negative. Given the range of the parameters ϑ and ζ, we can conclude that the effect of t_d on the price level P is positive:

$$\epsilon_{P,t_d} > 0. \tag{8.16}$$

The decrease in E can be understood more clearly given that Q moves in the opposite direction to P, and does it more than equiproportionally (see equation (8.13)).

Moreover, since ϵ_{A,θ_d} can be decomposed as follows:

$$\epsilon_{A,\theta_d} = \epsilon_{A,P}\epsilon_{P,\theta_d} = \mathcal{B}\epsilon_{P,\theta_d} > 0. \tag{8.17}$$

8.5 Analytical solutions for the comparative statics on θ_d and θ_x

In this subsection we solve analytical solutions for the effects on the productivity thresholds from the subsection on the educational channel.

Take the derivative of equation (3.2) with respect to t_d, yielding

$$\epsilon^B_{\rho,t_d} \equiv \epsilon^B_{\theta_d,t_d} - \epsilon^B_{\theta_x,t_d} = \frac{\Gamma}{\beta}\frac{t_d}{f_d} - \mathcal{D}\cdot\epsilon_{\Gamma,t_d}, \tag{8.18}$$

which is the equation (3.12) in the main text. Now consider $\Gamma \equiv 1-\beta\gamma-\beta\frac{(1-\gamma k)}{\delta}$ and differentiate it with respect to t_d, considering the education technology from equation (3.11). The result is

$$\epsilon_{\Gamma,t_d} = -\frac{\beta}{\Gamma}\frac{\gamma}{\delta}k\cdot\varepsilon\left(\frac{f_d}{t_d} - z\cdot\epsilon^B_{\theta_d,t_d}\right)\frac{t_d}{f_d}, \tag{8.19}$$

where ϵ refers to the elasticity. Using equations (3.13) and (8.19), we obtain the analytical solution for $z\epsilon^B_{\theta_d,t_d}$ as follows:

$$z\epsilon^B_{\theta_d,t_d} = \frac{z\epsilon_{\theta_d,t_d} + \left(\frac{f_x\rho^z}{(f_d+f_x\rho^z)}\mathcal{D} + \frac{\Gamma}{(z\Gamma-\beta)}\right) z\cdot\frac{\beta}{\Gamma}\frac{\gamma}{\delta}k\cdot\varepsilon\cdot\frac{f_d}{t_d}}{1+\left(\frac{f_x\rho^z}{(f_d+f_x\rho^z)}\mathcal{D} + \frac{\Gamma}{(z\Gamma-\beta)}\right) z\cdot\frac{\beta}{\Gamma}\frac{\gamma}{\delta}k\cdot\varepsilon}. \tag{8.20}$$

To obtain the analytical solution for $z\epsilon^B_{\theta_x,t_d}$, use equations (3.14) and (8.19). As a result, we obtain:

$$z\epsilon^B_{\theta_x,t_d} = \frac{z\epsilon_{\theta_x,t_d} - z\cdot\frac{\gamma}{\delta}k\cdot\varepsilon - \left(-\mathcal{D} + \frac{f_x\rho^z}{(f_d+f_x\rho^z)}\mathcal{D} + \frac{\Gamma}{(z\Gamma-\beta)}\right) z\cdot\frac{\beta}{\Gamma}\frac{\gamma}{\delta}k\cdot\varepsilon\cdot\left(1-\frac{f_d}{t_d}\right)}{1+\left(\frac{f_x\rho^z}{(f_d+f_x\rho^z)}\mathcal{D} + \frac{\Gamma}{(z\Gamma-\beta)}\right) z\cdot\frac{\beta}{\Gamma}\frac{\gamma}{\delta}k\cdot\varepsilon}. \tag{8.21}$$

8.6 Admissible parameter and necessary and sufficient conditions

The sufficient condition for $\epsilon^B_{\theta_x,t_d} < 0$ in the equation (3.14) can be seen graphically in Figure 8.1. The blue curve shows ρ^z while the red one is the sufficient condition. For the negative values of the red curve, the condition is satisfied. It can be noted that this condition holds for the admissible parameter space used in the literature (see Helpman et al., 2008a). Specifically, we set $\beta = 0.75$, $\gamma = 1/3$, $\delta/k = 3.5$,$k = 2.2$, $\tau = 1.5$, $A = A^*$, $z = 2.6$, $\varepsilon = 0.7$, $k = 2.2$, ${f_x}/{f_d} = 1.2$, and $c_1 = 0.94$. These values imply a total government expenditure in education, equal to $\mathcal{G} = 0.3$. For example, they show that empirical studies estimate $\rho^z \approx 0.18$, which makes the condition hold clearly.

