Endogenous asymmetries in technology adoption and international trade (*work in progress: incomplete preliminary draft*)

Ivan Ledezma *
Université Paris-Dauphine, LEDa
IRD, UMR225-DIAL

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Abstract

This note explores the interaction between trade integration and asymmetric choices of technology adoption. It seeks to bring micro foundations of firm heterogeneity into an open-economy model. By so doing, the analysis shows the complementarity between an imperfect competition framework of strategic substitutability and a system of preferences specially well suited for general equilibrium analysis. Preliminary results, still in partial equilibrium, confirm standard claims on price reduction and the ability of economies of scale to facilitate technology adoption. More interesting, the number of active firms is reduced by the increase in market size and subtile interactions arises from demand aggregation.

1 Introduction

Firm-level heterogeneity is one of the major stylised facts extensively documented by applied micro-level studies, specially those at the frontier of

*Address: Place du Maréchal de Lattre de Tassigny, 75775 Paris Cedex 16, France. Email: ivan.ledezma@dauphine.fr, Tel. 33 (0)1 44 05 42 67, Fax 33 (0)1 44 05 45 45.

industrial organisation and trade literatures (see for instance Dune et al. 1988; Tybout, 2003; Greenaway & Kneller, 2007). Firms belonging to the same industry are different in several aspects, namely isize and productivity. This holds true if we vary the period, the sector definition or the country under consideration. Heterogeneity within a given industry is closely related to the continuous process of firm renewal as the type of firm that enters and exits the market alters the shape of the distribution of firm characteristics.

Most of theoretical efforts, specially those of trade literature inspired by Melitz (2003) and Bernard et al. (2003), have been devoted to take into account these patterns in the analysis of industry outcomes and have been able to encompass several firm-level empirical facts. However, they are silent about the question of the origin of heterogeneity, notably in terms of marginal costs, often assumed as a random variable drawn from a negatively skewed distribution. On this line, the story is one in which everybody would like to be a superstar, no matter the context, and only a few, exogenously well endowed or lucky, succeed in practice. One exception is Ederington and MacCalman (2008) who brings into an open-economy model a theoretical toolkit helping to analyse the timing of technology adoption. The key idea is that, under the assumption of technological diffusion, some firms may prefer to invest later in order to pay lower sunk costs. Hence firms are different because they adopt a performant technology at different dates. This line of attack puts forward industry evolution as a determinant of firm heterogeneity. Profits at equilibrium, however, are the same for all firms.

This note asks related but different questions : what if sometimes it worth to be small (in size and profits) relative to their competitors? what if entrepreneurs, depending on the context, *choose* to produce with low or with high marginal costs? How does economic integration may affect these decisions? We are then concerned with strategic behaviour rather than with dynamic issues. Consequently we rely on a particular strand of the industrial organisation literature that has given some simple and deep answers to the question of firm heterogeneity and, by doing so, explored the problem in a rich and tractable context, that of a Cournot competition game.

While usually seen as less appealing than price competition, competition in quantities (Cournot oligopoly) appears as a good starting point to study strategic interactions. Contrary to monopolistic competition, here firms take into account the effects of their actions on industry-level outcomes. For instance, it is a natural feature in a Cournot game with free entry that a new entrant anticipates the changes in profits generated after she enters the market. In what we are concerned, the retrospection starts with the work of Mills and Smith (1996) who in a simple two-stage Cournot model of technology adoption (henceforth CMTA) showed the existence of asymmetric equilibrium for a duopoly: ex-ante identical firms end-up tacking different decisions. As the title of Mills and Smith (1996) summarises: it pays to be different. To understand this claim, recall the equilibrium concept of Nash (1951), which is the one used here. At equilibrium each firm, fully aware of the strategies of the others, has no incentive to change its technology choice, even if this implies to be (disadvantageously) different. It is then crucial that firms anticipate the effect of their actions at the industry level. For instance, it can be the case that being another big firm may make lower the equilibrium price too much.[1] Mills and Smith (1996)'s result was generalised by Elberfeld (2003) to the case of multiple firms. In a more sophisticated fashion, these concepts are used in Elberfeld (2002) to obtain further analytical insights on the Stigler (1951)'s hypothesis linking the effect of market size and vertical integration. An interesting feature of Elberfeld (2002) is to explicitly consider the effect of free entry in downstream and upstream markets. While rich in its results, such a deep scrutiny complicates the analysis for our focus. More recently, Götz (2005) revisited the basic CMTA when free entry applies. He provides general conditions concerning the existence of symmetry and uniqueness. As the focus of Götz (2005) is on general characteristics of the free entry game, the analysis of asymmetric outcomes is derived from the symmetry requirements and it mainly relies on numerical examples.[2]

