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International trade with heterogenous firms and asymmetric product varieties

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International trade with heterogenous firms and asymmetric product varieties

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Abstract

We extend the Melitz-Ottaviano (2008) model by introducing asymmetric groups of varieties in terms of degree of product differentiation. The introduction of these different market segments in the demand system allows us to structurally derive more complex relations between firm productivity, size and markups, which ultimately depend on the degree of product differentiation, for both the closed and open economy settings. The theoretical results are tested at the empirical level by comparing the performance of French wine producers in market segments characterized by heterogeneous levels of product differentiation, defined geographically based on the "Denomination of Controlled Origin" areas.

1 Introduction

We extend the Melitz-Ottaviano (2008) theoretical model by introducing asymmetric groups of product varieties. The asymmetry is related to the level of substitutability across varieties within different groups. In particular, in our framework consumers still choose between a homogeneous good and a continuum of differentiated varieties, indexed by $i \in \Omega$. However, Ω is now split in multiple subsets, each characterized by a different level of product differentiation. These subsets correspond to narrowly defined competitive segments within a single industry, e.g. standard vs. luxury cars, to follow the example by Goldberg (1995). By introducing different segments in the demand system, we are able to derive more complex relations between productivity, size, markups and firms' export engagement, all crucially moderated by the level of product differentiation within the segment. This helps in explaining the non-linear relations between firm productivity, size, mark-ups and exporting behavior observed in our data, even within a narrow 4-digit industry.

We are certainly not the first to explore the empirical oddities of the relationship between productivity, firm's size and export status. In particular, Hallak and Sivadasan (2009) discuss how most of the existing models of firm heterogeneity and international trade leave much of the observed relationship between firm size and export status unexplained. To that extent, they provide cross-country evidence of the fact that firm size is not monotonically related with export status: there are small firms that export and large firms that only operate in the domestic market. They explain the latter finding through a model that employs a Dixit-Stiglitz CES demand function, augmented in order to account for product quality variation across varieties (as in Hallak and Schott 2008). On the supply side they introduce, in addition to productivity, another source of heterogeneity: the "caliber", defined as the ability of firms to produce quality using fewer fixed inputs.

In our setup, on the contrary, we do not explicitly model quality. Rather, we try to make sense of the non-linear relations between firm productivity, size, mark-ups and the exporting behavior by modelling different market segments within a linear demand system with endogenous markups, allowing firms to choose in which (exclusive) market segment they compete[1].

For the sake of simplicity, and without loss of generality, we focus on the case in which Ω is split in two separate subsets: Ω^l and Ω^h. Where Ω^l is assumed to be the subset of varieties witnessing a "low" degree of product differentiation, while Ω^h contains those varieties characterized by a "high" degree of product differentiation. We derive a number of results for both the closed and open economy settings. First, the price elasticity of demand is lower for the highly differentiated varieties in Ω^h than for their counterparts in Ω^l, where substitutability is higher. Second, concerning producers, the cost cut-off for survival is higher in Ω^h than in Ω^l.

[1] The non-linearity recorded at the empirical level is not the result of the level of aggregation. Indeed, even in the multi-product setting by Mayer, Melitz and Ottaviano (2009), all products are treated as symmetric from a demand perspective, and thus, to the extent that heterogeneous product differentiation plays a role in the firm-level performance measures and productivity, a non-linear relation is likely to be detected also at the product-level.

So, some less productive firms can survive in the high-differentiation sector, while they would exit in the low-differentiation one. This result is explained by the fact that, given the same cost draw c, a firm in the high-differentiation sector charges a higher price and thus obtains a higher markup than a firm in the low-differentiation sector. Unlike for prices and markups, the output relation between two firms with the same productivity in Ω^l and Ω^h is not obvious. Indeed, we prove that the ratio of firm output in Ω^l over Ω^h is greater than 1 for low levels of c (i.e. high productivity), and decreases for increasing levels of the cost draw, becoming lower than 1 after a certain threshold.

Opening up to trade has the same pro-competitive effects as in Melitz-Ottaviano (2008). In particular, the minimum productivity level which is required in order to survive in the domestic market grows. As long as trade liberalization is symmetric across sectors, the impact of trade is exactly proportional for firms in Ω^l and Ω^h. Hence, all the closed-economy differences between the two sectors are confirmed in the open economy case. Moreover, one further important difference between Ω^l and Ω^h emerges in terms of exporters' productivity. In fact we have that the cost cut-off for exporting is lower in the low-differentiation sector than in the high-differentiation one. This means that relatively less productive firms self-select into exporting in Ω^h as compared to Ω^l, where selection is tougher. Thus, the relation between firm productivity and export engagement across sectors is crucially moderated by the sector-specific level of product differentiation.

The theoretical results are tested at the empirical level by comparing the performance of French wine producers in market segments characterized by heterogenous levels of product differentiation. These segments are defined geographically, based on the "Denomination of Controlled Origin" areas. The analysis focuses on around 1,000 producers, observed over the time span 1999-2008. The empirical evidence supports the testable predictions of the model. First, producers in the high-differentiation segment are found to obtain higher price-cost margins relative to firms in the low-differentiation group. Second, at low levels of productivity, firms in the high-differentiation segment are bigger than firms in the low-differentiation one. However, this relation is inverted as TFP grows, after a certain threshold. Finally, exporters in the high-differentiation segment display a relatively lower productivity premium than in the low-differentiation segment, consistent with the idea of a milder selection being associated to a lower level of substitutability across varieties.

The remaining of the paper is organized as follows. In section 2 we present the theoretical model. In section 3 we discuss the three main testable predictions. The empirical analysis is presented in section 4, while section 5 concludes.

2 Theoretical model

2.1 Model setup: consumers

Consumers choose between an homogeneous good and a continuum of differentiated varieties, indexed by $i \in \Omega$. In particular, the set Ω is split in two separate subsets: Ω^l and Ω^h, where Ω^l is assumed to be the subset (or market segment) of varieties characterized by a "low" degree of product differentiation, while Ω^h contains those varieties characterized by a "high" degree of product differentiation.

Formally, considering an economy with L consumers, each supplying one unit of labour, the utility function of a representative consumer can be written as:

$$U = q_o + \sum_{\xi=l,h} \left[\alpha^\xi \int_{i\in\Omega^\xi} q_i di - \frac{1}{2}\gamma^\xi \int_{i\in\Omega^\xi} (q_i)^2 di - \frac{1}{2}\eta^\xi \left(\int_{i\in\Omega^\xi} q_i di \right)^2 \right] \quad (1)$$

where $\xi = l, h$ indicates the high vs. low differentiation market segment, q_o stands for the consumption level of the homogeneous good (taken as a numeraire), q_i represents the consumption level for each variety $i \in \Omega^\xi$, with $\Omega^l \cap \Omega^h = \oslash$ and $\Omega^l \cup \Omega^h = \Omega$. Differently from Melitz-Ottaviano (2008), the parameters α^ξ, γ^ξ and η^ξ, all positive, are not unique, but specific to each of the two market segments (Ω^l and Ω^h).

By solving the consumer problem, and assuming a positive demand for the numeraire good ($q_o > 0$), we can obtain the inverse demand function of each variety in each of the two subsets Ω^l and Ω^h:

$$p_i^\xi = \alpha^\xi - \gamma^\xi q_i - \eta^\xi Q_c^\xi \qquad \forall i \in \Omega^{l,h} \quad (2)$$

where $Q_c^\xi = \int_{i\in\Omega^\xi} q_i di$. By focusing, as in Melitz-Ottaviano (2008), on the subsets of consumed varieties Ω^{l*} and Ω^{h*} (s.t. $q_i > 0$), equation (2) can be inverted to retrieve the following linear market demand system for each market segment:

$$q_i^\xi \equiv L q_i = \frac{\alpha^\xi L}{\eta^\xi N^\xi + \gamma^\xi} - \frac{L}{\gamma^\xi} p_i^\xi + \frac{\eta^\xi N^\xi}{\eta^\xi N^\xi + \gamma^\xi} \frac{L}{\gamma^\xi} \overline{p}^\xi \qquad \forall i \in \Omega^{l*,h*} \quad (3)$$

where N^ξ indicates the number of consumed varieties in Ω^{l*} and Ω^{h*}, with average prices equal to $\overline{p}^\xi = \frac{1}{N^\xi} \int_{i\in\Omega^{\xi*}} p_i^\xi di$.

