

MULTI-PRODUCT FIRMS AT HOME AND AWAY: COST- VERSUS QUALITY-BASED COMPETENCE*

Carsten Eckel[†] Leonardo Iacovone[‡] Beata Javorcik[§]
University of Munich The World Bank University of Oxford and CEPR

J. Peter Neary[¶]
University of Oxford and CEPR

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Abstract

We develop a new model of multi-product firms in which firms invest to improve the quality of their products as well as the quality of their overall brand. Because of flexible manufacturing, firms produce more of products closer to their core competence. They also have incentives to invest more in the quality of those goods. These two effects have opposite implications for the profile of prices. Applying our model to Mexican data provides robust confirmation of a key prediction of the model: firms in differentiated-good sectors exhibit quality-based competence, but the export sales of firms in non-differentiated-good sectors do not.

Keywords: Flexible manufacturing, multi-product firms, quality competition.

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[†]Department of Economics, Ludwig-Maximilians-Universität München, Schackstr. 4, D-80539 München; e-mail: carsten.eckel@lrz.uni-muenchen.de.

[‡]The World Bank, 1818 H Street, NW, Washington, D.C., 20433, USA; e-mail: liacovone@worldbank.org.

[§]Department of Economics, University of Oxford, Manor Road Building, Oxford, OX1 3UQ, U.K.; e-mail: beata.javorcik@economics.ox.ac.uk.

[¶]Department of Economics, University of Oxford, Manor Road Building, Oxford, OX1 3UQ, U.K.; e-mail: peter.neary@economics.ox.ac.uk. (Corresponding author)

1 Introduction

What makes a successful exporter? This question has attracted a lot of interest from policy makers, keen to design effective export promotion programs, and academics striving to understand the implications of globalization for economic growth. Two answers have been proposed. The first focuses on firm productivity. Studies by Clerides, Lach and Tybout (1998) and Bernard and Jensen (1999), among others, have found that firms self select into export markets on the basis of their successful performance at home. This evidence inspired the theoretical work by Melitz (2003) where only the most productive firms find it worthwhile to cover the extra costs of exporting. The second answer focuses on product quality. A growing body of work has provided evidence that successful exporters charge higher prices on average, suggesting that quality matters.¹

This study integrates these two views and shows both theoretically and empirically that firms may choose to compete on the basis of either cost or quality depending on the characteristics of the products they sell and the markets in which they operate.² Unlike other studies which have compared the behaviour of different firms, and emphasized the between-firm extensive margin, we focus on the portfolio of products sold by multi-product firms, and highlight what Eckel and Neary (2010) have called the “within-firm extensive margin.” Thus our theoretical innovation is to construct a model of multi-product firms in which the quality of goods is determined endogenously by firms’ profit-maximizing decisions. Because of flexible manufacturing, firms produce more of products closer to their core competence. They also have incentives to invest more in the quality of those goods. These two effects have opposite implications for the profile of prices and lead to what we call “cost-based” and “quality-based” competence. The former corresponds to the case where a firm’s core products are sold at lower prices, passing on their lower production costs to consumers. In the words of Jack Cohen, founder of the UK supermarket chain Tesco, firms “pile ’em high and sell ’em cheap”. As a result, the profile of prices across a firm’s products is inversely correlated with its profile of sales. By contrast,

¹A large and growing literature includes Antoniadou (2009), Baldwin and Harrigan (2007), Hallak and Schott (2010), Hallak and Sivadasan (2009), Iacovone and Javorcik (2007), Johnson (2010), Khandelwal (2009), Kugler and Verhoogen (2008), Mandel (2009), Manova and Zhang (2009), and Verhoogen (2008).

²Hallak and Sivadasan (2009) also integrate the productivity and quality approaches in a model of international trade by assuming two sources of exogenous firm heterogeneity: productivity and “caliber”, the latter being the ability to produce quality using fewer fixed inputs. Provided exporting requires attaining minimum quality levels, their model explains the empirical fact that firm size is not monotonically related to export status, and predicts that, conditional on size, exporters sell products of higher quality and at higher prices. However, they confine attention to single-product firms.

quality-based competence corresponds to the case where firms invest more in enhancing the quality of their core products. As a result, these products command quality premia, and so the profile of prices across a firm's products is positively correlated with its profile of sales.

Our model not only allows for different profiles of prices but also makes predictions about which kinds of goods should exhibit which profile. We test these predictions using Mexican data. Most previous empirical studies of multi-product firms at plant level have used data on export sales only or have combined export and production data at different levels of aggregation.³ By contrast, a unique characteristic of our data is that it provides consistently disaggregated information on both the home and export sales of all goods produced by a large representative sample of manufacturing establishments. As we shall see, the Mexican data provide robust confirmation of a key prediction of the model: firms in differentiated-good sectors exhibit quality-based competence both at home and abroad. By contrast, in non-differentiated-good sectors, Mexican producers compete on quality at home and on cost abroad. The latter pattern is consistent with the predictions of our model if investment in quality is more effective in Mexico than abroad. Our results are robust to focusing attention on a variety of subsamples, including only those products sold both at home and abroad, only those plants which sell on the home market and also select into exporting, and only single-plant firms.

Our finding that exporters from a middle-income country such as Mexico, compete in foreign markets on either cost or quality has policy implications for export promotion activities. It suggests that export promotion efforts should focus on improving the perceived product quality in differentiated-good sectors and should assist producers with lowering production costs in non-differentiated-good sectors. The former type of intervention can take the form of marketing campaigns to stress the advantages of national products or reductions in the costs of quality certifications (e.g. ISO 9000 or 14000) to improve the producer's image. The latter type of intervention can focus on stimulating investment in cost-saving technologies and worker training.

Our paper builds on and extends the existing literature on multi-product firms in international trade. While there already existed a large literature on multi-product firms in the theory of industrial organization, our model is one of a number of recent trade models which

³Examples of the first approach include Arkolakis and Muendler (2009), Berthou and Fontagné (2009), Eaton, Eslava, Kugler and Tybout (2008), and Mayer, Melitz and Ottaviano (2009). Examples of the second include Bernard, Redding and Schott (2006, 2010), and Goldberg, Khandelwal, Pavcnik and Topalova (2010a, 2010b). Baldwin and Gu (2005) use compatible data on production and exports by Canadian plants, but implement a theoretical framework which imposes symmetry between a firm's products, an issue which we discuss in more detail below.

is more applicable to the kinds of large-scale firm-level data sets which are increasingly becoming available.⁴ Within this latter tradition, existing models impose one or other profile of a firm's prices by assumption. One class of models assumes that products are symmetric on both the demand and supply sides, with the motivation for producing a range of products coming from diseconomies of scope. As a result, all products sell in the same amount and at the same price.⁵ A different approach, pioneered by Bernard, Redding and Schott (2010, 2009), emphasizes asymmetries between products on the demand side. Before they decide to enter, firms draw their overall level of productivity as well as product-market-specific demand shocks. The latter determine the firm's scale and scope of sales in different markets, and imply that its price and output profiles are always negatively correlated. By contrast, Eckel and Neary (2010) develop a model that emphasizes asymmetries between products on the cost side and implies that price and output profiles are always positively correlated.⁶ The present paper integrates the demand and cost approaches by assuming that costs determine the profile of investment in quality across different varieties, and develops a model which is more in line with recent work on models of heterogeneous firms that engage in process and product R&D: see, for example, Bustos (2010), Dhingra (2010), and Lileeva and Treffer (2010). It is even more closely related to those papers which allow for endogenous investment in quality, including the view that quality is really perceived quality, which may be market-specific, so investment in quality includes spending on marketing as in Arkolakis (2007). All this work has so far focused on single-product firms only.