In the present work, the full analytical characterisation of this equilibrium is obtained with the aim to study the possible effects of economic integration. The choice of the CMTA as the basic framework seeks to keep the representation as simple as possible. We work with the simplest technology choice: a high (or large-scale) technology and a low (or small-scale) technology. Free entry, however, must be analysed in a more complex way by considering the integer constraint. Intuitively, in our context, even only one large-scale firm exiting the market can lead to the entry of several small-scale firms. In order to visualise how the model predict the effect of economic integration, the results of another strand of the literature are invoked. They are well summarised in Neary (2009) whose effort is devoted to bring oligopolistic features

[1] For a more general theoretical analysis of the emergence of asymmetric equilibrium see Amir et al. (2010).

[2] For an application of Götz (2005)'s results to FDI see Elberfeld et al. (2005).

into general equilibrium. The development of Neary (2009) and related works (mainly cited there in) proves to be quite complementary for what we are endeavouring to do here. The inclusion of free entry and endogenous heterogeneity is something that can enrich that analysis. In this note we explore asymmetry in an integrated world of two similar countries (not necessarily identical) and limit ourselves to properly apply preferences aggregation for the product market equilibrium. As it become clear in a moment, several insights are worth to mention even at this first step of the walk from partial to general equilibrium.

The remainder of the paper presents the model and some of its features. Section 2 derives the asymmetric equilibrium for the CMTA with free entry. Section 3 presents the preference system that will help to understand how the skewness of marginal cost distributions is affected when a country opens up to trade integration.

2 The CMTA with free entry

2.1 Formal setup

Consider an homogenous good market characterised by the following inverse demand function

$$p = a - by$$

where a and b are positive demand parameters, p is the price of the good and y the total output in the industry. Firms are identical ex-ante but they choose amongst two technology of production. By investing f_0 a firm can produce with a small-scale (or low technology) at a constant marginal cost of c_0 . By investing $f_1 > f_0$ in large-scale (or high technology), firms can produce at a lower marginal cost $c_1 < c_0$. The number of firms and the number of each type of firms are determined at equilibrium.

We consider the following three-step game with technology adoption and free entry. First, firms belonging to an unbounded mass of potential entrants decide whether to enter to the market or not. Upon entry they must decide their technology of production. Firms then compete in quantities.

The net profits of firm i if it decides to enter as a low-technology firm is

$$\pi_i \left[y_1, ..., y_n\right] = \left(\theta - b \sum_{j=1}^{n} y_j\right) y_i - f_0 \qquad i \in \Omega$$

where Ω is the set of low-technology firms. For convenience, we have defined the parameter $\theta \equiv a - c_0$.

If firm i decides to enter with a large-scale technology, its profits are given by

$$\pi_i [y_1, ..., y_n] = \left(\theta + \Delta - b \sum_{j=1}^{n} y_j\right) y_i - f_1 \qquad i \in \Lambda$$

where Λ is the set of high-technology firms, $\Delta \equiv c_0 - c_1$.

Backward induction starts from competition in quantities. We focus on the Nash-equilibrium in quantities in which both type of firms are active. For a given technology, payoffs are the same so we can drop the subscript i and simply identify low- and high-technology firms by 0 and 1, respectively. Denoting n the total number of firms and m the number of low-technology firms, we can state the asymmetric equilibrium in the final stage as[3]

$$y_0 [m, n] = \frac{\theta - \Delta (n - m)}{b (n + 1)} \qquad y_1 [m, n] = \frac{\theta + \Delta (m + 1)}{b (n + 1)} \tag{1}$$

$$\pi_0 [m, n] = -f_0 + \frac{(\theta - (n - m) \Delta)^2}{b (1 + n)^2} \qquad \pi_1 [m, n] = -f_1 + \frac{(\theta + (m + 1) \Delta)^2}{b (1 + n)^2} \tag{2}$$