From the inverse demand function, we can derive the price condition in order for a variety to display a positive consumption level (i.e. $q_i > 0$). We assume, without loss of generality, that α^ξ and η^ξ are equal across the two market-segments, while $\gamma^h > \gamma^l > 0$, i.e. a greater utility "penalty" is attached to the uneven consumption of highly differentiated varieties (Ω^h), while less differentiated varieties (Ω^l) can be consumed in uneven patterns with a relative smaller loss

($\gamma^h > \gamma^l$) in terms of utility. The latter yields:

$$p_i^\xi \leq \frac{1}{\eta N^\xi + \gamma^\xi}(\alpha\gamma^\xi + \eta N^\xi \overline{p}^\xi) \equiv p_{\max}^\xi \qquad \forall i \in \Omega^{l*,h*} \tag{4}$$

From here we can express the price elasticity of demand for the two subsets of varieties as follows:

$$\varepsilon_i^\xi = \left(\frac{p_{\max}^\xi}{p_i^\xi} - 1\right)^{-1} \qquad \forall i \in \Omega^{l*,h*} \tag{5}$$

Hence, product varieties are allowed to be asymmetric in our model[2]. In order to give an illustrative example, we may think about two different segments of the car industry, e.g. standard vs. luxury cars. It has been shown, for instance by Goldberg (1995), that different varieties of standard cars are closer substitutes than varieties of cars in the luxury segment. The same argument can be extended to the differentiated products of virtually all other industries in which it can be assumed that different segments of the market vary in market structure and density of products, thus providing a rationale for a partition of the differentiated goods' set (Ω) such as ours. Alternatively, one could think of different degrees of product differentiation as correlated (also, but not necessarily only) to a different quality of the considered products, as an increase in the latter is known to induce a higher degree of product differentiation (and thus a lower elasticity of substitution) across products[3].

In order to focus on the role of the γ-parameters, let us assume that the average price and number of consumed varieties in the high-differentiation sector are not smaller than in the low-differentiation one, that is $N^h \geq N^l$ and $\overline{p}^h \geq \overline{p}^l$, both plausible assumptions, while $\gamma^h > \gamma^l$. Then it can be shown from eq. (4) that $p_{\max}^h > p_{\max}^l$, which in turn implies $\varepsilon_i^h < \varepsilon_i^l$. Hence we have that consumers are willing to pay a higher maximum price for varieties in the high differentiation sector, as compared to the low differentiation one. Consistently, the price elasticity of demand is lower for the highly differentiated varieties in Ω^h than for their counterparts in Ω^l, where substitutability is higher.

This result is intuitive and, as already discussed, in line with the empirical evidence.

2.2 Model setup: Firms

We maintain the same assumptions as in Melitz-Ottaviano (2008). In particular, labor is the only factor of production and is inelastically supplied in a competitive market. The production of the homogeneous good requires one unit of labour, under constant returns to scale. Since this numeraire good is sold in a competitive market, a unit wage is implied.

Entry in the differentiated sector involves a sunk cost, which is related to product development and start-up investments. An entrepreneur can decide whether to entry in the low-

[2] Clearly if $\gamma^h = \gamma^l = \gamma$ then we fall back in the original Melitz-Ottaviano (2008) symmetric specification, where all varieties are assumed to share the same level of product differentiation.

[3] See e.g. Berry, Levinsohn and Pakes (1995) or Goldberg (1995) for providing empirical evidence of these arguments. Coibion et al. (2007) discuss a unifying theoretical framework for these findings.

differentiation market segment (Ω^l), paying a sunk cost f_E^l, or in the high-differentiation one (Ω^h), at cost f_E^h. Having paid the sunk cost, independently on the chosen market segment, each firm draws an inverse productivity parameter c from the same common distribution $G(c)$, with support $[0, c_M]$. Here c represents the firm-level marginal cost (in terms of units of labour) for the production of the differentiated good. There are no fixed costs, so the technology is characterized by constant returns to scale. Hence, those firms that can cover the marginal cost start producing, while the others exit.

Competition in each of the differentiated market segments is of a monopolistic nature, with each firm in Ω^ξ facing a residual demand function as in eq. 3. As the choice of the high vs. low differentiation subset of varieties in which to produce is exclusive (a firm cannot produce in both), we can optimize the firm decision within each market segment. In particular, optimum price $p(c)$ and output $q(c)$ must satisfy the following condition:

$$q_i(c) = \frac{L}{\gamma^\xi}[p_i(c) - c] \qquad \forall i \in \Omega^{l*,h*} \tag{6}$$

If the profit maximing price is above the relevant $p_{\max}$ the firm exits. Thus the marginal firm (indifferent between staying and exiting) in each market segment is characterized by a cutoff cost level c_D such that its price is driven down to the marginal cost ($p(c_D) = c_D = p_{\max}$), and the demand goes to zero. We assume that both cutoffs c_D^l and c_D^h are lower than the upper bound of costs c_M, which implies that those firms with a cost draw between the cut-off level and c_M do exit, while the others stay in the market and earn positive profits.

2.3 Equilibrium in the closed economy

Equating demand (3) and supply (6) and using the expression for the cutoff derived in (4) allows us to solve for the optimal price $p^\xi(c)$:

$$p^\xi(c) = \frac{1}{2}\left(c_D^\xi + c\right) \qquad \text{for } \xi = l, h \tag{7}$$

and from here for the optimal firm's size $q^\xi(c)$ and markup $\mu^\xi(c)$ in each market segment:

$$q^\xi(c) = \frac{L}{2\gamma^\xi}\left(c_D^\xi - c\right) \tag{8}$$

$$\mu^\xi(c) = p^\xi(c) - c = \frac{1}{2}\left(c_D^\xi - c\right) \tag{9}$$

Analogously, it is then possible to solve for the firm-specific revenues and profits:

$$r^\xi(c) = \frac{L}{4\gamma^\xi}\left[(c_D^\xi)^2 - c^2\right] \tag{10}$$

$$\pi^\xi(c) = \frac{L}{4\gamma^\xi}(c_D^\xi - c)^2 \tag{11}$$

Assuming market segment-specific sunk entry costs f_E, the model can then be solved for the closed-economy free entry equilibrium as in Melitz-Ottaviano (2008).

2.4 Equilibrium in the open economy

As in Melitz-Ottaviano (2008) we consider two countries: H and F, with L^H and L^F consumers respectively. Consumers in the two countries share the same preferences, resulting in the same inverse demand functions as in eq. 2. In both countries we have the same market segmentation as before (Ω^h and Ω^l) in terms of product differentiation. Firms operating in one (and only one) market segment can produce in one country and sell in the other by incurring a iceberg-type per-unit trade cost $\tau_\delta > 1$, where δ indexes the destination country (H or F). There are no fixed-costs of exporting, and the per-unit trade cost for each country is assumed to be the same for both goods in Ω^h and Ω^l.

For each market segment ξ we now have a δ country-specific maximum price such that a variety displays a positive consumption level:

$$p_{\max}^{\delta\xi} = \frac{1}{\eta N^{\delta\xi} + \gamma^{\xi}}(\alpha\gamma^{\xi} + \eta N^{\delta\xi}\overline{p}^{\delta\xi}) \quad \text{with } \delta = H, F \text{ and } \xi = l, h \tag{12}$$

where as before N_δ^ξ is the total number of firms (both domestic and foreign) selling sector Ω^ξ goods in country δ, and $\overline{p}_\delta^\xi$ is the average price of sector Ω^ξ goods sold in country δ (across both domestic and foreign producers).

