Firms' heterogeneity, international trade and allocation of talents in a Cournot model

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Abstract

This paper analyzes the theoretical relationship between trade volumes and countries' GDP, focusing on the beneficial impact of openness via a better allocation of talents. We build a very simple model of heterogeneous agents that differ in their abilities to be entrepreneurs or workers. Some of them, the ones that have more managerial abilities, become entrepreneurs, the rest become workers. The entrepreneurs compete à la Cournot and, under the assumption of price discrimination across countries, trade (in the form of reciprocal dumping) takes place. Since increased competition reduces profits, the threshold level of talent needed to be an entrepreneur goes up. Least able producers are forced out of the production sector. This raises overall productivity and income. Thus, in equilibrium, openness raises GDP not only because of the beneficial pro-competition effect of trade but also by favoring a more efficient allocation of human resources.

PRELIMINARY.

1 Introduction

Recent empirical work has pointed out that firms' export behavior differs substantially even within narrowly defined industries. The use of plant- and firm-level data has allowed to identify some robust findings.[1] First, markups generally fall with import-competition and import competing firms cut back their production levels when foreign competition intensifies. Second, not all firms within an industry export. Firms who export tend to be larger, more productive and pay higher wages. The available evidence also supports the view that learning-by-exporting is not important,[2] and that the good firms are those that engage in export activities. Finally, international trade induces a significant reshuffling of output-shares among firms, reallocating shares from less to more productive firms.[3] The available theoretical trade literature is not able to provide an explanation of these facts, because it largely relies, with a few notable exceptions,[4] on the representative firm framework.

This paper departs from this setting. We build a very simple two-sector general equilibrium model of heterogeneous agents that differ in their abilities to be entrepreneurs or workers and face a career choice. Some of them, the ones that have more managerial abilities, become entrepreneurs, the rest become workers. The entrepreneurs compete à la Cournot in the market place. In this context, as shown by Brander and Krugman (1983), under the assumption that firms are able to discriminate price across countries, firms have incentives to dump into other firms' home market once countries are open. The consequent increase in competition, triggered by the presence of foreign producers in the home market, reduces profits. In partial equilibrium this is the end of the story. Differently, in a career choice setting, the drop in the profit rate raises the threshold level of talent needed to be an entrepreneur. Thus, in equilibrium, openness is beneficial not only because of the standard pro-competition effect, but also because it favors a more efficient allocation of human resources. Less talented producers not only do not export, but are indeed forced out of the production sector. This raises overall productivity and income, which in turn stimulates an increase in the wage rate due to a larger labor demand.

[1] For a survey of this literature see Tybout (2001).

[2] Bernard and Jensen (1999a) and (1999b), Clerides, Lath and Tybout (1998).

[3] This appears to happen both in developing countries (Roberts and Tybout (1997); Clerides et al., (1998)) and in the United States (Bernard and Jensen, (1999b)).

[4] Melitz (2000) and Bernard, Eaton, Jensen, Kortum (2002) described below.

Other theoretical papers introduce firm-level heterogeneity in trade models. Melitz (2000) adapts Hopenhayn' (1992a, 1992b) dynamic general equilibrium models to a monopolistically competitive environment. He assumes a per period fixed costs of production with a constant marginal cost. Firms face a fixed cost upon entry (thereafter sunk), and make entry decisions before knowing their productivity, that remains constant afterwards. The fixed production cost generates a productivity threshold below which firms exit immediately after entry. Thus, all firms surviving in the market (except the marginal one) make positive profits and are able to recoup the fixed entry cost. When the economy opens up, firms may export upon payment of an overhead cost. Clearly, only the more productive firms are able to afford the export cost, sell abroad and expand their production. Because of increasing returns to scale, the profits of exporting firms increase relative to the profits of non-exporting (less productive) firms. This leads to more entry and to a higher cutoff productivity level that induces exit of the least productive firms. Our story is different. We have constant returns to scale in production and do not need to assume the presence of (entry, production and export) fixed costs, whose empirical relevance is not clear, in order to generate an industry behavior consistent with the empirical evidence. The career choice is enough to make it.