The equilibrium in this type of game requires two sorts of conditions (Elberfeld, 2003; Götz, 2005). First, entry should not be profitable for a new firm (either as a large- or as a small-scale technology):

$$\pi_0 [m + 1, n + 1] < 0 \leq \pi_0 [m, n] \tag{3}$$

$$\pi_1 [m, n + 1] < 0 \leq \pi_1 [m, n] \tag{4}$$

Secondly, given the number of firms, there must be no incentive to switch from one technology to another. Hence

$$H_0 [m, n] \equiv \pi_1 [m - 1, n] - \pi_0 [m, n] \leq 0 \tag{5}$$

$$H_1 [m, n] \equiv \pi_0 [m + 1, n] - \pi_1 [m, n] \leq 0 \tag{6}$$

[3]More details on computations are available upon request. For a sake of brievety, mostly procedures of calculation are provided.

If the no-profitable entry (NPE) conditions (3) and (4) and the no-switching (NS) conditions (5) (6) are fulfilled for a positive couple (m, n) we have then an asymmetric equilibrium in which ex-ante identical firms end-up being different due to strategic behaviour. Notice that both set of conditions respect the integer restriction. This is important since the size of a large firm can be important enough to allow the entry of small firms.

Let be T_k the average cost obtained by a firm producing with technology $k \in \{0, 1\}$ in a symmetric free-entry equilibrium (i.e. if only technology k is used). Cost advantages of high-technology firms are defined as the difference between these average costs, viz:

$$A \equiv T_0 - T_1 = \sqrt{bf_0} - \sqrt{bf_1} + \Delta$$

Through all the model we work under the following assumption

Assumption 1 Cost advantages of high-technology firms are positive

$$A > 0$$

2.2 Asymmetric partial equilibrium

2.2.1 Equilibrium conditions

It is useful to start the analysis from the pivoting (real) number of firms related to no-switching (eq. 3) and no-profitable entry (eq. 6) conditions. For each $k \in \{0, 1\}$ let $m = h_k[n]$ be the relation between m and n defined by $H_k[m, n] = 0$. After some algebra it can be verified that

$$h_1[n] = h_0[n] - 1 \tag{7}$$

$$h_0[n] = \frac{-b(f_0 - f_1)(1+n)^2 + n\Delta(n\Delta - 2\theta)}{2n\Delta^2} \tag{8}$$

The number of small firms that (for a given number of total firms) implies zero rents from technological switching differs exactly by one, a result stemming from the integer constrained formulation. Notice that the functions defining the rents from switching ($H_k[m, n]$) are such that

$$\frac{\partial H_0[m, n]}{\partial m} = \frac{2n\Delta^2}{b(1+n)^2} > 0 \qquad \frac{\partial H_1[m, n]}{\partial m} = -\frac{2n\Delta^2}{b(1+n)^2} < 0 \tag{9}$$

Hence $H_0[m, n]$ is monotonically increasing in m and $H_1[m, n]$ monotonically decreasing in m. This helps to understand the following lemma.

Lemma 1 *The number of low-scale firms that simultaneously satisfies no-switching conditions (5) and (6) is the largest integer smaller than* $h_0[n]$.

Proof. Consider $\underline{m} = h_1[n]$. Then $H_1[\underline{m}, n] = 0$ (by definition). From (7) it follows that $H_0[\underline{m}+1, n] = 0$ and hence, from (9), $H_0[\underline{m}, n] < 0$. Conversely, consider $\overline{m} = h_0[n]$, by the same reasoning one has $H_0[\overline{m}, n] = 0$ and $H_1[\overline{m}, n] < 0$. Hence, by (9), the integer belonging to the interval $[h_1[n], h_0[n]]$ verifies (5) and (6) for $k \in \{0,1\}$ .It also follows immediately from (7) that this integer value is unique and it suffices to consider largest one smaller than $h_0[n]$. Because for each extreme of the interval, at least one inequality is strictly verified, the knife-edge case where $h_0[n]$ or $h_1[n]$ are themselves integers is excluded. ■