Since national markets are segmented and production is characterized by constant returns to scale, each firm in country δ solves two dinstinct profit maximization problems, one for the domestic and one for the export market, within each and the same market-segment ξ. Solving within each market segment, we can follow Melitz-Ottaviano (2008) and derive:

$$q_D^\delta(c) = \frac{L^\delta}{\gamma^\xi}[p_D^\delta(c) - c] \quad , \quad \delta = H, F \text{ and } \xi = l, h \tag{13}$$

$$q_X^\delta(c) = \frac{L^\psi}{\gamma^\xi}[p_X^\delta(c) - \tau^\psi c] \quad , \quad \delta = H, F \quad , \psi \neq \delta \text{ and } \xi = l, h \tag{14}$$

where $p_D^\delta(c)$ and $q_D^\delta(c)$ are the domestic profit maximizing price and quantity, while $p_X^\delta(c)$ and $q_X^\delta(c)$ are the profit maximizing delivered price and quantity for the export market.

As only firms earning non-negative profits in a certain market (domestic vs. foreign) will decide to sell in that market, this determines the existence of two different cost cut-offs for domestic versus foreign sales in each country-market segment pair. We call $c_D^{\delta\xi}$ the upper bound cost for firms in market segment ξ selling in their domestic market (country δ). The upper bound cost for exporters to country ψ is instead $c_X^{\delta\xi}$. These cutoffs must satisfy:

$$c_D^{\delta\xi} = \sup\left\{c : \pi_D^{\delta\xi}(c) > 0\right\} = p_{\max}^{\delta\xi} \tag{15}$$

$$c_X^{\delta\xi} = \sup\left\{c : \pi_X^{\delta\xi}(c) > 0\right\} = \frac{p_{\max}^{\psi\xi}}{\tau^\psi} \tag{16}$$

The last equation clearly shows how trade costs make it harder for exporters to break even relative to domestic producers selling in their home market, and how, also for exporters, the cutoff is in any case market segment-specific. Controlling for the market segment-specific expression of the cutoff in the open economy, the model can then be solved as in Melitz-Ottaviano (2008).

Firm-level performance measures, on both the domestic and foreign market, can be written in terms of the cost cut-offs:

$$p_D^{\delta\xi}(c) = \frac{1}{2}\left(c_D^{\delta\xi} + c\right) \tag{17}$$

$$q_D^{\delta\xi}(c) = \frac{L^\delta}{2\gamma^\xi}\left(c_D^{\delta\xi} - c\right) \tag{18}$$

$$\pi_D^{\delta\xi}(c) = \frac{L^\delta}{4\gamma^\xi}\left(c_D^{\delta\xi} - c\right)^2 \tag{19}$$

$$p_X^{\delta\xi}(c) = \frac{\tau^\psi}{2}\left(c_X^{\delta\xi} + c\right) \tag{20}$$

$$q_X^{\delta\xi}(c) = \frac{L^\psi}{2\gamma^\xi}\tau^\psi\left(c_X^{\delta\xi} - c\right) \tag{21}$$

$$\pi_X^{\delta\xi}(c) = \frac{L^\psi}{4\gamma^\xi}(\tau^\psi)^2\left(c_X^{\delta\xi} - c\right)^2 \tag{22}$$

3 Model implications and testable predictions

In the previous section we have shown that $p^h_{\max} > p^l_{\max}$ (given that $N^h \geq N^l$ and $\overline{p}^h \geq \overline{p}^l$). This now implies that $c_D^h > c_D^l$, i.e. the cost cut-off for survival is higher in Ω^h than in Ω^l. As a result, some less productive firms (with costs ranging between c_D^l and c_D^h) can survive in the high-differentiation market segment, while they would exit in the low-differentiation one.

In particular, since $c_D^h > c_D^l$, from equations (7) and (9) we have the following:

Proposition 1 *Given the same cost draw c, a firm in Ω^h will charge a higher price and will thus obtain a higher markup than a firm in Ω^l.*

The latter provides an explanation for the survival of relatively less productive firms in the high-differentiation market segment as compared to the low-differentation one, and is again consistent with empirical evidence. For instance, Goldberg (1995) estimated producers' markups to be higher for luxury cars than for standard ones.

However, looking at equations (8 and 11) the equilibrium levels of output and profits between two firms with the same productivity ($1/c$) operating in different market segments (Ω^l and Ω^h) are not obvious. In particular, it is possible to prove the following:

Proposition 2 *The ratio of firm output in Ω^l over Ω^h is > 1 for low levels of c, and decreases for increasing levels of the cost draw, becoming < 1 after a threshold level c^T.*

Proof. First, by equating the optimal quantities $q^l(c)$ and $q^h(c)$ from eq. 8 we can derive the threshold cost level $c^T = \frac{\gamma^h c_D^l - \gamma^l c_D^h}{\gamma^h - \gamma^l}$, with $c^T > 0$ as long as $\gamma^h c_D^l > \gamma^l c_D^h$. If the latter holds, it is straightforward to prove that $c^T < c_D^l < c_D^h$ and hence that a level of the cost draw exists, at which a firm operates in either the high or the low differentiated market segment (as the threshold is smaller than both cutoffs) with the same optimal size. In order to study the variation in the optimal size around the threshold, for any cost level below c^T, say $c^T - \epsilon$, we would have from eq. 8 that the optimal quantities in the two market segments are equal up to a term $\frac{L}{2\gamma^\xi}\epsilon$. From here, since $\gamma^h > \gamma^l$, it follows that $q^l(c) > q^h(c)$. Symmetrically, for any cost level $c^T + \epsilon$ the optimal quantities would be equal up to a term $\frac{L}{2\gamma^\xi}(-\epsilon)$. Therefore, since $\gamma^h > \gamma^l$, it follows that $q^l(c) < q^h(c)$.

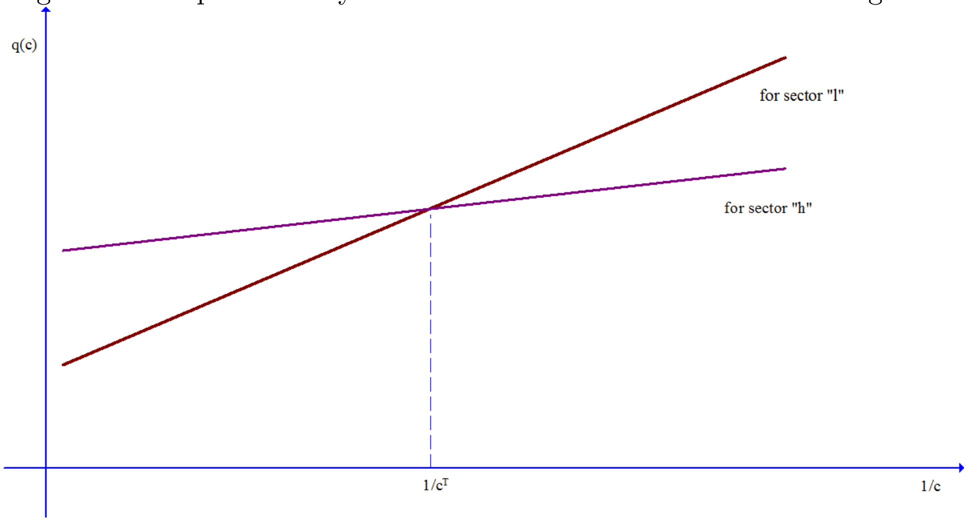
More in general, considering a continuum of different product differentiation levels γ^ξ, it can be shown (from eq. 8) that the sign of $\frac{\partial q^\xi(c)}{\partial \gamma}$ changes from negative to positive, as c grows from zero to c_D^ξ[4]. ■

The implication of the above proposition is that highly productive firms operating in the high-differentiation segment have an optimal size smaller than firms with similar levels of productivity operating in the low-differentiation segment, and viceversa. This result is described graphically in Figure 1. Notice that the quantity difference between the two sectors (in absolute value) is directly proportional to the distance of each firm from the threshold $1/c^T$ and to the difference in the degrees of product differentiation ($\gamma^h - \gamma^l$).

The described result has an intuitive explanation: if two firms are very productive (low c), then the firm in the low-differentiation market segment will produce a greater output with respect to the firm operating in the high-differentiation segment. In fact, the former can leverage upon the favourable cost draw to a larger extent, thanks to the high substitutability across varieties. Using again the example of the car sector, the optimal size of a highly efficient ($c < c^T$) producer of 'luxury' cars (high-differentiation) would be smaller than that of an equally efficient producer of 'standard' cars (low-differentiation). The reverse will be true if the two firms have a low productivity (high c), for exactly the same reason: for a relatively inefficient firm it will be easier to attain a relatively higher level of output if varieties are less substitutable for each other.

