Quality Upgrading and Price Heterogeneity: Evidence from Brazilian Exporters *

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Abstract

This paper studies the relation between quality upgrading and pricing across firms and destination countries. The paper builds a model based on heterogeneous firms that set quality and prices to heterogeneous consumers. To test the predictions of this model, the paper uses a uniquely rich data that combines producer quality information and exporter prices by firm and destination country. Direct evidence on self-reported quality upgrading over time makes it possible to separate the quality effect from other sources of price variation, using a difference-in-difference-in-differences approach, that discerns quality upgrading by destination market and timing. Results document quality-based market segmentation, by which firms raise quality and prices at high-income destinations. The paper shows that the difference in prices across countries is not driven by differences in market shares, markups, or elasticities of substitution, but by demand for quality in high-income destinations.

Key-words: export prices, quality upgrading, innovation, market segmentation.
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1 Introduction

A growing body of literature has documented a systematic variation in export prices across destination countries and suggested that quality differences may be one plausible explanation for this variation, i.e. high-income countries consume high quality products.[1] Besides product quality, the observed price variation may reflect other factors, such as market competition, firm composition, and destination market characteristics. Yet, the lack of direct data on producer quality has limited the empirical evidence to the use of proxies for quality, and it has been impossible to separate the quality effect from other sources of price variation.[2] [3]

I use producer quality information of Brazilian exporters over time and propose a new methodology which allows sorting out product quality from other sources of price variation, such as market competition and firms' characteristics. I find evidence of quality-based market segmentation: Firms increase product quality and product prices at high-income destinations. Results reveal that differences in prices across destination countries are not driven by differences in markups, market share, or elasticities of substitution, but by demand for high quality in high-income countries. To my knowledge, this is the first study to provide direct evidence on quality upgrading over time and to sort out the different effects that drive price variation across firms and destination countries.

To provide a framework for the empirical analysis, I present a stylized partial equilibrium model that combines quality upgrading, skill upgrading, and product innovation investments. The model considers two markets heterogeneous in their income, North (high income) and South (low income), and heterogeneous firms that endogenously set prices and quality to these markets. The model generates three testable predictions. First, for firms that invest in product innovation, it is optimal to increase product quality and product prices. Second, due to different willingness to pay for quality across countries, firms have relatively stronger profit incentives to increase product quality and product prices for high-income (Northern) countries. For a sufficiently low income in Southern countries, consumers in the South consume only low quality products. Thus, quality upgrading and market segmentation explain higher prices in Northern countries. Third, producing high quality requires better qualified workers. Hence, firms that upgrade quality also increase their share of skilled workers.

[1] Hummels and Klenow (2005) and Hallak (2006) find that prices increase with exporter and importer income per capita, respectively. Their results suggest that high-income countries consume and produce high quality products. Similar evidence is found at the firm-level (see Manova and Zhang (2011) and Bastos and Silva (2010b)), and using a structural approach as Khandelwal (2010) and Hallak and Schott (2011).

[2] Understanding the sources of price variation is crucial for policy analysis. For instance, if price variation across destination countries is due to markup pricing, it comes at the expense of the importing countries' consumer surplus. Evidence on pricing to market has been found, e.g. by Simonovska (2010).

[3] Crozet, Head, and Mayer (2011) study French wine producers and are the only direct evidence on how quality ratings affect prices and exports. They focus on price variation across firms (and not across destination markets) in cross-section analysis, which does not allow disentangling the different causes of price variation.

I test these predictions using a novel and uniquely rich data set that matches three firm-level data sources of Brazilian exporters over the period 1997-2000: (i) The PINTEC (2000) firm innovation survey, which contains detailed measures on product and process innovation, including self-reported information on the importance of product quality upgrading;[4] (ii) Export price data by firm, product and destination country from SECEX (Foreign Trade Secretariat); and (iii) Employer-employee data from RAIS (*Relação Anual de Informações Sociais*) with information on workers' characteristics. These three databases are matched with additional data sources containing various time-varying characteristics, such as the NBER-UN world bilateral trade flows data. The richness of the combined data allows for tracking variations in prices over time by firm, product, and destination country, as well as variations in producer quality, firms' characteristics, measures of competition and market-share. Thus, it allows for separating the different sources of price variation.

The period under analysis, 1997-2000, provides a unique empirical setting to test the predictions of my theoretical model. After trade liberalization[5], Brazilian firms faced tougher competition and made important efforts to adapt their products to the demand of foreign consumers. In the period under analysis, export orientation was the main determinant of product innovation (Kannebley, Porto, and Pazello 2005) and firms' efforts to increase product quality were 30% higher in comparison to the later years (PINTEC 2003).[6] Anecdotal evidence shows that many firms created an *export type product* in this period, a higher quality variety in conformity with the international quality standards, as requested in European countries, for instance. Nevertheless, Mercosur countries continued consuming low quality varieties.

The econometric approach to identify the effect of quality upgrading on prices is a difference-in-difference-in-differences (DDD) strategy over the period 1997-2000. The DDD discerns firms that upgraded quality from others that did not, by export market over time. I evaluate price changes due to changes in product quality, mainly for European Union (North) and Mercosur (South), and conduct several placebo exercises to test whether the effect of quality on prices is driven by firm selection or other factors not related to quality.[7]

Results show that producers raise quality and prices at high-income (Northern) countries, confirming the first two predictions of my stylized model. Hence, demand for high quality

[4]The PINTEC (2000) firm innovation survey is available for a representative sample of 3750 Brazilian manufacturing exporters, and contains 154 questions related to product and process innovation. Some questions are specifically related to product quality upgrading and to the firm's export destination market. For instance, the share of sales of the innovated product in the domestic and foreign market.

[5]Trade liberalization occurred mainly until 1995.

[6]Among the reasons for manufacturing exporters to innovate, the most cited were: to improve product quality (80% of the firms) and to maintain market share (82% of the firms) (PINTEC 2000). For 86% of the firms, foreign consumers were the main source of information for product development (PINTEC 2000).

[7]As quality is an endogenous variable, I achieve identification by evaluating differences across groups over time, combined with firm-product-country fixed effects, period fixed effects and various time-varying firm, product and destination country characteristics.

explains higher prices in Northern countries. I discuss the markup hypothesis and show that differences in prices across destinations are not driven by markup pricing or different elasticities of substitution, but rather by demand for quality in high-income destinations. In particular, results reveal that firms that did not upgrade quality do not receive a price premium in Northern countries, and firms that upgrade quality only receive a price premium in Northern countries. Regarding the third prediction of the model, results document that firms that jointly increase quality and workers' skills charge higher prices.[8]

The results are extended in several ways. First, I include different groups of countries in the analysis and show that the results are not specific to the European Union and Mercosur. Second, I show that price differentials across countries are specific to quality upgrading, and are not related to other firm-level changes, such as process innovation.[9] Third, asymmetries across products reveal that the effect of quality on prices is captured by the firms' most important product (in terms of sales), for which the firm has higher profit incentives to invest in quality.[10] Finally, several placebo exercises confirm the validity of the difference-in-difference-in-differences methodology.

This paper is related to a broad literature investigating the relationship between quality, prices and trade. A first generation of papers has shown that prices increase with exporter income per capita (Flam and Helpman (1987) and Hummels and Klenow (2005)) and importer income per capita (Hallak 2006). These results are supported by Khandelwal (2010) and Hallak and Schott (2011), who relax the direct price-quality relation and infer quality from both price and market share data. Their results suggest that high-income countries consume and produce high quality products. With the availability of firm-level data, a second generation of papers emerged. Manova and Zhang (2011) and Bastos and Silva (2010b) use firm-level export data and show a systematic price variation across destination countries. They attribute price variation to quality sorting: firms export high quality products to high income and distant countries.[11] Recently, Crozet, Head, and Mayer (2011) have focused on the wine industry and found in a cross-section that firms ranked as high-quality producers charge higher prices and export more to more markets.[12] Using data on quality upgrading

[8] Although, I show that quality and skills do not cancel out each other. Instead, the level effect of quality upgrading remains significant, suggesting that skill upgrading might not completely explain increases in producer quality.

[9] For process innovation (technology upgrading), there is no price differential across destinations, suggesting that firms receive a premium in Northern countries from increasing product quality, but not from producing existing products with better technology.

[10] According to Eckel, Iacovone, Javorcik, and Neary (2011), a firm with quality competence may obtain higher quality premia for the products closer to the core competence. Thus, incentives to invest in the quality of the core variety are higher.

[11] Similar results are found by Görg, Halpern, and Muraközy (2010) for Hungarian firms.

[12] Their cross-section results focus on effects across firms (and not across countries). Moreover, the cross-section analysis does not allow sorting out different sources of firm and price heterogeneity.

over time combined with price data, I offer a quality-based explanation for price variation across countries and industries, and separate the different sources of price variation.

The paper is also related to a literature investigating product quality, wage inequality, and the gains from trade for developing economies. The literature suggests that countries with intermediate levels of productivity and product quality may be the big winners of globalization: in the catch-up phase of globalization, wage, productivity, and quality differentials in countries such as Brazil, China and India create profit incentives for firms to increase product quality, with subsequent dynamics leading to gains from trade.[13] In particular for Latin-American economies, it has been argued that, after trade liberalization, firms increased quality of products exported to high income countries, while the domestic market and neighboring low income countries continued consuming low quality varieties. Verhoogen (2008) finds that more productive Mexican firms export more and pay higher wages, and suggests that these firms produce higher quality to export to high income destinations. A similar argument is used by Brambilla, Lederman, and Porto (2010) to explain skill composition of Argentinean firms. I build on a similar argument for the Brazilian economy, and integrate information on workers' skills and wages with direct information on producer quality upgrading, which allows explaining the importance of product quality to the cross-country patterns of trade.

Finally, my paper is also related to the literature on firm heterogeneity, a central feature in the trade literature for the last decade. An additional implication from the paper relates to the isomorphism between different heterogeneous firm models. First, I show empirically that firms are indeed heterogeneous in quality and confirm the predictions from the theoretical literature. Second, by showing that quality varies not only across firms, but also within firms across destination countries, I show that efficiency sorting models (with heterogeneity in productivity)[14] and quality sorting models (with heterogeneity in the ability to produce product quality)[15] may be non-isomorphic.[16]

The paper is organized as follows. Section 2 develops the theoretical framework. Section 3 describes the data and presents descriptive statistics. Section 4 presents the empirical strategy. Section 5 shows the results and Section 6 provides further extensions. Section 7 concludes.

[13]See Sutton (2007) for a discussion on the winners of globalization. Sutton (2007) argues that trade liberalization per se does not benefit countries in the intermediate range. But the dynamics that follow with subsequential phases of liberalization, with foreign direct investment, and capability transfers, may determine the big winners from globalization.

[14]Examples of such models are Melitz (2003) and Melitz and Ottaviano (2008).

[15]Examples of such models include Baldwin and Harrigan (2011) and Hallak and Sivadasan (2009).

[16]For these models to be isomorphic, one would need to assume that firm-level technological change is also destination country specific. Although, in my results, I show that the asymmetric effect across countries is specific to quality upgrading. It does not hold for other firm-level changes, such as technology upgrading.

2 Product innovation and market segmentation

To provide a framework for the empirical analysis, this section presents a partial equilibium model of trade, product quality upgrading and market segmentation. The model combines product quality (as in Verhoogen (2008)), workers skills (similar to Brambilla, Lederman, and Porto (2010)) and fixed innovation costs (similar to Bustos (2011)).

The model has two important sources of heterogeneity. From the production side, some firms pay a fixed product innovation cost F^I and increase product quality. From the demand side, income differences lead to a different willingness to pay for quality. Firms endogenously set prices and quality.

2.1 Demand

The demand side of the model follows Verhoogen (2008). There are two markets, North and South. In each market, indexed by $c = N, S$, there are K statistically identical consumers, indexed by k. The utility that each consumer k in country c derives from consuming a product from firm j is given by:

$$U_{kjc} = u(x_o) + \theta_{jc} + \epsilon_{kjc} \tag{1}$$

where x_o is the consumption of the numeraire good, ϵ_{kjc} is a consumer-specific random deviation, and θ_{jc} is the quality parameter of one unit of a product consumed in country c and sold by firm j.

Consider the optimization problem for an individual with income y_c. After paying p_{jc} to buy one unit of his most preferred differentiated product, the individual spends the residual income $(y_c - p_{jc})$ on the numeraire good. Optimization yields the indirect utility[17]

$$V_{kjc} = \theta_{jc} - p_{jc}u'(y_c) + \epsilon_{kjc} \tag{2}$$

where $u'(y_c)$ is the marginal utility of income. The inverse of $u'(y_c)$ captures the quality valuation: the lower $u'(y_c)$, the higher is the willingness to pay for quality.[18]

As is standard in discrete choice models[19], for ϵ_{kjc} a random deviation that follows a type 1 extreme-value distribution, the expected demand for each good can be represented as a standard multinomial-logit formulation:

$$x_{jc} = \frac{K_c \exp\left[\frac{1}{\mu}(\theta_{jc} - p_{jc}u'(y_c))\right]}{\sum_{z \in Z^c} \exp\left[\frac{1}{\mu}(\theta_{zc} - p_{zc}u'(y_c))\right]} \tag{3}$$

[17] As in Verhoogen (2008), product price p_{jc} needs to be small relative to the consumer's income y_c. Then the first-order expansion of the sub-utility yields equation (2). Note that $u(y_c)$ does not affect the choice probability and will drop out of the aggregate demand, what leads to equation (2).

[18] For a given quality level θ_{jc}, individuals with lower $u'(y_c)$ are willing to pay higher prices.