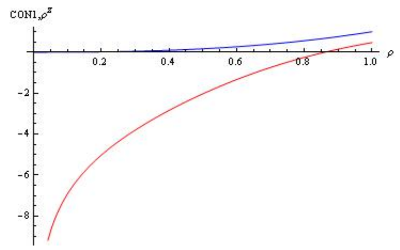

Figure 8.1: Sufficient condition for $\epsilon^B_{\theta_x,t_d} < 0$

The necessary and sufficient condition for $\frac{\partial \bar{\pi}^B_x}{\partial t_d} > 0$ in the equation 3.17 holds always. This can be seen graphically in Figure 8.2. The blue curve shows ρ^z, as in the previous figure. The red one is the $\frac{\partial \bar{\pi}^B_x}{\partial t_d} > 0$ condition. The condition is satisfied for the negative values of the red curve. As in Figure 8.1, we use the admissible parameter space in our theoretical model and the one used in the literature.

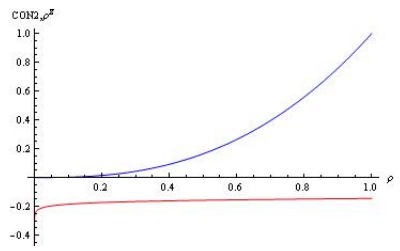

Figure 8.2: Necessary and sufficient condition for $\frac{\partial \bar{\pi}^B_x}{\partial t_d} > 0$

9 Simulations

We report Table 9.1, which collects parameter values that are consistent with data for major economies. We used values in this table for all the reported figures, unless stated otherwise.

Table 9.1: Values for parameter and variables used for calibration

Parameter/variable	Value	Source/Explanation
γ	1/3	Helpman et al. (2008a)
δ	7	
k	2	
ε	0.7	
f_x/f_d	1.6	
$f_d/f_e = f_d$	0.2	
β	0.74	Bernard et al. (2007)
z	3.4	
τ	1.3	Ghironi and Melitz (2005)
θ_{min}	1	Normalisation
f_e	1	Normalisation in exogenous case (see Ghironi and Melitz (2005))

References

Abel-Koch, J. (2013): "Endogenous Trade Policy with Heterogeneous Firms," Working papers. 1

Anderson, J. E. and E. van Wincoop (2003): "Gravity with Gravitas: A Solution to the Border Puzzle," American Economic Review, 93(1), 170–192. 4.2

Bernard, A. B., S. J. Redding, and P. K. Schott (2007): "Comparative advantage and heterogeneous firms," The Review of Economic Studies, 74, 31–66. 9.1

Bombardini, M., G. Gallipoli, and G. Pupato (2012): "Skill Dispersion and Trade Flows," American Economic Review, 102, 2327–48. 1, 2, 5

Bonfiglioli, A. and G. Gancia (2014): "Heterogeneity, Selection and Labor Market Disparities," Working Papers 734, Barcelona Graduate School of Economics. 1

Bruckner, M., A. Chong, and M. Gradstein (2012): "Estimating the permanent income elasticity of government expenditures: Evidence on Wagner's law based on oil price shocks," Journal of Public Economics, 96, 1025 – 1035. 4.2

Cosar, K., N. Guner, and J. R. Tybout (2010): "Firm Dynamics, Job Turnover, and Wage Distributions in an Open Economy," Working Paper 16326, National Bureau of Economic Research. 1

Dietzenbacher, E., B. Los, R. Stehrer, M. Timmer, and G. de Vries (2013): "The construction of world input-output tables in the WIOD project," Economic Systems Research, 25, 71–98. 4.1, 6.2