[4] The cost level c^* at which the derivative becomes positive in each market segment $\xi = l, h$ has the following expression: $c^{\xi *} = \overline{p}^\xi \frac{2\gamma^\xi \eta N^\xi + \eta^2 (N^\xi)^2}{2\gamma^\xi \eta N^\xi + \eta^2 (N^\xi)^2 + (\gamma^\xi)^2} + \alpha \frac{(\gamma^\xi)^2}{2\gamma^\xi \eta N^\xi + \eta^2 (N^\xi)^2 + (\gamma^\xi)^2}$. From here it is relatively straightforward to prove that $c^{\xi *} < c_D^\xi$.

Figure 1: The productivity - size relation across different market segments



Mutatis mutandis, the same conclusions are also valid for optimal revenues and profits (eq. 10 and 11) in the closed-economy setting, although the cost threshold c^T in this case is lower than for quantities[5].

As the size and profits of firms change along the distribution of costs (productivity) with different slopes in the high vs. low-differentiation market segments, it is interesting to assess how average markups, firm size and profits compare in the two segments. As the latter would clearly depend on the assumed cost distribution, in the Appendix we follow Melitz-Ottaviano (2008) and model the case of a Pareto distribution of productivity. We show that, under the latter distribution, firms in Ω^h charge higher average prices and earn higher average mark-ups. However, notwithstanding such higher "per-unit" performance, they are on average smaller in terms of produced output, and thus earn on average less (total) revenues and profits.

Moving to the analysis of exporting firms, recall that we have assumed the distribution of cost draws $G(c)$ to be constant across countries (as in Melitz-Ottaviano, 2008) and market segments; moreover, we have not differentiated trade costs for firms in Ω^l and Ω^h. As a result, *prima facie* the impact of trade appears to be completely symmetric in both market segments, as the change in the cost cutoffs induced by economic integration has exactly the same proportion in both Ω^h and Ω^l.

In particular, we still have that $c_D^{\delta l} < c_D^{\delta h}$, which implies that, for a given cost c, firms in Ω^h charge a higher price and earn higher markups. However, in an open economy context, one further important difference between Ω^l and Ω^h emerges in terms of exporters' productivity. In fact we have that $c_X^{\delta l} < c_X^{\delta h}$, i.e. the cost cut-off for exporting is lower in the low-differentiation sector than in the high-differentiation one. Hence it is straightforward to prove the following:

[5] In other words, in the case of, e.g., profits, the crossing of the γ^h and γ^l lines in the previous graph takes place at a lower threshold c^T; as a result, one would have a larger share of relatively less efficient firms ($c > c^T$) in the high differentiation market segment which are more profitable than their equally efficient counterparts in the low differentiation one. This follows from the fact that firms in Ω^h charge higher prices and earn higher markups than their counterparts in Ω^l.

Proposition 3 *Self-selection into exporting in Ω^h requires a relatively smaller productivity premium than in Ω^l*

Proof. From equations (15) and (16) we have that $c_X^{\delta\xi} = c_D^{\psi\xi}/\tau^{\psi}$. Indeed, since $c_D^{\psi l} < c_D^{\psi h}$ and $\tau^{\psi} > 1$ is the same for both sectors, it follows that $c_X^{\delta l} < c_X^{\delta h}$. ■

The latter finding extends the previous results of Melitz-Ottaviano (2008) to a differentiated demand system also in the open economy case, and conveys a very interesting message: the relation between firm productivity and export engagement across market segments is moderated by the segment-specific level of product differentiation.

More explicitly, while it holds true that the relatively more productive firms within each sector do export, the minimum productivity level (the productivity premium) which is required for becoming an exporter is inversely proportional to the level of product differentiation, with the high-differentiation market segment displaying a relatively lower productivity premium. Intuitively, this result comes from the fact that firms operating in market segments characterised by a high level of product differentiation are relatively more protected from competition (they charge higher prices and have higher markups) and thus face relatively less the product market competition induced by the process of economic integration, which in the Melitz-Ottaviano (2008) framework is the driving force behind the self-selection of firms into exporting.

Clearly, all these theoretical insights calling for a relation between productivity, size / profitability and export activity, which crucially depends on the level of product differentiation within each market segment, open the way for interesting empirical analyses, to which we now turn.

4 Empirical evidence

The empirical test of our theoretical predictions is conducted by analysing firm-level performance measures of the French wine-making industry (NACE-Rev. 2, 1102). There are two main reasons for such a choice. The most important one is the divisibility of the industry in multiple segments defined by a specific protocol (the "Appellation d'Origine Contrôlée") which is well known to consumers, so that each segment can be characterized by a specific set of product characteristics and a level of product differentiation. The second reason is the availability of firm-level data including information on export activities (i.e. exports as a share of turnover) for each producer.

We first present the French wine industry and discuss its peculiar structure. We then move to the description of the firm-level dataset, and discuss our estimation of TFP. Finally, we focus on the empirical tests for each of the three propositions presented in the previous section.

4.1 The French AOC market segments

The French wine-making industry has been historically characterized by a strong geographical-based partition. Since 1935, a law decree has introduced a system of denomination of controlled origin: the "Appellation d'Origine Contrôlée" (AOC henceforth). Within this system, a given

AOC wine can be labelled and sold as such 'if and only if' the production takes place within a specific geographic area, which can be as narrow as one municipality. This is meant to enhance and value the deep linkages between a certain wine and a specific territory, with its combination of peculiar climatic and geological conditions, grape varieties as well as production techniques.

As a result, wines sharing the same denomination do share some distinctive technical characteristics, and ultimately a distinctive taste: a Bordeaux is definitely different than a Bourgogne, and both are different from a generic non-AOC table wine. Moreover, there is room for substantial product differentiation within each denomination, to a larger or lesser extent depending on the specific area: within Bordeaux, for instance, a Margaux is different than a Pomerol.

Going back to our model, in case many varieties of the same wine are available, within the same range of quality levels, consumers are expected to attach a greater utility penalty to uneven consumption, i.e. high γ, in the model's notation: if you are a wine consumer and you like Bordeaux wines, for instance, normally you would like to taste different varieties over time, rather than buying exactly the same bottle every time. On the other hand, if you drink a non-AOC table wine, one bottle would not be much different than the other, that is: in our model consumers attach only a lower penalty to uneven consumption across varieties, i.e. a low γ.

As different AOC vs. non-AOC areas can be used in order to identify market segments witnessing heterogeneous degrees of product differentiation, the model propositions will be tested by comparing the performance of wine producers across different AOCs and, most importantly, with respect to a control group of wine-makers located outside of any AOC area.

The first step in the empirical analysis has thus been that of identifying the AOC areas. The list of AOC wine denominations and areas has been evolving over time. At the moment, there are around 330 official denominations. For each of them, the French Institute of Origin and Quality (INAO) publishes the list of municipalities making up the production area. Each municipality ("commune") is identified by a unique INSEE code[6].

After downloading and merging all these lists, we have noticed that the same municipality can appear in the list of several denominations. The most evident case is that of Vosne-Romanée, in the Burgundy region. A small town where wines can be produced with 15 different denominations, from the standard "Bourgogne" to the exclusive "Romanée-Conti". In order to address such situations we have aggregated different denominations in broader homogeneous groups, in such a way that each municipality is assigned to a unique AOC broader area. This is extremely important for identifying the market segment of each producer in the firm-level dataset, based on the firm's address.

Following this first step, a second re-aggregation of homogeneous areas in macro AOC areas has been performed, in line with the classical subdivision of the French wine industry. The final

[6] INSEE codes are used by the French National Institute for Statistics and Economic Studies for identifying geographical entities. These codes allow for deeper territorial disaggregation than zipcodes. In fact, several small municipalities often share the same zipcode. Instead, INSEE codes are always specific to a single municipality.

outcome has been the identification of 10 macro areas: Alsace, Bordeaux, Bourgogne, Champagne, Jura-Savoie, Languedoc-Roussillon, Loire, Provence, Rhône and South-West[7]. From now on we will refer to these macro-areas simply as AOC areas.