[19] See McFadden (1974), McFadden (1978).

where K_c is the mass of consumers in country c, Z_c is the set of all available products in c and μ is a parameter that captures the degree of differentiation between goods.[20]

2.2 Production

For simplicity, there is a fixed number of firms J in the source country producing a differentiated product. Similar to Brambilla, Lederman, and Porto (2010), to produce one unit of a product, the firm needs standard manufacturing inputs and activities, as well as inputs and activities to differentiate the product and produce a certain level of quality. The first requires a units of labor. The second requires $b\theta_{jc}^{\beta}$ units of labor, with $\beta > 1$.[21] θ_{jc} is the vertical differentiation parameter, i.e., the quality level the firm decides to produce. Thus, producing higher quality requires more skilled workers. For simplicity, I assume, as Brambilla, Lederman, and Porto (2010), that standard manufacturing activities require only unskilled labor, while producing a certain level of quality requires skilled labor. Wages of the unkilled workers are normalized and wages of the skilled workers are denoted by w.[22]

I distinguish firms according to the innovation costs. Some firms pay a fixed innovation cost F^I to increase product quality. Since firms innovate to upgrade quality, the innovation cost does not affect the production of standard manufacturing activities (conducted by unskilled workers), but only the costs of producing the quality differentiated variety (activities performed by the skilled workers).[23] [24]

Firms that incur cost F^I can more efficiently produce a certain quality level, by a factor $\gamma_j > 1$ (a firm-specific random draw). Firms with sufficiently low γ_j will not incur the innovation cost to increase product quality. The total cost functions TC for innovative firms I and non-innovative firms NI are, respectively,

$$TC_j^I = \left(a + \frac{b\theta_{jc}^{\beta} w}{\gamma_j} \right) x_j(\theta_{jc}, p_{jc}) + F^I \tag{4}$$

[20] As $\mu \to 0$, the model approaches perfect competition (see Verhoogen (2008)).

[21] There are decreasing returns of vertical differentiation. When quality increases, there are diminishing returns of reaching an additional consumer (search efforts are higher and shifting the demand function becomes more difficult). This assumption follows Brambilla, Lederman, and Porto (2010), for quality differentiation, and Arkolakis (2010), for marketing investments. In Arkolakis (2010), as marketing expenditure increases, marketing efficiency declines and it becomes more difficult to shift demand. Higher values of β correspond to more intense diminishing returns.

[22] There is a large homogeneous goods sector that employs skilled and unskilled workers in fixed proportions. This pins down wages, as in Brambilla, Lederman, and Porto (2010).

[23] The innovation costs differ from the technological upgrading in Bustos (2011), where the fixed cost represents a standard process innovation.

[24] F^I could be, for instance, investment in softwares for product design or product engineering. These costs will not affect standard manufacturing activities but will increase the productivity of the skilled workers (e.g., after the innovation cost, designers have more time for product development, will be more creative and able to produce highly differentiated products). Thus, one can think of the innovation cost as a skill-biased innovation, which will lead to the production of higher quality.

$$TC_j^{NI} = \left(a + b\theta_{jc}^{\beta} w\right) x_j(\theta_{jc}, p_{jc}) \tag{5}$$

with $\gamma_j > 1$ for innovative firms and aggregate demand (demand in North and South) for a firm j defined as $x_j = x_{jN} + x_{jS}$.

Firms with $\gamma_j > 1$ will incur the fixed cost F^I; for firms with sufficiently low γ_j it is not optimal to pay the fixed innovation cost F^I. The maximization problem for innovative I and non-innovative NI firms follow:

Innovative firms **I** maximize profits $\pi_j^I = \pi_{jN}^I + \pi_{jS}^I - F^I$, where π_{jN}^I and π_{jS}^I are the profits before fixed cost in each destination country $c = N, S$:

$$\pi_{jc}^I = \left(p_{jc} - a - \frac{b\theta_{jc}^{\beta} w}{\gamma_j}\right) x_{jc}(\theta_{jc}, p_{jc}), \text{ with } c = N, S.$$

Non-innovative firms **NI** maximize profits $\pi_j^{NI} = \pi_{jN}^{NI} + \pi_{jS}^{NI}$, where π_{jN}^{NI} and π_{jS}^{NI} are the profits before fixed cost in each destination country $c = N, S$:

$$\pi_{jc}^{NI} = \left(p_{jc} - a - b\theta_{jc}^{\beta} w\right) x_{jc}(\theta_{jc}, p_{jc}), \text{ for } c = N, S.$$

Firms choose p_{jc} and θ_{jc} and maximize profits for each country of destination c. The vertical differentiation parameter θ_{jc} is chosen to equalize its marginal cost to the inverse of $u'(y_c)$, which represents the quality valuation. Using equation (3), the solution for θ_{jc} is given by:

$$\theta_{jc} = \left(\frac{\gamma_j}{\beta b w} \frac{1}{u'(y_c)}\right)^{\frac{1}{\beta - 1}} \tag{6}$$

with $\gamma_j = 1$ for non-innovative firms.

The parameter θ_{jc} increases with the quality valuation $\frac{1}{u'(y_c)}$: firms produce high quality for markets willing to consume high quality. θ_{jc} also increases with γ_j: for firms that invest in product innovation, for which $\gamma_j > 1$, it is optimal to increase product quality. For firms that did not incur the innovation cost, it is too costly to increase product quality by the same amount. Note that, because of a higher optimal θ_{jc}, innovative firms (that initially reduced marginal costs by γ_j) increase marginal costs by $\gamma_j^{\frac{1}{\beta-1}}$ by producing a higher quality level. The solution for prices follows

$$p_{jc} = a + \frac{1}{u'(y_c)} + \left(\frac{\gamma_j}{bw}\right)^{\frac{1}{\beta-1}} \left(\frac{1}{\beta u'(y_c)}\right)^{\frac{\beta}{\beta-1}} \tag{7}$$

with $\gamma_j = 1$ if the firm does not incur the F^I innovation cost.

2.3 Product quality and export destinations: effect on the profile of prices

I derive three predictions from the model, which are tested empirically using Brazilian firm-level data. I study which firms upgrade product quality and to which markets they upgrade quality, i.e., whether firms segment the market and offer higher quality at higher prices to Northern countries. These predictions can be summarized as follows:

Prediction 1: *Innovative firms sell higher quality at higher prices after innovation.*

Heterogeneity in γ_j leads innovative firms to produce higher quality at higher prices. From the solution for θ_{jc}, if a firm innovates, it optimally produces a higher level of θ_{jc}, since $\gamma_j > 1$. A higher γ_j leads to higher quality (from equation 6) and to higher prices (from equation 7). Thus, innovative firms jointly increase price and quality.

Prediction 2: *Northern consumers buy the quality upgraded product and pay higher prices. For a sufficiently low income y_S, Southern consumers choose low quality products and pay low prices.*

Since Northern consumers have a higher quality valuation ($\frac{1}{u'(y_N)} > \frac{1}{u'(y_S)}$), it is optimal for the firm to choose a higher θ_{jc} to sell in Northern countries. From equation (7), $\frac{1}{u'(y_N)} > \frac{1}{u'(y_S)}$ implies that $p_N > p_S$ for a given firm j.

From equation 7, since $\gamma_j > 1$, $\frac{\partial p^I_{jc}}{\partial \frac{1}{u'(y_c)}} > \frac{\partial p^{NI}_{jc}}{\partial \frac{1}{u'(y_c)}}$: the difference in prices is higher for innovative firms. For a sufficiently low y_S and a residual income $y_S - p_{jc}$, Southern consumers can only afford consuming the low quality product with price p_L, such that $x_o + p_L \approx y_S$ and $u(y_S - p_H) \approx 0$, for p_H the price of a high quality product.[25]

An important caveat of the model refers to the non-innovative firms exporting to Northern countries. The model predicts that $p^I_{jN} > p^{NI}_{jN} > p^{NI}_{jS}$. Given a different willingness to pay in North and South, non-innovative firms would increase (by less than innovative firms) prices to the North (this could be interpreted as a markup pricing). In the empirics, I show that the difference $p^{NI}_{jN} - p^{NI}_{jS}$ is not statistically significant. For a more complete analysis, one could extend the model as in Fajgelbaum, Grossman, and Helpman (2011), in which consumers are heterogeneous within a country, and quality and prices increase in income. In this case, there would be a share of the population in Northern countries consuming low quality at low prices, as shown in the empirics.

[25] Note that prices may not be too similar to income, such that the first-order expansion of sub-utility in equation 1 holds.

Prediction 3: *Innovative firms jointly increase product quality and the share of skilled workers, and hire* $\gamma_j^{\frac{1}{\beta-1}}$ *more skilled workers than non-innovative firms.*

Quality differentiation activities are performed by skilled workers, while standard manufacturing activities are performed by unskilld workers. Using the solution for θ_{jc}, the demand for skilled workers for innovative firms is given by:
$\frac{b\theta_{jc}^{\beta}}{\gamma_j} = \left(\frac{\gamma_j}{b}\right)^{\frac{1}{\beta-1}} \left(\frac{1}{\beta w u'(y_c)}\right)^{\frac{\beta}{\beta-1}}$. Thus, relative to non-innovative firms, innovative firms hire more skilled workers by a factor of $\gamma_j^{\frac{1}{\beta-1}}$.[26]

3 Data

3.1 The Brazilian economy in the 1990s

The period under analysis in the empirical part of the paper is 1997-2000. To understand firms' behavior in this period, I provide a background on the Brazilian economy in the 1990s.

The 1990s represent a particular moment for the Brazilian economy: economic stability after the end of decades of inflation, trade liberalization, the introduction of the *Real* as the new currency in 1994, high increases in productivity and a sharp currency devaluation in 1999. Trade liberalization created opportunities for Brazilian exporters but also represented a challenge, once they faced tougher competition and needed to adapt their products to be able to compete in tougher markets.[27] The local currency, pegged to the U.S. dollar until 1999, was overvalued in the last years of this period. Thus, firms were able to import better technology at lower prices and to adapt their production to international standards. In 1999, the change in the exchange rate regime to free float culminated in a sharp devaluation that created additional incentives for firms to export.

Firm internal R&D activities were 40% higher in the period 1998-2000 in comparison to the later years (PINTEC 2003). Among the reasons for manufacturing exporters to innovate, the most cited in the period 1998-2000 were (1) *to maintain their market share* and, (2) *to improve product quality* (PINTEC 2000).[28] When asked about the most important market and the most important strategic change, most firms answered they *innovate to meet foreign*

[26] For simplicity, the demand for unskilled workers does not change.

[27] Mündler (2004) studies the effects of trade barriers on the productivity of Brazilian firms in the period 1986-98. His results indicate that foreign competition pressures are an important source of productivity change. Bloom, Draca, and Rennen (2011) look at the effect of competition with Chinese products on innovation rates in developed countries. They find that trade liberalization caused developed countries to increase their investments in technology due to competition. Martin and Méjean (2011) study the effect of low-income countries' competition on quality upgrading of French firms.

[28] These informations are available for 3750 exporters surveyed in the period 1998-2000. For instance, concerning the market, firms were asked whether they innovated to maintain their market shares, to enter new markets or to increase their market shares. Most firms answered to maintain their market shares.

consumers requirements and *innovate to change product design*, respectively.[29] Moreover, anecdotal evidence suggests that many firms created an *export type product* in this period, a variety associated with higher quality. This variety was produced in conformity with the international quality standards, as requested for example in Japan and European countries. Thus, firms adapted their production lines to reach consumers with high/low willigness to pay for quality. Mercosur countries continued consuming the low quality varieties as before, while the high quality variety was shipped to high-income countries. A similar argument for other Latin-American economies is found in Verhoogen (2008) and Brambilla, Lederman, and Porto (2010). Brambilla, Lederman, and Porto (2010) claim that exporting to high-income countries requires higher quality and better skilled workers, while selling to neighboring Mercosur countries may require the same quality level from the domestic sales. Verhoogen (2008) uses a similar argument for the Mexican economy in the 1990s. [30]

The period was also marked by high increases in productivity: the productivity increase in 2000 was of 6.5% and in the years before it outnumbered 10% per year in some industries (Bonelli, 2001). Moreover, in an attempt to protect the home industry and to increase exports, the government implemented several programs to support firms to meet international standards, upgrade quality and be able to compete in tougher markets. Some important policies in this period were: (i) sectoral policies that included export financing facilities from the BNDES (the Brazilian Development Bank); (ii) the creation of the *Ministry of Development, Industry and Foreign Trade* (MDIC) in 1999; and (iii) special R&D incentives from the Ministry of Technology (Bonelli, 2001).[31]

3.2 Data sources

The data set is uniquely rich and combines three main data sources of Brazilian firms: (i) the three dimensional exports and price data, (ii) the employer-employee data, and (iii) the innovation survey. I match these three databases with additional sources, including the NBER-UN World Bilateral Trade Data and other data sources described in 3.2.2. These additional data provide a set of control variables for product, sector and country characteristics.

[29] For instance, concerning strategic changes, firms are asked whether they changed (i) the organizational structure, (ii) the marketing strategies, (iii) the product design or (iv) certifying norms. The highest mean of positive responses was attributed to changes in product design, followed by certifying norms.

[30] Verhoogen (2008) focuses on the effect of quality upgrading on wage dispersion. Verhoogen (2008) argues that after trade liberalization, Mexican firms had one product for the home market and one to be exported to the United States. The argument is illustrated with the example of the enterprise Volkswagen. Volkswagen produced at that time the Original Beetle with old technology to sell in the home market, and the New Bettle and Jetta with state-of-the-art technology to export to the U.S. market.

[31] Moreover, many other policies were created to help small and medium sized exporters, many of them specific to the European market.

3.2.1 Firm-level data: innovation, export prices and workers data

The firm-level data comes from three databases, and, in all of them, firms are identified by the unique CNPJ tax number. The first is the Brazilian three dimensional exports data from SECEX (Foreign Trade Secretariat). The second is the linked employer-employee data on the basis of Brazil's labor force records RAIS (*Relação Anual de Informações Sociais*). The third is the PINTEC Survey (Brazilian Firm Industrial Innovation Survey) from the IBGE (Brazilian Statistical Office).

SECEX exports data:[32] Contains annualized data on export sales, quantities and weights (mainly kilograms) by *firm, product and destination country* for the universe of Brazilian manufacturing exporters. The period used is 1997-2000. The classification of products follows the 8 digit level NCM classification (*Nomenclatura Comum do Mercosul*). The first six digits of NCM correspond to the first 6 digits HS classification (international Harmonized System), which allows comparison with international databases.[33]
All export values are reported in U.S. dollars (USD) *free on board* (f.o.b.). Values are deflated by the US CPI (United States Consumer Price Index) from August 1994.[34]
With the SECEX data, I create a measure of average prices as $Uprice_{fcgt} = \frac{Value_{fcgt}}{Quant_{fcgt}}$, in which $Value_{fcgt}$ represents sales and $Quant_{fcgt}$ the quantity sold of product g by firm f to country c at time t. Thus, $Uprice_{fcgt}$ represents the yearly average price by g, f, c and t. The precise steps to build the SECEX dataset are explained in the online Data Appendix.