Our brief review of the literature on multi-product firms highlights our main interest: how the theoretical models differ in the way they model the demand for and the decision to supply multiple products. The models also differ in other ways which are of less interest in the present application. One type of difference is in the assumptions made about market structure. In particular, most recent models assume that markets can be characterized by monopolistic competition, in which firms produce a large number of products but are themselves infinitesi-

⁴Most models of multi-product firms in industrial organization make one or more assumption which makes them harder to apply to large firm-level data sets. In particular, they typically assume that products are vertically rather than horizontally differentiated; and/or that the number of products produced by a firm is fixed, so the key question of interest is where in quality space it will choose to locate; and/or that the number of products produced is relatively small. For examples from a large literature, see Brander and Eaton (1984), Klemperer (1992), and Johnson and Myatt (2003). Baldwin and Ottaviano (2001) apply this kind of model in a trade context.

⁵See, for example, Allanson and Montagna (2005), Feenstra and Ma (2009), Nocke and Yeaple (2006), and Dhingra (2009).

⁶Arkolakis and Muendler (2009) and Mayer, Melitz and Ottaviano (2009) apply this approach to heterogeneous-firm models of monopolistic competition with CES and quadratic preferences, respectively.

mal relative to the size of the overall market.⁷ By contrast, Eckel and Neary (2010) assume in their core model that markets are oligopolistic. In this paper, we know little about the market environment facing individual firms: we do not know with which other Mexican plants in the sample they compete directly, and we have no information at all on their foreign competitors. Hence we prefer to remain agnostic on this issue, where possible deriving predictions which will hold at the level of individual firms irrespective of the market structure in which they operate. A further dimension of difference concerns the level of analysis, whether partial or general equilibrium. Some of the trade theory papers, including Eckel and Neary (2010), highlight general-equilibrium adjustments working through factor markets as an important channel of transmission of external shocks. However, with the data set we use, it is not possible to ascertain how factor prices are affected by general-equilibrium adjustments to changes in trade policy. Hence, we concentrate on testing implications of the model in partial equilibrium.

Section 2 of the paper presents the model and shows how differences in technology, tastes and market characteristics determine whether a multi-product firm exhibits cost-based or quality-based competence. Section 3 describes the data, and Section 4 explores the extent to which they confirm our theoretical predictions.

2 The Model

2.1 Preferences for Quantity and Quality

As already explained, the paper extends the flexible-manufacturing model of Eckel and Neary (2010) to allow for the interaction of quality and cost differences between the varieties produced by a multi-product firm. To simplify ideas and notation, we focus on the case of a single monopoly firm, but it is easily shown that the results extend to a heterogeneous-firms industry in which firms engage in Cournot competition. Section 2.2 reviews the earlier model, which allowed for cost-based competence only, showing how a firm chooses its product range, its total sales, and their distribution across varieties in a single market. Section 2.3 explores the additional complications which quality-based competence introduce.

Consider a single market, in which each one of L consumers maximizes a quadratic sub-utility function defined over the consumption and quality levels of a set $\tilde{\Omega}$ of differentiated

⁷This is true, for example, of all the theoretical models cited in the first paragraph, including Section 5.1 of Eckel and Neary.

products:

$$\begin{aligned}
 u &= u_1 + \beta u_2 & (1) \\
 u_1 &= a^0 Q - \frac{1}{2} b \left[(1-e) \int_{i \in \tilde{\Omega}} q(i)^2 di + e Q^2 \right], & Q \equiv \int_{i \in \tilde{\Omega}} q(i) di \\
 u_2 &= \int_{i \in \tilde{\Omega}} q(i) \tilde{z}(i) di
 \end{aligned}$$

Utility is additive in a component that depends only on quantities consumed, u_1 , and one that depends on the interaction of quantity and quality, u_2 . The first component is a standard quadratic function, where $q(i)$ denotes the consumption of a single variety and Q denotes total consumption. The parameter e is an inverse measure of product differentiation, assumed to lie strictly between zero and one (which correspond to the extreme cases of independent demands and perfect substitutes respectively). The second component shows that additional utility accrues from consuming goods the higher their quality, where $\tilde{z}(i)$ is the perceived quality level of an individual variety. We defer until Section 2.3 a detailed consideration of how the quality levels $\tilde{z}(i)$ are determined.

As discussed in the introduction, we remain agnostic in this paper about whether this sub-utility function is embedded in a general or partial equilibrium model: our analysis is compatible with both approaches. All we need assume is that the marginal utility of income can be set equal to one. This is ensured if the sub-utility function (1) is part of a quasi-linear upper tier utility function, with all income effects concentrated on the “numéraire” good. Alternatively, as in Eckel and Neary (2010), (1) can be one of a mass of sub-utility functions without an outside good, with the marginal utility of income set equal to unity by choice of numéraire.

Maximization of (1) subject to a budget constraint generates linear demand functions for the typical consumer. Assuming that there are L identical consumers in the market, the individual demand functions can then be aggregated over all consumers. Imposing market-clearing, so sales $x(i)$ equal total demand $Lq(i)$, gives the market inverse demand functions faced by the monopoly firm:

$$\begin{aligned}
 p(i) &= a(i) - \tilde{b} [(1-e)x(i) + eX], & i \in \Omega & (2) \\
 \tilde{b} \equiv \frac{b}{L} & & X \equiv \int_{i \in \Omega} x(i) di & a(i) = a^0 + \beta \tilde{z}(i)
 \end{aligned}$$

Here $p(i)$ is the price that consumers are willing to pay for an extra unit of variety i . This

depends negatively on a weighted average of $x(i)$, the sales of that variety, and X , the total volume of all varieties produced and consumed in the market. Note that X is defined over the set of goods actually consumed, Ω , which is a proper subset of the exogenous set of potential products $\tilde{\Omega}$, $\Omega \subset \tilde{\Omega}$. We will show below how Ω is determined. Finally, the demand price also depends positively, through the intercept $a(i)$, on the perceived quality of the individual variety, $\tilde{z}(i)$.

2.2 Cost-Based Competence

Consider next the technology and behaviour of the firm in a single market, which is segmented from the other markets in which the firm operates. The firm’s objective is to maximise profits by choosing both scale $\{x(i)\}$ and scope Ω , as well as choosing how much to invest in enhancing the quality of individual varieties and of its overall brand. We begin by abstracting from the quality dimension in this sub-section, and recapping the results of Eckel and Neary (2010) for the case where the firm’s competence derives from differences between varieties in production costs only. This is most easily done by setting β equal to zero in equation (1), so utility does not depend on quality. Though it is convenient to make explicit the variety-specific intercepts $a(i)$ in all equations, we do not consider the implications of differences between them until the next sub-section.