Consider now the requirements of no-profitable entry. For each $k \in \{0,1\}$ let $m = g_k[n]$ be the relation between m and n defined by $\pi_k[m,n] = 0$. More precisely $g_k[n]$ is the positive root of $\pi_k[m,n] = 0$ when solving for m.[4]

$$
\begin{aligned}
g_0[n] &= \frac{\sqrt{bf_0}(n+1) + n\Delta - \theta}{\Delta} \\
g_1[n] &= \frac{\sqrt{bf_1}(n+1) - (\Delta + \theta)}{\Delta}
\end{aligned}
$$

Lemma 2 *Under Assumption 1, there exists a positive real* n^* *verifying for both technologies zero profits and zero rent from switching. This pivoting (real) number of firms is given by*

$$
n^* = \frac{\sqrt{bf_1} - \sqrt{bf_0}}{\sqrt{bf_0} - \sqrt{bf_1} + \Delta} \tag{10}
$$

and the associated (real) number of low-technology firm is

$$
m^* = \frac{\sqrt{bf_1}}{\left(\sqrt{bf_0} - \sqrt{bf_1} + \Delta\right)} - \frac{\theta}{\Delta}
$$

Proof. The n^* solving $h_0[n] = g_0[n]$ is the same than the one solving $h_1[n] = g_1[n]$ because both equations are related through the underlying relationship

[4]For $m = g_1[n]$ only one root is positive whereas for $m = g_0[n]$ two roots can potentially be positive. The excluded one implies negative profits for firms-1 at equilibrium, which excludes the asymmetric equilibirum

(7). Solving the system amounts then to solve the reduced equation $g_1[n^*] = g_0[n^*] - 1$. The implied number of small firms is obtained from $m^* = h_0[n^*]$. ■

Proposition 1 *Within the parameters region*

$$1 + \frac{\sqrt{bf_0}}{\left(\sqrt{bf_0} - \sqrt{bf_1} + \Delta\right)} < \frac{\theta}{\Delta} < \frac{\sqrt{bf_1}}{\left(\sqrt{bf_0} - \sqrt{bf_1} + \Delta\right)} - 1 \qquad (11)$$

$$\sqrt{bf_1} - \sqrt{bf_0} < \Delta < \sqrt{bf_1} \qquad (12)$$

the asymmetric equilibrium satisfying (3)-(6) exists and it is unique. In such equilibrium, the total number of firms is the largest integer smaller than the real number $n^*$and the number of low-technology firms the largest integer smaller than m^*.

Proof. If (m^*, n^*) is an asymmetric equilibrium it must verify $m^* > 1$ and $n^* - m^* > 1$ as well as conditions (3)-(6). Restriction (11) ensures $m^* > 1$ and $n^* - m^* > 1$ under Assumption 1, which is included in the LHS of (12). By proposition 1 no-switching conditions (5) and (6) are satisfied by $h_0[n^*]$. No-profitable entry conditions (3) and (4) are also fulfilled because

(i) $\pi_0[h_0[n^*], n^*] \geq 0$ is verified by construction as $\pi_0[h_0[n^*], n^*] = 0$. Moreover, we can verify $\pi_0[h_0[n^*] + 1, n^* + 1] = f_0\left(-1 + \frac{\Delta^2}{\left(\sqrt{bf_0} - \sqrt{bf_1} + 2\Delta\right)^2}\right) < 0$ under Assumption 1. Observe that there is a monotonic decreasing response of π_0 to the entry of small firms : $\frac{\partial^2 \pi_0}{\partial m \partial n} < 0$ if $\theta > \Delta(n - m)$,which is true whenever small firms have positive production; see equation (1).