Bernard, Eaton, Jensen and Kortum (2002) build a model that allows to link observed variances and covariances in productivity, size and export participation to firm level characteristics of technological efficiency. They model firm-level heterogeneity by assuming firm-specific technological differences in a Ricardian framework and assume the presence of iceberg export costs. They assume Bertrand competition so that the more efficient producers are able to set higher markups and appear more productive in terms of value added per worker. Their simulation exercise, however, fails to match the moments of productivity, size and export participation of the U.S. manufacturing establishment.

The rest of the paper is organized as follows. Section 2 describes the consumers behavior. Section 3 introduces the closed economy and section 4 discusses the open economy. Section 5 illustrates the results and discusses some possible extensions of the model. Section 6 concludes.

2 The model: consumers behavior

There are two goods produced in the economy, X and Z. Good X is non-tradable and is produced in a competitive sector. Good Z is produced in a sector where firms compete à la Cournot. Consumers have CES utility functions defined on X and Z and maximize:

$$\begin{aligned}
\max_{X,Z} U(x,z) &= \left(Z^{\frac{\theta-1}{\theta}} + X^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}} \\
& s.t. \\
\frac{p_x}{P}X + \frac{p_z}{P}Z &= Y
\end{aligned}$$

where $P = \left(p_x^{1-\theta} + p_z^{1-\theta}\right)^{\frac{1}{1-\theta}}$ is the price of the aggregate good, Y is the real income in terms of the aggregate good, p_x is the price of good X, p_z is the price of good Z and $\theta > 1$ denotes the elasticity of substitution between goods. The above problem delivers the following standard demand functions:

$$\begin{aligned}
Z &= Y\left(\frac{p_z}{P}\right)^{-\theta} \qquad (1) \\
X &= Y\left(\frac{p_x}{P}\right)^{-\theta}
\end{aligned}$$

3 Closed economy: the Cournot sector

We assume that agents are heterogenous and differ in their ability to run businesses. Agents are indexed by $i \in \mathbb{N}$, their total number being $N < \infty$. We assume that if agent i, with ability $q_i \in \mathbb{R}_+$, sets up a firm in the Z sector, she has available the production technology $z = q_i L$, where L denotes the labor input. The agents that choose to become entrepreneurs compete à la Cournot in the Z sector. Using (1), an agent of type q_i maximizes

$$\begin{aligned}
\max_{L} \pi &= \frac{p_z}{P} q_i L - wL = \left(\frac{Y}{Z}\right)^{\frac{1}{\theta}} q_i L - wL \\
& s.t. \\
Z &= \sum_{i \in \mathcal{E}} q_i L
\end{aligned}$$

where Z denotes the aggregate quantity of good z, $\mathcal{E}$ is a set that includes all agents that become entrepreneurs, and w is the real wage rate.

The first order condition implies that:

$$q_i L = \theta Z \left[1 - \frac{w}{q_i} \left(\frac{Z}{Y} \right)^{\frac{1}{\theta}} \right] \tag{2}$$

Summing over all i's, the left hand side delivers the aggregate production of good Z, thus:

$$Z = \sum_{i \in \mathcal{E}} \theta Z \left[1 - \frac{w}{q_i} \left(\frac{Z}{Y} \right)^{\frac{1}{\theta}} \right]$$

from which

$$Z = Y \left(\frac{1}{w\mu} \right)^{\theta}$$

and

$$\frac{p_z}{P} = w\mu$$

with

$$\mu = \frac{\sum_{i \in \mathcal{E}} \frac{1}{q_i}}{M - \frac{1}{\theta}}$$

$M < N$ is the total number of entrepreneurs. The quantity produced by of firm i and its profits are given by:

$$z(q_i) = q_i L(q_i) = \theta Y \left(\frac{1}{w\mu} \right)^{\theta} \left(1 - \frac{1}{q_i} \frac{1}{\mu} \right) \tag{3}$$

$$\pi(q_i) = \frac{p_z}{P} z(q_i) - wL(q_i) = \theta Y (w\mu)^{1-\theta} \left(1 - \frac{1}{q_i} \frac{1}{\mu} \right)^2 \tag{4}$$

Thus, in order to have positive quantities produced, the condition $\left(1 - \frac{1}{q_i} \frac{1}{\mu} \right) > 0$ must hold. We now turn to the equilibrium conditions.

3.1 Closed economy equilibrium conditions

First, we need to make assumptions on how the ability parameter is distributed among agents. To keep things simple we assume that the N agents are ordered by ability level in an increasing manner and that $q_i = i$ for each i.