4.2 Firm-level data and TFP estimation

Firm-level data are obtained from AMADEUS. This is a commercial database produced by the Bureau Van Dijk, containing annual balance sheet data for over 14 million companies across all European countries, spanning the period 1999-2008. In general, for each firm, information is available on turnover, value added, capital, number of employees, materials, labor costs and other financials. In the case of French firms, each company is also reporting the share of turnover coming from exports, a feature already used in the empirical literature on trade (e.g. Konings and Vandenbussche, 2009).

Given the choice of our sector, we focus on the NACE (Rev. 2) 4-digit industry: "1102", named "Manufacture of wine from grape". For this industry AMADEUS reports data on 1,124 French firms. For each of them, we do have information on the municipality where they are located. This allows us to identify all the producers being active in one of the AOC areas, as well as the control group of companies located outside any of these areas. After dropping a handful of clearly problematic companies (e.g. obvious mistakes in the data input process), and those firms located in the "Cognac" area (see the previous footnote), we are left with 1,095 firms.

Table 1 reports the distribution of the firms in our sample across AOC areas. As it can be seen, the largest group of producers is the Champagne one, with 392 firms, followed by the Languedoc-Roussillon, with 180 companies. Also, 129 firms in our dataset are located outside any AOC area, and will constitute the control group for the upcoming analyses.

Table 1: Firms' distribution across AOC areas

AOC	number of firms	Percent	Cum.
no - AOC	129	11.78	11.78
Alsace	24	2.19	13.97
Bordeaux	49	4.47	18.45
Bourgogne	67	6.12	24.57
Champagne	392	35.8	60.37
Jura-Savoie	20	1.83	62.19
Languedoc-Roussillon	180	16.44	78.63
Loire	55	5.02	83.65
Provence	56	5.11	88.77
Rhône	94	8.58	97.35
South-West	29	2.65	100
Total	1,095	100	

Since all the testable propositions in our model crucially deal with firms' productivity, we

[7] A distinct "Cognac" area has also been identified. However, we have decided not to consider it, given the particular nature of this product, which is a spirit rather than a wine. Accordingly, producers located in the Cognac area will be dropped from the analysis. See the next section.

start by discussing our estimates of TFP. First, we estimate total factor productivity through OLS, by regressing value added (output minus materials) over capital and labor inputs (employment). Physical output is proxied by deflated turnover. The employed deflators are specific to the 4-digit industry, and are published by the French National Statistical Institute. Materials' costs are deflated using input deflators obtained from the EU-KLEMS database[8]. Finally, capital is proxied by tangible fixed assets, deflated using the GDP deflator.

Second, given the well known simultaneity problems of OLS estimates (see Van Beveren, 2010, for a review), we obtain TFP estimates by applying the value-added version of the Levinsohn-Petrin (2003) algorithm. The results from both estimations can be compared in Table 2. In line with expectations, the labor coefficient is significantly reduced, from 0.69 to 0.51. We take the Levinsohn-Petrin estimates as our benchmark in the subsequent analyses.

Table 2: TFP estimation - OLS vs. Levinsohn-Petrin

Dep. Variable: ln(Value Added)	**OLS**	**Lev-Pet**
	(1)	**(2)**
ln(labor)	0.688***	0.514***
	(0.012)	(0.023)
ln(capital)	0.332***	0.126**
	(0.009)	(0.055)
N. of obs.	2894	2894

Third, as a robustness check we also estimate TFP through the Index Numbers methodology, as applied by Aw et al. (2001). With this methodology, the efficiency of each firm (in each year) is computed relative to a hypothethical firm (in the base year). The hypothetical firm has input revenue shares equal to the arithmetic mean of revenue shares over all observations, and log input levels equal to the arithmetic mean of the log of the inputs over all the observations (in the base year).

More in detail, the TFP index for a firm f in year t is defined as:

$$\ln TFP_{ft} = (\ln Y_{ft} - \overline{\ln Y_t}) + \sum_{s=2}^{t} (\overline{\ln Y_s} - \overline{\ln Y_{s-1}}) -$$
$$- \left[\sum_{i=1}^{n} \frac{1}{2}(s_{ift} + \overline{s_{it}})(\ln X_{ift} - \overline{\ln X_{it}}) + \sum_{s=2}^{t} \sum_{i=1}^{n} \frac{1}{2}(\overline{s_{is}} + \overline{s_{is-1}})(\overline{\ln X_{is}} - \overline{\ln X_{is-1}}) \right] \quad (23)$$

where $i = 1..n$ indexes the employed inputs, Y_{ft} stands for the output, while X_{ift} is the level of each employed input. The term s_{ift} is the share of firm's expenditure for input i out of total revenues while $\overline{\ln Y_t}$, $\overline{\ln X_{it}}$ and $\overline{s_{it}}$ stand for the corresponding arithmetic means over all firms in year t.

[8] The EU KLEMS database is the outcome of a project financed by the European Commission for the analysis of productivity and growth. It has been produced by a consortium of 15 organizations across the EU, with support from Eurostat, OECD, the Groningen Growth and Development Centre and various National Statistical Institutes. More details are available on the EU KLEMS website: http://www.euklems.net/index.html

In our application, the base year is 1999. Output and materials are proxied by deflated turnover and material costs (see above), while the number of employees is used as the labor input. The revenue shares of materials and labor are computed by taking the ratio of materials and labor costs over turnover, in nominal terms. The capital share is instead computed as a residual, by relying on the product-exhaustion theorem.

Tables 3 and 4 report some descriptive statistics for the three different measures of productivity, as well as their correlations. As expected, the three measures are all positively and significantly correlated, with some differences. In particular, the correlation between Levinsohn-Petrin and Index Numbers estimates is somewhat lower, about 0.44. This provides an interesting room for the robustness check of our findings.

Table 3: TFP - descriptive statistics

Variable: ln(TFP)	Obs	Mean	Std. Dev.	Min	Max
Lev-Pet	2894	5.154	0.890	1.658	8.090
Index Numbers	2893	0.178	0.414	-1.935	2.555
OLS	2894	3.460	0.680	0.127	7.286

Table 4: TFP - correlations across different measures

Correlation	Lev-Pet	Index Numbers	OLS
Lev-Pet	1		
Index Numbers	0.44	1.00	
OLS	0.76	0.75	1.00

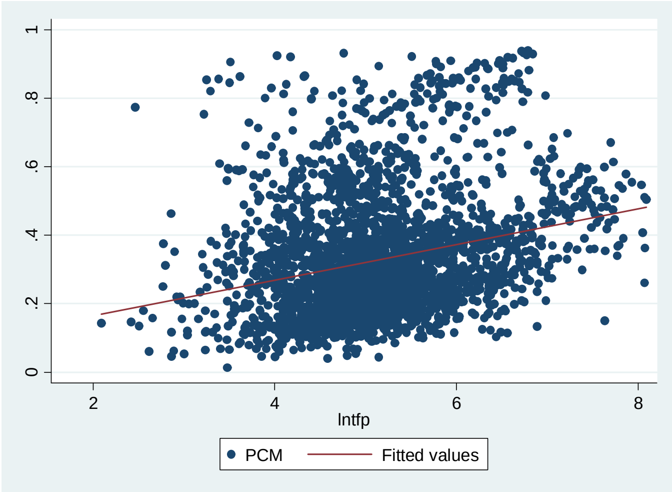
4.3 Test of the model's propositions

Our model predicts that markups rise with firm productivity with the same slope within each market segment (eq. 9). However, such a markup/TFP linear relation is predicted to have a different intercept in different segments. Indeed, the first proposition of our model states that, at any given level of productivity, firms in the high-differentiation segment charge a higher price and thus obtain a higher markup than firms in the low differentiation segment. Assuming the latter holds, then pooling together producers of different segments should result in a high variance of markups at each level of productivity.

This is in line with the evidence reported in Figure 2, where price-cost margins are plotted against the logarithm of TFP[9]. As it can be seen, price-cost margins show a great variance for most levels of productivity. This could not be explained by the standard Melitz-Ottaviano (2008) model. Indeed when focusing on a narrow 4-digit industry such as this, we would expect to see a "clean" linear relation between mark-ups and TFP, with little variation in price-cost margins at each level of productivity.