(ii) $\pi_1[h_0[n^*], n^*] = \frac{\left(\sqrt{bf_0} + \Delta\right)^2 - bf_1}{b} \geqslant 0$ under Assumption 1. $\pi_1[h_0[n^*], n^* + 1] = -f_1 + \frac{\Delta^2\left(\sqrt{bf_0} + \Delta\right)^2}{b\left(\sqrt{bf_0} - \sqrt{bf_1} + 2\Delta\right)^2} < 0$ holds true under Assumption 1 and $\Delta < \sqrt{bf_1}$, the RHS of (12). Also, π_1 presents a monotonic decreasing response to the entry of large-scale firms as $\frac{\partial \pi_1}{\partial n} < 0$. ■

It is useful to follow Götz (2005) and represent the equilibrium conditions in the (m, n) space (Figure 1). In such a graph, the zero profit conditions $g_0[n]$ and $g_1[n]$ are two straight lines. Under Assumption 1, one has $\frac{dg_0}{dn} > \frac{dg_1}{dn}$. For each type of firm, profits are negative or positive depending one situates bellow or above the respective zero profit condition. Call D the horizontal distance between both lines at the horizontal intercept. One of the main results of Götz (2005) for our case is that (leaving integer concerns aside), if $D > 1$ the equilibrium is symmetric with only large-scale firms active. Intuitively, if we have only small firms making zero profits (i.e. if we are at g_0), the entry of low-marginal cost firms is profitable as long as we lie above g_0. Loosely speaking, one can move to the right and there is profitable switching from the low to the high technology. At point of zero low scale firms no reversal switch is profitable because the vertical distance is greater than 1 (if we move up we lie bellow g_0) since $D > 1$ and $\frac{dg_0}{dn} > \frac{dg_1}{dn}$.

The asymmetric equilibrium characterised by proposition 1 implicitly considers this claim. Analytically, the condition $\widetilde{n}_1 - \widetilde{n}_0 < 1$ with $g_k[\widetilde{n}_k] = 0$ (i.e. when symmetry should not hold) is certainly verified by the RHS of (11).[5] In the (m, n) space, NS-conditions are satisfied within the region depicted by the curves $h_0[n], h_1[n]$, which are separated vertically by a distance of 1. When solving for n^* this distance is taken into account by the underlying relationship $h_0[n] = h_1[n] - 1$ (see proof of proposition 1). The example of Figure 1 ($f_1 = 3000, b = 1/800, f_0 = 1, \Delta = 2.3, \theta = 2.5$) is that of close zero profit conditions (solid lines), that is to say when $D > 1$ does not hold. The points along the zero profit line g_0 that are within the parallels h_0, h_1 (dashed lines) are then equilibrium candidates.

[5] Considering the integer constraint the requirement for symmetry is $D > 2$. This leads to a less restrictive parameter region than what is presented in Lemma 1.

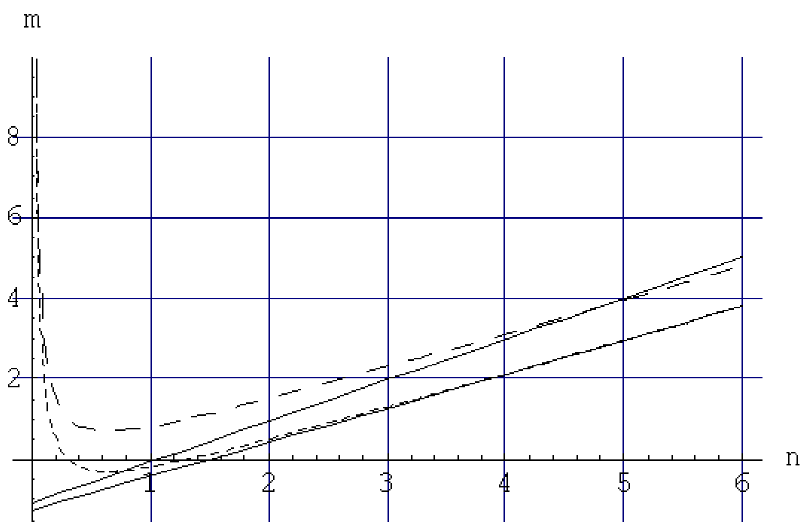


Figure 1

3 Trade integration

3.1 Consumer preferences

The following utility representation closely follows Neary (2009). Consider consumers preferences as being linearly additive over a continuum of goods (sectors) of mass 1. The sub-utility associated to each of them is represented by a quadratic functional form:

$$U\left[\{x\left[z\right]\}\right] = \alpha \int_0^1 x\left[z\right] dz - \frac{1}{2}\beta \int_0^1 x\left[z\right]^2 dz \equiv \alpha\mu_{1x} - \frac{1}{2}\beta\mu_{2x} \tag{13}$$