There are three equilibrium conditions concerning:

1. Career choices.
2. The labor market.
3. The goods market.

We discuss them in turn.

3.1.1 Career choices

Agent i will choose to become entrepreneur if and only if q_i is such that $w < \pi(q_i)$. Thus, there exists an ability threshold $\widetilde{q}$ defined by the condition $\pi(\widetilde{q}) = w$, i.e.

$$\theta Y \left(w\mu\left(\widetilde{q}\right)\right)^{1-\theta}\left(1 - \frac{1}{\widetilde{q}\mu\left(\widetilde{q}\right)}\right)^2 = w, \tag{5}$$

with

$$\mu\left(\widetilde{q}\right) = \frac{\sum_{i=\widetilde{q}}^{N} \frac{1}{q_i}}{N - \widetilde{q} - \frac{1}{\theta}}$$

such that agent i becomes entrepreneurs if and only if $q_i > \widetilde{q}$.

Notice that, since $q_i = i \in \mathbb{N}$ for all i, then the lowest ability level needed to become an entrepreneur is $\overline{q} = \text{integer}\left(\widetilde{q}\right) + 1$, and the total number of entrepreneurs is therefore $M = N - \overline{q}$.

3.1.2 Labor market

The labor supply is given by the agents that choose to become workers, i.e. all i's such that $q_i < \overline{q}$. They work both in the X and Z sector. Therefore, labor market equilibrium condition reads as follows:

$$\overline{q} - 1 = L_z + L_x$$

where L_z is the demand for labor of the firms producing good Z, and L_x is the demand for labor of the firms producing good X.

Recall that the X sector is perfectly competitive. Moreover, we assume that labor is the only input needed and the production function is $X = \phi L$. Thus, in equilibrium the condition $\frac{p_x}{P} = \frac{w}{\phi}$ must hold. Furthermore, being the supply of good X infinitely elastic at $\frac{p_x}{P} = \frac{w}{\phi}$, the quantity actually produced in the competitive sector are determined by consumers' product demand. Therefore, the demand for labor of the X sector is given by $L_x = \frac{X}{\phi} = \frac{Y}{\phi}\left(\frac{p_x}{P}\right)^{-\theta} = \phi^{\theta-1} Y w^{-\theta}$.

Hence, the condition defining the labor market equilibrium, using (3), can be rewritten as follows:

$$\begin{aligned} \overline{q} - 1 &= \sum_{i=\overline{q}}^{N} L(q_i) + Y\left(\frac{p_x}{P}\right)^{-\theta} \\ \overline{q} - 1 &= \sum_{i=\overline{q}}^{N} \frac{\theta Y}{q_i}\left(\frac{1}{w\mu}\right)^{\theta}\left(1 - \frac{1}{q_i}\frac{1}{\mu}\right) + \phi^{\theta-1} Y w^{-\theta} \end{aligned}$$

The latter equation implies that:

$$w = \left(\frac{Y}{\overline{q} - 1}\right)^{\frac{1}{\theta}} \left(\theta\mu^{-\theta} \sum_{i=\overline{q}}^{N} \frac{1 - \frac{1}{q_i}\frac{1}{\mu}}{q_i} + \phi^{\theta-1}\right)^{\frac{1}{\theta}} \tag{6}$$

with μ given by

$$\mu = \frac{\sum_{i=\overline{q}}^{N} \frac{1}{q_i}}{N - \overline{q} - \frac{1}{\theta}} \tag{7}$$

3.1.3 Goods market

The goods market clears if the sum of labor income and profits equal aggregate income, i.e.

$$Y = (\overline{q} - 1)\, w + \sum_{i=\overline{q}}^{N} \pi(q_i)$$

Plugging profits into the above equation, using equation (4), we get:

$$Y = (\overline{q} - 1)\, w + \theta Y (w\mu)^{1-\theta} \sum_{i=\overline{q}}^{N} \left(1 - \frac{1}{q_i \mu}\right)^2 \tag{8}$$

3.2 Solving the closed economy

The unknowns of the model are Y, w and $\overline{q}$. The model does not lend itself to be solved analytically. However, one can solve for the income and the wage as functions of $\overline{q}$ and then find the equilibrium level of $\overline{q}$ numerically.

