Quality upgrading and price heterogeneity: evidence from Brazilian manufacturing exporters

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[Preliminary and incomplete]

Abstract

This paper uses a Brazilian firm-product level data to investigate the firm's product price and quality decisions across countries. I present preliminary evidence that productive firms in differentiated goods sectors segment the market and adapt product quality to different markets. First, results in cross-section reveal that firms in differentiated goods sectors sort on quality, while homogeneous goods follow a different pattern. These results are robust to several specifications. Second, I use the time dimension of the data and show a mechanism in which increasing incentives to export lead more productive firms to upgrade quality to attend demand for higher quality products. I test this mechanism using exports to the European Union (North) and to Mercosur (South) over years in a difference-in-difference-in-differences (DDD) strategy, and show that the hypothesis of quality upgrading and market segmentation is confirmed for differentiated goods, but not for homogeneous goods. Even though further research is necessary to sort out the markup and the quality effect, the results suggest that, besides the well-known productivity premium, the within firm-product quality adjustment is important for firms' success.

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

JEL classification: F1, L1.

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1 Introduction

A recent literature has documented the relation between export prices and destination country characteristics. Many of those studies find a strong positive relationship between the price of the good and the country's level of income and income per-capita (Hallak(2006,2008), and Klenow(2005), Fieler(2008)), and attribute higher prices to higher quality. Even though this empirical evidence is robust, prices aggregated to the country level might fog some important unobserved characteristics related to the firm, product and market but not to the quality of the good.

At the firm level, two main types of models explain exporters' performance: (i) the efficiency sorting models as Melitz (2003) and Melitz and Ottaviano (2008), which attribute better export performance to firms with higher efficiency and lower marginal costs; (ii) and the quality sorting models (as Baldwin and Harrigan, 2007, Antoniades, 2008 and Grossman, Helpman and Fajgelbaum, 2009), which add the quality dimension to models with heterogeneous firms and explain why large productive exporters pay higher wages, use better inputs and have marginal costs increasing in quality. Empirically, even though firm heterogeneity is a stylized fact, the analysis of price variation across countries at the firm level is a new and rapidly growing literature: some relevant contributions are Bastos and Silva (2010), Manova and Zhang (2009), Kugler and Verhoogen (2008) and Martin and Méjean (2010), which emphasize the price variation across firms [1].

This paper presents an alternative approach, that focuses on *within firm effects* and goes beyond cross-section analysis of unit values. I show evidence of quality differentiation within the firm and evidence that higher incentives to export increased the quality gap of the exported products. The cross-section results indicate that firms selling differentiated goods sort on quality, while firms in homogeneous goods sectors follow an opposite pattern. Moreover, the analysis over time shows that productive firms in differentiated goods sectors segment the market and upgrade quality to more exigent markets that are willing to pay more for quality, what is reflected in higher unit prices to those markets. This last result is shown using a

[1] Manova and Zhang (2009) and Bastos and Silva (2010) use data on Chinese and Portuguese firms, respectively, and focus on the price variation across firms in a cross-section. Bastos and Silva (2010) show evidence of quality differentiation due to distance, while Manova and Zhang (2010) test empirically different models from the literature. Kugler and Verhoogen (2008) use data for Colombian firms and show convincing evidence that input quality and plant productivity are complementary in generating output quality. Martin and Méjean (2010) use French firm level data and show that quality upgrading of french firms may be a result of low-wage countries competition (specially of Chinese competition).

difference-in-difference-in-differences (DDD) estimate for Brazilian manufacturing exporters in the period 1997-2000.

First, I show in a cross-section that there is a significant firm-product price variation across destinations and study the different hypotheses that may drive this variation. In Section 4, I show preliminary evidence in cross-section that supports the hypothesis of quality variation for differentiated goods: firms in differentiated goods sectors confirm the predictions from quality sorting models [2] and contradict the predictions from efficiency sorting models [3], while firms in homogeneous goods sectors follow the opposite pattern (main results in Tables 3 and 4). These predictions hold both for firm and firm-product price variation across countries and are robust to several specifications.

Second, I use the time dimension of the data and a particular moment of the Brazilian economy to study the effects of changes in the incentives to export on quality upgrading and prices. I compare North (treated) and South (control group) markets from the year 1997 (before quality treatment) to 2000 (after quality treatment), for fims that upgraded quality (treated) and others that did not (control group). I use proxies for quality across time to study whether firms upgraded quality [4] and to which markets they upgraded quality, i.e., whether firms segmented the market as North and South markets. *Results from the DDD estimate indicate that firms segment the market and upgrade quality to markets willing to pay more for higher quality*, and, as expected, these results hold only for differentiated goods [5].

The results from quality upgrading mechanism from Section 5 are inline with the historical moment of the Brazilian economy. With trade liberalization in the 1990's, firms faced tougher competition and adapted their products to be able to compete in tougher markets. Brazil pegged its currency to the U.S. dollar in 1994, and changed the exchange regime to free-float in January 1999. In the last years of this period, the currency was overvalued and firms were able to import better technology and to adapt their production to international standards.

[2] Baldwin and Harrigan (2007), Antoniades (2008) and Grossman, Helpman and Fajgelbaum (2009).

[3] Essentially the Melitz(2003) model.

[4] As proxies for quality, I use information on workers characteristics, the share of white and blue collar workers (workers' occupation), workers' education and their wages. If the firm's increase in those proxies (from 1997 to 2000) is above the median of the industry, the firm upgraded quality.

[5] This idea is related to Verhoogen (2008) for Mexican firms: firms export different quality types in the domestic and foreign markets, what is illustrated in his paper with the example of the two production lines from Volkswagen. Although, the research question and the empirical approach differ from Verhoogen(2008). Verhoogen(2008) uses information on total revenues by destination country, and the exchange rate shock is used to explain how quality upgrading led to more wage dispersion within industries, comparing *domestic sales* to exports. I use product unit values (and product weights) and compare sales *across different export markets*, and the interest is mainly in the quality upgrading mechanism.