Table 1 shows price variation in terms of standard deviations. Since most results shown in the empirical section refer to European Union and Mercosur, the standard deviation in Table 1 refers to these markets. Similar results to further countries are shown in the online Data Appendix. The upper part of the table shows that the standard deviation of log prices across destinations for a firm-product pair is on average 0.188 in the year 1997 and 0.200 in the year 2000. The lower part of Table 1 shows that the deviation of log prices within product-country pairs across firms is, on average, 0.459 and 0.486 in the years 1997 and 2000, respectively.[35] As expected, in both cases the variation is high for differentiated goods and

[32] The data comes from the Brazilian customs declarations for merchandize exports that is collected for every exporting firm by the SECEX (*Secretaria de Comércio Exterior* - Foreign Trade Secretariat).

[33] The correspondence between the NCM 6 digit and the HS 6 digit allows matching the Brazilian data with the NBER-UN bilateral world trade data documented by Feenstra, Lipsey, Deng, Ma, and Mo (2005), as well as with the Rauch (1999) classification of goods. I match the information of the HS classification with the SITC classification (Standard International Trade Classification) in order to be able to use the Rauch (1999) classification of goods and the NBER-UN world trade data.

[34] The reason for the base August 1994 is the introduction of the new currency, the real, in July 1994.

[35] The standard deviation is small comparing to the results reported by Manova and Zhang (2011) for Chinese firms. In the case of Chinese expoters, the standard deviation within firm-product across countries and within product-country across firms are, respectively, 0.46 and 0.90

low for homogeneous goods.

Employer-employee data from RAIS: The RAIS provides annual information on workers formally employed in any sector (exporters and non-exporters). I use annual information by firm on workers' education, occupation and average wages for the period 1997-2000. The firm-level variables of interest are: (i) average wages, (ii) share of workers with primary, high-school and tertiary education, (iii) number of workers, and (iv) share of workers by occupation, according to the International Labour Office (ILO) ISCO-88 classification of occupations. The variables are summarized in Table 3. More informations in the online Data Appendix.

PINTEC Industrial Innovation Survey: the PINTEC (*Pesquisa Industrial de Inovação Tecnológica*) conducts a triennial innovation survey among Brazilian firms. In this paper I use the wave 1998-2000, which contains detailed information concerning the firms' innovative efforts in the period 1998-2000.[36] Overall, there are 154 questions related to *product and process innovation*. For instance, for product innovation, firms are asked whether they improved a product in the period 1998-2000.[37] Firms are also asked about the importance of product innovation to improve *product quality* and asked for which market they innovate (domestic versus foreign).[38] The main variables used for the quality treatment are described in Table 2. Moreover, many other questions allow for robustness checks, including information on the main destination market (EU, Asia, Mercosur, US, other american countries), whether the firm invested in product design and whether the firm innovated to *maintain the market*[39]. The questions also allow evaluating asymmetries across products (e.g., the share of sales of the innovated product in the domestic and in the foreign market). See description of main variables in Table 2. For further information, see the online Data Appendix.

Since I am interested in manufacturing exporters, I keep only manufacturing industries in the sample. Keeping only manufacturing industries also makes the data comparable to other studies on the Brazilian economy, as Arkolakis and Muendler (2011). In Figure 2, I show the share of exports of the main industries that exported products to European Union and Mercosur. Firms are divided into industries according to their decision to upgrade product

[36] The innovation questionnaire is available at:
`http://www.pintec.ibge.gov.br/downloads/PUBLICACAO/Publicacao%20PINTEC%202000.pdf`.

[37] Corresponds to Questions 7 and 8 from the survey. In Question 7 firms are asked whether they improved a product already existent in the market (already sold by other firms). In Question 8 firms are asked if they improved a product that was new to the market

[38] Question 77 asks the importance of product innovation to increase *product quality*. Question 106 asks where are located the consumers to which the firm innovated. Most firms that innovated answered they innovated to meet foreign consumers requirements.

[39] Firms are asked whether they innovated to maintain the market, to increase market share, to enter new markets, to increase the scope of product, to increase production capacity or production flexibility, to reduce labour costs, to reduce energy costs, among others.

quality.[40]

The SECEX exports data and the employer-employee data are available for the universe of Brazilian manufacturing exporters. The Innovation Survey from PINTEC is available for a representative sample of 3750 manufacturing exporters.[41] Of those, 3070 exported in the year 2000 and 2868 exported in the year 1997. Since I am mainly interested in the variation over time (before and after the innovation survey), I keep only firms that are permanent exporters. This reduces the sample to 2443 firms. New exporters and quitters are analyzed separately only for robustness checks.[42]

Table 4 presents summary statistics for the 2443 permanent exporters, by innovative behavior and year. I show their main characteristics for the years 1997 and 2000. Clearly, innovative firms have higher revenues and sell more products in more destination markets. An interesting fact from Table 4 is that the two groups have *similar trends* from the year 1997 to 2000. Despite for the variables related to workers' characteristics, the variation over time for the two groups go in the same direction. Moreover, the fact that workers' characteristics face different trends in the two groups is an interesting result: as stated in Prediction 3, innovative firms need better skilled workers to produce higher quality. Thus, I expect an increase in skills for the innovative firms.

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[40]For the sample of exports to the European Union and Mercosur (the sample used in great part of the paper), the industries used are: Manufacture of beverages, Manufacture of tobacco products, Manufacture of textile products, Manufacture of clothes, Leather manufacture, Wood products, Cellulose and derivatives, Paper, paperboard and articles of paper pulp, Reproduction and printing services of didactic and commercial materials, Refinery of petroleum, Manufacture of pharmaceuticals, Manufacture of fertilizers and pesticides, Manufacture of rubber and plastics, Manufacture of glass and stone products, Iron and steel basic industries, Processing and manufacturing of nonferrous metals, Manufacture of metal products (excluding machines and equipments), Manufacture of machines and equipments, Manufacture of office, computing and accounting machinery, Manufacture of electrical industrial machinery and apparatus, Manufacture of basic electronic components, Manufacture of radio, television and communication equipment and apparatus, Manufacture of medical and therapeutic apparatus, manufacture of measurement testing, automation and control instruments, Manufacture of automobiles, light trucks and utility vehicles, Manufacture of motor vehicle bodies, interiors and trailers for trucks and other vehicles, Manufacture of motor vehicles, Building and repair of ships, boat for sports and leisure and floating structures, Manufacture and repair of aircrafts, Manufacture of furniture, Manufacture of toys and games, hunting, fishing and sporting goods, musical instruments (diverse goods).

[41]The survey was conducted with manufacturing exporters, non-manufacturing exporters and domestic firms, with a total of 10658 firms. The interest of this work lies in manufacturing exporters, and therefore the sample has 3750 firms. Note that also intermediaries and their commercial resales of manufactures are removed from the sample. Thus, the products and firms from the sample are comparable to the sample used in other studies, as Arkolakis and Muendler (2011) and Eaton, Kortum, and Kramarz (2004).

[42]For the comparison between European Union and Mercosur, I keep only firms that exported to these groups of countries. In a second step, I also drop all firms that exported exclusively to Mercosur, which reduces the sample to 1400 permanent exporters. As a comparison regarding sample size, in the study on innovation and technology upgrading with Argentinian firms, Bustos (2011) uses a sample of 1639 surveyed firms.

3.2.2 Control variables

World bilateral trade flows: The bilateral trade flows data comes from the NBER-UN yearly trade data (`www.nber.org/data`), documented by Feenstra, Lipsey, Deng, Ma, and Mo (2005). The NBER-UN trade data provides an accurate measure of trade flows using the Standard International Trade Classification (SITC 2 - Division), 4 digits, which is matched with the HS classification.[43] Since the first six digits of the Brazilian NCM product classification correspond to the first 6 digits HS (international Harmonized System) classification, it is possible to match these databases. The values are mainly reported by the importing country, leading to a more accurate measure (because of differences between c.i.f. and f.o.b. prices , s. Feenstra, Lipsey, Deng, Ma, and Mo (2005)).

With the NBER-UN data I calculate different measures of market power and a proxy for production (measured by the importance of each sector in the destination market). The variables are defined in Table 3.

World trade elasticities: Data on import demand elasticities from Broda, Greenfield, and Weinstein (2010). The elasticities are available at the 3-digit HS for 73 countries.

GDP per capita: Data on GDP per capita ($CGDP_c$) comes from the Penn World Table (PWT) 6.2. The version 6.2 uses the year 2000 as the base year.

Income inequality: Income inequality data (Gini coefficient and income deciles) comes from the UNO-WIDER (United Nations World Institute for Development Economics Research)[44]. In case of duplicate values for a year-country pair, I choose the highest quality rating, keep the latest revision, keep if the area covered is the whole country, and give preference to disposable income information.[45] [46]

Rauch classification of goods: Rauch (1999) uses the 4 digit SITC product classification (issued by the United Nations) to aggregate the trade data in three groups of commodities: (i.) w, homogeneous (organized exchange) goods: goods traded in an organized exchange; (ii.) r, reference priced goods: not traded in an organized exchange, but which have some quoted reference price, as industry publications; and (iii.) n differentiated goods: without

[43] The U.S. Imports data from the NBER-UN provides a concordance concordance between SITC 2 and the HS 6 digits classification.

[44] Data available at http://www.wider.unu.edu/research/Database/en_GB/wiid/.

[45] The precise steps to drop duplicate values are: (i) keep the highest quality rating, (ii) keep the latest Revision, (iii), keep if the area covered is the whole country, (iv) keep if the income unit is the household, (v) keep if the statistical unit is the person, (vi) keep if the income definition is Disposable Income, (vii) drop if information on currency is not available.

[46] Information on the Gini coefficient is available for all countries in the sample of EU and Mercosur countries, except for Paraguay in the year 2000. For Paraguay I use the information from the year 1999. For robustness checks using additional countries, I need to expand the Gini coefficient in case the information is missing for a given year: for the cross-section 2000, for instance, information on the Gini coefficient was available only for 73 countries. Thus, in case the information for the year 2000 is missing, I use information from the years 1999 and 2001, respectively. Similar for 1997, which increases the sample to 91 countries.

any quoted price.[47] When I refer to non-differentiated goods, I mean reference priced goods and homogeneous goods.

4 Empirical strategy

In this section I design the empirical approach to test Predictions 1, 2 and 3 from the model. The identification strategy follows a difference-in-difference-in-differences (DDD) strategy. I compare export prices in the years 1997 (t_0, before treatment) and 2000 (t, after treatment) for the EU (treated) and Mercosur (control group) for firms that upgraded product quality (treated) and firms that did not (control group). Figure 3 presents in a simple way the structure of the treatment effects. I assume that, controlling for firm-product-country fixed effects, period fixed effects and several time-varying variables, the price effect I identify is due to quality differences across groups. In Sections 5 and 6 I discuss identification issues. To test Prediction 3 from the stylized model, the treated group is represented by firms that did both skill and quality upgrading over time.

Since the interest lies in the variation over time, only permanent exporters active in the destination markets of interest are kept in the sample. Most of the results refer to EU and Mercosur, and in Section 6 the analysis is extended to further countries, such as the United States. Mercosur and EU are used in the main analysis for two main reasons. First, besides the United States, the EU and Mercosur represent the main markets for Brazilian products. Second, following the motivation from Section 3.1, EU and Mercosur represent the extremes of the quality varieties exported by Brazilian firms. Thus, for these two groups, there is a lower probability that the firm ships a mix of quality products to the same market. For the EU, a market with a high share of high-income individuals, firms are willing to innovate and to upgrade quality. For the Mercosur, a market with a high share of low-income individuals, firms have low profit incentives to introduce their high quality product (e.g. because of entry and marketing costs, or production capacity constraints).[48] [49]

[47]With this classification, goods are divided in 349 reference priced goods, 146 homogeneous goods and 694 differentiated goods. As shown in Bastos and Silva (2010a), the Rauch (1999) classification of goods is well suited for capturing quality differentiation across products.

[48]In some South American countries as Chile, for instance, it is less clear whether consumers buy the low quality variety or the high quality variety. This is also the case of some new European countries that were not in the European Union by 2000.

[49]I also carry robustness checks using only the EU countries with similar (high) income per capita and same currency: France, Germany, Netherlands, Luxembourg and Austria.

4.1 Quality upgrading

A firm upgrades product quality from time t_0 to t if answers affirmatively in the innovation survey to the questions: *undertook product innovation and product innovation was important to increase product quality.* See the description of questions in Table 2. For $Qual_{ft_0}$ the initial level of quality of a firm f, if the firm answers positively both questions, then $Qual_{f,t} > Qual_{ft_0}$. The dummy variable for quality upgrading over time follows:

$$Upgrade_{ft} = \begin{cases} 1 & \text{if } t > t_0 \wedge Qual_{ft} > Qual_{ft_0} \\ 0 & \text{if } t < t_0 \vee Qual_{ft} = Qual_{ft_0} \end{cases}$$

I check the robustness of the results using different questions from the survey: whether firms innovated to meet foreign consumers requirements, whether they innovated to change product design, and the share of sales of the innovated product in the domestic and foreign market.

According to **Prediction 1** from the theoretical model, if a firm invests in product innovation and increases product quality ($Upgrade_{ft} = 1$), then $\Delta_{t,t_0} Uprice_{fcgt} > 0$, for $Uprice_{fcgt}$ the yearly average export price of product g from firm f sold to country c in time t (see variables description in Table 2). Importantly, for simplicity of exposition, the stylized model from section 3 assumed that each firm produces one variety. In the empirics, around 77% of the firms in the sample are multiproduct firms. Thus, products are indexed by g and firms by f. I exploit asymmetries across products later in this section.

Firms that did not upgrade quality over time, for which $Upgrade_{ft} = 0 \ \forall t$, are used as a control group. Note that $Upgrade_{ft} = 0 \ \forall f$ in t_0. I control for many firm, product and market characteristics that might vary over time. The DD specification follows:

$$log(Uprice_{fcgt}) = \mathbf{Upgrade}_{ft}\gamma_{dd} + log(\mathbf{X}_{fcgt})\beta + \delta_{fcg} + \mu_t + u_{fcgt} \quad (8)$$

where the TREATED group is composed by firms that upgraded product quality over time ($Upgrade_{ft} = 1$); $log(\mathbf{X}_{fcgt})$ is a vector of control variables described in Table 3; δ_{fcg} is a firm-product-country unobserved heterogeneity; μ_t is a time-varying intercept; and u_{fcgt} is an error term.