[9] Price-cost margins are computed as: (turnover - labor costs - material costs)/turnover.

Figure 2: PCM/TFP relation - overall (R-squared=0.07)



Our extended model can in principle make sense of such an unexpected pattern, as the latter could be explained by the fact that we are pooling together different market segments. In fact, when we restrict the previous plot to only one of our AOC areas (the Burgundy region, reported in Figure 3 as an example) we do get a much more linear picture in the productivity/markup relation.

Figure 3: PCM/TFP relation - "Bourgogne" producers only (R-squared=0.13)

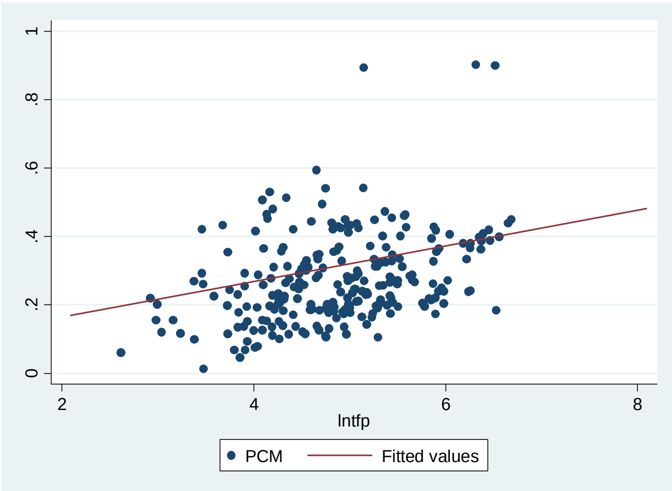


Table 5 reports the result of an econometric test of the latter hypothesis for all AOC vs. non-AOC market segments. Column 1 reports the results from a simple regression of price-cost margins over TFP (Levinsohn-Petrin) and a constant. In column 2 we add a set of AOC dummies, keeping the non-AOC producers as the control group. As expected, the TFP coefficient is positive and stable across the two specifications. In line with our model, however, the AOC dummies are jointly different from zero, and statistically different from each other.

Table 5: PCM/TFP relation - econometric results

Dep. Variable: Price Cost Margin	**Lev-Pet**		**Index Numbers**		**OLS**	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
ln(TFP)	0.052***	0.046***	0.170***	0.160***	0.092***	0.084***
	(0.004)	(0.004)	(0.007)	(0.007)	(0.005)	(0.005)
Constant	0.061***	0.074***	0.298***	0.288***	0.01	0.025
	(0.019)	(0.021)	(0.003)	(0.010)	(0.016)	(0.019)
AOC dummies	no	yes	no	yes	no	yes
H0: All intercepts equal to zero, F-stat		11.07		10.17		8.47
p-value		(0.000)		(0.000)		(0.000)
H0: All intercepts equal, F-stat		11.99		11.16		9.30
p-value		(0.000)		(0.000)		(0.000)
N. of obs.	2873	2873	2879	2879	2873	2873
R-sq	0.07	0.1	0.16	0.19	0.12	0.15
Alsace		-0.016		-0.028		-0.016
		(0.020)		(0.019)		(0.019)
Bordeaux		0.040**		0.027*		0.039**
		(0.017)		(0.017)		(0.017)
Bourgogne		-0.022		-0.031**		-0.026*
		(0.015)		(0.014)		(0.015)
Champagne		0.040***		0.032***		0.027**
		(0.012)		(0.011)		(0.012)
Jura-Savoie		0.086***		0.038*		0.061***
		(0.023)		(0.022)		(0.023)
Languedoc-Roussillon		0.043***		0.042***		0.034***
		(0.013)		(0.013)		(0.013)
Loire		0.013		-0.008		0.01
		(0.017)		(0.016)		(0.016)
Provence		-0.053***		-0.067***		-0.065***
		(0.019)		(0.018)		(0.019)
Rhône		-0.045***		-0.028*		-0.037**
		(0.016)		(0.015)		(0.015)
South-West		-0.004		0.009		0.009
		(0.021)		(0.020)		(0.020)

Hence, as expected, producers of different AOC segments seem to be competing in different strategic groups. When looking at the individual AOC effects, we can see that most of the significant ones are positive, in line with Proposition 1. The only two exceptions are "Provence" and "Rhône". The magnitudes of the effects are meaningful. For instance, given the same level of TFP, a producer of Champagne is predicted to obtain a 4% price-cost margin premium with respect to a firm located outside of any AOC area. Such findings are robust to employing different measures of TFP. In particular, columns 3 and 4 report the outcome of the same regressions when employing Index Numbers estimates of productivity. The most evident change is an increase in the linear term, from 0.05 to around 0.17[10].

In Table 6, focusing on the Levinsohn-Petrin estimates of productivity, we collapse the set of AOC dummies into a single one, which identifies all the firms located in either one of the 10 areas.

[10] The "wine expert" reader might be worried by the negative coefficient on the "Bourgogne" dummy. Reassuringly, and in line with the predictions of our model, that negative coefficient disappears when excluding the producers of "Beaujolais" from the broad "Bourgogne" group.

Having assumed that AOC areas, overall, can be seen as a high-differentiation segment relative to the low-differentiation "non-AOC" one, this is the most straighforward test of Proposition 1. The outcome is in line with our hypothesis, i.e. the overall AOC dummy effect is positive and statistically significant.

Table 6: PCM/TFP relation - econometric results

Dep. Variable: Price Cost Margin	**Lev-Pet**
	(1)
ln(TFP)	0.051***
	(0.004)
AOC Overall Dummy	0.019*
	(0.011)
Constant	0.047**
	(0.021)
N. of obs.	2873
R-sq	0.07

We now turn to the analysis of the size/TFP relation. Our model predicts size to be an increasing function of TFP within each segment. However, such a function has both a different intercept and a different slope for different market segments (eq. 8). Proposition 2 actually states that, for low levels of productivity, firms in the high-differentiation segment are bigger than their counterparts in the low-differentiation segment. This relation is inverted as the level of productivity grows, after a certain TFP threshold. Table 7 reports the outcome of an econometric test on the size/TFP relation, where size is proxied by deflated turnover.

In column 1, size is simply regressed over TFP and a constant. In column 2, we add the full set of AOC dummies and their interactions with TFP, thus allowing for both intercepts and slopes to vary across different segments. The results are in line with expectations: both the AOC dummies and their interactions are jointly different from zero, and statistically different from each other. This holds true for each of the three measures of TFP. Looking across columns, basically all of the intercepts are estimated to be positive, while the opposite holds true for the interactions.

In Table 8, the set of AOC dummies has been again collapsed into a single overall dummy. We are thus directly comparing the high-differentiation AOC broad segment relative to the low-differentiation non-AOC one. The results are perfectly in line with Figure 1. For low levels of productivity, firms tend to be bigger in the high-differentiation segment (i.e. role of the positive intercept). However, as TFP increases, size grows faster in the low-differentiation segment (i.e. role of the negative interactions). Therefore, as stated in Proposition 2, we expect the initial size-productivity relation across segments to be inverted after a certain threshold of productivity.