With no investment in quality, the firm’s problem is to maximise its operating profits only:

$$\pi = \int_{i \in \Omega} [p(i) - c(i) - t] x(i) di \tag{3}$$

Here t is a uniform trade cost payable by the firm on all the varieties it sells. The marginal cost function $c(i)$ embodies an assumption which Eckel and Neary (2010) identify as a key aspect of flexible manufacturing: marginal costs differ between varieties and rise as the firm moves away from its “core competence” variety, the one with lowest marginal cost.⁸ More precisely, the firm’s marginal cost of production for variety i is independent of the amount produced of that variety, is lowest for the core-competence variety indexed “0”, and rises monotonically as the firm moves away from its core competence: $c'(i) > 0$. With specific trade costs included, this is shown by the upward-sloping locus $c(i) + t$ in Figure 1.⁹

⁸We assume that production costs are independent of the market served. Mayer, Melitz and Ottaviano (2009) add an exogenous market-specific adaptation cost function which augments the production costs $c(i)$. With existing data sets, this is observationally equivalent to exogenous market-specific taste shifts $a(i)$, as in Bernard, Redding and Schott (2006).

⁹Figures 1 to 2 are drawn under the assumption that the cost function $c(i)$ is linear in i . Though a convenient

To derive the firm's behaviour, we first consider the optimal choice of output for each variety produced, i.e., for all i in the set Ω . The first-order conditions with respect to $x(i)$ are:

$$\frac{\partial \pi}{\partial x(i)} = [p(i) - c(i) - t] - \tilde{b}[(1 - e)x(i) + eX] = 0, \quad i \in \Omega \quad (4)$$

These imply that the net price-cost margin for each variety, $p(i) - c(i) - t$, equals a weighted average of the output of that variety and of total output, where the weights depend on the degree of product substitutability. The presence of total output in this expression reflects the ‘‘cannibalization effect’’: an increase in the output of one variety will, from the demand function (2), reduce its sales of *all* varieties. Taking this into account induces the firm to reduce its sales relative to an otherwise identical multi-divisional firm where decisions on the output of each variety were taken independently.¹⁰ Combining the first-order conditions with the demand function (2) we can solve for the output of each variety as a function of its own cost and of the firm's total output:

$$x(i) = \frac{a(i) - c(i) - t - 2\tilde{b}eX}{2\tilde{b}(1 - e)} \quad i \in \Omega \quad (5)$$

With $a(i)$ independent of i , the outputs of different varieties are unambiguously ranked from larger to smaller by their distance from the firm's core competence. Hence the problem of choosing the set of products to produce Ω reduces to the problem of choosing the marginal variety, denoted δ in Figure 1. As shown in Eckel and Neary (2010), the first-order condition for choice of δ is that the output of the marginal variety is exactly zero: $x(\delta) = 0$. Hence the profile of outputs is as shown by the downward-sloping locus $x(i)$ in Figure 1. Finally, since demands are symmetric when $a(i) = a^0$, the prices which will induce this pattern of demand must be increasing in i . This is confirmed when we substitute for outputs $x(i)$ from (5) into the first-order condition (4) to obtain the profit-maximising profile of prices:

$$p(i) = \frac{1}{2}[a(i) + c(i) + t] \quad (6)$$

Thus prices increase with costs, though less rapidly, implying that the firm's mark-up is lower on non-core varieties. However, it makes a strictly positive mark-up on all varieties: because of

special case, this assumption is not needed for any of the results.

¹⁰Each division of such a firm would independently set $p(i) - c(i) - t$ equal to $\tilde{b}x(i)$, thereby foregoing the gains from internalizing the externality which higher output of one variety imposes on the firm by reducing demand for all others. Such a myopic firm would also be indistinguishable from a set of single-product firms which happened to have the same profile of marginal costs. (Thanks to Jonathan Vogel for the latter point.)

the cannibalization effect, it would not be profit-maximizing to set price equal to marginal cost on the marginal variety $x(\delta)$.¹¹ All this is illustrated in Figure 1.

2.3 Quality-Based Competence

Consider next the case where consumers care about quality as well as quantity, so β in the utility function (1) is positive. Consumers therefore perceive a quality premium $\tilde{z}(i)$ attaching to each variety, which we assume can be decomposed as follows:

$$\tilde{z}(i) = (1 - e)z(i) + e\bar{Z} \tag{7}$$

Here $z(i)$ is the variety-specific component of quality, and \bar{Z} is the quality of the firm’s brand as a whole. Note that \bar{Z} is *not* equal to $\int_{i \in \bar{\Omega}} z(i) di$, the aggregate of individual varieties’ quality. Here too, product differentiation matters. If varieties are close to independent in demand (so e is close to zero), then the consumer perceives little benefit from a higher quality brand in itself. By contrast, if varieties are close substitutes (so e is close to one), then the consumer attaches more importance to the quality of the brand as a whole than to that of individual varieties. In general, the perceived quality of each individual variety is a weighted average of the variety-specific quality component and that of the firm’s brand as a whole, where the weights are $1 - e$ and e respectively.

Next, we need to specify how the components of quality are determined. It would be possible to assume that the perceived qualities of different varieties and of the firm’s brand vary exogenously, perhaps determined by a random process as in Bernard et al. (2010). However, this would be hard to reconcile with the assumption of flexible manufacturing, where a firm’s products are ranked by their distance from its core competence. We assume instead that, in the absence of investment in quality, consumers are indifferent between all varieties. However, the firm can invest to enhance the perceived quality of each of its individual varieties, as well as the perceived quality of its overall brand. As we will see, this generates a rich framework where differences between varieties are ultimately determined by costs, but where the profiles of outputs and prices may exhibit what we call “quality-based competence” if investment in quality is sufficiently effective.

To allow for explicit solutions, we assume that the costs of and returns to investment take

¹¹The price-cost margin on the marginal variety is $p(\delta) - c(\delta) - t = \tilde{b}eX > 0$, using (4) and the fact that $x(\delta)$ is zero. For a multi-divisional firm which ignored the cannibalization effect, it would be zero.

simple functional forms. With $k(i)$ denoting the firm's investment in the quality of variety i , we assume that the cost incurred is linear in $k(i)$, equal to $\gamma k(i)$, while the benefits come in the form of higher quality, though at a diminishing rate: $z(i) = 2\theta k(i)^{0.5}$. Similarly, investment in the quality of the brand incurs costs of $\Gamma \bar{K}$ and raises brand quality at a diminishing rate: $\bar{Z} = 2\Theta \bar{K}^{0.5}$. Total firm profits in the market are thus given by:

$$\Pi = \int_{i \in \Omega} [\{p(i) - c(i) - t\} x(i) - \gamma k(i)] di - \Gamma \bar{K} \quad (8)$$

The first-order conditions for scale and scope are as before. The new feature is the firm's optimal choice of investment in quality, which is determined by the following first-order conditions:

$$(i) \gamma k(i)^{0.5} = \beta(1 - e)\theta x(i), \quad i \in [0, \delta] \quad \text{and} \quad (ii) \Gamma \bar{K}^{0.5} = \beta e \Theta X \quad (9)$$

The first equation shows that the firm will invest in the quality of variety i up to the point where the marginal cost of investment γ equals its marginal return. The latter is increasing in β , the weight that consumers attach to quality as a whole, and in θ , the effectiveness of investment in raising quality. However, it is decreasing in the substitution parameter e : as goods become less differentiated the incentive to invest in the quality of an individual variety falls. Exactly analogous considerations determine the optimal level of investment in the firm's brand, with one key difference: for given output this is increasing rather than decreasing in the substitution parameter e . The more consumers view the firm's varieties as close substitutes, the greater the pay-off to investing in the brand.