In the DD specification, interest lies in the pattern of the coefficient γ_{dd}. It shows the effect of quality upgrading on the profile of prices, expected to be positive.

Moreover, according to **Prediction 2**, firms differentiate product quality to attend demand from the North. The motivation and plausibility for this prediction has been discussed in Section 3.1. As a hypothesis, products sold to the EU by innovative firms received the quality treatment, while products exported to Mercosur did not receive the treatment over time (control group). The DDD specification follows:

$$log(Uprice_{fcgt}) = \mathbf{Upgrade}_{ft} * \mathbf{EU}\gamma_{ddd} + Upgrade_{ft}\alpha_1 + EU\alpha_2 + log(X_{fcgt})\beta + \delta_{fcg} + \mu_t + u_{fcgt} \quad (9)$$

where the TREATED group are the products exported to the ($EU = 1$), by firms that upgraded product quality over time ($Upgrade_{ft} = 1$).

In the DDD specification, the coefficient of interest is γ_{ddd}. The effect is expected to be positive: higher prices in the EU are explained by imports from firms that innovate and upgrade product quality.

Results for equation (9) are shown for different types of goods, using the Rauch (1999) classification of goods. I expect a positive and significant effect of γ_{ddd} only for differentiated goods, which have scope for quality differentiation. For non-differentiated goods (reference priced goods and homogeneous goods) results are expected to be non-significant.

I discuss the markup hypothesis and whether higher prices to the EU might be a consequence of different elasticities of substitution. Results are shown in Section 5.

Since the treatment is not a random assignment, I carry out several robustness checks in Sections 5 and 6.

As alternative treatment measures for $Upgrade_{ft}$, I use different questions from the PINTEC (2000) innovation survey. For instance, the importance (percentage of sales) of the innovated product in the domestic and foreign markets, the importance of product innovation and whether the firm changed the product to adapt to international rules and certifying norms.

4.2 An integrated quality and skill upgrading mechanism

According to Prediction 3, producing higher quality requires a higher share of skilled workers.[50] Thus, by increasing the level of quality θ_{jc}, firms also increase the quality of their workers.

The prediction on complementarity is tested using a *skill upgrading mechanism*. The variation in workers skills over time (*skill upgrading*) is proxied by the increase in the firm's share of workers with tertiary education ($\Delta_{t,t_0} ShareHighEduc_f$), the increase in the firm's

[50] Firms that upgrade product quality need better qualified workers. Similar cases were analysed in the literature before by, e.g., Yeaple (2005) for technology choice, and Brambilla, Lederman, and Porto (2010) for quality choice.

share of professionals ($\Delta_{t,t_0}ShareProfessionals_f$) and the increase in firm's average wages ($\Delta_{t,t_0}Wages_f$) between 1997 (t_0) and 2000 (t). I compare the variation over time to the median of the industry i, taken as the threshold.[51] The dummy variable for skill upgrading follows:

$$Skills_{ft} = \begin{cases} 1 & \text{if } t > t_0 \wedge \\ & \Delta_{t,t_0}ShareProfessionals_f > median(\Delta_{t,t_0}ShareProfessionals)_{\mathbf{i}} \wedge \\ & \Delta_{t,t_0}ShareHighEduc_f > median(\Delta_{t,t_0}ShareHighEduc)_{\mathbf{i}} \wedge \\ & \Delta_{t,t_0}Wages_f > \wedge median(\Delta_{t,t_0}Wages)_{\mathbf{i}} \\ 0 & otherwise \end{cases}$$

$Skills_{ft}$ means that a firm upgraded workers skills from t_0 to t if the variation in workers characteristics is higher than then median variation in the same industry i.[52] Prediction 3 of the model suggests that skill upgrading over time ($Skills_{ft} = 1$) leads to increases in prices, $\Delta_{t,t_0}Uprice_{ft} > 0$.

To estimate the joint effect of quality and skill upgrading, I include the interaction effect $Skills_{ft}{*}Upgrade_{ft}$. The effect of quality and skill upgrading on prices is estimated as follows:

$$log(Uprice_{fcgt}) = Skills_{ft}{*}Upgrade_{ft}\gamma_{dds} + Skills_{ft}\beta_1 + Upgrade_{ft}\beta_2 + log(\mathbf{X}_{fcgt})\beta_3 + \delta_{fcg} + u_{fcgt} \tag{10}$$

where the TREATED group is composed by firms that upgraded product quality and workers' skills over time ($Skills_{ft} * Upgrade_{ft}$). The coefficient of interest is γ_{dds} and is expected to be positive. Firms that jointly increase product quality and workers' skills charge higher prices. The variable $Skills_{ft}$ is also tested separately.

One important critique to the *skill upgrading mechanism* could be that wages may be determined ex post and they would, in this case, reflect rent-sharing and not skill upgrading. See, for instance, the discussion of rent-sharing in Frías, Kaplan, and Verhoogen (2009).

As a robustness check, the same analysis is carried out without wages, using the variable $Skills_{ft}^{nowage}$. This variable considers only the $\Delta_{t,t_0}ShareProfessionals_f$ (measure of white-collar occupation) and $\Delta_{t,t_0}ShareHighEduc_f$ (measure of education), which are for sure ex ante decisions of the firm, as follows.

[51] If a firm increased these shares and the average wages more than the industry median between 1997 (t_0) and 2000 (t), then the firm upgraded workers' skills in this period.

[52] With this assumption, it might happen that some firms below the median upgraded workers' skills too, what would underestimate the results. Although, the assumption rules out a possible bias due to trends in specific industries. Another concern with this specification relates to negative values of the median (in case the whole industry had a negative shock). Thus, alternatively, I estimate the results only for the industries that have not suffered negative shocks in the period. I also estimate results without wages. Results are robust in both cases.

$$Skills^{nowage}_{ft} = \begin{cases} 1 & \text{if } t > t_0 \wedge \\ & \Delta_{t,t_0} ShareProfessionals_f > median(\Delta_{t,t_0} ShareProfessionals)_{\mathbf{i}} \wedge \\ & \Delta_{t,t_0} ShareHighEduc_f > median(\Delta_{t,t_0} ShareHighEduc)_{\mathbf{i}} \wedge \\ 0 & otherwise \end{cases}$$

The skill upgrading without wages, with interaction term $Skills^{nowage}_{f,t} * Upgrade_{ft}$, is tested in the same way shown in equation 10.

5 Results

This section presents evidence of quality-based market segmentation: firms increase product quality and prices to high-income countries. The section is divided as follows. In section 5.1., I confirm prediction 1 from the stylized model: firms jointly increase product quality and product prices. In section 5.2., I confirm prediction 2 from the model: firms that upgrade quality raise quality and prices to high-income countries. In section 5.3., I show that higher prices in high-income countries are not driven by different markups or elasticities of substitution, but are rather a result from quality upgrading and market segmentation. Finally, in section 5.4, I discuss prediction 3 from the model on the complementarity between quality upgrading and workers' skills.

Results are shown for European Union and Mercosur and, in section 6, I extend the analysis to further countries. Since I am interested in the variation *over time*, results are reported for permanent exporters to the EU and Mercosur.[53]

Tables 5 to 10 show results for predictions 1, 2 and 3 of the model and results against the markup pricing hypothesis. The control variables $\mathbf{x}_{gfc}$ used are described in Table 3.

5.1 Quality upgrading as an explanation for price differences across firms

The first results are shown in Table 5 and confirm Prediction 1 from the model: firms that increased product quality over time charge higher prices. The estimation strategy is the DD described in equation 9. The control group is represented by firms that did not upgrade product quality, for which $Upgrade_{ft} = 0 \; \forall t$. Estimations are shown using firm-product-country fixed effects, a period dummy and various control variables, described in Table 3.[54] Columns (1) to (3) include different measures of market share. Columns (1) to (3) show results for

[53] Permanent exporters are firms exporting to these markets in all years.

[54] The data is clustered at the firm-product level. Alternatively, clustering by firm-product-country does not change in general the significance and magnitude of the results.

differentiated goods and include different firm-product and country characteristics. Columns (4) to (6) show results for homogeneous goods. As expected, the effect on prices is only observed for differentiated goods, which have scope for quality differentiation. The results are robust to several measures of market power and to other firms' characteristics. Results from Table 5 are in line with the results from Crozet, Head, and Mayer (2011) for the French wine industry. They have shown that higher quality leads to higher prices.

5.2 Market segmentation: innovative firms upgrade quality to Northern countries

Table 6 shows the first results for the DDD, which corresponds to Prediction 2 from the model. Northern countries have a high demand for high quality products. Thus, firms increase product quality to attend this demand. In particular, in the period of the Brazilian economy under analysis, firms innovated to adapt to foreign requirements and to maintain their foreign markets, as discussed in Section 3.1. As shown in Columns (1) to (3), for differentiated goods the effect of quality upgrading on prices is captured by products sold to the EU. This is shown by the interaction term $Upgrade_{ft} * EU$: firms increased product quality and product prices to EU countries. As expected, results for homogeneous goods are not significant.[55]

5.3 Further evidence of market segmentation: higher prices in Northern countries can not be explained only by markups

5.3.1 The markup hypothesis

One important concern is pricing to market. It could be that the observed price variation across countries reflects markups and not quality shifts, even though the analysis controls for several measures of market power and market competition. Variation in markups across countries has been shown, e.g., by Simonovska (2010). To overcome this caveat, I present further evidence that supports the quality hypothesis, also using information on the elasticity of substitution across countries.

Before showing the robustness checks, one important fact is that, if we only analyse firms that exported *exclusively* to Mercosur, very few of them did product innovation. Out of 400 firms that exported exclusively to Mercosur in the period 1997-2000, only 3 firms did product innovation (information from the PINTEC (2000) innovation survey). This is an important

[55]Note that the level effect, $Upgrade_{ft}$ is not significant but even negative. This reinforces the fact that firms upgraded quality to Northern countries, since EU captures the whole effect.

support to the anecdotal evidence mentioned in Section 3: firms increased product quality to meet demand for high quality products, as requested in high-income countries. Firms that exported to neighbor countries had no incentive to increase product quality.

As a first exercise falsification exercise, I compare sales of non-innovative firms across markets. If the price effect is due to a (first degree) price discrimination in European countries and not due to quality upgrading, non-innovative firms should receive a price premium from their exports to the EU. In Table 7 I show results for the *EU* dummy. In Columns (4) to (6), I compare exports to the EU and to Mercosur only for non-innovative firms. Interestingly, the variable *EU* is not significant and even negative.[56] Thus, the variation in prices across countries can not be attributed to higher markups in Northern countries.

This analysis also rules out the possibility that prices are driven by market-specific shocks in Northern countries, or by changes in transportation costs: in this case, we would observe also for non-innovative firms an increase in prices to the EU. In contrast, results are not significant, as shown in Table 7.

A second falsification exercise is to compare sales to the South for firms that upgraded product quality compared to those that did not.[57] It could be that, after incuring the innovation cost to increase product quality, firms also sell the high quality variety to Southern markets. And, in case firms export high quality to the South, they should receive a price premium in the South. I check whether innovative firms increase prices to the South after quality upgrading (in comparison to firms that did not upgrade quality) in Table 8. Interestingly, the variable $Upgrade_{ft}$ has no effect on prices, i.e., firms that upgrade quality do not receive any price premium in the South in comparison to firms that did not upgrade quality. Thus, if there is only a small demand for high quality in Southern countries, firms have low incentives to introduce the high quality variety in the South. Results from Table 8 support the hypothesis that the price premium is completely driven by exports to the EU.

5.3.2 Markups and the elasticity of substitution

Using the 3 HS digit demand elasticities computed by Broda, Greenfield, and Weinstein (2010), I check whether results are robust to different elasticities of substitution across countries. If demand elasticities vary across countries, price variation across markets could reflect pricing to market, and not quality differences.

I divide the sample according to the relative similarity in the elasticity of substitution. If

[56] The effect is also not significant for the $COREPRODUCT_{ft}$ (the firms' most important variety, defined in Table 2).

[57] Innovative and non-innovative firms are active in both markets.

results for EU and Mercosur are not due to different elasticities (but due to different product quality), the effect of quality upgrading on prices should yield significant results also in sectors with similar elasticities.

The HS 3 digit sectors are divided according to the *similarity in the demand elasticity* in the EU and Mercosur. I generate two groups of elasticities (high and low), defined as follows: $SimilarHIGH = 1$ if both Mercosur and EU have a relatively high demand elasticity in a given HS 3 digit sector. An elasticity is defined as high if it is *above the median elasticity* in the HS 3 digit sector. The median is computed across all countries for which elasticity data is available (73 countries).

$SimilarLOW = 1$ if both Mercosur and EU have a relatively low demand elasticity in a given HS 3 digit sector. An elasticity is defined as low if it is *below the median elasticity* in the HS 3 digit sector. Also in this case, the median is computed across all countries for which data is available.

Thus, $SimilarHIGH$ and $SimilarLOW$ are measures of relative similarity in the elasticity comparing to other countries in the world.

Finally, I divide the sample according to the relative similarity in the elasticity (both high and low). The first sample corresponds to observations for which $SimilarHIGH = 1$ or $SimilarLOW = 1$ (in this case EU and Mercosur have similar elasticities, high or low). The second sample corresponds to observations for which $SimilarHIGH = 0$ or $SimilarLOW = 0$ (in this case EU and Mercosur have relatively different elasticities, either high or low).

If the price effect is not a result from variation in elasticities (implying markup pricing), then the price effect should hold for observations for which Mercosur and EU have relatively similar elasticities (either $SimilarHIGH = 1$ or $SimilarLOW = 1$).

Results are shown in Table 9. Columns (1) to (3) show that the effect of quality upgrading on prices is significant for sectors with relatively similar elasticities across countries. Columns (4) to (6) present results for sectors with different elasticities. Thus, results can not be explained only by different elasticities of substitution across countries.