Substituting (6) into (8) one gets:

$$Y(\overline{q}) = (\overline{q}-1)\left(\theta\mu^{-\theta}\sum_{i=\overline{q}}^{N}\frac{1-\frac{1}{q_i}\frac{1}{\mu}}{q_i}+\phi^{\theta-1}\right)^{\frac{1}{\theta-1}}\left(1+\frac{\theta\mu^{1-\theta}\sum_{i=\overline{q}}^{N}\left(1-\frac{1}{q_i\mu}\right)^2}{\theta\mu^{-\theta}\sum_{i=\overline{q}}^{N}\frac{1-\frac{1}{q_i}\frac{1}{\mu}}{q_i}+\phi^{\theta-1}}\right)^{\frac{\theta}{\theta-1}} \tag{9}$$

and plugging (9) back into (6) the wage reads as follows:

$$w(\overline{q}) = \left(\phi^{\theta-1}+\theta\mu^{-\theta}\left(\sum_{i=\overline{q}}^{N}\frac{1-\frac{1}{q_i}\frac{1}{\mu}}{q_i}+\mu\sum_{i=\overline{q}}^{N}\left(1-\frac{1}{q_i\mu}\right)^2\right)\right)^{\frac{1}{\theta-1}} \tag{10}$$

where again μ is given by (7). Both $w(\overline{q})$ and $Y(\overline{q})$ are positive under the restriction that $\left(1-\frac{1}{q_i}\frac{1}{\mu}\right)>0$, that must indeed hold for any i that becomes entrepreneur (see equation (3)).

Substituting (9) and (10) into (5) only one equation in one unknown is left. The numerical characterization of the closed economy equilibrium is provided in section 5 together with the open economy one.

4 Open economy: the Cournot sector

We now assume that there are two countries, A (home country) and B (foreign country). Agents may sell both in the domestic and foreign markets. We assume that the domestic and foreign markets are segmented and the production aimed at the export market cannot be redirected to the domestic one (and viceversa). We denote the amount produced in the home country for domestic consumption as z_{AA}, and the amount produced for foreign consumption as z_{AB}.[5] As before, the production function of agent i is $z=q_iL$. In each country there is (the same) number of agents $N<\infty$ indexed by $i\in\mathbb{N}$; firms compete à la Cournot.

A producer of type q_i living in country j maximizes

$$\begin{aligned}\max_{L_{jj},L_{jk}}\pi &= q_i\left(\frac{Y_j}{Z_j}\right)^{\frac{1}{\theta}}L_{jj}+q_i\left(\frac{Y_k}{Z_k}\right)^{\frac{1}{\theta}}L_{jk}-w\left(L_{jj}+L_{jk}\right)\\ &\quad s.t.\end{aligned}$$

[5] Viceversa we denote the amount produced abroad for foreign consumption as z_{BB} and the amount produced abroad for consumption in the home country as z_{BA}.

$$Z_j = \sum_{i \in \mathcal{E}_j} q_i L_{jj} + \sum_{i \in \mathcal{E}_k} q_i L_{kj}$$

for $j, k = A, B$ with $j \neq k$;

L_{jk} denotes the amount of labor needed by country j entrepreneur to produce the good to be sold in country k; Y_j is country j aggregate income. The set $\mathcal{E}_j$ denotes country j entrepreneurs. The aggregate quantity of good Z_j is given by the total amount produced by country j entrepreneurs for domestic purposes, i.e. $\sum_{i \in \mathcal{E}_j} q_i L_{jj}$, plus the amount produced by country k entrepreneurs for export, i.e. $\sum_{i \in \mathcal{E}_k} q_i L_{kj}$.

The first order conditions imply that:

$$q_i L_{jj} = \theta Z_j \left[1 - \frac{w}{q_i} \left(\frac{Z_j}{Y_j} \right)^{\frac{1}{\theta}} \right] \tag{11}$$

$$q_i L_{jk} = \theta Z_k \left[1 - \frac{w}{q_i} \left(\frac{Z_k}{Y_k} \right)^{\frac{1}{\theta}} \right] \tag{12}$$

for $j, k = A, B$ with $j \neq k$.