The relationship between the different components of investment is highlighted by comparing total investment in the quality of individual varieties, $K \equiv \int_0^\delta k(i) di$, with investment in brand quality \bar{K} :

$$\frac{K}{\bar{K}} = \left(\frac{1 - e}{e} \frac{\theta}{\Theta} \frac{\Gamma}{\gamma} \right)^2 \Phi \quad \text{where:} \quad \Phi \equiv \frac{\int_0^\delta x(i)^2 di}{X^2} \quad (10)$$

Clearly, investment in varieties is higher than in the overall brand the more effective it is (the higher is θ relative to Θ) and the less expensive it is (the lower is γ relative to Γ). It is also higher the less substitutable are different varieties (the lower is e). In addition, it is also higher the greater is Φ , which Eckel and Neary (2010) define as an ex post measure of the flexibility of technology of a multi-product firm. Intuitively, the more flexible is its technology the more the firm wants to differentiate its marketing spending across different varieties; by contrast, if

Φ is low, the distribution of outputs across varieties is more even and the firm will focus on promoting its brand as a whole.

Consider next the implications of investment in quality for the pattern of the firm's sales across varieties. The first-order condition (9)-(i) shows that the firm will invest more in a variety with greater sales volume. The latter is endogenous of course, but combining this with the expression for outputs in (5) allows us to write the output of each variety as a function of exogenous variables and of total sales only:

$$x(i) = \frac{a^0 - c(i) - t - 2(\tilde{b} - \bar{\eta}e)eX}{2[\tilde{b} - \eta(1 - e)](1 - e)}, \quad i \in [0, \delta] \quad \eta \equiv \frac{\beta^2 \theta^2}{\gamma} \quad \bar{\eta} \equiv \frac{\beta^2 \Theta^2}{\Gamma} \quad (11)$$

Here, η and $\bar{\eta}$ are composite parameters which we can call, following Leahy and Neary (1996), the “marginal efficiency of investment” in the quality of individual varieties and of the firm's brand respectively.¹² Note that they cannot be too high: both $\tilde{b} - \eta(1 - e)$ and $\tilde{b} - \bar{\eta}e$ must be positive from the second-order conditions for optimal choice of outputs and investment. To see the implications of (11) more clearly, evaluate it at $i = \delta$ and use the fact that the output of the marginal variety is zero, $x(\delta) = 0$. The output of each variety can then be expressed in terms of the difference between its own cost and that of the marginal variety:

$$x(i) = \frac{c(\delta) - c(i)}{2[\tilde{b} - \eta(1 - e)](1 - e)}, \quad i \in [0, \delta] \quad (12)$$

This confirms that the profile of outputs across varieties is the inverse of the profile of costs: outputs fall monotonically as the firm moves further away from its core competence. Moreover, it shows that the output profile is steeper the higher is η . The greater the marginal efficiency of investment in the quality of individual varieties, the more a firm faces a differential incentive to invest in the quality of its most efficient varieties, those closer to its core competence, since they have the highest mark-ups in the absence of investment.

Equation (12) shows that investment in quality increases the variance of outputs but does not change their qualitative profile. By contrast, it can reverse the slope of the firm's price profile. To see this, we can substitute from the expression for output (12) into the first-order

¹²Similar parameter combinations appear in many models in trade and industrial organisation where investment in process innovation or in quality enhancement takes a linear-quadratic form. See for example, d'Aspremont and Jacquemin (1988) and, in the literature on heterogeneous firms and trade, Antoniadis (2009), Bustos (2010), and Dhingra (2009).

condition (4) to solve for the equilibrium prices:

$$p(i) = \frac{\tilde{b} - 2\eta(1 - e)}{2[\tilde{b} - \eta(1 - e)]}c(i) + \frac{\tilde{b}}{2[\tilde{b} - \eta(1 - e)]}c(\delta) + t + \tilde{b}eX, \quad i \in [0, \delta] \quad (13)$$

The coefficient of $c(i)$ in this expression gives one of our key results. Recalling that the denominator must be positive from the second-order conditions, the slope of the price profile depends on the sign of the numerator $\tilde{b} - 2\eta(1 - e)$. When the direct effect of an increase in i , working through a higher production cost, dominates, the numerator is positive, and the price profile exhibits “cost-based competence”: varieties closer to the firm’s core competence must sell at a lower price to induce consumers to purchase more of them. The extreme case of this is where investment in the quality of individual varieties is totally ineffective, so η is zero and the coefficient of $c(i)$ in (13) reduces to one half as in the last sub-section. By contrast, if the indirect effect of an increase in i , working through a higher value of $a(i)$, is sufficiently strong, so the firm invests disproportionately in the quality of products closer to its core competence, then it charges higher prices for them, and the price profile slopes downwards, as illustrated in Figure 2. We call this case one of “quality-based competence”. Summarising:

Proposition 1 *The profile of prices across varieties increases with the distance from the firm’s core competence if $\tilde{b} > 2\eta(1 - e)$, whereas it decreases with the distance if $\tilde{b} < 2\eta(1 - e) < 2\tilde{b}$.*

Clearly, quality-based competence, the case where prices of different varieties are inversely correlated with sales, is more likely to dominate: (i) when investment in quality is more effective, so η is larger; (ii) when market size L is larger, so \tilde{b} is smaller; and (iii) when products are more differentiated, so e is smaller.

It should be noted that our distinction between cost- and quality-based competence is an ex post one, based on the observable correlation between the slopes of the price and sales profiles. In a fundamental sense, a firm’s core competence in our model is always based on production costs, since these determine the firm’s incentives to invest in improving the quality of different varieties. It is also possible to consider how the firm’s “full marginal costs”, i.e., its marginal production cost plus the average cost of investing in the quality of each variety, varies as it moves away from its core competence. Combining the first-order condition for investment with the expression for output in (12), the average cost of investing in the quality of each variety can

be shown to equal:

$$\gamma \frac{k(i)}{x(i)} = \frac{\eta(1-e)}{2[\tilde{b} - \eta(1-e)]} [c(\delta) - c(i)], \quad i \in [0, \delta] \quad (14)$$

Hence the full marginal cost equals:

$$c(i) + \gamma \frac{k(i)}{x(i)} = \frac{2\tilde{b} - 3\eta(1-e)}{2[\tilde{b} - \eta(1-e)]} c(i) + \frac{\eta(1-e)}{2[\tilde{b} - \eta(1-e)]} c(\delta), \quad i \in [0, \delta] \quad (15)$$

Combining this with Proposition 1, we can conclude that neither marginal production costs nor full marginal costs predict the profile of prices across varieties. There are three cases:

- (i) If cost-based competence dominates, so $\eta(1-e) < \frac{1}{2}\tilde{b}$, then both prices and full marginal costs rise with i .
- (ii) If quality-based competence dominates, but mildly, so $\frac{1}{2}\tilde{b} < \eta(1-e) < \frac{2}{3}\tilde{b}$, then prices fall with i but full marginal costs rise with i .
- (iii) If quality-based competence strongly dominates, so $\frac{2}{3}\tilde{b} < \eta(1-e) < \tilde{b}$, then *both* prices and full marginal costs fall with i .

Note that in case (ii), both measures of cost rise with i , despite which prices fall with i . Finally, the mark-up over full marginal cost is always decreasing in i , and takes a particularly simple form:

$$p(i) - \left\{ c(i) + \gamma \frac{k(i)}{x(i)} \right\} = \frac{1}{2} [c(\delta) - c(i)] + t + \tilde{b}eX, \quad i \in [0, \delta] \quad (16)$$

This is independent of η and $\bar{\eta}$ for given X and δ . Hence the relative contribution of different varieties to total profits is independent of the effectiveness of investment in quality.