With the free-float regime in 1999, the currency suferred a sharp devaluation, what also created additional incentives for firms to innovate and export. Moreover, the government implemented several policies to increase exports and to help firms adapt their products to tougher markets, what made many firms create an *export type product*. This product was a higher quality variety, in conformity with the international quality standards, as requested in Japan and European countries, for instance. Although, the variety exported to European countries was not the same as the one exported to Mercosur countries: products exported to the neighboor countries remained in general with the same quality as the one sold in the domestic market, i.e., the low income countries continued to trade low quality as before.

This motivates and gives support to the results from this paper. I find that firms in differentiated goods sectors adjust prices and quality according to the willingness to pay for quality. While differentiated goods follow the predictions from quality sorting models, homogeneous goods show an opposite effect. For the cross-section of firms in differentiated goods sectors, the main results indicate that: (1) firms adjust quality to more distant and richer markets; (2) the effect of income per capita on prices can not be explained only by higher markups because of greater market power, since the empirical specification also controls for the firm's market share in different ways and for the number of firms competing in each market; (3) firms also sell higher quality to countries with higher income inequality. As expected, these effects are confirmed only for differentiated goods.

For the analysis over time using the DDD model, I show that, if firms upgraded quality, they did that for countries willing to pay more for quality. I show this result by comparing sales to the European Union (treated) to sales to Mercosur (control group). Thus, I confirm the hypothesis that firms used strategies of market segmentation in this period and created *export type products*, as the anecdotal evidence suggests. As expected, this effect is only observable for differentiated goods.

The remainder of the paper is organized as follows. Section 2 presents a brief discussion on the Brazilian economy in the 1990's. Section 3 describes the data and presents the descriptive statistics. Section 4 presents cross-section results and preliminary results that support the hypothesis of quality variation. Section 5 presents the North/South evidence over time. Section 6 concludes.

2 The Brazilian economy in the 1990's

The 1990's represent a particular moment for the Brazilian economy: economic stability after the end of decades of inflation, trade liberalization, the introduction of 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 big challenge, once they faced tougher competition in the destination market and needed to adapt their products to compete in tougher markets [6]. The real was pegged to the U.S. dollar from 1994 until january 1999, when the regime changed to free-float. In the last years of this period, the currency was overvalued and firms were able to import better technology and to adapt their production to the 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.

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 (Bonelli, 2001). Moreover, in an attempt to protect the home industry and to increase exports, the government implemented several policies 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) [7]. During the second half of the 1990's, many firms created an *export type product*, a variety associated with higher quality that was specially thought for the European market and other markets with high quality standards, as Japan and the United States. Thus, firms adapted their production lines to meet different consumers with different willigness to pay for quality; this effect is reinforced by the exchange rate devaluation in 1999, that increased the incentives for firms to invest in the quality of the products to be exported.

A similar case is reported in Verhoogen(2008) for the Mexican economy in the 1990's: he

[6] Bloom, Draca and van Reenen (2010) show, from the perspective of a developed country, empirical evidence that trade liberalization caused developed countries to increase their investments in technology due to competition - they show evidence of the effect of chinese imports on the innovation rates in developed countries. Martin and Méjean (2010) study the effect of low income countries' competition on quality upgrading of French firms. From the perspective of Brazilian firms, exporters to developed countries also faced tougher competition after trade liberalization.

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

studies the effect of quality upgrading on wage dispersion and argues that after trade liberalization firms had one product for the home market and one to be exported to the United States, what Verhoogen (2008) illustrates 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.

3 Data and descriptive statistics

3.1 Brazilian firms and workers data

The firm and workers data comes from three Brazilian sources, and, in all datasets, firms are identified by the unique CNPJ tax number. The first is the Brazilian three dimensional exports data from the Foreign Trade Secretariat (SECEX), which contains information by firm-product-destination on sales, quantities and weights of all manufacturing firms. The second is the linked employer-employee data on the basis of Brazil's labor force records RAIS (*Relação Anual de Informações Sociais*), which gives information on the characteristics of the workers by firm. The third is the data on Foreign Direct Investment (FDI) from the Central Bank of Brazil (*Banco Central do Brasil*), with information on whether a firm received FDI from 1997 until 2000 (all foreign investments are registered with Brazil's central bank and, thus, available in the dataset).

SECEX exports data: Contains information from 1997 to 2000 on every manufactured product exported by Brazilian firms at the 8 digit level (NCM classification), by country. The data has information on sales, quantities and weights for every firm-product-country [8]. The data comes from the Brazilian customs declarations for merchandize exports that is collected for every exporting firm by the SECEX. All export values are reported in U.S. dollars (USD) free on board (f.o.b.).
The variable unit prices (p_{fcgt}) is generated using sales ($Value_{fcgt}$) and quantities ($Quant_{fcgt}$): the new variable p_{fcgt} represents the average price of good g exported by firm f to country

[8] The first six digits of NCM correspond to the 6 digits HS (international Harmonized System) classification. I match the information of the SITC with the HS classification in order to be able to use the Rauch classification of goods and the NBER-UN World trade data. Moreover, this also provides better comparison to the literature.

c in year t. p_{fcgt} is defined as $p_{fcgt} = \frac{Value_{fcgt}}{Quant_{fcgt}}$, where $Value$ represents total sales of f with good g in country c and $Quant$ is the total quantity exported of g by firm f to country c (by year t).

The precise steps to build the SECEX dataset are explained in the Appendix.

Employer-employee data from RAIS: The RAIS provides annual information on workers formally employed in any sector (exporters and non-exporters). Every job observation is identified by the worker ID (PIS) and the plant ID. Employees information is aggregated to the plant level to obtain the following informations: share of workers with primary, high-school and tertiary education, average wages, number of workers, and share of workers by occupation according to the International Labour Office (ILO) ISCO-88 classification of occupations.

FDI data for Brazilian firms (foreign ownership status): Brazil attracted an important amount of FDI following the trade reforms in the 1990s. From 1995 to 2000, the FDI stock more than quintupled following the trade and capital account reforms and the economic stabilization.

I use a dummy variable which equals one if the firm has foreign ownership status. The data was compiled by Jennifer Poole (2009) using information on FDI stocks and FDI flows. All foreign investments are registered with Brazil's Central Bank (Banco Central do Brasil) and, thus, available in the dataset. Some assumptions were made to construct the dummy from the FDI information. As explained in Poole (2009), an establishment with positive foreign investment stock in t=2001 and positive flows in $t-3$ and $t-4$ is classiffied as a foreign-owned establishment through the whole period. If the establishment has no stock in t=2001 but positive inflows in other years, the establishment is classiffied as foreign-owned only for the years with positive flows. And, if the establishment has a positive stock in t=2001 but no flows in the years before, it is classified as foreign-owned for the whole period[9].