5.4 An integrated quality and skill upgrading mechanism: upgrading workers' skills reinforces the effect of quality on prices

Innovative firms need more skilled workers to produce higher quality, a result shown in Prediction 3 of the model. Table 10 shows the results for the unified quality and skill upgrading mechanism.

Columns (1) and (2) show the results for $Skills_{ft}$: increasing workers' skills leads to higher prices. In Columns (3) and (4), the interaction term combining quality and the skill upgrading $Skills_{ft} * Upgrade_{ft}$ is added. Results reveal that firms jointly increasing product quality and workers' skills charge higher prices. While the level effect of $Skills_{ft}$ is not significant and even negative, the level effect for the variable $Upgrade_{ft}$ remains significant, suggesting that the complementarity among quality upgrading and skills is not perfect. Thus, factors different from workers' skills help explaining the effect of product quality on prices.

The analysis shown in columns (1) to (4) includes information on wages. As discussed in Frías, Kaplan, and Verhoogen (2009), wages might reflect rent-sharing. In this case, it would not capture skill upgrading. Thus, columns (5) to (8) present results including the interacton term $Skills_{ft}^{nowage} * Upgrade_{ft}$ (using only information on workers education and occupation, ex ante decisions of the firm). Results in columns (6) and (8) suggest that using information on wages might generate an upward bias in the coefficient of $Skills_{ft}^{nowage} * Upgrade_{ft}$, even though the significance of the results does not change [58].

The level effect of $Skills_{ft}^{nowage}$ is even negative and significant once the interaction term with quality is added. This negative result might capture observations for which skill upgrading is related to process innovation and not to product innovation.[59] Thus, while the effect of quality upgrading has a positive and robust effect on prices, the effect of skill upgrading on prices might reflect process upgrading as well.

[58] Although, further analysis is needed to study which firms are in each of the groups.

[59] One can easily imagine cases in which skill upgrading is related to technology upgrading, and not directly to product upgrading.

6 Extensions and placebo exercises

6.1 Results using different set of countries: The quality effect is not driven by EU and Mercosur

I extend the results to different groups of countries. The variable $Group = 1$ for Northern countries, and $Group = 0$ for Southern countries. Due to a small sample problem in some cases, all products (differentiated and non-differentiated) are included in the estimations, leading to a consistent analysis across groups. The groups are defined as:

$Group_1 = 1$ if country is EU or United States; zero if Mercosur.

$Group_2 = 1$ if country is United States; zero if Mercosur.

$Group_3 = 1$ if country is United States or Canada; zero if Mercosur.

$Group_4 = 1$ if country is EU, United States or Canada; zero if South America.

Results are shown in Table 11. In all cases, the interaction term $\mathbf{Upgrade}_{f,t} * Group$ is positive and significant, which means that results are not specific to the EU and Mercosur.

6.2 Price variation across countries is not observable for other sources of firm heterogeneity not related to quality

I evaluate whether price differences across firms and countries are indeed due to quality upgrading, or if they are also observable for other changes in firms' characteristics (other sources of firm heterogeneity). In particular, I look at process innovation for comparison.

The PINTEC (2000) innovation survey contains information on process innovation activities, as described in Table 2. The variable for process innovation $Process_{ft}$ is constructed in a similar way to $Upgrade_{ft}$:

$Process_{ft} = 1$ for firms that answered they did *process innovation* in time t, and zero otherwise.

I show results for $Process_{ft}$ across firms in Table 12. In Table 13 I add an interaction term $Process_{ft} * EU$ and show results *across firms and countries.*

Results in Table 12 reveal that $Process_{ft}$ is not significant, which is a plausible result. Following the efficiency sorting models of trade[60], more productive firms have lower marginal costs and charge lower prices. Thus, these models would predict a negative effect of process innovation (technology upgrading) on prices. Importantly, controlling for efficiency, the variable related to quality upgrading ($Upgrade_{ft}$) remains positive and significant in all specifications.[61].

[60] As Melitz (2003) and Melitz and Ottaviano (2008).

[61] The correlation between process and product innovation is very small, i.e., few firms did both types of innovation in the same period.

Results in Table 13 reveal that differences in prices *across countries* are not driven by process innovation. I show the results for the interaction term $Process_{ft} * EU$ in Table 13. As expected, prices are not higher in Northern (EU) countries in case of process innovation, wich supports the hypothesis of a quality-based market segmentation. The only significant value is found at the 10% level, without controlling for important changes in country characteristics. The control variables are the same used in the benchmark Table 6 for quality upgrading (the only difference is the additional column (2) in Table 13, which shows that the change in the significance of the results is not driven by the control variable $Mktshare_{gfct}$).[62] Thus, the differences in prices across countries can be attributed to quality upgrading.

6.3 Asymmetries across products, sectors and the importance of the core product for quality upgrading

I look at asymmetries among the firm's coreproduct ($COREPRODUCT_{ft}$) and other products. The $COREPRODUCT_{ft}$ is defined as the 8 digit variety representing the firm's highest sales.[63] [64] According to Eckel, Iacovone, Javorcik, and Neary (2011), firms invest more in the quality of the products closer to their core competence, since they may obtain higher margins with these products. Thus, the profile of prices is positively correlated with the profile of sales and the effect of $Upgrade_{ft}$ on prices is expected to be higher for the core product. I confirm this result in columns (1) and (2) for differentiated goods. The core product captures the effect of quality upgrading on prices, a result shown by the interaction term $COREPRODUCT * Upgrade_{ft}$. As expected, for homogeneous goods no effect is observed, as shown in columns (5) and (6).

- investment should be higher for the $COREPRODUCT_{ft}$. Thus, the effect of innovation on prices should be magnified for the core product.

The results for the core product are plausible, given the importance of the core variety for firms' sales. Around 77% of the firms in the sample are multiproduct firms. The core product represents more than 75% of exports for 38% of the multiproduct firms, and more than 50%

[62] I do similar robustness checks using further questions from the innovation survey not related to quality. For instance, whether the firm changed the organizational structure (question v150 from the innovation survey). Results are similar to the ones from Table 13.

[63] 77% of the firms in the sample are multiproduct firms. Interestingly, for 60% of the multiproduct firms, the coreproduct corresponds to more than 50% of the sales

[64] In the period under analysis, only 2 firms from the sample changed their 8 digit $COREPRODUCT_{ft}$. This does not imply that there is no product level dynamics within the firm. First, I find evidence of changes in the product mix for varieties that are not in the core. Second, within the 8 digit product there is a lot of quality variation and, most likely, product churning. Third, I evaluate only *permanent exporters*, which have less variation in their core business. Thus, the fact that the core product remains stable for those firms does not contradict the results from Iacovone and Javorcik (2010), Bernard, Redding, and Shott (2011) and Nocke and Yeaple (2008) on product level dynamics within the firm.

of exports for 73% of the multiproduct firms. Thus, sales are highly concentrated in the core product.[65]

The results are also in line with the results from Chatterjee, Dix-Carneiro, and Vichyanond (2011). They study multiproduct Brazilian exporters between 1997 and 2006 and find that, with a real exchange rate depreciation, firms adapt prices and quantities across products. Produts closer to the firms' core competence perceive higher increases in markups, since for the core product the firm has lower marginal costs of production. Although, they do not find any evidence of variation within firms across countries. Moreover, they do not use innovation data, and, thus, can not sort out the markup and the quality effect.

I also look at asymmetries across sectors using the Khandelwal (2010) classification of short and long quality ladders ($LADDER_{st}$, for a sector s and time t). The long quality ladders are sectors with higher scope for quality differentiation and, thus, the effect of quality upgrading on prices should be magnified for these sectors.

Columns (3) and (4) from Table 15 show that, for differentiated goods, the effect of quality upgrading on prices is captured by the products classified as long quality ladders. This result is shown by the interaction term $LADDER_{st} * Upgrade_{ft}$. For homogeneous goods, no effect is observed.

6.4 A placebo exercise using 1998 (year before treatment) as the treatment year: The effect of quality on prices is not driven by firms' characteristics

Results from Table 6 could be driven by firm-specific characteristics not related to quality upgrading. I generate a placebo exercise to overcome this issue. For that, the price variation in the period 1997-1998 (before treatment) is evaluated for the firms that received the treatment in the later period, compared to the control group that did not receive the treatment. I generate the variable $\mathbf{UpgradePlacebo}_{ft}$: $UpgradePlacebo_{ft} = 0$ in the year 1997 for all firms, and $UpgradePlacebo_{ft} = 1$ in the year 1998 for firms that received the treatment ($Upgrade_{ft} = 1$) in the subsequent period (1998-2000). If the effect is not firm-specific but related to the quality treatment effect, the variable $UpgradePlacebo_{ft}$ should not be significant. In Table 14, results show that the effect of the placebo variable $UpgradePlacebo_{ft}$ on prices is not significant. This result shows that the effect on prices is not firm-specific and supports the hypothesis of a quality-driven effect on prices.

[65]This results are in line with the results reported in Arkolakis and Muendler (2011).

7 Conclusion

A large empirical literature has argued that high-income countries consume high quality. To explain product quality variation across countries, the literature mainly uses prices as a proxy for quality (higher prices meaning higher quality).[66] Yet, without direct data on product quality, it has been impossible to separate product quality from other sources of price variation across countries, such as market competition and other sources of firm heterogeneity. I use direct information on quality upgrading over time and propose a new methodology using difference-in-difference-in-differences approach, which allows sorting out these effects.

The detailed firm-level measures on quality upgrading and prices by firm, product and destination country over time allow studying whether the observable price variation is due to quality variation, or to confounding factors. I find evidence of quality-based market segmentation, by which firms raise quality and prices to high-income countries. I show that differences in prices across countries are not driven by markups, but by demand for high quality.

The analysis is extended in several ways. First, using different North/South countries, I show that results are not specific to the EU and Mercosur. Second, I show that price differences across countries are specific to quality upgrading, and do not hold for other changes in firm's characteristics. Third, asymmetries across products reveal that the core product captures the whole effect of quality upgrading on prices. Finally, the robustness checks confirm the validity of the methodology.

[66] The literature also uses the destination country as a proxy for quality: exporting to destinations with high income suggests exporting higher quality.

A Data Appendix

Please check the online **Data Appendix** at

https://sites.google.com/site/lisandraflach/research.

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Table 1: Variation in export prices. Standard deviation for the years 1997 and 2000

	Obs	Mean	Std.Dev.	Min	Max
Variation in export prices across destinations within firm-product pairs					
Standard deviation of prices across destinations:					
Total trade, year 1997	9902	**0.188**	0.407	0	4.321
Differentiated goods, year 1997	8514	0.196	0.410	0	4.321
Homogeneous goods, year 1997	214	0.056	0.223	0	2.638
Total trade, year 2000	16030	**0.200**	0.464	0	5.705
Differentiated goods, year 2000	13025	0.201	0.454	0	5.705
Homogeneous goods, year 2000	245	0.094	0.272	0	2.019
Variation in export prices across firms within country-product pairs					
Standard deviation of prices across firms:					
Total trade, year 1997	6611	**0.459**	0.772	0	5.766
Differentiated goods, year 1997	5321	0.499	0.797	0	5.766
Homogeneous goods, year 1997	168	0.072	0.179	0	1.746
Total trade, year 2000	10768	**0.486**	0.824	0	6.150
Differentiated goods, year 2000	8173	0.511	0.821	0	6.150
Homogeneous goods, year 2000	203	0.212	0.618	0	4.015

Table 2: Description of the dependent variable and main explanatory variables

Variable	Variable description	Data source
Average prices:		
$Uprice_{fcgt}$	Average US dollars f.o.b. export prices by firm f, country c and product g at time t: $\frac{Value_{fcgt}}{Quant_{fcgt}}$, where $Value_{fcgt}$ is the export value and $Quant_{fcgt}$ the export quantity.	SECEX
Quality Upgrading and Product and Process Innovation:		
$Upgrade_{ft}$	$Upgrade_{ft} = 1$ if $t > t_0$ and if Firm did product innovation (questions v07 and v08 from PINTEC (2000) Survey) AND product innovation was important to increase product quality (question v77)[1]	PINTEC-IBGE
$Process_{ft}$	$Process_{ft} = 1$ if $t > t_0$ and if Firm did process innovation (questions v10 and v11 from PINTEC (2000) Survey)	PINTEC-IBGE
$HighShareD_{ft}$	Share of domestic sales of the innovated product (questions v71 and v72)[2]	PINTEC-IBGE
$HighShareX_{ft}$	Share of foreign sales of the innovated product (questions v74 and v75)	PINTEC-IBGE
Coreproduct:		
$Coreproduct_{ft}$	First ranked 8 digit NCM product according to the firm's world sales	SECEX

Notes: The innovation survey is available at:
`http://www.pintec.ibge.gov.br/downloads/PUBLICACAO/Publicacao%20PINTEC%202000.pdf`
1. Question v77 us according to the importance of product quality: (i) high, (ii) medium, (iii) low or (iv) did not do product innovation. I assume that product innovation was important if the firm answered either (i) or (ii).
A robustness check using only with (i) does not change the main results.
2. Alternatively, question v73 refers to the share of domestic sales of the non-innovated products.