Table 7: Size/TFP relation - econometric results

Dep. Variable: ln(size)	Lev-Pet		Index Numbers		OLS	
	(1)	(2)	(3)	(4)	(5)	(6)
ln(TFP)	1.526***	1.657***	0.353***	1.100***	0.791***	1.043***
	(0.02)	(0.063)	(0.074)	(0.248)	(0.043)	(0.148)
Constant	0.132	-0.457	7.935***	7.559***	5.257***	4.257***
	(0.105)	(0.313)	(0.033)	(0.101)	(0.152)	(0.487)
AOC dummies	no	yes	no	yes	no	yes
*ln(TFP) * AOC dummies*	no	yes	no	yes	no	yes
H0: All intercepts equal to zero, F-stat		24.06		13.94		9.05
p-value		(0.000)		(0.000)		(0.000)
H0: All intercepts equal, F-stat		26.38		13.85		9.27
p-value		(0.000)		(0.000)		(0.000)
H0: All interactions equal to zero, F-stat		25.67		4.57		10.56
p-value		(0.000)		(0.000)		(0.000)
H0: All interactions equal, F-stat		28.09		3.69		11.20
p-value		(0.000)		(0.000)		(0.000)
N. of obs.	2894	2894	2893	2893	2894	2894
R-sq	0.67	0.71	0.01	0.08	0.1	0.18
Alsace		-0.484		0.226		2.399**
		(0.697)		(0.195)		(0.974)
Bordeaux		1.437***		0.165		0.905
		(0.489)		(0.175)		(0.7310)
Bourgogne		-0.205		0.144		1.014
		(0.470)		(0.149)		(0.791)
Champagne		-0.308		0.693***		0.027
		(0.349)		(0.116)		(0.545)
Jura-Savoie		1.061		-0.968***		1.013
		(0.778)		(0.239)		(1.049)
Languedoc-Roussillon		4.870***		0.181		3.169***
		(0.452)		(0.129)		(0.610)
Loire		-1.394**		0.342*		3.629***
		(0.707)		(0.176)		(1.016)
Provence		2.089***		-0.115		2.240**
		(0.791)		(0.193)		(0.943)
Rhône		0.739		0.591***		2.769***
		(0.607)		(0.151)		(0.919)
South-West		2.091**		1.379***		5.292***
		(0.876)		(0.209)		(1.099)
Alsace * ln(TFP)		0.134		-0.75		-0.679**
		(0.141)		(0.462)		(0.296)
Bordeaux * ln(TFP)		-0.287***		-0.535		-0.235
		(0.097)		(0.388)		(0.219)
Bourgogne * ln(TFP)		0.059		-1.355***		-0.311
		(0.095)		(0.425)		(0.240)
Champagne * ln(TFP)		0.016		-0.565**		0.065
		(0.069)		(0.271)		(0.162)
Jura-Savoie * ln(TFP)		-0.359**		-1.208***		-0.658**
		(0.166)		(0.434)		(0.309)
Languedoc-Roussillon * ln(TFP)		-1.009***		-1.397***		-0.963***
		(0.090)		(0.306)		(0.182)
Loire * ln(TFP)		0.283**		-1.540***		-1.068***
		(0.141)		(0.426)		(0.305)
Provence * ln(TFP)		-0.448***		-1.104**		-0.769***
		(0.164)		(0.522)		(0.282)
Rhone * ln(TFP)		-0.088		-1.497***		-0.693**
		(0.121)		(0.572)		(0.282)
South-West * ln(TFP)		-0.321*		-2.167***		-1.265***

Table 8: Size/TFP relation - econometric results

Dep. Variable: ln(size)	Lev-Pet
	(1)
ln(TFP)	1.657***
	(0.067)
AOC Overall Dummy	0.642*
	(0.350)
*ln(TFP) * AOC Overall Dummy*	-0.143**
	(0.070)
Constant	-0.457
	(0.332)
N. of obs.	2894
R-sq	0.67

Table 9 reports a direct test of this prediction. The average size of firms has been computed within each decile of the overall TFP distribution, both for AOC and non-AOC firms. The findings are clear: AOC firms are on average bigger for the lowest levels of TFP. This relation is inverted after the fourth decile, thus providing a direct confirmation of our Proposition 2.

Table 9: Proposition 2 - direct test

	Average firm size: (deflated turnover, 000s eur)		
Quantiles of ln(TFP) Lev-Pet	No -AOC	Within AOCs	Ratio
1	290.4	341.8	0.85
2	669.7	757.5	0.88
3	1290.4	1355.3	0.95
4	1401.2	1650.6	0.85
5	2871.0	2242.8	1.28
6	3154.9	3041.8	1.04
7	4716.4	4114.2	1.15
8	7158.8	6339.8	1.13
9	13401.2	10675.4	1.26
10	141449.8	45501.5	3.11

In so far we have found significant evidence on both the PCM/TFP and size/TFP relations, across different market segments, in line with our theoretical predictions.

However, it could well be the case that the AOC dummies introduced in our empirical tests are just capturing generic regional effects, instead of any specific role of the distinct market segments, as our model postulates. Indeed, if that would be the case, then we would expect to find similar patterns in the PCM/TFP and size/TFP relations also for other comparable industries, when introducing the same set of geographical dummies.

In order to rule out this possibility, we have repeated the latter analyses for two other French 4-digit food industries: "Production of meat and poultrymeat products" (NACE-1513) and "Manufacture of bread; manufacture of fresh pastry goods and cakes" (NACE-1581). The reason for selecting these two industries is twofold. First, they arguably produce goods which are less differentiated than wine, at least on a geographic base. Second, when restricting ourselves to the same municipalities covered by the wine-producers database, these industries display a significant coverage in terms of number of firms reported by AMADEUS, and thus could be used as a valid robustness check.

To that extent, Table 10 replicates the results of Table 6 for the two other industries, imposing exactly the same set of AOC areas as a regional effect. As it can be seen, in both cases the coefficient on the overall AOC dummy is not statistically different from zero. Thus, regarding Proposition 1, we do not find evidence of generic regional effects working in the same way as for the wine industry.

Table 10: PCM/TFP relation - robustness checks

	NACE 1513 (meat products)	NACE 1581 (bread products)
Dep. Variable: Price Cost Margin	**Lev-Pet**	**Lev-Pet**
	(1)	**(2)**
ln(TFP)	0.164***	0.169***
	(0.017)	(0.009)
AOC Overall Dummy	-0.002	-0.002
	(0.006)	(0.004)
Constant	-0.083**	-0.029*
	(0.033)	(0.017)
N. of obs.	1002	5698
R-sq	0.09	0.06

Turning to Proposition 2, in Table 11 we replicate the direct test of Table 9 for the meat and bread industries. Again, the results are much different than those obtained for the wine industry. In particular, for the meat industry the size/productivity relation looks pretty erratic. Instead, for the bread industry we find that firms located outside of any AOC area are bigger than AOC firms, on average, at all levels of productivity, i.e. there is no inversion of the relationship as for the 'segmented' wine industry.

Table 11: Proposition 2, direct test - robustness checks

NACE 1513 (meat products)				NACE 1581 (bread products)			
	Average firm size: (deflated turnover, 000s eur)				Average firm size: (deflated turnover, 000s eur)		
Quantiles of ln(TFP) Lev-Pet	**No -AOC**	**Within AOCs**	**Ratio**	**Quantiles of ln(TFP) Lev-Pet**	**No -AOC**	**Within AOCs**	**Ratio**
1	160.7	295.3	0.54	1	167.4	158.1	1.06
2	418.5	341.9	1.22	2	268.2	242.6	1.11
3	441.1	468.5	0.94	3	292.9	276.2	1.06
4	537.8	595.3	0.90	4	353.2	283.0	1.25
5	623.3	734.1	0.85	5	359.3	307.4	1.17
6	873.7	516.8	1.69	6	396.0	320.7	1.23
7	777.1	435.6	1.78	7	470.1	340.9	1.38
8	702.0	534.2	1.31	8	513.1	328.0	1.56
9	918.3	629.4	1.46	9	487.9	373.3	1.31
10	648.1	839.1	0.77	10	584.2	408.7	1.43

Overall, such findings suggest that our results for the wine producers are indeed likely to be driven by the segmentation of the industry in different - geographic based - competitive segments, consistent with the predictions of the theoretical model.

Finally, the third proposition of the model deals with the productivity of exporters. Consistent with Melitz-Ottaviano (2008) - and with any other model of international trade with heterogeneous firms - our model predicts that the most productive firms self-select into exporting within each market segment. However, when introducing asymmetric product differentiation, the cut-off levels of productivity inducing self-selection are heterogeneous across different market segments.

In particular, Proposition 3 states that exporting in the high-differentiation segment requires a lower productivity advantage (over purely domestic firms) than in the low-differentiation segment. Table 12 presents a direct test for this prediction. The average TFP of exporters is compared to the average TFP across all firms within each market segment. Not surprisingly, all the ratios are greater than one. This confirms the idea that exporters are the most productive companies within each segment. And yet, there is quite some variation in the productivity premia.