[9]Two dummies for the foreign ownership status were created, where the main difference is that one of the dummies refers only to the foreign ownership status of the firm, and the other assumes that also subsidiaries of firms receiving inflows are foreign-owned (even if the subsidiary is not classified as having received inflows or with a stock of foreign investment). Throughout this paper the dummy used is the second one. Both dummy variables were constructed using three main data sources from the Brazil's Central Bank: plant-level inflows information from 1996 to 2001, plant-level stock information in the year 2001, and (incomplete) information on the holding company corporate structure. If there was no information on FDI stocks by year, the data allowed for a procedure to infer which establishments were at least partially foreign-owned for each year; see Poole (2009).

Further information about the data is available at Poole (2009) [10].

3.2 Control variables and classification of goods

International Codes for products: The codes used for the Brazilian exports refer to 8 digit NCM classification of goods (NCM-SH – Nomenclatura Comum do Mercosul, Sistema Harmonizado). The first 6 digits of the NCM correspond to the HS (international Harmonized System), which is the international standard for the classification of goods. Thus, NCM can be merged with the NCM/HS code with the SITC, ISIC and CNAE classifications.

Rauch classification of goods: Rauch(1999) uses the 4 digit SITC 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 any quoted price. With this classification, goods are divided in 349 reference priced goods, 146 homogeneous goods and 694 differentiated goods. As shown in Bastos and Silva (2009), the Rauch (1999) classification of goods is well suited for capturing quality differentiation.

GDP per capita: Data on GDP per capita ($CGDP_c$) comes from the Penn World Table (PWT 6.2 for 188 countries. The version 6.2 uses the year 2000 as the base year).

Income inequality: Data on income inequality (Gini coefficient and income deciles) come from the UNO-WIDER (United Nations World Institute for Development Economics Research) [11] [12].

Spatial data and country codes: The bilateral gravity regressors (distance, language, colony, common colony, contiguity) come from the CEPII - Centre d'Etudes Prospectives et d'Informations Internationales. The same source gives the international *cty* country codes.

World exports and imports – bilateral flow: Data on bilateral imports and exports come from NBER-UN yearly bilateral trade data (www.nber.org/data), documented by Feenstra et al (2005). The NBER-UN trade data gives an accurate measure of trade flows by sector

[10] Jennifer Poole kindly provided the information on FDI.

[11] 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, we use information from the years 1999 and 2001, respectively. In this way we have information for 91 countries.

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

SITC2 [13], since the values are mainly reported by the importing country - which is a better measure due to the differences between c.i.f. and f.o.b. prices (s. Feenstra, 2005).

This data allows to calculate different measures of market power of Brazilian firms, as well as a proxy for the production in the destination country and a measure of the importance of each sector in each country. All variables are described in Table 1.

3.3 Descriptive Statistics

What determines f.o.b. export prices? Table 1 presents a brief summary of the dependent variables x_{gfc} (for g the good sold by firm f to country c) that might be important to explain price variation across countries. Some of those variables are not studied in the trade literature but are frequent in the Industrial Organization (IO) literature. Column (3) of Table 1 shows the expected sign of each variable according to the respective literature (in column (4)).

The models in Table 1 column (4) are: (1) quality sorting; (2) efficiency sorting; and (3) IO literature. The efficiency sorting models, as Melitz (2003) and Melitz and Ottaviano (2008), assume fixed marginal costs once firms draw their productivity, while the quality sorting models allow for marginal costs increasing in quality.

The Appendix 7.1 contains a thorough description of the main variables and the expected sign according to the literature; it also shows further descriptive statistics in Tables 9 and 10.

Table 2 shows the price variation in terms of standard deviations. The standard deviation of log prices across destinations is on average 0.10 for a firm-product pair. For comparison, the second part of Table 2 presents the deviation of prices within product-country pairs across firms, which is higher, as one would expect (it is already a stylized fact that firms are heterogeneous and produce different qualities with different productivities). As expected, the price variation comes mostly from differentiated goods in both cases [14], and the variation is smaller within the European Union.

Results from Table 2 are shown for all 10,559 firms and all 4,828 products exported to 179 countries in the year 2000.

[13] The NBER-UN data uses the Standard International Trade Classification (SITC 2 - Division), 4 digits.

[14] Those values in Table 2 are smaller than the ones reported in Manova and Zhang (2009), respectively, 0.46 and 0.90 for the variation across destinations and across firms.

Table 1: Control variables x_{gfc} and expected effect on unit prices:

$\mathbf{x}_{gfc}$	variable description	expected sign	theoretical model
Country characteristics:			
GDP_c	GDP of country c (measure of country size)	-	(1)
$Dist_c$	Distance to country c [1]	+	(1*)
$CGDP_c$	GDP per capita of c	+	(1)
$Gini_c$	Gini coefficient in c	+	(1)
Firm characteristics:			
$Scope_{fc}$	Scope of the firm: number of goods sold by f in each destination c	+/-	(3**)
$Ndest_{gf}$	*Extensive margin of entry*: number of c to which the firm f exports good g	+/-	(3**)
$Quant_{gfc}$	*Intensive margin*: quantity exported of good g to country c by firm f	-	(1,2,3)
$Nworkers_f$	Number of workers in f (measure of firm size)	+	(1)
$SumRev_f$	Total export revenues of f (measure of firm size)	+	(1)
$Wages_f$	Average wages of workers in firm f	+	(1***)
$ShareHighEduc_f$	Share of workers in f with tertiary education	+	(1***)
$ShareProfe_f$	Share of professional workers in f (ISCO-88 classification)	+	(1***)
$ShareWhite_f$	Share of white collar workers in f	+	(1***)
$ShareBlue_f$	Share of blue collar workers in f	-	(1***)
$Mktshare_{gfc}$	Market share of fg in c with respect to the sum of firms exporting g to c	+	(3)
Other market characteristics:			
$ShareImp_{c,s}$	$\frac{Imp_{cs_i}}{\sum_{j\neq i} Imp_{cs_j}}$. Share of imports of c in sector s_i with respect to all sectors $j \neq i$	+	(3)
$ShareExp_{c,s}$	$\frac{Exp_{cs_i}}{\sum_{j\neq i} Exp_{cs_j}}$. Share of exports of c in sector s_i as *proxy for production in* c	-	(3)
$Mktshare_{fc,s}$	Share of imports in s_i from Brazilian firms with respect to total imports from the World	+	(3)
$Nfirms_{gc}$	Number of Brazilian firms selling g in country c (competition measure)	-	(3)

Notes

MODELS: (1) quality sorting; (2) efficiency sorting; and (3) IO literature.