Table 3: List of control variables $\mathbf{x}_{gfc}$

Variable	Variable description	Data source
Country characteristics:		
GDP_c	GDP of country c (measure of country size)	PWT 6.2
$CGDP_c$	GDP per capita of c	PWT 6.2
$Gini_c$	Gini coefficient in c	UNO-WIDER
$Dist_c$	Distance to country c	CEPII
$Contiguity_c$	Contiguity to country c	CEPII
$Language_c$	Common official primary language	CEPII
Firm-product characteristics:		
$Scope_{fc}$	Scope of the firm: number of goods sold by f in each destination c.	SECEX-Brazil
$Ndest_{gf}$	*Extensive margin of entry*: number of c to which the firm f exports good g.	SECEX-Brazil
$Quant_{gfc}$	*Intensive margin*: quantity exported of good g to country c by firm f.	SECEX-Brazil
$Revenues_f$	Total export revenues of f (measure of firm size).	SECEX-Brazil
$Wages_f$	Annualized average december wages of workers in firm f, deflated to the US-CPI August 1994.	RAIS-Brazil
$Nworkers_f$	Number of workers in f (measure of firm size).	RAIS-Brazil
$ShareHighEduc_f$	Share of workers in f with tertiary education.	RAIS-Brazil
$ShareProfe_f$	Share of professional workers in f (ISCO-88 classification).	RAIS-Brazil
$ShareWhite_f$	Share of white collar workers in f.	RAIS-Brazil
$ShareBlue_f$	Share of blue collar workers in f.	RAIS-Brazil
$Mktshare_{gfc}$	Market share of fg in c with respect to the sum of firms exporting g to c.	SECEX-Brazil
Other market characteristics:		
$ShareImp_{c,s}$	$\frac{Impcs_i}{\sum_{j \neq i} Impcs_j}$. Share of imports of c in sector s_i with respect to all sectors $j \neq i$	NBER-UN
$ShareExp_{c,s}$	$\frac{Expcs_i}{\sum_{j \neq i} Expcs_j}$. Share of exports of c in sector s_i as *proxy for production in c*	NBER-UN
$Mktshare_{fc,s}$	Share of imports in s_i from Brazilian firms with respect to total imports from the World	NBER-UN
$Nfirms_{gc}$	Number of Brazilian firms selling g in country c (competition measure)	SECEX-Brazil

Notes
[1] The distance from firm f to country c is assumed to be the same for all Brazilian firms.

Figure 1: Reasons for firms to innovate. Set of firms that did product innovation, according to the PINTEC (2000) innovation survey, wave 1998-2000

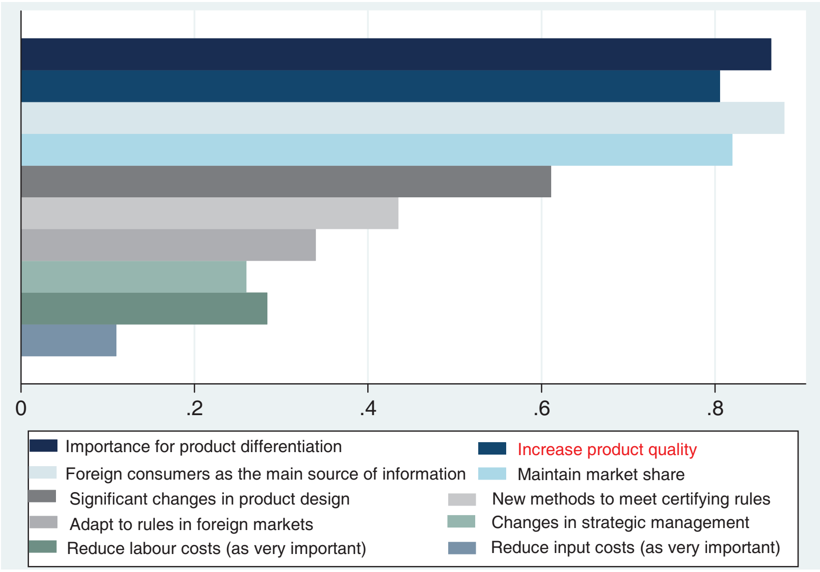

Figure 2: Share of exports to the EU and Mercosur of the 10 top manufacturing industries. Industries divided according to the firms' decision to upgrade quality (year 2000).

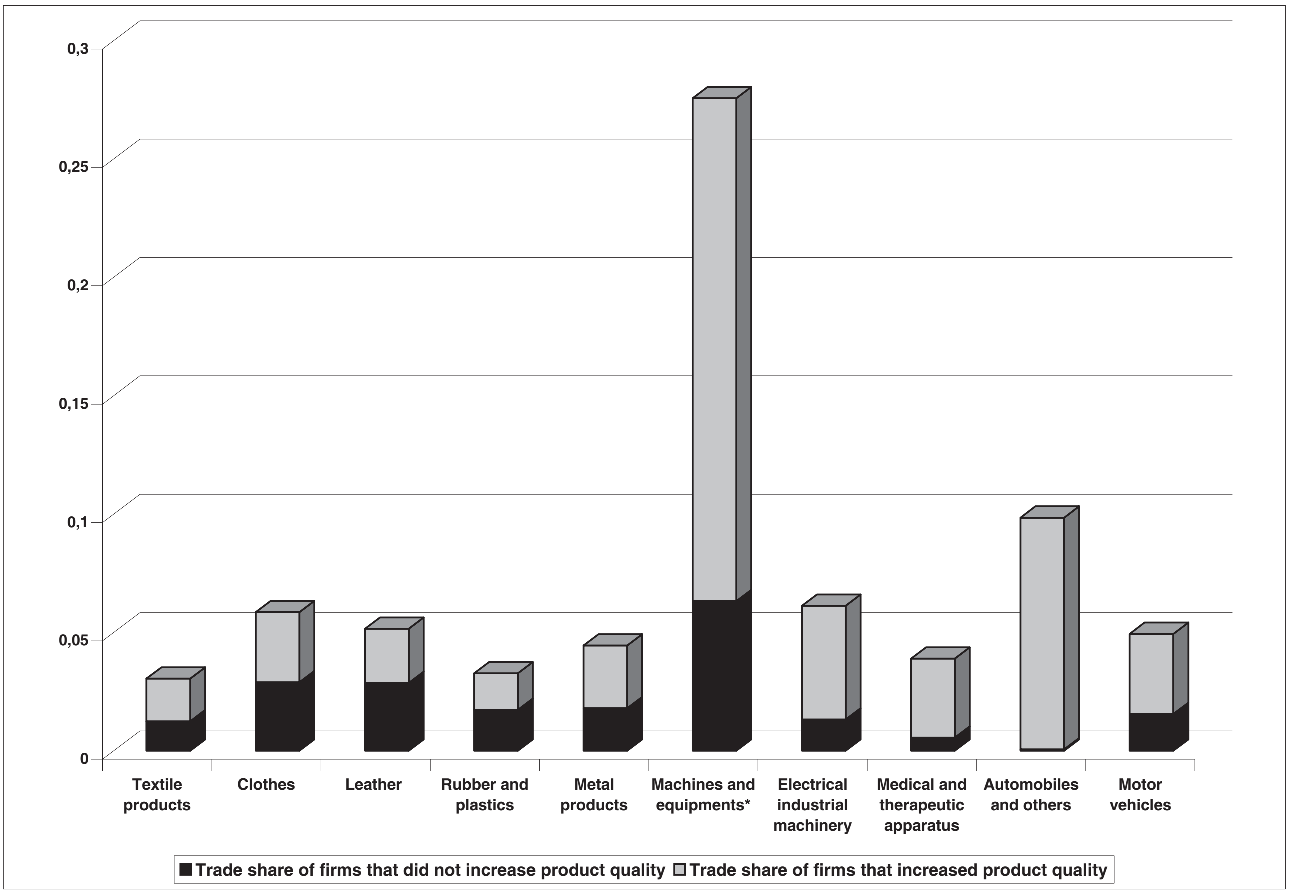

Table 4: Firm-level summary statistics for permanent exporters: by innovative behavior and year

	Innovative Firms				**Non-innovative Firms**			
	1997		**2000**		**1997**		**2000**	
Variable	Mean	Std.Dev	Mean	Std.Dev	Mean	Std.Dev	Mean	Std.Dev
$Revenues_{ft}$	1.41e+08	2.38e+08	1.40e+08	3.99e+08	2.17e+07	4.44e+07	1.56e+07	4.12e+07
FDI_{ft}	0.428	0.495	0.559	0.496	0.195	0.396	0.221	0.415
$Ndestinations_{gft}$	30.240	18.198	30.043	18.201	16.945	15.317	16.662	1
$Nproducts_{ft}$ (scope)	176.220	162.581	144.295	154.230	44.766	84.695	41.600	77.996
$Nworkers_{ft}$	4049.300	5740.197	2972.693	3763.597	908.570	2019.499	673.194	1355.703
$ShareHighEduc_{ft}$	0.169	0.118	0.203	0.128	0.119	0.107	0.141	0.129
$ShareProfessionals_{ft}$	0.128	0.067	0.135	0.084	0.097	0.078	0.0100	0.087
$ShareTechnicians_{ft}$	0.146	0.070	0.155	0.083	0.123	0.084	0.136	0.105
$Wages_{ft}$	9204.780	4486.152	5240.148	2534.877	5681.827	3576.581	3815.166	2466.484
Number of firms	1166		1166		1277		1277	

Notes:

Table 5: Effect of Quality Upgrading ($\mathbf{Upgrade}_{ft}$) on Prices.

Dependent variable: $ln(uprice)_{fcgt}$	Differentiated goods (1)	(2)	(3)	Non-differentiated goods (4)	(5)	(6)
$\mathbf{Upgrade}_{ft}$	**0.237*** **	**0.235*** **	**0.245*** **	-0.0617	-0.0712	0.0153
	(0.0405)	(0.0404)	(0.0408)	(0.193)	(0.194)	(0.198)
$\log(Nworkers_f t)$	0.0267	0.0302	0.0228	0.291	0.260	0.249
	(0.0370)	(0.0375)	(0.0377)	(0.221)	(0.229)	(0.244)
$\log(CGDP_{ct})$	0.911***	0.952***	0.883***	2.003*	2.097*	2.641**
	(0.253)	(0.250)	(0.252)	(1.213)	(1.200)	(1.199)
$\log(Gini_{ct})$	-0.0596	-0.0893	-0.0785	0.445	0.406	0.922
	(0.268)	(0.266)	(0.267)	(1.125)	(1.132)	(1.134)
$\log(Ndestinations_{gft})$	0.0449	0.0578	0.0515	-0.431**	-0.572**	-0.453**
	(0.0484)	(0.0509)	(0.0488)	(0.207)	(0.225)	(0.204)
$Mktshare_{fct,s}$	0.213*			-1.687**		
	(0.114)			(0.662)		
$ShareImp_{ct,s}$	1.300			7.030		
	(5.725)			(66.79)		
$ShareExp_{ct,s}$	-5.173			-11.20		
	(7.300)			(92.52)		
$\log(Scope_{fct})$		-0.0446			0.216	
		(0.0393)			(0.180)	
$Mktshare_{gfct}$		0.314***			0.184	
		(0.0637)			(0.345)	
$\log(Nfirms_{gct})$			0.0198			-0.544***
			(0.0306)			(0.158)
$ShareProfessionals_{ft}$			-0.759*			-0.923
			(0.445)			(1.820)
$ShareHighEduc_{ft}$			0.177			-0.379
			(0.181)			(0.904)
$\log(Wages_{ft})$			-0.0220			0.0813
			(0.0415)			(0.185)
Period FE	yes	yes	yes	yes	yes	yes
Firm-product-country FE	yes	yes	yes	yes	yes	yes
Constant	yes	yes	yes	yes	yes	yes
Observations	32,090	32,090	32,090	3,330	3,330	3,330
R-squared	0.108	0.112	0.108	0.084	0.070	0.098

Notes: Products are classified according to the Rauch (1999) classification of goods.
Robust t-statistics in absolute value within parentheses, based on standard errors clustered at the firm level.
Clustering at the firm-product or at the industry CNAE level do not change the robustness of the results.
* significant at 10%; ** significant at 5%; *** significant at 1%.
Dependent variable $ln(uprice)_{fcgt}$ is the (log) free on board export price by firm, product and destination.

Table 6: Effect of Quality Upgrading on Prices, for EU (North) and Mercosur (South).

Dependent variable:	**Differentiated goods**			**Non-differentiated goods**		
$ln(uprice)_{fcgt}$	(1)	(2)	(3)	(4)	(5)	(6)
Upgrade$_{ft}$	-0.193	-0.108	-0.179	-0.170	-0.112	-0.139
	(0.665)	(0.664)	(0.367)	(0.260)	(0.261)	(0.259)
Upgrade$_{ft}$ * **EU**	**0.236*****	**0.234*****	**0.247*****	0.199	0.224	0.150
	(0.0681)	(0.0678)	(0.0689)	(0.321)	(0.324)	(0.323)
$\log(Nworkers_{ft})$	0.0413	0.0430	0.0377	0.292	0.249	0.254
	(0.0372)	(0.0376)	(0.0379)	(0.222)	(0.230)	(0.244)
$\log(CGDP_{ct})$	-0.0791	-0.0286	-0.171	0.810	0.783	1.822
	(0.424)	(0.422)	(0.431)	(2.087)	(2.091)	(2.098)
$\log(Gini_{ct})$	-0.0216	-0.0425	-0.0294	0.413	0.423	0.890
	(0.271)	(0.270)	(0.271)	(1.138)	(1.145)	(1.144)
$\log(Ndestinations_{gft})$	0.0524	0.0630	0.0597	-0.456**	-0.604***	-0.461**
	(0.0485)	(0.0510)	(0.0489)	(0.205)	(0.222)	(0.202)
$Mktshare_{fct,s}$	0.236**			-1.719**		
	(0.115)			(0.664)		
$ShareImp_{ct,s}$	-0.0586			5.531		
	(5.747)			(66.79)		
$ShareExp_{ct,s}$	-4.432			-9.574		
	(7.318)			(92.63)		
$\log(Scope_{fct})$		-0.0387			0.227	
		(0.0395)			(0.180)	
$Mktshare_{gfct}$		0.321***			0.163	
		(0.0638)			(0.321)	
$\log(Nfirms_{gct})$			0.0281			-0.539***
			(0.0309)			(0.158)
$ShareProfessionals_{ft}$			-0.547			-1.016
			(0.446)			(1.788)
$ShareHighEduc_{ft}$			0.145			-0.370
			(0.182)			(0.907)
$\log(Wages_{ft})$			-0.0367			0.0817
			(0.0417)			(0.184)
Period FE	yes	yes	yes	yes	yes	yes
Firm-product-country FE	yes	yes	yes	yes	yes	yes
Constant	yes	yes	yes	yes	yes	yes
Observations	32,090	32,090	32,090	3,330	3,330	3,330
R-squared	0.105	0.108	0.105	0.085	0.071	0.099

Notes: Products are classified according to the Rauch (1999) classification of goods.
Robust t-statistics in absolute value within parentheses, based on standard errors clustered at the firm level.
Clustering at the firm-product or at the industry CNAE level do not change the robustness of the results.
* significant at 10%; ** significant at 5%; *** significant at 1%.
Dependent variable $ln(uprice)_{fcgt}$ is the (log) free on board export price by firm, product and destination.