Using the fact that $Z_j = \sum_{i \in \mathcal{E}_j} q_i L_{jj} + \sum_{i \in \mathcal{E}_k} q_i L_{kj}$ we may obtain country j aggregate production by using (11) and (12) and summing over all i's as follows:

$$Z_j = \sum_{i \in \mathcal{E}_j} \theta Z_j \left[1 - \frac{w}{q_i} \left(\frac{Z_j}{Y_j} \right)^{\frac{1}{\theta}} \right] + \sum_{i \in \mathcal{E}_k} \theta Z_j \left[1 - \frac{w}{q_i} \left(\frac{Z_j}{Y_j} \right)^{\frac{1}{\theta}} \right]$$

and therefore

$$M_j + M_k = \frac{1}{\theta} + w \left(\frac{Z_j}{Y_j} \right)^{\frac{1}{\theta}} \left(\sum_{i \in \mathcal{E}_j} \frac{1}{q_i} + \sum_{i \in \mathcal{E}_k} \frac{1}{q_i} \right)$$

Where M_j and M_k denote the total number of entrepreneurs in country j and k. We denote, for brevity, $\mu_j = \frac{\sum_{i \in \mathcal{E}_j} \frac{1}{q_i} + \sum_{i \in \mathcal{E}_k} \frac{1}{q_i}}{M_j + M_k - \frac{1}{\theta}}$ for $j, k = A, B$ with $j \neq k$. With this notation in hand aggregate quantities and prices are given by

$$Z_j = Y_j \left(\frac{1}{w \mu_j} \right)^{\theta}$$

$$\frac{p_{zj}}{P} = \mu_j w$$

for $j = A, B$.[6]

The quantities produced by firm i for the domestic and foreign market are:

$$z_{jj}(q_i) = q_i L_{jj}(q_i) = \theta Y_j \left(\frac{1}{w\mu_j}\right)^{\theta} \left(1 - \frac{1}{q_i}\frac{1}{\mu_j}\right) \tag{13}$$

$$z_{jk}(q_i) = q_i L_{jk}(q_i) = \theta Y_k \left(\frac{1}{w\mu_k}\right)^{\theta} \left(1 - \frac{1}{q_i}\frac{1}{\mu_k}\right) \tag{14}$$

The quantities produced are increasing in q_i, keeping μ fixed. However, a larger q_i decreases μ making the total effect ambiguous.[7]

The profits of agent q_i living in any of the two countries read as follows

$$\pi_E(q_i) = \theta w^{1-\theta} \left(\mu_A^{1-\theta} Y_A \left(1 - \frac{1}{q_i\mu_A}\right)^2 + Y_B \mu_B^{1-\theta}\left(1 - \frac{1}{q_i\mu_B}\right)^2\right) \tag{15}$$

4.1 Open economy equilibrium conditions

We keep assuming that the N agents are ordered by ability level in an increasing manner and $q_i = i$ that for each i, in both countries.

There are three equilibrium conditions concerning:

1. Career choices.
2. The labor market.
3. The goods market.

We assume that countries are symmetric and describe them in turn.

[6] Notice that if $q_i = 1$ for all i prices boil down to the standard formula: $p_{zj} = \frac{w}{1-\frac{1}{\theta 2N}}$.

[7] The decrease in μ increases the aggregate quantity Z and provides incentives for agent i to decrease its own domestic production because of strategic substitutability. However, the total effect is surely negative for θ large enough (formally, $\frac{\partial z_{jk}(q_i)}{\partial \mu_j} = \theta Y_j \left(\frac{1}{w}\right)^{\theta}\left(\frac{1}{q_i}\frac{1}{\mu_j}\frac{\theta+1}{\theta} - 1\right)\theta\mu_j^{-\theta-1}$).

4.1.1 Career choices

Agent i will decide to become entrepreneur in the open economy setting if and only if q_i is such that $w < \pi_E(q_i)$, i.e. using (15) and symmetry $2\theta w^{1-\theta} Y \mu^{1-\theta} \left(1 - \frac{1}{q_i \mu}\right)^2 > w$. Thus, the threshold $\widetilde{q}_E$ is implicitly defined by the condition

$$2\theta Y \left(w\mu\left(\widetilde{q}_E\right)\right)^{1-\theta} \left(1 - \frac{1}{\widetilde{q}_E \mu}\right)^2 = w \tag{16}$$

where

$$\mu = \frac{2\sum_{i=\widetilde{q}_E}^{N} \frac{1}{q_i}}{2\left(N - \widetilde{q}_E\right) - \frac{1}{\theta}}$$

Again, since $q_i = i \in \mathbb{N}$, the lowest ability level needed to become an entrepreneur is $\overline{q}_E = \text{integer}\left(\widetilde{q}_E\right) + 1$, and therefore the total number of entrepreneurs in one country is $M = N - \overline{q}_E$.