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

As an extension I could use the available information on the Brazilian state where the good was produced.

* The IO literature (3) would predict +/- : reverse dumping (+, higher markup to distant markets) vs. dumping (-).

* The efficiency sorting literature (2) would predict a negative relation.

** Fixed entry costs vs. market power and scale effects.

*** Quality sorting: more productive firms pay higher wages to employ qualified workers and produce higher quality at higher prices.

Table 2: Variation in export prices - standard deviation

	Obs	Mean	Std. Dev.	Min	Max
Variation in export prices across destinations within firm-product pairs					
Standard deviation of prices across destinations:					
Total trade	54619	**0.1073**	0.2180	0	1.5677
Diff. goods	45271	0.1099	0.2201	0	1.5677
Ref. priced goods	4623	0.0754	0.1814	0	1.4623
Homog. goods	1203	0.0607	0.1331	0	1.0653
only european countries (total trade)	9562	0.0614	0.1642	0	1.5159
Variation in export prices across firms within country-product pairs					
Standard deviation of prices across firms:					
Total trade	43525	**0.2106**	0.3211	0	1.5955
Diff. goods	34314	0.2268	0.3282	0	1.5955
Ref. priced goods	5304	0.1097	0.2476	0	1.5301
Homog. goods	924	0.1048	0.2089	0	1.5032
only european countries (total trade)	6419	0.1527	0.2835	0	1.5052

4 Preliminary evidence of quality heterogeneity using cross-section data: price variation within firm-product pairs across countries

This section presents preliminary results in cross-section. Results indicate that firms in differentiated goods sectors sort on quality, while homogeneous goods follow a different pattern. The empirical approach is initially similar to Manova and Zhang (2009) and Bastos and Silva (2010), even though those papers focus the variation across firms, while I am interested in the within-firm variation. Moreover, I extend the analysis in several ways. Bastos and Silva (2010) use a cross-section of Portuguese firms and find convincing evidence that f.o.b. prices increase in distance; Manova and Zhang (2009) test different trade theories at the firm level and point out to quality differentiation as a cause of differences in prices [15].

Subsection 4.3 shows several robustness checks not addressed in the literature before and that might be relevant to explain the variation of prices across countries, as intra-firm trade, tariff and non-tariff barriers and the quality length of the industry.

4.1 Econometric specification for cross-section analysis

I first carry some simple tests for the determinants of f.o.b. prices across countries by firm-product pairs using *fixed effects transformation.* From the linear unobserved effects model $Y_{cgf} = \mathbf{X}_{cgf}\beta + \delta_{gf} + u_{cgf}$, the averages of firm f and product g over C countries follow:

$$\underbrace{C^{-1}\sum_{c=1}^{C} Y_{cgf}}_{\bar{Y}_{gf}} = \underbrace{C^{-1}\sum_{c=1}^{C} \mathbf{X}_{cgf}}_{\bar{X}_{gf}}\beta + \delta_{gf} + \underbrace{C^{-1}\sum_{c=1}^{C} u_{cgf}}_{\bar{u}_{gf}} \tag{1}$$

where $Y_{cgf} = uprice_{cgf}$ represent unit values $(\frac{Value_{fcgt}}{Quant_{fcgt}})$ and $\mathbf{X}_{cgf}$ is the vector of control

[15]Many studies have found that price variations across countries are related to non-homothetic preferences. Hallak(2006,2008) and Hummels and Klenow(2005) find that prices are positivelly correlated to exporter per capita income, which suggests that countries with higher income have a comparative advantage in producing goods of higher quality. Fieler(2008) studies both demand and supply side and find that unit prices increase both with importer and exporter income per capita, i.e., *for the same commodity category, unit prices increase with importer income per capita.* This result indicates that countries with higher income produce and consume goods of higher quality (Fieler, 2008). Although, all those studies are at the country level; new studies as the ones mentioned from Manova and Zhang (2009) and Bastos and Silva (2010) are the new attempts to study price variation using firm-level data.

variables described in Table 1.

In terms of deviations from the mean, $\ddot{Y}_{cgf} = Y_{cgf} - \bar{Y}_{gf}$, it follows:

$$\ddot{Y}_{c(gf)} = \ddot{X}_{c(gf)}\beta + \ddot{u}_{c(gf)} \tag{2}$$

For linear models, the within estimator from equation 2 is equivalent to the least-squares dummy-variable estimator (LSDV). Thus, they may be used interchangeably once the standard errors are clustered in the correct way, given the sample dimensions [16].

4.2 Preliminary evidence and competiting hypotheses: homogeneous versus differentiated goods

The results in this section follow the within estimator from equation 2, in logs if applicable. An important support to the hypothesis of vertical differentiation across countries is presented in Tables 3 and 4.

I show that differentiated goods (Table 3) follow different patterns if compared to homogeneous goods (Table 4). Assuming for a moment that the results from Table 3 reflect quality variation across countries, results could be interpreted as follows. For distance $Dist_c$: the highest quality will be shipped to distant countries since, with per unit transaction costs, the relative price of the higher quality products decrease with distance (Alchian and Allen (1964) effect) [17]. For the GDP_c, the relation can be explained with a selection effect: as the market size grows, the firms ship not only the high quality variety but also the lower quality variety, what will lower average prices; thus, prices decrease with market size.