where μ_j^x stands for the j^{th} moment of consumption levels. The single representative consumer maximises (13) subject to the budget constraint, whereby, as usually, consumption is bounded by aggregate income

$$\int_0^1 p\left[z\right] x\left[z\right] dz \leq I$$

This calculation leads to the inverse demand function

$$p[z] = \frac{1}{\lambda}(\alpha - \beta x[z])$$

where λ is the Lagrange multiplier that "penalises" the excess of consumption and hence represents the marginal utility of income. Its value is obtained thanks to the saturation of the budget constraint given optimal demands, viz.:

$$\lambda = \frac{\alpha\mu_{1p} - \beta I}{\mu_{2p}}$$

$\mu_{1p} \equiv \int_0^1 p[z]\,dz$ and $\mu_{2p} \equiv \int_0^1 p[z]^2\,dz$ are the first and the second moments of the distribution of prices across goods. The endogenous marginal utility of income λ contains all economy-wide information that is taken as given within industries. It is then the key to bring our previous results further to general equilibrium.

3.2 Aggregate demand in the integrated economy

Neary (2009) shows that the indirect utility function of the system of preferences used here follows a Gorman polar form (see Gorman,1961). If the demand parameter β is the same for all individuals the demand structure is quasi-homothetic and the results of Gorman (1953,1961) about aggregation of preferences can be applied here. As long as β is the same for all individuals, the intercept of the Engel curves may differ across countries (and/or individuals), but these income-consumption paths remain parallel straight lines. If there is free trade between a home country, with the same economic structure described so far, and a foreign country with similar preferences (identified by *), then the world economy presents the following inverse demand for each good z,

$$p[z] = a - b\overline{x}[z]$$

where $a \equiv \frac{\alpha+\alpha^*}{\lambda+\lambda^*}, b \equiv \frac{\beta}{\lambda+\lambda^*}$ and $\overline{x}[z] \equiv x[z] + x^*[z]$. Hence we can directly apply our results for the CMTA with free entry, provided that.

$$\overline{x}[z] = y[z] + y^*[z]$$

with $y = my_0[m,n,z] + (n-m)\,y_1[m,n,z]$ and similarly for y^*

The demand parameter b is usually interpreted as negatively correlated with market size. The aggregation of demands teaches us that not only the market size parameter is modified in the open economy, but also the intercept of the perceived oligopolistic demand. It is only in the case of identical countries that a remains unchanged. As a participates in the determination of the number of small-scale firms m^* (through $\theta \equiv a - c_0$), this observation can have consequences on the number of large-scale firms $\ell^* = n^* - m^*$.

In the previous section we showed that the asymmetric equilibrium exists for a wide range of parameters constellation. We can now assume those conditions (derived in proposition 1) and, after relaxing the integer constraint, analyse the effect of trade integration in terms of marginal effects on markets structure variables. The following results can then be established:

Proposition 2 *Within the parameter region defined by proposition 1, relative to the autarky situation, trade integration between countries of identical technology but not necessarily identical demand intercepts, implies that*

(i) the number of small-scale firms m^* and the number active firms n^* decrease

(ii) the percentage of large-scale firms $\frac{\ell^*}{n^*}$ increases, but this variation is modulated by the change in the intercept