3 The Data

We turn next to review the data set.¹³ A unique characteristic of our data is the availability of plant-product level information on the value and the quantity of sales for *both* domestic and export markets. Our data source is the *Encuesta Industrial Mensual* (EIM) administered by the *Instituto Nacional de Estadística Geografía e Informática* (INEGI) in Mexico. The EIM is

¹³For a more complete account, see Iacovone and Javorcik (2007).

a monthly survey conducted to monitor short-term trends and dynamics in the manufacturing sector. As we are not primarily interested in short-term fluctuations, we aggregate monthly EIM data into annual observations. The survey covers about 85% of Mexican industrial output, with the exception of “maquiladoras.” It includes information on 3,183 unique products produced by over 6,000 plants.¹⁴ Plants are asked to report both values and quantities of total production, total sales, and export sales for each product produced, making the data set particularly valuable for our purposes.

Products in the survey are grouped into 205 *clases*, or activity classes, corresponding to the 6-digit level CMAP (Mexican System of Classification for Productive Activities) classification. Each *clase* contains a list of possible products, which was developed in 1993 and remained unchanged during the entire period under observation. For instance, the *clase* of *distilled alcoholic beverages* (identified by the CMAP code 313014) lists 13 products: gin, vodka, whisky, other distilled alcoholic beverages, coffee liqueurs, “habanero” liqueurs, “rompope”, prepared cocktails, hydroalcoholic extract, and other alcoholic beverages prepared from either agave, brandy, rum, or table wine. The *clase* of *small electrical appliances* contains 29 products, including vacuum cleaners, coffee makers, toasters, toaster oven, 110 volt heaters, and 220 volt heaters; within each group of heaters the classification distinguishes between heaters of different sizes: less than 25 liters, 25-60 liters, 60-120 liters, and more than 120 liters. These examples illustrate the narrowness of the product definitions and the richness of the micro-level information available in our dataset.

Table 1 shows that the number of plants in the sample varies from 6,291 in 1994 to 4,424 in 2004. Between 1,579 and 2,137 plants were engaged in exporting.¹⁵ The decline in the number of establishments during the period under analysis is due to exit.¹⁶ In this paper, we refer to each plant-product combination as a product variety. The number of varieties sold ranges from 19,154 in 1994 to 12,887 in 2004, while the number of varieties exported rose from 2,844 in 1994 to 3,118 in 2004, reaching a peak of 4,193 in 1998.

¹⁴The classification system has a total of 4,085 potential products. However, this includes headings entitled "Other unspecified products" and "Other non-generic products" in each *clase*. Excluding the latter, 3,183 is the number of products actually produced at some point in the sample period. For comparison, the US production data at the five-digit SIC code level used by Bernard, Redding and Schott (2010) contain approximately 1,800 product codes, while the US export data used by Bernard, Redding and Schott (2006) contain approximately 8,000 product codes, though these include agricultural products and raw materials as well as manufactures.

¹⁵We exclude a very small number of plant-year observations (23 in total) which reported positive exports but no production: see Table 1.

¹⁶The objective of the survey was to provide an accurate picture of the evolution of Mexican manufacturing industry. Plants that exited after 1994 were not systematically replaced, though some new firms were added in an effort to ensure that larger firms were represented throughout.

Notwithstanding the many advantages of our data set, two drawbacks should be mentioned. First, we can only identify which plants were owned by the same firm in the penultimate year in our sample, 2003. This poses a dilemma: on the one hand, treating plants as the unit of observation risks ignoring the interdependence of decision-making within multi-plant firms; on the other hand, the pattern of plant ownership in 2003 is unlikely to be typical of previous years because of plant sales and divestitures as well as mergers and acquisitions. In practice, most of the results we present are for plant-level data, but we also explore the robustness of our findings by looking only at those plants which belonged to single-plant firms in 2003. Second, while our data set is unique in providing information at the same level of disaggregation on both home and export sales, we cannot distinguish between different export destinations. Fortunately, this problem is much less severe in the case of Mexico, since the U.S. is by far the dominant market for most Mexican manufacturing exports. Our work is thus complementary to those of Bernard, Redding and Schott (2010) and Goldberg, Khandelwal, Pavcnik and Topalova (2010), who look at home production by multi-product firms in the U.S. and India respectively.

Arkolakis and Muendler (2009), Bernard, Redding and Schott (2009), Berthou and Fontagné (2009), and Mayer, Melitz and Ottaviano (2009), who apply models of multi-product firms similar to ours to data sets for Brazil, Chile, the U.S. and France. They are able to examine how the profile of exports varies across export destinations, but they do not have information on home and foreign sales at the same level of disaggregation.

4 Price Profiles at Home and Away

4.1 Empirical Strategy

Our theoretical model makes a number of novel predictions about the behaviour of multi-product firms. One of these in particular is unique to our model, has both theoretical and policy interest, and lends itself to empirical testing with our data. This is the prediction from Proposition 1 that the prices of different goods produced by multi-product firms may rise or fall with their distance from the firm's core competence, depending on a number of factors. In this sub-section we explain how we operationalise this prediction; subsequent sub-sections present the results of testing it and consider various robustness checks.

The first issue we need to address is "prices relative to what?" In the theoretical model, all goods are symmetrically differentiated and so their units of measurement are directly compa-

rable. By contrast, with real-world data, we have to compare the price of each good with the average price of an appropriate set of comparator goods. The strategy we adopt is the following. Prices are measured throughout by unit values, equal to sales value divided by sales quantity. For each product i , let J_i denote the number of plants that produce a variety of that product. We measure the relative price of each variety as its own price relative to the average price of all varieties of the same product. More precisely, in all the regressions below, the dependent variable is the log of the unit value of product i from plant j at time t , relative to the weighted average unit value of all J_i varieties of product i produced in or exported from Mexico at time t . We call this the price premium:

$$\ln Price Premium_{ijt} \equiv \ln \frac{Unit Value_{ijt}}{\sum_{j=1}^{J_i} \omega_{ijt} Unit Value_{ijt}} \quad (17)$$

Note that we are comparing the price of a particular variety of each product with different varieties of the same good, which in all cases are produced in different plants. The weights ω_{ijt} are either $1/J_i$ or shares in domestic sales or exports.

Given our price premia, we relate them to the ranking of products produced or exported by the same plant. Thus our measure of how close a product is to its plant's core competence relies on observable production or export data, not on unobservable cost data. In all the tables below, the estimating equation is then:

$$\ln Price Premium_{ijt} = \beta_0 + \sum_{r=1}^R \beta_r D_{ijt}^r + X + \varepsilon_{ijt} \quad (18)$$

where D_{ijt}^r is a dummy variable, which equals one if product i is ranked r in the production or exports of plant j in year t , and zero otherwise; X is a set of controls, which always includes plant fixed effects; and ε_{ijt} is a stochastic error term. We present results for a range of values of the number of products R , trading off the improvement in the fine detail of the price profile which we are able to estimate against the loss of degrees of freedom as we exclude more plants which produce or export only a small number of products.