Do, Q.-T. and A. A. Levchenko (2009): "Trade, inequality, and the political economy of institutions," Journal of Economic Theory, 144(4), 1489–1520. 1, 3, 4

Durevall, D. and M. Henrekson (2011): "The futile quest for a grand explanation of long-run government expenditure," Journal of Public Economics, 95, 708 – 722. 27

Feenstra, R. (2004): Advanced International Trade: Theory and Evidence, Princeton University Press. 4.2

Felbermayr, G. J., M. Larch, and W. Lechthaler (2013): "Unemployment in an Interdependent World," American Economic Journal: Economic Policy, 5, 262–301. 1

Ghironi, F. and M. J. Melitz (2005): "International Trade and Macroeconomic

Dynamics with Heterogeneous Firms," The Quarterly Journal of Economics, 120, 865–915. 9.1

Grossman, G. and E. Helpman (1994): "Protection for sale," American Economic Review, 84(4), 833–850. 1

Helpman, E. and O. Itskhoki (2009): "Labor Market Rigidities, Trade and Unemployment: A Dynamic Model," Tech. rep., Harvard University. 12

——— (2010): "Labour Market Rigidities, Trade and Unemployment," The Review of Economic Studies, 77, 1100–1137. 1

Helpman, E., O. Itskhoki, and S. Redding (2008a): "Inequality and Unemployment in a Global Economy," Working Paper 14478, National Bureau of Economic Research. 19, 20, 8.6, 9.1

——— (2010): "Inequality and Unemployment in a Global Economy," Econometrica, 78, 1239–1283. 1, 2, 2.2, 5

Helpman, E., M. J. Melitz, and Y. Rubinstein (2008b): "Estimating Trade Flows: Trading Partners and Trading Volumes," Quarterly Journal of Economics, 123(2), 441–487, 2007. 4.2

Lastauskas, P. (2013): "Europe's Revolving Doors: Import Competition and Endogenous Firm Entry Institutions," Cambridge Working Papers in Economics 1360, Faculty of Economics, University of Cambridge. 1

Magee, C. (2002): "Endogenous trade policy and lobby formation: an application to the free-rider problem," Journal of International Economics, 57(2), 449–471. 11

Melitz, M. J. (2003): "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," Econometrica, 71, 1695–1725. 1, 2, 2

Mortensen, D. T. and C. A. Pissarides (1994): "Job Creation and Job Destruction in the Theory of Unemployment," The Review of Economic Studies, 61(3), 397–415. 2

Mrázová, M. and J. P. Neary (2012): "Selection Effects with Heterogeneous Firms," CEP Discussion Papers dp1174, Centre for Economic Performance, LSE. 1

Rebeyrol, V. and J. Vauday (2009): "Live or Let Die: Intra-Sectoral Lobbying on Entry," Working Paper. 1

Smeets, R. and H. Creusen (2011): "Fixed export costs and multi-product firms," CPB Discussion Paper 188, CPB Netherlands Bureau for Economic Policy Analysis. 1

Smeets, R., H. Creusen, A. Lejour, and H. Kox (2010): "Export margins and export barriers: Uncovering market entry costs of exporters in the Netherlands," CPB Document, 208. 1

Stock, J., J. Wright, and M. Yogo (2002): "A survey of weak instruments and weak identification in generalized method of moments," Journal of business and economic statistics, 20, 518–529. 28

Stock, J. and M. Yogo (2005): "Testing for Weak Instruments in Linear IV Regression," in Identification and inference for econometric models: essays in honor of Thomas Rothenberg, ed. by D. Andrews and J. Stock, Cambridge University Press, 80–108. 4.3, 4.3, 4.3

Stole, L. A. and J. Zwiebel (1996a): "Intra-Firm Bargaining under Non-Binding Contracts," The Review of Economic Studies, 63, pp. 375–410. 2.2

——— (1996b): "Organizational Design and Technology Choice under Intrafirm Bargaining," The American Economic Review, 86, pp. 195–222. 2.2