(iii) the markup and profits of large-scale firms increase

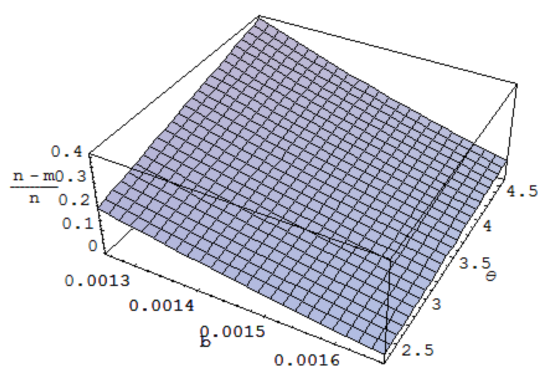
(iv) price decreases

Proof. The proposition is proved by the properties of the CMTA equilibrium with free entry. We can capture market size through the inverse of b and the intercept by $\theta \equiv a - c_0$ since technologies are assumed to be identical. For each part of the proposition, respectively, we find: (i) $\frac{\partial n^*}{\partial b} > 0$, $\frac{\partial m^*}{\partial b} > 0$; (ii) $\frac{\partial(\ell^*/n^*)}{\partial b} < 0$, $\frac{\partial^2(\ell^*/n^*)}{\partial\theta\partial b} < 0$; (iii) $p[z]|_{m^*,n^*} = \sqrt{bf_0} + c_0$, which is the average costs of small-scale firms $\left(c_0 + \frac{f_0}{y_0}\right)$.On the other hand, from the proof of proposition 1 we know that $\pi_1[m^*, n^*] > 0$. Thus, large-scale firms have larger markup. Finally observe also that $\frac{\partial\pi_1}{\partial b} < 0$; (iv) $\frac{\partial\left(p[z]|_{m^*,n^*}\right)}{\partial b} > 0$ ■

Our framework is quite different than that of models with exogenous heterogeneity and monopolistic competition, such as, for instance Melitz (2003).

Even if they go deeper in terms of factor and product market interactions as well as export sorting, some comparisons can be made. There are some basic features of our model that are familiar in those with exogenous heterogeneity, namely in terms of exit of high-marginal cost firms and entry of more productive ones, as well as, profits, size and markup heterogeneity (Melitz and Ottavianno, 2008). Some important departures , however, arise here and deserve further exploration. First, since heterogeneity is a choice for *ex-ante* identical firms, the total number of active firms (at the world level) can be reduced if market size increases. Thanks to scale economies, more producers are willing to adopt a large-scale technology in the integrated world leading to lower room for entry. This means exit or/and absorption of a subset of small firms. Secondly, the increase in the proportion of high-technology firms may not be important if oligopolists in a given country perceive a low variation of a. For different countries this variation depends on general equilibrium variables, as $a = \frac{\alpha+\alpha^*}{\frac{\alpha\mu_{1p}-\beta I}{\mu_{2p}}+\frac{\alpha^*\mu_{1p}^*-\beta I^*}{\mu_{2p}^*}}$.

Figures 2 illustrate for $f_1 = 3000, f_0 = 1, \Delta = 2.3$ the percentage change of high-technology firms when the inverse of b changes from 600 to 800 units (to be read from the right to the left) and when the parameter θ, that captures the change in a, ranges from Δ to.2Δ. Significant changes are only observed for high values of θ. Hence in a model with two identical countries this variation is expected to be low. For the same parameter values Figure 3 shows that the downward change in the number of active firms can be sizeable specially for smaller markets.



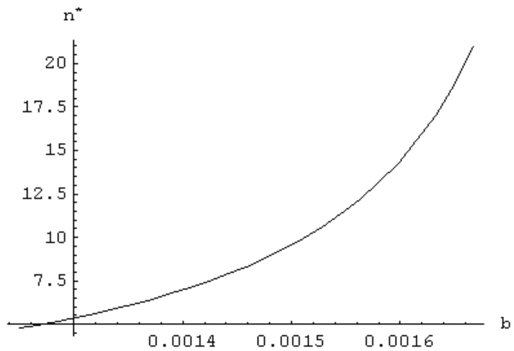


Figure 3.

4 Conclusion

In this note we have explored the ability of our framework to analyse some of the interactions between trade integration and asymmetric choices of technology adoption. The micro economic environment of the Cournot model of technology adoption under free trade has proved to be a good starting points to obtain tractable solutions with deep insights on firm decisions. The brief discussion of demand aggregation shows that the use of this IO tool in interaction with a continuum-quadratic system of preferences can be a promising way to obtain micro foundations of aggregate equilibrium outcomes usually observed under firm heterogeneity. This brief note can be extended in several directions. Export sorting can be investigated by assuming fixed export costs. More complex heterogeneity distribution can be investigated if we consider multiple set of technologies. Under another line of attack one could also go to general equilibrium by endogenously characterising the marginal utility of income. We conjecture that such extensions are feasible within the present framework and deserve further analysis.

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