Table 12: Productivity premia of exporters

AOC	Avg. Exporters' TFP / Avg. TFP (AOC Specific)
no - AOC	1.08
Alsace	1.03
Bordeaux	1.01
Bourgogne	1.01
Champagne	1.06
Jura-Savoie	1.05
Languedoc-Roussillon	1.01
Loire	1.01
Provence	1.04
Rhone	1.02
South-West	1.01
AOC Overall	1.03

Consistent with Proposition 3, the highest premium (8%) is displayed by exporters in the non-AOC / low-differentiation segment. Instead, the average premium within AOC areas (weighted for the number of firms in each area) is only 3%. Such a low figure might also be partly explained by the exporting model of firms in the AOC areas. In fact, as explained by Crozet et al. (2009), many of these wine producers do not export directly, but only through specialized dealers, who manage worldwide sales with significant scale economies. This is likely to reduce the per-unit costs of exporting for producers, thus resulting in a milder selection of exporters, and ultimately in lower observed productivity premia.

An exception discussed by the same Crozet et al. (2009) is constituted by the Champagne area, where most producers are also direct exporters. Consistent with the latter feature, we indeed find that the TFP premium for Champagne exporters (6%) is the highest among the AOC areas, though still lower than the one for non-AOC producers.

5 Conclusions and further lines of research

In this paper we have provided a preliminary evidence of the richness of results that can be obtained in terms of the relationship between firm size, markups and productivity when adding some more structure to the demand system, by introducing in a very simple way an asymmetric degree of product differentiation.

In particular, we have been able to derive three novel and testable propositions on the relationship between productivity and markups, productivity and size and exporting cutoffs, together with their empirical validation on a specific industry, the French wine industry, characterized by officially defined market segments, thanks to the AOC system.

Clearly, these results have to be considered as preliminary, although their robustness opens the way to a number of promising lines of research.

On the theoretical side, in particular, we have insofar treated the different market segments as entirely separable in the utility function. For instance, any disutility coming from the consumption of the differentiated vs. the homogeneous good in one market segment is currently independent from the same disutility coming from the other market segment. In other words, consumers allocate separately their consumption decisions across the two market segments, with no interactions among them. Secondly, firms decide ex-ante in which (exclusive) market segment they compete, irrespectively of their productivity draw. Interacting consumers' decisions in the high vs. low-differentiation market segment, as well as discussing alternative ways of modelling the choice of firms' market segment constitute two possible refinements of the present model.

On the empirical side, we also need to nest considerations on firm size with the firm export status, as insofar we have been able to test only for the (relative) productivity cut-off of exporting firms, that is modelling their export extensive margins. However, we do not derive insofar any implication for the relation between export status and optimal firm size in the different market segments, i.e. the evolution of the firms' export intensive margins. The latter relation however features prominently in the growing literature on export and quality.

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Appendix: average performance measures across market segments

Given the result of Proposition 2, in which we have shown that the size and profits of firms change along the distribution of costs (productivity) with different slopes in the high vs. low-differentiation market segment, it is interesting to assess how average markups, firm size and profits compare among them.

As the latter clearly depends on the assumed distribution of the cost draw $G(c)$, we follow Melitz-Ottaviano (2008) and assume that the productivity draws $(1/c)$ follow a Pareto distribution with lower bound $(1/c_M)$ and shape parameter $k \geq 1$. The cumulative distribution function for the cost draws (the inverse of productivity) can then be written as $G(c) = \left(\frac{c}{c_M}\right)^k$ with $c \in [0, c_M]$.

The distribution of cost draws for the two sets of surviving firms (in Ω^l and Ω^h) is a truncation of $G(c)$, with upper bound c_D^ξ. Since a truncated Pareto distribution is still Pareto distributed with the same shape parameter, we then have that:

$$G_D^\xi(c) = \left(\frac{c}{c_D^\xi}\right)^k \ , \ c \in [0, c_D^\xi] \ , \ \ \xi = l, h$$

In equilibrium, the expected firm profits (net of sunk entry costs) for a potential entrant need to be equal to zero, for both market segments. Hence, from equation (11), we can write:

$$\int_0^{c_D^\xi} \pi^\xi(c) dG(c) = \frac{L}{4\gamma^\xi} \int_0^{c_D^\xi} \left(c_D^\xi - c\right)^2 dG(c) = f_E^\xi \quad \text{with } \xi = l, h \tag{24}$$

Using the fact that $\frac{dG(c)}{dc} = g(c)$, we can write $g(c) = \frac{kc^{k-1}}{c_M^k}$, solve the Riemann–Stieltjes integral in (24) and derive the following parametric expression for the cutoffs:

$$c_D^\xi = \left[\frac{2(k+1)(k+2)(c_M)^k f_E^\xi \gamma^\xi}{L}\right]^{\frac{1}{(k+2)}} \qquad \text{with } \xi = l, h \tag{25}$$

Assuming for simplicity that $f_E^l = f_E^h$, then $\gamma^h > \gamma^l$ implies once again $c_D^h > c_D^l$[11]. The Pareto parametrization then allows us to obtain average measures of firm performance in terms of the cost cutoff c_D^ξ. In particular, for $\xi = l, h$ we have[12]:

$$\overline{c}^\xi = \frac{k}{k+1} c_D^\xi \tag{26}$$

[11] This result would be even stronger when assuming $f_E^h > f_E^l$, in line with the plausible idea that pre-entry product development costs are larger for the highly differentiated product varieties in Ω^h than for the more standardized ones of Ω^l.

[12] The average figure for the generic performance measure z has been obtained as follows: $\overline{z} = [\int_0^{c_D^\xi} z(c)dG(c)]/G(c_D^\xi)$, starting from the firm level performance measures defined in eq. 7-11.

$$\overline{p}^{\xi} = \frac{2k+1}{2k+2} c_D^{\xi} \tag{27}$$

$$\overline{\mu}^{\xi} = \frac{1}{2}\frac{1}{k+1} c_D^{\xi} \tag{28}$$

$$\overline{q}^{\xi} = \frac{L}{2\gamma^{\xi}}\frac{1}{k+1} c_D^{\xi} = \frac{(k+2)(c_M)^k}{(c_D^{\xi})^{k+1}} f_E^{\xi} \tag{29}$$

$$\overline{r}^{\xi} = \frac{L}{2\gamma^{\xi}}\frac{1}{k+2} (c_D^{\xi})^2 = \frac{(k+1)(c_M)^k}{(c_D^{\xi})^{k}} f_E^{\xi} \tag{30}$$

$$\overline{\pi}^{\xi} = f_E^{\xi}\frac{(c_M)^k}{(c_D^{\xi})^k} \tag{31}$$

Equations 26-31 allow us to draw a set of important conclusions for the comparison of average firm performance in Ω^l vs. Ω^h. Having shown that $c_D^h > c_D^l$ (given $f_E^l = f_E^h$), it follows that firms in Ω^h are on average less productive (higher $\overline{c}$), they charge higher average prices and earn higher average mark-ups. However, notwithstanding such higher "per-unit" performance, firms in Ω^h are on average smaller in terms of produced output, and thus earn on average less (total) revenues and profits.

While the first results on average productivity, prices and mark-ups do not add much to the previous findings for the general $G(c)$ case, the second set of conclusions about average output, revenues and profits are very interesting. In fact, Proposition 2 shows that given two firms - one in Ω^l and the other in Ω^h - with an equal cost draw c, the relation between output, revenues and profits for the two market segments changes according to c. In particular, for low levels of costs (highly productive firms), we have that output, revenues and profits are higher in Ω^l, while the opposite holds true for cost levels above a certain threshold. For the Pareto case, we have found out that the first pattern prevails on average, i.e. firms in Ω^h are on average smaller and earn less revenues and profits than their counterparts in Ω^l.

Finally, solving the model for the equilibrium number of firms, given an equal number of entrants in the two sectors we also have that $N^h > N^l$. In fact, it is true that entrepreneurs in both Ω^l and Ω^h share the same distribution of cost draws $G(c)$. However, since $c_D^h > c_D^l$, firms in the high-differentiation sector enjoy a higher chance of survival. This result is again not specific to the Pareto case, but holds true for any parametrization of $G(c)$.