Besides market size and distance, I am particularly interested in the hypothesis of market specific qualities, i.e., that firms adjust quality to countries that are willing to pay more to consume higher quality. Interesting results are shown in Tables 3 and 4. For differentiated goods (Table 3), firm-product prices are higher in richer countries (measured by the country GDP per capita), while for homogeneous goods no effect is observed (Table 4). *The income*

[16] The only difference between the two estimators refers to the cluster-robust standard errors because of different small-sample correction. Consider the LSDV model: $Y_{cgf} = \left(\sum_{n=1}^{N} \alpha_{cgf}\mathbf{d}_{n,cgf}\right) + \mathbf{X}_{cgf}\beta + u_{cgf}$, where $n = 1, ..., N$ are N $firm * product$ specific indicator variables, $\mathbf{d}_{n,cgf}$, with $\mathbf{d}_{n,cgf} = 1$ for the nth $firm * product$ pair observation, and *zero* otherwise.
The inference in the least-squares dummy-variable estimator is designed for N fixed and $C \to \infty$, while in the within estimator C is fixed and $N \to \infty$. See Cameron and Trivedi (2009).

[17] In the literature of price variation *across firms*, the argument of the quality sorting literature is that more productive firms sell higher quality, and high observed prices indicate high competitiveness; thus, marginal costs increase in distance, as argued in Verhoogen (2008) and Baldwin and Harrigan(2007).

effect on prices can not be explained only by higher markups because of greater market power, since $Mktshare_{fcg}$ also controls for the firm's market share by country and product, as in Manova and Zhang (2009). Controlling for the firm-product market share in a specific country, the results for GDP per capita remain robust (column (3), Table 3).

Moreover, in columns (4) and (5), different measures of market share are added as well as a proxy for production in country c using the NBER-UN World Trade data. $ShareImp_{c,s}$ controls for the importance of sector s_i in the total imports from country c; and $ShareExp_{c,s}$ controls for the importance of sector s_i in total exports of country c, as a proxy for production in country c. Moreover, $ln(Nfirms)_{cg}$ controls for the number of firms selling the same product in each market as a measure of competition. Interestingly, the coefficient for the GDP per capita remains significant in all specifications.

The results are also robust controlling for the *elasticity of substitution* measured by Broda and Weinstein (2006), as shown in column (7) [18].

Another striking result refers to income inequality, measured by the Gini coefficient $Gini_c$. Different than for homogeneous goods (results in columns (3) and (4) of Table 4), for differentiated goods higher income inequality leads to higher prices. As shown in Table 3 columns (3) and (4), this is true even controlling for the firm-product market share, what gives further support to the hypothesis of quality differentiation.

This last result is very intuitive: in countries with higher income inequality, a share of the population demands products of higher quality. Thus, due to non-homothetic preferences, countries with higher income inequality pay higher prices, for a given GDP per capita and market size.

Table 4 presents the results for homogeneous goods. Interestingly, no effect on $CGDP_c$ is observed. Moreover, the effect of distance follows a different pattern for this type of goods: distance has a negative effect on prices. Moreover, $ShareExp_{c,s}$ as a proxy for production in the destination market is important to explain the differences in prices across markets for homogeneous goods.

[18] The drawback is that world trade elasticities are measured only for 73 countries in the world and, thus, results might be subject to sample selection.

Table 3: Variation in export prices within firm-product pairs across countries for Differentiated goods

Dependent variable: $ln(uprice)_{fcg}$	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$ln(CGDP)_c$	0.0132**	0.0202***	0.0215***	0.0110*	0.0113**	0.0118**	0.0215**
	(0.00609)	(0.00692)	(0.00693)	(0.00569)	(0.00569)	(0.00573)	(0.0102)
$ln(GDP)_c$	-0.0140***	-0.0148***	-0.0133***	-0.0160***	-0.0161***	-0.0145***	-0.0128***
	(0.00264)	(0.00265)	(0.00269)	(0.00288)	(0.00287)	(0.00296)	(0.00367)
$ln(Dist)_c$	0.0221***	0.0280***	0.0214***	0.0304***	0.0315***	0.0232***	0.0391***
	(0.00557)	(0.00597)	(0.00637)	(0.00549)	(0.00550)	(0.00739)	(0.00877)
$ln(Gini)_c$		0.0469**	0.0552**				0.0786**
		(0.0232)	(0.0231)				(0.0321)
$Mktshare_{fcg}$			0.0397***				
			(0.0136)				
$ShareImp_{c,s}$				-1.158**			
				(0.577)			
$ShareExp_{c,s}$					-0.953**	-0.984**	
					(0.457)	(0.458)	
$ln(Nfirms)_{cg}$						-0.00789	
						(0.00556)	
$Sigma_{c,s}$							-4.17e-05
							(0.000133)
Constant	2.872***	2.595***	2.567***	2.854***	2.841***	2.891***	2.359***
	(0.0622)	(0.146)	(0.145)	(0.0663)	(0.0662)	(0.0721)	(0.215)
Firm-product FE	Y	Y	Y	Y	Y	Y	Y
Observations	85,486	85,486	85,486	85,486	85,486	85,486	67,477
R-squared	0.974	0.974	0.974	0.973	0.973	0.973	0.976
F-statistic	11.52	10.20	9.80	13.15	13.11	10.53	4.68
P-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003
Number of countries	89	89	89	89	89	89	89
Number of products	2948	2948	2948	2948	2948	2948	2948
Number of firms	5090	5090	5090	5090	5090	5090	5090

NOTES:
1. The standard errors are clustered at the country level.
2. The R-squared reported refer to the LSDV estimator, which includes the firm-product FE.
The within effect of the estimations using fixed effects transformation is, on average, 0.03 and, thus, similar to (although strictly greater than) the within effect reported in Bastos and Silva(2010) in their working paper.
3. Since the focus of the paper is the variation across countries for a firm-product pair, all observations for which the number of destinations is less than 2 are dropped.