4.2 Labor market

The total labor supply is given by all agents that choose to become workers, i.e. all i's such that $q_i < \overline{q}_E$. The labor demand is given by L_z, the demand for labor of the firms producing good Z, and L_x the demand for labor of the firms producing good X.[8]

Then, the labor market equilibrium condition in country j, $\overline{q}_E - 1 = L_z + L_x = \sum_{i=\overline{q}_E}^{N} L_{jj}(q_i) + \sum_{i=\overline{q}_E}^{N} L_{jk}(q_i) + \frac{Y}{\phi}\left(\frac{p_x}{P}\right)^{-\theta}$, using (13) and (14), reads as follows:

$$\begin{aligned} \overline{q}_E - 1 \;\; = \;\; & \sum_{i=\overline{q}_E}^{N} \frac{\theta}{q_i} Y_A \left(\frac{1}{w\mu_A}\right)^{\theta} \left(1 - \frac{1}{q_i}\frac{1}{\mu_A}\right) + \sum_{i=\overline{q}_E}^{N} \frac{\theta}{q_i} Y_B \left(\frac{1}{w\mu_B}\right)^{\theta} \left(1 - \frac{1}{q_i}\frac{1}{\mu_B}\right) + \\ & + \phi^{\theta-1} Y w^{-\theta} \end{aligned}$$

and exploiting symmetry,

$$\left(\overline{q}_E - 1\right) = 2\theta Y \left(\frac{1}{w\mu}\right)^{\theta} \sum_{i=\overline{q}_E}^{N} \frac{1 - \frac{1}{q_i}\frac{1}{\mu}}{q_i} + \phi^{\theta-1} Y w^{-\theta}$$

[8] Recall that we assume perfect competition in the X sector, and that the production function is $X = L$. Then, in equilibrium it must be that $\frac{p_x}{P} = w$, and the quantity actually produced in the competitive sector is determined by consumers' product demand. Therefore the demand for labor in sector X is given by $L_x = Y\left(\frac{p_x}{P}\right)^{-\theta} = Y w^{-\theta}$.

In turn, the above implies that:

$$w = \left(\frac{Y}{\overline{q}_E - 1}\right)^{\frac{1}{\theta}} \left(2\theta\mu^{-\theta} \sum_{i=\overline{q}_E}^{N} \frac{1 - \frac{1}{q_i}\frac{1}{\mu}}{q_i} + \phi^{\theta-1}\right)^{\frac{1}{\theta}} \tag{17}$$

with

$$\mu = \frac{2\sum_{i=\overline{q}_E}^{N} \frac{1}{q_i}}{2\left(N - \overline{q}_E\right) - \frac{1}{\theta}}$$

4.3 Goods market

In each country the goods markets clear if the sum of labor income and profits equal aggregate income, i.e.

$$Y_j = \left(\overline{q}_E - 1\right) w + \sum_{i=\overline{q}_E}^{N} \pi_E\left(q_i\right)$$

using (15) and symmetry

$$Y = w\left(\overline{q}_E - 1\right) + \theta Y \left(w\mu\right)^{1-\theta} 2 \sum_{i=\overline{q}_E}^{N} \left(1 - \frac{1}{q_i\mu}\right)^2 \tag{18}$$

4.4 Solving the open economy

Again, as in the closed economy case, it is not possible to get an analytical solution. We solve for the income and the wage as functions of $\overline{q}$ and then find the equilibrium level of $\overline{q}$ numerically.