The estimated coefficients on the product-rank dummy variables in (18) allow us to compare the profiles of prices and sales and determine whether they are positively or negatively correlated. They also allow us to test one of the predictions implied by Proposition 1. Specifically, we can test the prediction that a higher degree of product differentiation should make firms more likely to exhibit a price profile that reflects quality-based rather than cost-based competence. To

implement this test, we need independent observations on the degree of product differentiation, and for this purpose we make use of the classification developed by Rauch (1999). He grouped goods by the Standard International Trade Classification (SITC), Revision 2, four-digit classification into three categories, “differentiated,” “traded on organised exchanges” or “reference priced.” We combine the latter two into a catch-all “non-differentiated” category, and follow many authors in adopting the so-called “liberal” classification, which maximises the number of goods classified as non-differentiated. To implement this classification with our Mexican data, we had to make a concordance between the *clases* in our data and the SITC system. Fortunately, this was possible without too much arbitrariness. We are thus able to explore how the relationship between the price and sales profiles of multi-product firms varies with the degree of product differentiation.

4.2 Results

Table 2 gives the results of estimating equation (18) for sales in the home market over different subsets of the data. Each column corresponds to an equation estimated for plant/product/year observations on plants with different numbers of products. Thus the first equation has 128,493 observations on plants which sold at least two products, and has only one dummy variable for the highest selling product. Later equations add dummies for the second, third and fourth ranking product. In each equation the residual category is all products with ranks lower than the lowest-ranking dummy variable included. Thus in the first equation, the coefficient 0.042 is relative to the excluded category of all products ranked second or lower in production; while in the final equation, all four coefficients are relative to the excluded category of all products ranked fifth or lower in production. In this table we include all observations for which the relevant dummy variables are meaningful, and so the number of observations falls as we move to the right through the table. Nevertheless, we still have 75,808 observations on products produced in plants with five or more products.

The main implication of Table 2 is that it provides overwhelming evidence of quality-based competence, in the sense in which we have used the term in our theoretical model. All coefficients in the table are positive and highly significant, implying that products which are closer to a plant’s core competence sell for higher prices on average than products lower down the ranking. The implied price premium for the top product ranges from 4.3% when all plants producing two

or more products are included, to 8.3% when only those producing five or more are included.¹⁷ Of even greater interest is that, in the second, third and fourth equations, there is clear evidence that the profile of prices falls with a product's rank. Not only is each coefficient of the dummy variables for second- and lower-ranking products in these equations significantly different from zero, it is also significantly smaller than the coefficient above it in the table. We can thus conclude that there is strong evidence that prices fall with a product's distance from a plant's core competence, so the price and production profiles are negatively correlated, implying that on average the firms in our sample compete on the basis of quality-based competence.

The results of Table 2 are of interest, but do not test the predictions of Proposition 1. It turns out that distinguishing between differentiated and non-differentiated products makes little difference to the results for home sales.¹⁸ However, we find that export sales behave very differently depending on the degree of product differentiation. Consider first Table 3, which shows that exports of products in differentiated sectors exhibit the same price profile as total production. The evidence for a monotonically decreasing profile is less strong in the case of plants producing five or more products, although this may be due to the smaller number of observations in this sub-sample, and in any case the top three products command a significant price premium over products ranked fifth or lower. Moreover, the quantitative magnitude of the effects is much higher than in Table 2: the implied price premium for the top product ranges from 8.4% when all plants producing two or more products are included, to 16.1% when only those producing five or more are included.

By contrast, Table 4 tells a very different story for exports of non-differentiated products. Not a single coefficient in this table is significantly positive, most are negative, and all the coefficients of the dummy variable for the top product are significantly negative at the 5% level. Unlike Tables 2 and 3, this provides strong evidence against quality-based competence, and clear evidence in favour of cost-based competence for exports of non-differentiated products. Though not as overwhelmingly significant as the results for differentiated products, the results imply that the two groups of products behave very differently, and exactly in the way predicted by Proposition 1. For differentiated exports, prices fall with their distance from the plant's core competence, suggesting that Mexican exporters in these sectors compete on the basis of quality.

¹⁷The estimated difference between the natural logarithm of the price premium for the top product and that for all other products in the first equation is 0.042, implying a difference in the levels of 4.289%.

¹⁸Results for home sales broken down by differentiated and non-differentiated sectors are available on request for each of the four types of firms given in Table 2. Both differentiated and non-differentiated sectors show strong evidence of quality-based competence, just like the aggregate in Table 2. See also Tables 5 and 6 below.

By contrast, for non-differentiated exports, prices rise with their distance from the plant's core competence, suggesting that competition in such sectors is on the basis of cost rather than quality, exactly as our theory suggests.

4.3 Robustness Checks

A possible concern with the results so far is that the sample sizes are very different in different tables, with more products produced for the home market than for exports. This is perfectly consistent with our model which predicts that higher costs of accessing a foreign market will reduce the range of products sold there. Nevertheless it might suggest a concern that the regularities we have found in our data reflect behaviour very different from that predicted by our model; for example, that plants sell different products in the home and foreign markets, or that plants which select into exporting are very different from those that sell only on the home market. To address these concerns we reestimate our price profile equations first for those products that are sold on both markets, and next for the home sales of exporting plants.

Tables 5 and 6 address the issue of different sample sizes directly by reestimating the equations for only those observations on products that are *both* exported and sold at home. The two tables present results for plants selling two or more and five or more products respectively. It can be seen that the conclusions drawn from the earlier tables survive this robustness check. All significant coefficients in the first five columns in both tables are positive, whereas the significant coefficient in the sixth column, the regression equation for non-differentiated exports, is negative. It is true that the evidence for quality-based competence by plants in non-differentiated sectors is weaker, with no significant coefficients in the third equation in Table 6. However, in Table 5 the coefficient of the dummy variable on the top product when all observations on plants producing two or more products are included remains significant and positive. We can conclude that the evidence from this smaller sample is less overwhelmingly in support of different behaviour by non-differentiated product plants at home and away; but that the evidence for a difference between behaviour by plants in differentiated and non-differentiated sectors remains very strong, especially in export markets.

Table 7 addresses the question of whether plants that select into exporting behave differently on the home market. It gives results for plants in both differentiated and non-differentiated classes, but it is clear that the two behave very similarly to each other. They also behave very similarly to the sample of all plants selling on the home market, as in Tables 2, 5 and 6. Bearing

in mind that the plants in Table 7 are identical to those whose exporting behaviour is shown in Tables 3 and 4, our earlier conclusions are reinforced. Exporting plants in both differentiated and non-differentiated sectors exhibit quality-based competence in the home market, so the very different behaviour of exporters in non-differentiated sectors shown in Table 4 does not reflect any differential selection process of plants into exporting.

A different robustness check addresses the concern that our theory was developed for multi-product *firms*, whereas our data consist of observations on multi-product *plants*. If all the plants owned by a single firm operated independently, then there would be no inconsistency. However, this would imply that decisions on scale and scope to internalise the externalities which different products impose on each other are decentralized to plants rather than taken at firm level: an implausible combination of assumptions. To deal with this problem empirically we would ideally like to have data on the ownership patterns of plants in all years. Unfortunately, such data are available only for the penultimate year of the sample, 2003. We therefore adopt the following strategy. We retain in the sample only those plants which were single-plant firms in 2003, and consider their sales and price profiles in all years. This risks including some observations on plants which did not correspond to single-plant firms either in 2004 because of mergers, or in years prior to 2003 because of divestitures. However, the number of such cases is likely to be small, and this strategy seems preferable to losing many more degrees of freedom by focusing on single-plant firms in 2003 only.¹⁹

Tables 8 and 9 give the results of this robustness check, for single-plant firms selling at least two and at least five products respectively. The evidence for quality-based competence remains overwhelming for both categories of home sales and for differentiated exports. The profile of the sales-rank dummies is not always monotonically decreasing, and definitely not significantly so. However, all coefficients are significant at the 1% level, implying that products closer to the core sell for higher prices than the non-core products in the default category of each equation. As for exports of non-differentiated products, the evidence for cost-based competence is much less strong than in earlier tables. At the same time, with all coefficients insignificant, there is no evidence for quality-based competence either. We can conclude that our earlier results are reasonably robust to excluding plants owned by multi-plant firms in 2003.