4.3 The effect of the firm's core product:

Eckel et al (2010) study multiproduct firms that have a core competence in producing a differentiated or homogeneous good. Goods closer to the firms core competence have lower costs, so the firm produces more of those goods, and has also *more incentives to invest in their quality.* These two effects generate opposite predictions for prices of homogeneous and differentiated goods: for differentiated goods, the effect of quality upgrading dominates and prices increase as the firm moves to its core competence. For homogeneous goods, without quality differentiation, prices increase as the firm moves away from its core competence. Thus, the firm's core product is sold at higher prices for differentiated goods, and at lower prices

Table 4: Variation in export prices within firm-product pairs across countries for Homogeneous goods

Dependent variable: $ln(uprice)_{fcg}$	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
$ln(CGDP)_c$	-0.00456	-0.00396	-0.00686	-0.00478	-0.00164
	(0.0176)	(0.0182)	(0.0171)	(0.0176)	(0.0168)
$ln(GDP)_c$	0.0092*	0.00761	0.00730	0.00800	0.00990
	(0.0044)	(0.00655)	(0.00652)	(0.00620)	(0.00652)
$ln(Dist)_c$	-0.0654***	-0.0630**	-0.0639***	-0.0661***	-0.0690***
	(0.0226)	(0.0262)	(0.0221)	(0.0227)	(0.0225)
$Mktshare_{fcg}$		-0.0139	-0.0153		
		(0.0398)	(0.0405)		
$ln(Gini)_c$		0.00836			
		(0.0621)			
$ShareImp_{c,s}$			-0.497		
			(1.312)		
$ShareExp_{c,s}$				-1.064**	-1.139**
				(0.525)	(0.561)
$ln(Nfirms)_{cg}$					-0.00929
					(0.0133)
Constant	5.425***	5.381***	5.456***	5.438***	5.417***
	(0.212)	(0.432)	(0.209)	(0.213)	(0.203)
Firm-product FE	Y	Y	Y	Y	Y
Observations	2,016	2,016	2,016	2,016	2,016
R-squared	0.987	0.987	0.987	0.987	0.987
F-statistic	3.04	1.94	2.12	2.90	2.39
P-value	0.0348	0.0993	0.0738	0.0283	0.0472
Number of countries	72	72	72	72	72
Number of products	151	151	151	151	151
Number of firms	512	512	512	512	512

NOTES:
1. The standard errors are clustered at the country level.
2. The R-squared reported refer to the LSDV estimator, which includes the firm-product FE.
The within effect of the estimations using fixed effects transformation is, on average, 0.03 and, thus, similar to (although strictly greater than) the within effect reported in Bastos and Silva(2010) in their working paper.
3. Since the focus of the paper is the variation across countries for a firm-product pair,
all observations for which the number of destinations is less than 2 are dropped.

for homogeneous goods.

I confirm these assymetries across products looking at the firm's core product versus other products (for a firm-country pair). The core product is a dummy $Coreproduct_{fg}$ equal one for the 8 digit variety that represents the firm's highest revenues (not country specific). In Table 5, I show results for the firm-country price variation across the products produced by the firm. For differentiated goods, the firm's core product has a positive effect on prices, what confirms the hypothesis from Eckel et al (2010). Although, for homogeneous goods, the Eckel et al (2010) model suggests a negative relation between $Coreproduct_{fg}$ and prices; in my estimations no effect is observed for homogeneous goods.

As the main interest of this paper refers to the variation across countries, I check whether the core product magnifies the effect on income per capita ($CGDP_c$). If the firm invests more in quality upgrading of the core product (as suggested in Eckel et al (2010)), and if countries with higher income per capita are willing to pay more for higher quality, the effect of income per capita on prices should be higher for those products. This is confirmed in Table 6 only for differentiated goods, as expected. If the product sold is the *firms core competence*, the effect of the $CGDP_c$ on prices is magnified, as shown in columns (1), (2) and (3). The same effect is not observed for homogeneous goods, as shown in column (5). Moreover, this effect is not significant if the interaction is between the $Coreproduct_{fg}$ and distance, and is negative if the interaction is between the $Coreproduct_{fg}$ and $ln(Gini)_c$, as shown in column (4).

As a complementary explanation for those effects, the observed variation in prices across markets could be a result of different markups. Interestingly, the elasticity of substitution across sectors and countries, $Sigma_{c,s}$, does not affect the results, as also shown in Table 3. Moreover, I also control for market power and competition in different ways, as well as for the quality ladder length (see Section 4.4). Although, further research is needed to sort out those the markup and the quality effects.

In the next section I discuss several robustness checks that rule out different competing hypotheses, most of them not mentioned in the literature before.

Table 5: Variation in export prices across products for firm-country pairs

Dependent variable: $ln(uprice)_{fcg}$	**Differentiated goods**		**Homogeneous goods**	
Coreproduct$_{fg}$	0.655***	0.644***	0.236	0.237
	(0.0291)	(0.0291)	(0.252)	(0.251)
$ln(nfirms)_g$	-0.536***	-0.507***	-0.00145	-0.0289
	(0.0154)	(0.0167)	(0.0912)	(0.137)
$ln(dest)_g$	0.237***	0.230***	-0.176	-0.173
	(0.0199)	(0.0199)	(0.183)	(0.184)
$Mktshare_{fcg}$		0.146***		-0.126
		(0.0447)		(0.444)
Constant	3.508***	3.417***	5.246***	5.335***
	(0.0359)	(0.0436)	(0.277)	(0.415)
Observations	83,796	83,796	2,628	2,628
R-squared	0.653	0.653	0.988	0.988
Firm-country FE	Y	Y	Y	Y
P-value	0.000	0.000	0.000	0.000

NOTES:
1. The standard errors are clustered at the product level.
2. The R-squared reported refer to the LSDV estimator, including firm-country FE.

Table 6: Variation in export prices within firm-product pairs across countries - CORE PRODUCTS

Dependent variable: $ln(uprice)_{fcg}$	**Differentiated goods**				**Homogeneous goods**
$ln(CGDP)_c$	0.00143	0.00792	0.00793	0.0153**	-0.0627*
	(0.00773)	(0.00857)	(0.00860)	(0.00764)	(0.0374)
Coreproduct$_{fg} * ln(CGDP)_c$	**0.0306****	**0.0325*****	**0.0304****		0.00770
	(0.0124)	**(0.0125)**	**(0.0125)**		(0.00656)
$Coreproduct_{fg} * ln(Gini)_c$				-0.104***	0.0103
				(0.0403)	(0.0385)
$ln(GDP)_c$	-0.0161***	-0.0155***	-0.0157***	-0.0155***	-0.0139
	(0.00317)	(0.00322)	(0.00330)	(0.00321)	(0.0609)
$ln(Dist)_c$	0.0229***	0.0212***	0.0260***	0.0211***	-0.0109
	(0.00589)	(0.00684)	(0.00843)	(0.00684)	(0.0308)
$Mktshare_{fcg}$		0.0370**		0.0385***	0.00988
		(0.0145)		(0.0146)	(0.0779)
$ln(Gini)_c$		0.0433*	0.0364	0.0687**	
		(0.0258)	(0.0257)	(0.0299)	
$ShareImp_{c,s}$			-1.292**		
			(0.619)		
$ShareExp_{c,s}$			-0.152		
			(0.477)		
$ln(Nfirms)_{cg}$			-0.000755		
			(0.00610)		
Constant	2.923***	2.686***	2.700***	2.668***	5.379***
	(0.0736)	(0.166)	(0.170)	(0.167)	(0.575)
Firm-product FE	Y	Y	Y	Y	Y
Observations	85,486	85,486	85,486	85,486	2,016
R-squared	0.974	0.974	0.974	0.974	0.987
Number of countries	89	89	89	89	72
Number of products	2948	2948	2948	2948	151
Number of firms	5090	5090	5090	5090	512