Substituting (17) into (18) one gets:

$$Y_E\left(\overline{q}_E\right) = \left(\overline{q}_E - 1\right) \left(\theta\mu^{-\theta} 2 \sum_{i=\overline{q}_E}^{N} \frac{1 - \frac{1}{q_i}\frac{1}{\mu}}{q_i} + \phi^{\theta-1}\right)^{\frac{1}{\theta-1}} \left(1 + \frac{2\theta\mu^{1-\theta} \sum_{i=\overline{q}_E}^{N} \left(1 - \frac{1}{q_i\mu}\right)^2}{2\theta\mu^{-\theta} \sum_{i=\overline{q}_E}^{N} \frac{1 - \frac{1}{q_i}\frac{1}{\mu}}{q_i} + \phi^{\theta-1}}\right)^{\frac{\theta}{\theta-1}} \tag{19}$$

and plugging (19) back into (17) the wage reads as follows:

$$w_E\left(\overline{q}_E\right) = \left(\phi^{\theta-1} + 2\theta\mu^{-\theta}\left(\sum_{i=\overline{q}_E}^{N} \frac{1 - \frac{1}{q_i}\frac{1}{\mu}}{q_i} + \mu \sum_{i=\overline{q}_E}^{N} \left(1 - \frac{1}{q_i\mu}\right)^2\right)\right)^{\frac{1}{\theta-1}} \tag{20}$$

with

$$\mu_E = \frac{2\sum_{i=\overline{q}_E}^{N}\frac{1}{q_i}}{2\left(N-\overline{q}_E\right)-\frac{1}{\theta}}$$

5 Preliminary results

In this section we present and compare the results obtained in the open and closed economy.

In order to get results for the open (closed) economy we plug equations (19) and (20) (respectively (9) and (10)) into condition (16) (respectively (5)), so as to get one equation in one unknown and solve numerically for $\overline{q}_E$ in the open economy framework and $\overline{q}$ in the closed economy. Of course, this exercise is not meant to be a calibration. Rather, it serves as a tool to have a better understanding of the functioning of the model.

Given our symmetry assumption, we have only three exogenous variables, namely θ, the elasticity of substitution between good X and good Z, N, the total number of agent in each country and ϕ, the labor productivity in the X sector. In table 1 we set $N = 1000$ and $\phi = 500$ and analyze what happens in the open and closed economy as θ varies.[9]

θ	$\overline{q}_E$	$\overline{q}$	Y_E	Y	w_E	w	$\frac{p_z^E}{P^E}$	$\frac{p_z}{P}$
2	976	975	5307360	3373450	1439	1430	1.532735	1.53736
4	977	976	2018120	1662640	987	984	1.047533	1.048052
6	977	976	1613820	1424370	952	950	1.008209	1.008294
8	977	976	1447680	1320090	946	945	1.001654	1.001669
10	977	977	1354530	1260570	946	943	1.00036	1.000367

Table 1. $N = 1000$, $\phi = 500$

The first reading of the table is horizontal and compares the closed and open economy (the latter is denoted by the subscript $_E$) for each value of θ. First, notice that, as expected, the ability threshold level needed to become entrepreneur increases when trade takes place, i.e. $\overline{q}_E \geq \overline{q}$.[10] The reason

[9] Further simulations (not reported) show that changes in N and ϕ do not qualitatively affect the results.

[10] When, as for $\theta = 10$, the ability level does not change it is because of the *discrete* number of agent, since it is always the case that $\widetilde{q}_E > \widetilde{q}$.

is simple. When countries open up, firms face more competition.[11] This, as always in a Cournot setting, reduces prices and profits. This is what Brander and Krugman (1983) call the pro-competition effect of trade. On top of this, there is an allocation of talents effect. The profit reduction that takes place in the open economy pushes some "closed economy entrepreneurs" out of the production sector, and forces them to become workers. Despite the reduction in the number of entrepreneurs in each country, the quantity supplied of good Z goes up because the *total* number of firms competing (domestic and foreign) goes up. Thus, the price of good Z goes down while the labor demand and the real wage increase. The reduction of p_z jointly with the rise of the wage rate implies that firms' mark-ups go down.

The second reading of the table is vertical, and serves to make "comparative statics" with respect to θ. Of course, as θ goes up the ability needed to become entrepreneur increases. The reason is that a higher substitutability among goods, not only increases the elasticity of the demand of Z and X, but also shifts the demand schedules down. Both the lower demand level and the higher elasticity reduce firms' market power, depress the price of good Z and firms' profits. This, in turn, implies the need of higher ability to become entrepreneurs and consequently a reduction in their number. Moreover, the drop in the demand for labor reduces the wage rate.

Overall this fairly simple model is able to replicate a number of stylized facts established by the empirical literature analyzing firms' behavior after trade liberalization using plant- and firm-level data. In particular, the model is consistent with the following facts (Tybout (2001)).