Table 7: Effect of EU on Prices for all Firms and for Sample of Non-Innovative Firms.

Dependent variable: $ln(uprice)_{fcgt}$	**Differentiated goods**			**Differentiated goods** **Sample of non-innovative firms**		
	(1)	(2)	(3)	(4)	(5)	(6)
Upgrade$_{ft}$	-0.0517	-0.0505	-0.0414			
	(0.0582)	(0.0575)	(0.0598)			
Upgrade$_{ft}$ * **EU**	**0.0942****	**0.0928****	**0.103****			
	(0.0417)	(0.0426)	(0.0385)			
EU	**-0.0665**	**-0.128**	**-0.0492**	**0.00400**	**-0.0681**	**0.0282**
	(0.0754)	(0.0807)	(0.0828)	(0.0623)	(0.0690)	(0.0779)
$\log(Nworkers_ft)$	0.0456	0.0497	0.0274	-0.00765	0.00626	-0.0472
	(0.0622)	(0.0662)	(0.0667)	(0.0942)	(0.105)	(0.106)
$\log(CGDP_{ct})$	0.0445	0.0321	0.0150	0.0844	0.0459	0.0254
	(0.0933)	(0.0715)	(0.0692)	(0.100)	(0.0777)	(0.0731)
$\log(Gini_{ct})$	0.127	0.173	0.107	0.202	0.222	0.144
	(0.198)	(0.191)	(0.186)	(0.211)	(0.205)	(0.199)
$\log(Ndestinations_{gft})$	0.0181	0.0275	0.0299	0.00133	0.0279	0.0265
	(0.0676)	(0.0653)	(0.0652)	(0.112)	(0.110)	(0.0997)
$Mktshare_{fct,s}$	0.0775			0.120		
	(0.0974)			(0.0920)		
$ShareImp_{ct,s}$	0.682			-0.245		
	(1.759)			(1.455)		
$ShareExp_{ct,s}$	0.805			-0.127		
	(1.830)			(2.399)		
$\log(Scope_{fct})$		-0.0286			-0.0701	
		(0.0550)			(0.102)	
$Mktshare_{gfct}$		0.200***			0.200***	
		(0.0484)			(0.0563)	
$\log(Nfirms_{gct})$			0.0154			0.0229
			(0.0164)			(0.0185)
$ShareProfessionals_{ft}$			-1.135			-1.551
			(1.302)			(1.362)
$ShareHighEduc_{ft}$			-0.135			-0.0527
			(0.350)			(0.246)
$\log(Wages_{ft})$			-0.0159			-0.0254
			(0.0498)			(0.0568)
Period FE	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Firm-product FE	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Constant	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Observations	32,090	32,090	32,090	18,121	18,121	18,121
R-squared*	0.939	0.939	0.939	0.940	0.940	0.940

Notes: *R^2 include the contribution of fixed effects.
Notes: Differentiated goods are classified according to the Rauch (1999) classification of goods.
Robust t-statistics in absolute value within parentheses, based on standard errors clustered at the firm level.
Clustering at the firm-product or at the industry CNAE level do not change the robustness of the results.
* significant at 10%; ** significant at 5%; *** significant at 1%.
Dependent variable $ln(uprice)_{fcgt}$ is the (log) free on board export price by firm, product and destination.

Table 8: Effect of Quality Upgrading on Prices for Sample of Sales *within Mercosur*.

Dependent variable:	**Differentiated goods**			**Non-differentiated goods**		
$ln(uprice)_{fcgt}$	(1)	(2)	(3)	(4)	(5)	(6)
$\textbf{Upgrade}_{ft}$	-0.00924	-0.0144	-0.00244	-0.977	-0.982	-1.626*
	(0.0370)	(0.0368)	(0.0376)	(0.797)	(0.746)	(0.904)
$\log(Nworkers_{f}t)$	0.00463	0.00959	-0.0121	0.547	0.350	0.693
	(0.0417)	(0.0421)	(0.0426)	(1.227)	(1.225)	(1.344)
$\log(CGDP_{ct})$	3.724	2.814	2.119	1.690	22.23	-1.546
	(3.192)	(3.085)	(3.112)	(95.48)	(88.67)	(90.91)
$\log(Gini_{ct})$	-5.530	-4.362	-3.816	-4.683	-27.85	-2.672
	(3.860)	(3.721)	(3.742)	(112.6)	(98.56)	(106.5)
$\log(Ndestinations_{gft})$	0.0317	0.0425	0.0450	-1.451*	-1.248	-1.498
	(0.0421)	(0.0442)	(0.0424)	(0.842)	(0.866)	(0.894)
$Mktshare_{fct,s}$	0.280***			0.672		
	(0.107)			(3.029)		
$ShareImp_{ct,s}$	-2.573			164.5		
	(6.073)			(2,022)		
$ShareExp_{ct,s}$	2.694			250.1		
	(8.851)			(501.3)		
$\log(Scope_{fct})$		-0.0216			-0.574	
		(0.0359)			(0.853)	
$Mktshare_{gfct}$		0.231***			-0.533	
		(0.0771)			(1.843)	
$\log(Nfirms_{gct})$			0.0457			-0.578
			(0.0326)			(0.774)
$ShareProfessionals_{ft}$			-0.887**			0.276
			(0.420)			(13.39)
$ShareHighEduc_{ft}$			-0.0776			-3.966
			(0.182)			(3.124)
$\log(Wages_{ft})$			-0.0187			1.256
			(0.0407)			(1.690)
Period FE	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Firm-product-country FE	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Constant	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Observations	17,404	17,404	17,404	2,612	2,612	2,612
R-squared	0.121	0.121	0.121	0.171	0.174	0.222

Notes: Products are classified according to the Rauch (1999) classification of goods.
Robust t-statistics in absolute value within parentheses, based on standard errors clustered at the firm level.
Clustering at the firm-product or at the industry CNAE level do not change the robustness of the results.
* significant at 10%; ** significant at 5%; *** significant at 1%.
Dependent variable $ln(uprice)_{fcgt}$ is the (log) free on board export price by firm, product and destination.

Table 9: Effect of Quality Upgrading on Prices within Sectors of Similar/Different Elasticities of Substitution. Differentiated Goods.

Dependent variable: $ln(uprice)_{fcgt}$	**Differentiated goods** Similar elasticities across countries			**Differentiated goods** Different elasticities across countries		
	(1)	(2)	(3)	(4)	(5)	(6)
Upgrade$_{ft}$	-0.133**	-0.126**	-0.143**	-0.0586	-0.0643	-0.0757
	(0.0631)	(0.0630)	(0.0634)	(0.102)	(0.103)	(0.104)
Upgrade$_{ft}$ $*$ **EU**	**0.188****	**0.205****	**0.205****	**0.287****	**0.290****	**0.329****
	(0.0805)	(0.0798)	(0.0811)	(0.131)	(0.131)	(0.133)
log($Nworkers_f t$)	0.0532	0.0615	0.0533	0.0332	0.0117	0.0245
	(0.0408)	(0.0412)	(0.0413)	(0.0912)	(0.0928)	(0.0965)
log($CGDP_{ct}$)	0.0114	-0.0415	-0.125	-0.176	-0.0892	-0.372
	(0.504)	(0.497)	(0.508)	(0.813)	(0.811)	(0.828)
log($Gini_{ct}$)	-0.0925	-0.120	-0.0925	0.0985	0.175	0.125
	(0.310)	(0.307)	(0.308)	(0.577)	(0.572)	(0.575)
log($Ndestinations_{gft}$)	0.00710	0.0324	0.0147	0.181*	0.155	0.195*
	(0.0550)	(0.0580)	(0.0554)	(0.105)	(0.110)	(0.106)
$Mktshare_{fct,s}$	0.125			0.696***		
	(0.133)			(0.241)		
$ShareImp_{ct,s}$	16.34			-4.935		
	(12.16)			(7.090)		
$ShareExp_{ct,s}$	-1.062			-18.73*		
	(10.74)			(11.37)		
log($Scope_{fct}$)		-0.0749*			0.0806	
		(0.0445)			(0.0850)	
$Mktshare_{gfct}$		0.283***			0.372***	
		(0.0772)			(0.116)	
log($Nfirms_{gct}$)			0.00736			0.0811
			(0.0364)			(0.0598)
$ShareProfessionals_{ft}$			-0.542			-0.784
			(0.505)			(0.972)
$ShareHighEduc_{ft}$			0.0742			0.438
			(0.206)			(0.392)
log($Wages_{ft}$)			-0.0195			-0.0721
			(0.0467)			(0.0919)
Period FE	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Firm-product-country FE	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Constant	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Observations	22,254	22,254	22,254	9,836	9,836	9,836
R-squared	0.117	0.120	0.116	0.084	0.084	0.080

Notes: Differentiated goods are classified according to the Rauch (1999) classification of goods.
Robust t-statistics in absolute value within parentheses, based on standard errors clustered at the firm level.
Clustering at the firm-product or at the industry CNAE level do not change the robustness of the results.
* significant at 10%; ** significant at 5%; *** significant at 1%.
Dependent variable $ln(uprice)_{fcgt}$ is the (log) free on board export price by firm, product and destination.

Table 10: Effect of Skill Upgrading on Prices: An Integrated Quality and Skill Upgrading Mechanism.

Dependent variable:				Differentiated goods				
$ln(uprice)_{fcgt}$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\mathbf{Upgrade}_{ft}$			0.147***	0.152**			0.243***	0.234**
			(0.0570)	(0.0608)			(0.0933)	(0.102)
$\mathbf{Skills}_{f,t} * \mathbf{Upgrade}_{ft}$			0.395***	0.376***				
			(0.105)	(0.108)				
$\mathbf{Skills}_{ft}$	0.113**	0.146***	-0.0592	-0.0274				
	(0.0499)	(0.0512)	(0.0590)	(0.0609)				
$\mathbf{Skills}^{nowage}_{f,t} * \mathbf{Upgrade}_{ft}$							0.259**	0.246**
							(0.116)	(0.124)
$\mathbf{Skills}^{nowage}_{ft}$					0.391***	0.384***	-0.339***	-0.264***
					(0.0658)	(0.0693)	(0.0324)	(0.0433)
$\log(Nworkers_{f}t)$	0.0106	0.0591	0.00905	0.0480	0.0296	0.0976	0.0648	0.120
	(0.0713)	(0.0774)	(0.0709)	(0.0770)	(0.104)	(0.114)	(0.105)	(0.114)
$\log(CGDP_{ct})$		0.899***		0.828**		0.0588		0.121
		(0.340)		(0.342)		(0.537)		(0.537)
$\log(Gini_{ct})$		-0.0537		-0.179		-0.108		-0.193
		(0.369)		(0.367)		(0.664)		(0.665)
$\log(Ndestinations_{gft})$		-0.125*		-0.0893		-0.236*		-0.206
		(0.0658)		(0.0659)		(0.133)		(0.133)
$Mktshare_{fct,s}$		0.137		0.121		-0.0552		-0.0574
		(0.143)		(0.142)		(0.230)		(0.230)
$Mktshare_{gfct}$	0.439***		0.409***		0.341***		0.365***	
	(0.0749)		(0.0755)		(0.117)		(0.118)	
Period FE	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Firm-product-country FE	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Constant	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Observations	32,090	32,090	32,090	32,090	32,090	32,090	32,090	32,090
R-squared	0.048	0.051	0.052	0.057	0.058	0.057	0.058	0.057

Notes: Differentiated goods are classified according to the Rauch (1999) classification of goods.
Robust t-statistics in absolute value within parentheses, based on standard errors clustered at the firm level.
Clustering at the firm-product or at the industry CNAE level do not change the robustness of the results.
* significant at 10%; ** significant at 5%; *** significant at 1%.
Dependent variable $ln(uprice)_{fcgt}$ is the (log) free on board export price by firm, product and destination.

Table 11: Effect of Quality Upgrading on Prices for different **North/South** groups of countries.

	Differentiated goods							
	Group1: EU, Mercosur and USA		Group2: Mercosur and USA		Group 3: Mercosur, Canada and USA		Group 4: Canada, USA, EU and South America	
Dependent variable: $ln(uprice)_{fcgt}$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Upgrade$_{ft}$	-0.111**	-0.101*	-0.0493	-0.0526	-0.0158	-0.0156	-0.0731*	-0.0609
	(0.0533)	(0.0533)	(0.0365)	(0.0370)	(0.0588)	(0.0588)	(0.0397)	(0.0396)
Upgrade$_{ft}$ ∗ **Group1**	0.236***	0.234***						
	(0.0681)	(0.0678)						
Upgrade$_{ft}$ ∗ **Group2**			0.239***	0.223***				
			(0.0490)	(0.0744)				
Upgrade$_{ft}$ ∗ **Group3**					0.243***	0.215***		
					(0.0503)	(0.0701)		
Upgrade$_{ft}$ ∗ **Group4**							0.244***	0.249***
							(0.0488)	(0.0484)
$\log(Nworkers_ft)$	0.0413	0.0430	-0.00264	-0.00930	0.0110	0.00894	-0.0160	-0.0139
	(0.0372)	(0.0376)	(0.0405)	(0.0349)	(0.0424)	(0.0429)	(0.0291)	(0.0293)
$\log(CGDP_{ct})$	-0.0791	-0.0286	4.689	0.464	0.880	0.823	-0.295	-0.262
	(0.424)	(0.422)	(3.154)	(0.353)	(1.108)	(1.103)	(0.265)	(0.264)
$\log(Gini_{ct})$	-0.0216	-0.0425	-6.597*	-1.443***	-2.429*	-2.242	-0.197*	-0.214**
	(0.271)	(0.270)	(3.804)	(0.534)	(1.451)	(1.440)	(0.105)	(0.104)
$\log(Ndestinations_{gft})$	0.0524	0.0630	0.0279	0.0263	0.0315	0.0359	0.0288	0.0430
	(0.0485)	(0.0510)	(0.0414)	(0.0394)	(0.0502)	(0.0529)	(0.0386)	(0.0404)
$Mktshare_{fct,s}$	0.236**		0.247**		0.285**		0.0831	
	(0.115)		(0.106)		(0.116)		(0.0972)	
$ShareImp_{ct,s}$	-0.0586		-3.147		-3.058		-1.769	
	(5.747)		(5.939)		(6.245)		(5.004)	
$ShareExp_{ct,s}$	-4.432		3.052		-0.744		-7.664	
	(7.318)		(9.149)		(9.445)		(7.178)	
$\log(Scope_{fct})$		-0.0387		-0.0169		-0.0107		-0.0591*
		(0.0395)		(0.0321)		(0.0424)		(0.0307)
$Mktshare_{gfct}$		0.321***		0.309***		0.257***		0.346***
		(0.0638)		(0.0660)		(0.0841)		(0.0473)
Period FE	yes	yes	yes	yes	yes	yes	yes	yes
Firm-product-country FE	yes	yes	yes	yes	yes	yes	yes	yes
Constant	yes	yes	yes	yes	yes	yes	yes	yes
Observations	32,117	32,117	32,817	40,873	25,292	25,292	56,950	56,950
R-squared	0.105	0.108	0.106	0.091	0.123	0.123	0.095	0.100

Notes: Differentiated goods are classified according to the Rauch (1999) classification of goods.
Robust t-statistics in absolute value within parentheses, based on standard errors clustered at the firm level.
Clustering at the firm-product or at the industry CNAE level do not change the robustness of the results.
* significant at 10%; ** significant at 5%; *** significant at 1%.
Dependent variable $ln(uprice)_{fcgt}$ is the (log) free on board export price by firm, product and destination.