NOTES:
1. The standard errors are clustered at the country level.
2. The R-squared reported refer to the LSDV estimator, which includes the firm-product FE.
The within effect of the estimations using fixed effects transformation is, on average, 0.03 and, thus, similar to (although strictly greater than) the within effect reported in Bastos and Silva(2010) in their working paper.

4.4 Robustness checks and further support to the hypothesis of quality differentiation across countries:

Besides quality variation, some competing hypotheses could help to explain price variation across countries and are usually not taken into account in the price-firm-level literature; I show some robustness checks to rule out those possible sources of price variation, as shown below. I am not aware of any paper in the price-quality literature that addresses those issues. Most of the robustness checks below are done joinly for all goods (homogeneous, differentiated and reference priced goods).

Intra firm trade: I also check whether intra-firm trade could bias the results. Since the information on final consumers is unobservable, I use information on the foreign ownership status of firms in the period 1997-2000 as a rough measure of intra-firm trade. I estimate equation (2) only for countries that have not received any kind of foreign direct investment in this period to rule out this possible source of bias. As shown in Table 12 in the Appendix 7.3, despite some few cases (the Gini coefficient, distance in columns (3) to (5) and GDP in columns (3) and (4)), results remain as expected.

The long and short of *Quality Ladders* (Khandelwal, 2010): Khandelwal(2010) characterizes industries according to the scope for quality differentiation. Industries are classified as long and short quality ladders, i.e., with long and short market's scope for quality differentiation. I use this classification of industries to analyse some sectors considered long and others considered short ladders. I expect higher effect of GDP per capita on prices for the long quality ladders, which can vertically differentiate more their products. Results are shown in Table 15 in the Appendix 7.3 for some selected sectors. For long quality ladders, GDP per capita is more important to explain prices (the elasticity of GDP per capita is the double if compared to the short quality ladders); moreover, the market share seems more important for the short quality ladders. It is important to notice, however, that Khandelwal's classification refers to US firms, which have a different structure in terms of vertical differentiation if compared to Brazilian firms; thus, even though results give support to quality differentiation, they are not conclusive.

Region/country effects: In order to rule out the possibility of pure *region or country effects*, important trade partners are excluded from the sample at a time. Results are shown in Table 13 in the Appendix 7.3: the elasticity of the GDP per capita changes but the effect remains significant, i.e., there is no specific country or region driving the results.

Exchange rate, tariff and non-tariff barriers and institutional setting: I use the European Union as a control for these effects, which could affect price behaviour. The sample from Table 11 Appendix 7.3 contains only observations for which the destination country was a member of the European Union in the year 2000.
Columns (1) to (4) of Table 11 show results for exports to all countries in the EU; columns (5) and (6) excludes countries that did not have the same currency by 2000; and columns (7) to (9) excludes the Netherlands from the sample. The Netherlands represent a special case in Europe: because of the distribution function of the Netherlands, what includes the Port of Rotterdam, the largest port in Europe, the Netherlands gives the basic access to European countries, specially the markets in the United Kingdom and Germany. From Rotterdam, goods are transported by ship, river barge, train or road. Thus, many goods exported by Brazilian firms are re-exported to other countries. According to the informations from the Port of Rotterdam, for instance, the share of re-export during the last few years has averaged in excess of 40 per cent [19]. The results do not change significantly once the Netherlands is excluded from the sample. In Table 11 in the Appendix 7.3, the variables remain with the expected sign and are significant in most cases. The variable of interest, the GDP per capita, remains significant in most cases; thus, price variations across countries can not be attributed to a pure exchange rate effect or to an effect of the institutional environment or tariffs [20] [21].

Market share, endowment and production effects: As already shown in Table 3, the price variation across countries can not be explained only by the market share $Mktshare_{fcg}$ of Brazilian firms. Moreover, using information on World trade flows by SITC sector, the

[19] Informations from the Port of Rotterdam website, URL
http://www.portofrotterdam.com/en/news/pressreleases/2009/2009040906.jsp.

[20] As already shown in Table 2, the standard deviation of log prices within firm-product pairs across destinations is 0.06 for sales to countries in the European Union. This variation is small, as expected: in terms of quality, countries in the European Union have preferences for similar quality if compared to other countries around the world.

[21] Note that $Dist_c$ does not appear in all regressions from Table 11 and when it does it is not significant; this result could be expected: if compared to the distance from Brazil to the EU, the distance within EU neighbor countries should not be relevant.

control variable $ShareImp_{c,s}$ in Table 3 implies that the results are not driven by sectors in which Brazil has a comparative advantage in comparison to other countries; and the control $ShareExp_{c,s}$ implies that the results are also not driven by sectors in which destination country c has a comparative advantage.

Automobile industry: The automobile industry and industry of parts of automobiles has great importance for the Brazilian economy and exports. Even though those goods are classified as differentiated goods, the price behaviour in this industry differs from other industries and the goods do not vary heavily in quality if compared to products in other industries. Thus, I redo the results without the automobile industry. Results are shown in the Appendix 7.3 in Table 14; most results remain significant, as before.

Median of variables proxies for quality, by industry: Information on workers' education, the average wage and the share of professionals as production inputs are relevant proxies for the quality of the product. By industry, I take the median of those characteristics and split the sample in two groups. As shown in Table 15 in the Appendix 7.3, firms above the median of those characteristics [22] capture the whole effect on GDP per capita. Those firms are probably the ones that are more able to vertically differentiate, and, thus, this result gives further support to the quality differentiation hypothesis.