1. Markups generally fall with import-competition, and import competing firms cut back their production levels when foreign competition intensifies.

2. Not all firms within an industry export. Firms who export tend to be larger, more productive and pay higher wages (Tybout (2001)). In this model, all entrepreneurs export, i.e. there are no agents choosing to become entrepreneurs and produce only for the domestic market. This feature may however be easily incorporated in the model by assuming that selling abroad is more difficult than selling in the home market (because of information problems, larger uncertainty etc.). Then, there

[11] Of course, the presence of transportation costs would mitigate this effect, but not make it disappear as long as they are finite.

would exist a range of agents that would indeed choose to become entrepreneurs but are not productive enough to be willing to export.

3. Finally, the available evidence supports the view that learning-by-exporting is not important and that international trade induces a significant reshuffling of output-shares among firms, reallocating shares from less to more productive firms.

The model also suggests the existence of an unexplored theoretical link between trade and growth, via a better allocation of human resources. It is very simple to amend the above model so as to allow for growth. If the entrepreneurs innovate and the rate of technological progress is given by, say, the average ability of the people engaged in entrepreneurship, then trade, by favoring a more efficient allocation of human resources would also boost growth.[12]

From an empirical point of view, the evidence does suggest the existence of a moderate positive relation between trade and growth.[13] However, the empirical literature dealing with trade and growth has been plagued by endogeneity problems. The main concern is that it might well be that countries that grow more tend also, for some reason, to trade more.[14] In this case, the OLS estimate would be upward biased.[15] However, though tentative, the

[12]For a model of allocation of talent and growth see Murphy, Shleifer and Vishny (1991).

[13]Among many others, Alcalá and Ciccone (2002), Frankel and Romer (1999), Edwards (1993), Levine and Renelt (1992), Dollar (1992). For a critic view, see Rodríguez and Rodrik (2000).

[14]For instance, richer countries for reasons other than trade may tend to have better infrastructures and lower transportation costs, thus tend to trade more.

[15]An important paper that takes a step in addressing the problem is Frankel and Romer (1999). To solve the endogeneity issue, Frankel and Romer adopt an IV strategy. Since - they claim - geography is a powerful determinant of bilateral trade, they instrument trade using countries' geographic characteristics which, they argue, are correlated with trade but not with income. They find that the IV specification provides a larger point estimates of the effect of trade on income (less precisely measured, though). Therefore, this approach allows them to argue that indeed trade causes growth (and not viceversa). However, the effect of trade is no longer significant when including countries' distance from the equator in the analysis. Alcalá and Ciccone (2002) use the same IV-geography based approach. However, they argue that the commonly used measure of openness (nominal exports plus imports relative to nominal GDP) may give rise to cross-country differences in the degree of openness simply due to the cross-country differences in the relative prices of non–tradable goods that may affect nominal GDP (the more the more inelastic the demand for non–tradable). Therefore, they implement two measures called *real openness*

conclusion that may be drawn from this empirical literature is that trade indeed causes growth (Baldwin (2003)). Therefore, our model, amended to incorporate growth, would fit well not only with the plant- and firm-level evidence but also with the macro evidence.

6 Concluding remarks

We build a very simple general equilibrium model of heterogeneous agents that differ in their abilities to be entrepreneurs or workers. Some of them, the ones that have more managerial abilities become entrepreneurs, the rest become workers. Risk neutral entrepreneurs compete à la Cournot in the market place. In this context, as shown by Brander and Krugman (1983), under the assumption that of price discrimination across countries, firms have incentives to dump into other firms' home market, once countries are open. However, the increase in competition triggered by the presence of foreign producers reduces profits. Thus, the threshold level of talent needed to be an entrepreneur goes up and only the more talented agents keep being entrepreneurs in the open economy setting. This raises overall productivity and income. Thus, in equilibrium, openness favor a more efficient allocation of human resources, because less talented producers not only do not export, but are indeed forced out of the production sector by the competition with the foreign exporters.

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and *tradable GDP openness*. The former is defined as imports plus exports in exchange rate US$ relative to GDP in purchasing-power-parity US$. The latter is given by nominal exports plus imports relative to nominal value of GDP in the tradable sector. Using these measures they find that the effect of trade on income and on average labor productivity is highly significant and robust to the inclusion of institutional and geography controls.

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