Table 12: Effect of Quality Upgrading and Process Innovation on Prices.

Dependent variable:	Differentiated Goods				Non-differentiated Goods			
$ln(uprice)_{fcgt}$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Upgrade$_{ft}$			**0.236*****	**0.234*****			-0.0689	-0.0810
			(0.0405)	(0.0405)			(0.190)	(0.192)
Process$_{ft}$	0.0158	0.0102	0.0202	0.0216	-0.187	-0.180	-0.808***	-0.739***
	(0.0326)	(0.0326)	(0.0463)	(0.0462)	(0.136)	(0.138)	(0.252)	(0.252)
$\log(Nworkers_ft)$	0.0428	0.0429	0.0274	0.0310	0.292*	0.345**	0.203	0.190
	(0.0336)	(0.0340)	(0.0371)	(0.0375)	(0.156)	(0.157)	(0.219)	(0.228)
$\log(CGDP_{ct})$	1.160***	1.163***	0.910***	0.952***	0.296	0.492	1.771	1.898
	(0.225)	(0.222)	(0.253)	(0.250)	(0.912)	(0.914)	(1.199)	(1.188)
$\log(Gini_{ct})$	-0.160	-0.177	-0.0619	-0.0917	0.468	0.458	0.543	0.482
	(0.236)	(0.234)	(0.268)	(0.266)	(0.867)	(0.873)	(1.111)	(1.120)
$\log(Ndestinations_{gft})$	0.0510	0.0563	0.0429	0.0556	-0.292*	-0.387**	-0.321	-0.470**
	(0.0396)	(0.0413)	(0.0486)	(0.0511)	(0.154)	(0.166)	(0.207)	(0.225)
$Mktshare_{fct,s}$	0.222**		0.212*		-0.968*		-1.840***	
	(0.104)		(0.114)		(0.537)		(0.655)	
$ShareImp_{ct,s}$	1.919		1.303		87.79**		11.35	
	(5.418)		(5.726)		(43.77)		(65.90)	
$ShareExp_{ct,s}$	-1.840		-5.140		61.40		11.00	
	(6.760)		(7.301)		(80.07)		(91.54)	
$\log(Scope_{fct})$		-0.0152		-0.0444		0.119		0.201
		(0.0319)		(0.0393)		(0.140)		(0.178)
$Mktshare_{gfct}$		0.281***		0.314***		-0.0451		0.206
		(0.0583)		(0.0637)		(0.269)		(0.341)
Period FE	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Firm-product-country FE	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Constant	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Observations	32,090	32,090	32,090	32,090	3,330	3,330	3,330	3,330
R-squared	0.102	0.104	0.108	0.112	0.050	0.035	0.111	0.093

Notes: Products are classified according to the Rauch (1999) classification of goods.
Robust t-statistics in absolute value within parentheses, based on standard errors clustered at the firm level.
Clustering at the firm-product or at the industry CNAE level do not change the robustness of the results.
* significant at 10%; ** significant at 5%; *** significant at 1%.
Dependent variable $ln(uprice)_{fcgt}$ is the (log) free on board export price by firm, product and destination.

Table 13: Effect of Quality Upgrading and Process Innovation on Prices, for EU and Mercosur.

Dependent variable:	Differentiated Goods				Non-differentiated Goods			
$ln(uprice)_{fcgt}$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Upgrade$_{ft}$			0.00106	0.00424			-0.471	-0.437
			(0.0507)	(0.0505)			(0.301)	(0.311)
Upgrade$_{ft}$ ∗ **EU**			**0.245****	**0.226****			-0.541	-0.643
			(0.0993)	(0.0990)			(0.389)	(0.391)
Process$_{ft}$	-0.170	-0.112	-0.0706	-0.0645	-0.111**	-1.651	-0.277	-0.236
	(0.260)	(0.261)	(0.0585)	(0.0584)	(0.0533)	(1.779)	(0.265)	(0.267)
Process$_{ft}$ ∗ **EU**	0.0469	0.0572	0.0516	0.0631	0.199	0.224	0.462	0.531
	(0.0487)	(0.0512)	(0.101)	(0.101)	(0.321)	(0.324)	(0.369)	(0.371)
log($Nworkers_f t$)	0.0413	0.0430	0.0489	0.0499	0.292	0.249	0.234	0.214
	(0.0372)	(0.0376)	(0.0373)	(0.0377)	(0.222)	(0.230)	(0.221)	(0.229)
log($CGDP_{ct}$)	-0.0791	-0.0286	-0.405	-0.330	0.810	0.783	2.205	2.549
	(0.424)	(0.422)	(0.443)	(0.441)	(2.087)	(2.091)	(2.371)	(2.384)
log($Gini_{ct}$)	-0.0216	-0.0425	-0.0580	-0.0758	0.413	0.423	0.737	0.782
	(0.271)	(0.270)	(0.272)	(0.270)	(1.138)	(1.145)	(1.134)	(1.144)
log($Ndestinations_{gft}$)	0.0524	0.0630	0.0454	0.0552	-0.456**	-0.604***	-0.382*	-0.537**
	(0.0485)	(0.0510)	(0.0487)	(0.0513)	(0.205)	(0.222)	(0.206)	(0.223)
$Mktshare_{fct,s}$	0.236**		0.245**		-1.719**		-1.786***	
	(0.115)		(0.115)		(0.664)		(0.659)	
$ShareImp_{ct,s}$	-0.0586		-0.152		5.531		12.70	
	(5.747)		(5.744)		(66.79)		(65.84)	
$ShareExp_{c,s}$	-4.432		-4.540		-9.574		10.37	
	(7.318)		(7.315)		(92.63)		(91.52)	
log($Scope_{fct}$)		-0.0387		-0.0358		0.227		0.201
		(0.0395)		(0.0395)		(0.180)		(0.177)
$Mktshare_{gfct}$		0.321***		0.318***		0.175		0.233
		(0.0638)		(0.0638)		(0.346)		(0.342)
Period FE	yes	yes	yes	yes	yes	yes	yes	yes
Firm-product-country FE	yes	yes	yes	yes	yes	yes	yes	yes
Constant	yes	yes	yes	yes	yes	yes	yes	yes
Observations	32,090	32,090	32,090	32,090	3,330	3,330	3,330	3,330
R-squared	0.105	0.108	0.106	0.109	0.085	0.071	0.117	0.101

Notes: The observations correspond only to differentiated goods according to the Rauch (1999) classification of goods.
Robust t-statistics in absolute value within parentheses, based on standard errors clustered at the firm level.
Clustering at the firm-product or at the industry CNAE level do not change the robustness of the results.
* significant at 10%; ** significant at 5%; *** significant at 1%.
The outcome variable $ln(uprice)_{fcgt}$ is the (log) free on board export price by firm, HS-8 product and destination.

Table 14: Effect of Quality Upgrading on Prices for a Placebo Year (pre-treatment year as the treatment year, $UpgradePlacebo_{ft}$).

Dependent variable:	**Differentiated goods**			**Non-differentiated goods**		
$ln(uprice)_{fcgt}$	(1)	(2)	(3)	(4)	(5)	(6)
UpgradePlacebo$_{ft}$	0.00485	0.00375	0.0146	0.0150	0.0112	0.0208
	(0.0312)	(0.0320)	(0.0263)	(0.0440)	(0.0426)	(0.0403)
UpgradePlacebo$_{ft}$ $*$ **EU**	-0.0157	-0.0175	-0.0154	-0.110***	-0.120***	-0.107***
	(0.0214)	(0.0180)	(0.0193)	(0.0329)	(0.0368)	(0.0320)
log($Nworkers_{f}t$)	-0.0259	-0.0294	-0.00460	-0.0381	-0.0307	-0.0392
	(0.0507)	(0.0508)	(0.0582)	(0.0425)	(0.0326)	(0.0533)
log($CGDP_{ct}$)	0.118	0.240	0.292	-0.543	-0.494	-0.671
	(0.255)	(0.252)	(0.227)	(0.630)	(0.572)	(0.666)
log($Ndestinations_{gft}$)	0.0323	0.0212	0.0211	-0.0306	0.0248	-0.0194
	(0.0511)	(0.0560)	(0.0576)	(0.0341)	(0.0339)	(0.0310)
$Mktshare_{fct,s}$	-0.0306			0.300***		
	(0.0392)			(0.0903)		
$ShareImp_{ct,s}$	16.05			4.284		
	(12.41)			(5.626)		
$ShareExp_{ct,s}$	-11.49			33.64		
	(8.571)			(30.49)		
log($Scope_{fct}$)		0.00783			-0.195	
		(0.0368)			(0.133)	
$Mktshare_{gfct}$		0.407***			-0.0202	
		(0.112)			(0.103)	
log($Nfirms_{gct}$)			-0.00791			0.000902
			(0.0204)			(0.0555)
$ShareProfessionals_{ft}$			-0.166			-0.800
			(1.190)			(0.490)
$ShareHighEduc_{ft}$			0.318**			0.465**
			(0.135)			(0.185)
log($Wages_{ft}$)			0.197			0.0523
			(0.190)			(0.0918)
Period FE	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Firm-product-country FE	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Constant	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Observations	34,477	34,477	34,442	3,446	3,446	3,446
R-squared	0.001	0.006	0.003	0.033	0.046	0.038

Notes: Products are classified according to the Rauch (1999) classification of goods.
Robust t-statistics in absolute value within parentheses, based on standard errors clustered at the firm level.
Clustering at the firm-product or at the industry CNAE level do not change the robustness of the results.
* significant at 10%; ** significant at 5%; *** significant at 1%.
Dependent variable $ln(uprice)_{fcgt}$ is the (log) free on board export price by firm, product and destination.

Table 15: Asymmetries across Products ($COREPRODUCT$) and Sectors (sector ladder-length $LADDER$).

Dependent variable:	**Differentiated Goods**				**Non-differentiated Goods**			
$ln(uprice)_{fcgt}$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Upgrade$_{ft}$	0.0496	0.0568	0.0394	0.0280	0.225	0.226	0.0454	0.0722
	(0.0508)	(0.0510)	(0.0981)	(0.0844)	(0.161)	(0.200)	(0.286)	(0.274)
COREPRODUCT$_{ft}$ $*$ **Upgrade**$_{ft}$	0.0781**	0.0798**			-0.327	-0.292		
	(0.0393)	(0.0396)			(0.244)	(0.205)		
LADDER$_{st}$ $*$ **Upgrade**$_{ft}$			0.124***	0.102**			-0.215	-0.237
			(0.0334)	(0.0372)			(0.524)	(0.498)
$\log(Nworkers_ft)$	0.0320	0.0353	0.0337	0.0359	0.234	0.201	0.311	0.198
	(0.0419)	(0.0457)	(0.0401)	(0.0439)	(0.223)	(0.261)	(0.214)	(0.265)
$\log(CGDP_{ct})$	1.016***	1.051***	0.858**	0.905**	2.400***	2.577***	1.180*	1.925**
	(0.307)	(0.311)	(0.342)	(0.344)	(0.814)	(0.773)	(0.630)	(0.761)
$\log(Gini_{ct})$	-0.0313	-0.0608	-0.0414	-0.0886	0.631	0.624	0.216	0.148
	(0.305)	(0.280)	(0.359)	(0.333)	(0.530)	(0.512)	(0.574)	(0.573)
$\log(Ndestinations_{gft})$	0.0422	0.0546	0.0422	0.0503	-0.409	-0.542	-0.390	-0.677
	(0.0913)	(0.0841)	(0.0909)	(0.0828)	(0.292)	(0.433)	(0.320)	(0.407)
$Mktshare_{fct,s}$	0.228*		0.242*		-1.584***		-1.302**	
	(0.133)		(0.131)		(0.486)		(0.598)	
$ShareImp_{ct,s}$	1.623		1.311		24.17		89.88	
	(5.154)		(5.565)		(86.35)		(80.57)	
$ShareExp_{c,s}$	-4.723		-8.215*		-26.91		-11.60	
	(3.701)		(4.324)		(141.2)		(145.3)	
$\log(Scope_{fct})$		-0.0428		-0.0324		0.194		0.447**
		(0.0643)		(0.0607)		(0.313)		(0.215)
$Mktshare_{gfct}$		0.314***		0.321***		0.198		-0.101
		(0.0570)		(0.0590)		(0.430)		(0.316)
Period FE	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Firm-product-country FE	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Constant	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Observations	32,090	32,090	32,090	32,090	3,330	3,330	3,330	3,330
R-squared	0.110	0.113	0.107	0.110	0.092	0.079	0.072	0.071

Notes: Products are classified according to the Rauch (1999) classification of goods.
Robust t-statistics in absolute value within parentheses, based on standard errors clustered at the firm level.
Clustering at the firm-product or at the industry CNAE level do not change the robustness of the results.
* significant at 10%; ** significant at 5%; *** significant at 1%.
Dependent variable $ln(uprice)_{fcgt}$ is the (log) free on board export price by firm, product and destination.

Figure 3: Difference-in-Difference-in-Differences: Quality upgrading in the EU and Mercosur