¹⁹Results for 2003 alone have similar coefficients to those reported here, but with larger standard errors.

5 Conclusion

This paper has developed a new model of multi-product production in which firms invest to improve the quality of their products as well as the quality of their overall brand. It is thus the first to integrate two important strands of recent work on the behaviour of firms in international markets. On the one hand, the growing evidence that many firms, and especially most large exporters, are multi-product, has inspired theoretical and empirical work which focuses on the “intra-firm extensive margin”, changes in the range of products produced by firms, distinct from the inter-firm extensive margin which has attracted so much attention in the literature on heterogeneous single-product firms. On the other hand, an increasing number of authors have suggested that successful firms in international markets compete on the basis of superior quality rather than superior productivity. Our model integrates these two strands in a tractable framework. Crucially, it endogenises both the choice of product range and the choice of quality, or more specifically, the choice of investment in quality, thus allowing a range of issues to be explored which have so far been little studied.

The model has interesting implications for the manner in which firms compete in international markets. In particular, it throws light on the question of whether productivity or quality is the key to successful export performance, and suggests a way of reconciling these two views. Because of flexible manufacturing, firms produce more of products closer to their core competence. They also have incentives to invest more in the quality of those goods. These two effects have opposite implications for the profile of prices. On the one hand, to the extent that consumers view all products as symmetric substitutes for each other, firms can only sell more of their core products by charging lower prices for them. Hence, the direct effect of lower production costs for core products is that firms “pile ’em high and sell ’em cheap,” implying that the profiles of prices and sales should be negatively correlated, an outcome we call “cost-based competence”. On the other hand, firms face stronger incentives to invest in raising the perceived quality of their core products, since these are the products with the highest mark-ups. Even though investment in the quality of an individual product is subject to diminishing returns, this implies that firms will invest more in the quality of their core products, so raising the price which consumers are willing to pay for them. This indirect effect of lower production costs for core products implies that the profiles of prices and sales should be positively correlated, an outcome we call “quality-based competence”. We show that both these outcomes are possible

in our model, and that which of them prevails depends on a number of exogenous factors. In particular, the greater the degree of product differentiation, the more the firm faces differential incentives to invest in the quality of different products, and so the more likely is the indirect effect to dominate, giving rise to quality-based competence.

This last prediction is the one we explore empirically, drawing on a unique data set on Mexican plants already used by Iacovone and Javorcik (2007, 2010). A great advantage of this data set is that it gives detailed information on both home and foreign sales at the same level of disaggregation, allowing us to test theoretical predictions about their relative profiles. Our findings show that a two-way distinction is crucial: between home sales and exports on the one hand, and between differentiated and non-differentiated products on the other. In the domestic market, we find that both differentiated and non-differentiated products exhibit quality-based competence, with prices falling as sales value falls. By contrast, in the export market we find robust evidence that plants in differentiated-product sectors exhibit quality-based competence, but those in non-differentiated-good sectors do not. We show that this finding holds whether we consider all products or only those which are sold in both home and foreign markets. It also holds when we consider only the sub-sample of single-plant firms: confirmation that our theory, which was developed for firms, helps in understanding behaviour at plant level too. We can thus conclude that, for this data set, quality-based competence is dominant for firms in differentiated-good sectors, but not for the export sales of firms in non-differentiated-good sectors.

These findings have broader implications for the nature of competition in international markets. Our data set shows that within-firm product heterogeneity is not just a rich-country phenomenon, but is also important in at least one middle-income country. Moreover, the evidence we present suggests that only firms in differentiated-product sectors compete in export markets on quality. This has a key implication for understanding how firms compete successfully abroad. While previous studies have shown that all exporters have a productivity premium, our results suggest that those in differentiated-product sectors have a quality premium too, whereas those producing non-differentiated goods behave differently at home and away, competing less on quality and more on price in their export markets.

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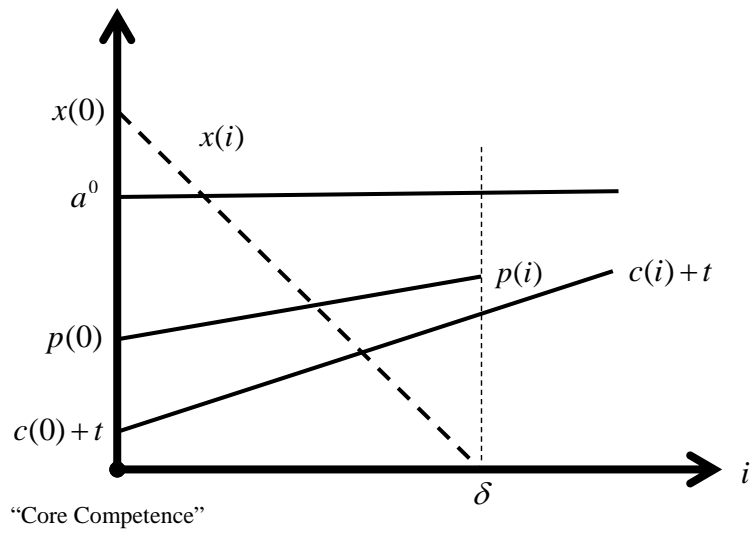


Figure 1: Profiles of Outputs, Prices and Costs with Cost-Based Competence

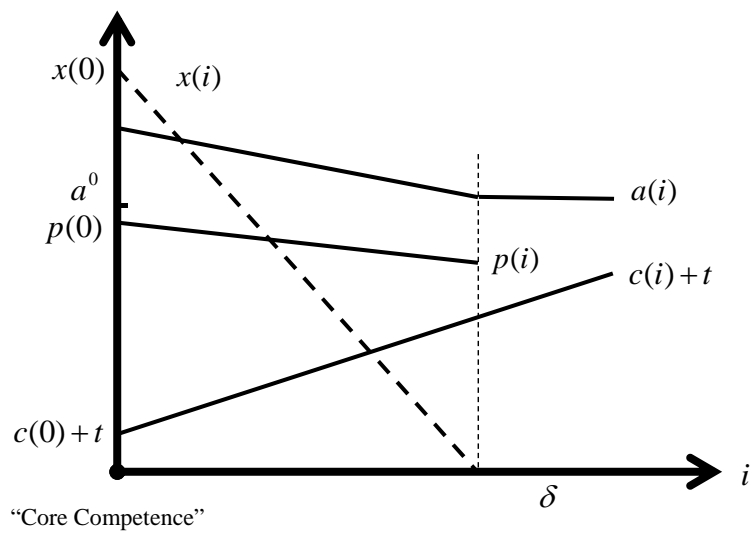


Figure 2: Profiles of Outputs, Prices and Costs with Quality-Based Competence

Year	Number of plants				Number of products		
	Total	Owned by MPFs ¹	Other	Exporters		Produced	Exported
				Total	Adjusted ²		
1994	6,291	1,259	5,032	1,582	1,579	19,154	2,844
1995	6,011	1,245	4,766	1,844	1,842	18,568	3,406
1996	5,747	1,256	4,491	2,024	2,023	17,662	3,881
1997	5,538	1,256	4,282	2,138	2,137	16,938	4,092
1998	5,380	1,268	4,112	2,095	2,094	16,419	4,193
1999	5,230	1,279	3,951	1,951	1,950	15,885	3,889
2000	5,100	1,280	3,820	1,901	1,899	15,279	3,737
2001	4,927	1,258	3,669	1,770	1,766	14,714	3,509
2002	4,765	1,237	3,528	1,686	1,684	14,182	3,321
2003	4,603	1,193	3,410	1,678	1,675	13,507	3,282
2004	4,424	1,159	3,265	1,602	1,599	12,887	3,118
Total	58,016	13,690	44,326	20,271	20,248	175,195	39,272

Table 1. Number of plants and products

- (1) MPFs: Multi-plant firms; information on the number of plants owned by a single firm is available for 2004 only.
(2) The adjusted data exclude plants not reporting production in the year in question.

Plants with:	2+ products	3+ products	4+ products	5+ products
Top Product:	0.042*** (0.004)	0.054*** (0.005)	0.066*** (0.006)	0.080*** (0.007)
Top 2nd:		0.037*** (0.005)	0.056*** (0.006)	0.073*** (0.007)
Top 3rd:			0.048*** (0.006)	0.064*** (0.007)
Top 4th:				0.053*** (0.007)
r^2	0.441	0.416	0.412	0.414
N	128,493	110,368	92,154	75,808

Table 2: Price Profiles at Home

(All regressions have plant fixed effects.)

(Here and subsequently, ***, **, and * denote coefficients that are significant at the 1%, 5%, and 10% levels, respectively.)

Plants with:	2+ products	3+ products	4+ products	5+ products
Top Product:	0.081*** (0.012)	0.128*** (0.015)	0.139*** (0.019)	0.149*** (0.024)
Top 2nd:		0.072*** (0.015)	0.115*** (0.020)	0.145*** (0.025)
Top 3rd:			0.107*** (0.020)	0.151*** (0.025)
Top 4th:				0.041* (0.024)
r^2	0.378	0.348	0.341	0.349
N	14,975	11,528	8,812	6,720

Table 3: Price Profiles Away: Differentiated Products

(All regressions have plant fixed effects.)

Plants with:	2+ products	3+ products	4+ products	5+ products
Top Product:	-0.031** (0.010)	-0.033** (0.014)	-0.053** (0.019)	-0.075** (0.027)
Top 2nd:		0.003 (0.014)	0.006 (0.019)	-0.016 (0.027)
Top 3rd:			0.010 (0.019)	-0.024 (0.027)
Top 4th:				-0.012 (0.027)
r^2	0.303	0.251	0.191	0.187
N	8,252	5,738	3,847	2,550

Table 4: Price Profiles Away: Non-Differentiated Products

(All regressions have plant fixed effects.)

Market:	Home			Export		
	All	Diff.	Non-Diff.	All	Diff.	Non-Diff.
Top Product:	0.045*** (0.009)	0.056*** (0.013)	0.027** (0.013)	0.037*** (0.009)	0.079*** (0.012)	-0.033** (0.010)
r^2	0.412	0.421	0.376	0.350	0.361	0.292
N	20,646	13,382	7,264	20,646	13,382	7,264

Table 5: Price Profiles for Products both Exported and Sold at Home

Including only observations on plants with two or more products

(All regressions have plant fixed effects.)

Market:	Home			Export		
	All	Diff.	Non-Diff.	All	Diff.	Non-Diff.
Top Product:	0.112*** (0.022)	0.162*** (0.027)	-0.036 (0.039)	0.092*** (0.021)	0.173*** (0.040)	-0.070*** (0.014)
Top 2nd:	0.099*** (0.022)	0.148*** (0.027)	-0.048 (0.039)	0.119*** (0.022)	0.108** (0.027)	-0.016 (0.027)
Top 3rd:	0.092** (0.022)	0.130*** (0.027)	-0.024 (0.039)	0.108*** (0.022)	0.102** (0.040)	-0.024 (0.027)
Top 4th:	0.022 (0.022)	0.040 (0.027)	-0.039 (0.039)	0.038* (0.021)	0.005 (0.040)	-0.012 (0.027)
r^2	0.321	0.337	0.265	0.329	0.400	0.380
N	7,636	5,679	1,957	7,636	5,679	1,957

Table 6: Price Profiles for Products both Exported and Sold at Home

Including only observations on plants with five or more products

(All regressions have plant fixed effects.)

Varieties:	Differentiated				Non-Differentiated			
# Prods.:	2+	3+	4+	5+	2+	3+	4+	5+
Top Prod.:	0.039*** (0.009)	0.054*** (0.010)	0.086*** (0.012)	0.095*** (0.014)	0.039*** (0.008)	0.034** (0.010)	0.032** (0.014)	0.052** (0.018)
Top 2nd:		0.052*** (0.010)	0.075*** (0.012)	0.100*** (0.014)		0.026** (0.011)	0.040** (0.014)	0.058** (0.018)
Top 3rd:			0.079*** (0.012)	0.105*** (0.014)			0.035** (0.014)	0.020 (0.018)
Top 4th:				0.089*** (0.014)				0.035* (0.018)
r^2	0.423	0.400	0.391	0.392	0.348	0.322	0.300	0.280
N	39,718	34,538	29,502	24,893	21,697	17,136	13,189	9,621

Table 7: Price Profiles for Home Sales of Exporting Plants

(All regressions have plant fixed effects.)

Market:	Home			Export		
Varieties:	All	Diff.	Non-Diff.	All	Diff.	Non-Diff.
Top Product:	0.049*** (0.005)	0.057*** (0.007)	0.035*** (0.006)	0.050*** (0.011)	0.086*** (0.014)	-0.013 (0.014)
r^2	0.439	0.444	0.389	0.384	0.401	0.306
N	95,881	64,720	31,161	14,690	9,896	4,794

Table 8: Price Profiles for Single-Plant Firms with Two or More Products

(All regressions have plant fixed effects.)

Market:	Home			Export		
Varieties:	All	Diff.	Non-Diff.	All	Diff.	Non-Diff.
Top Product:	0.093*** (0.008)	0.102*** (0.011)	0.071*** (0.012)	0.121*** (0.025)	0.146*** (0.031)	0.035 (0.036)
Top 2nd:	0.083*** (0.008)	0.091*** (0.010)	0.062*** (0.012)	0.160*** (0.025)	0.205*** (0.031)	0.028 (0.036)
Top 3rd:	0.081*** (0.008)	0.087*** (0.010)	0.065*** (0.012)	0.126*** (0.025)	0.176*** (0.032)	-0.021 (0.037)
Top 4th:	0.066*** (0.008)	0.067*** (0.010)	0.062*** (0.012)	0.055** (0.025)	0.053* (0.031)	0.042 (0.037)
r^2	0.403	0.413	0.318	0.343	0.359	0.203
N	57,579	41,576	16,003	5,600	4,229	1,371

Table 9: Price Profiles for Single-Plant Firms with Five or More Products

(All regressions have plant fixed effects.)