[22] The firm enters the group above the median if all proxies for quality are above the median.

5 Market Segmentation: results for the European Union and Mercosur

In this section I exploit the unique moment of the Brazilian economy and use the devaluation of 1999 as a source of variation in the incentives for firms to invest in product innovation. As mentioned in Section 2, this effect is expected to be assymetric across countries, as discussed with the example of the *export type varieties*. The model is tested using two important markets for Brazilian products: the European Union (North) and Mercosur (South). The hypothesis is that, from 1997 to 2000, products exported to the European Union by firms that upgraded quality received the quality treatment, while products exported to Mercosur by firms that did not upgrade quality did not receive the treatment (control group). Since the quality level affects prices, products exported to the European Union should observe an increase in prices (the dependent variable). I test the hypothesis of quality upgrading and market segmentation using differentiated and homogeneous goods. The effect is expected only for differentiated goods. The motivation for the differential effect in the two markets (Mercosur and EU) was shown in Section 2.

The identification strategy follows a difference-in-difference-in-differences (DDD). I use products exported to the European Union (treated) and to Mercosur (not treated) before $(t-3)$ and after (t) the quality treatment, for firms that were treated and others that were not. These groups of countries are used since they represent the extremes of the quality varieties exported by Brazilian firms and have a lower probability of containing a mix of quality types. 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 in 2000 [23]. Moreover, Mercosur and EU represent the main markets for Brazilian products, besides the United States [24].

[23] Although, concerning the EU, there might exist some mix of quality types. As a robustness check, I keep only the half of EU countries with higher income per capita.

[24] The United States could, however, suffer more from the problem of the mix of quality types mentioned before.

5.1 Econometric specification:

In the DDD specification, I compare firms' export prices in the years 1997 ($t-3$, before treatment) and 2000 (t, after treatment) for the EU (treated) and Mercosur (control group) for firms that upgraded quality (treated) and firms that did not (control group). Figure 2 in the Appendix 7.4 presents graphically the structure of the treatment effects.

The assumptions for the quality upgrading mechanism follow:

Assumption 1: If $Qual_{f,t} > Qual_{f,t-3}$, then $uprice_{f,t} > uprice_{f,t-3}$.

If a firm upgrades the quality of a product from $t-3$ to t, the firm will also increase the price of the higher quality product (since it affects the choice of inputs and marginal costs).

Assumption 2: A firm upgrades quality from $t-3$ to t if $EU = 1$ and $Upgrade_{f,t,t-3} = 1$ in year t,

where $EU = 1$ if the destination country is a country in the EU,

$Upgrade_{f,t,t-3} = 0$ in $t-3$ $\forall$ f,

$Upgrade_{f,t,t-3} = 1$ in t if

$\Delta ShareProfessionals_{ft,t-3} > median(\Delta ShareProfessionals_{\mathbf{i}t,t-3}) \wedge$

$\Delta ShareHighEduc_{ft,t-3} > median(\Delta ShareHighEduc_{\mathbf{i}t,t-3}) \wedge$

$\Delta Wages_{ft,t-3} > median(\Delta Wages_{\mathbf{i}t,t-3})$, for a firm f and an industry i.

Assumption 2 says that not all products exported to the European Union (EU=1) received the treatment: for an industry i, the firm upgrades product quality from $t-3$ to t if the variation in quality ($Upgrade_{f,t,t-3}$) is higher than the median variation in quality in the same industry[25]. The variation in quality (quality upgrading), is proxied by the increase in the share of workers with tertiary education ($\Delta ShareHighEduc_{\mathbf{f}t,t-3}$), the increase in the share of professionals ($\Delta ShareProfessionals_{\mathbf{f}t,t-3}$) [26] and the increase in average wages ($\Delta Wages_{\mathbf{f}t,t-3}$) between 1997 and 2000. For every industry, the median of these variables is taken as the threshold [27].

[25] With this assumption, it might happen that some firms below the median upgraded quality too, what would underestimate the results. Although, the assumption rules out a possible bias due to trends in specific industries.

[26] As a robustness check, I could use the share of white collar workers.

[27] If a firm increased those shares and the average wages more than the industry median between 1997 ($t-3$) and 2000 (t), then the firm upgraded quality in this period.

1. Difference-in-differences (DD) specification:

$ln(Uprice_{fcg,t}) = \mathbf{Upgrade}_{f,t}\gamma_{DD} + ln(X_{fcg})\beta_1 + u_{fcg}$

where X_{fcg} are control variables, as before,

the dummy $Qualupgr_{f,t} = 1$ if the firm upgraded quality.

2. Difference-in-differences-in-differences (DDD) specification:

$ln(Uprice_{fcg,t}) = \mathbf{Upgrade}_{f,t} * \mathbf{EU}\gamma_{DDD} + Upgrade_{f,t}\beta_1 + EU\beta_2 + ln(X_{fcg})\beta_3 + u_{fcg}$

where X_{fcg} are control variables, as before,

the dummy $Upgrade_{f,t} = 1$ if the firm upgraded quality,

and the dummy $EU = 1$ if the product was exported to the EU.

In specification 1 (DD), the coefficient of interest is γ_{DD}. It shows that firms that upgraded quality over time increased the prices of their products.

In specification 2 (DDD), the coefficient of interest is γ_{DDD}. It shows that, if firms upgraded quality, they upgraded to the countries in the EU, what is reflected in higher prices to the EU.

I expect a significant effect of γ_{DD} and γ_{DDD} only for differentiated goods.

5.2 Results:

Table 7 presents the results for specification 1. Controlling for the market share, firms' size (number of destinations and number of workers) and other firm and market characteristics, the quality treatment effect of firms above the median is captured by the coefficient γ_{DD}, which is positive and significant. Moreover, the treatment effect is observed only for firms in differentiated goods sectors (column (1) to (4)) and not for firms in homogeneous goods sectors (columns (5) and (6)).

Table 8 presents the results for specification 2. The quality treatment effect of firms above the median is captured by the coefficient γ_{DDD}, which is positive and significant. Thus, the price effect is only observed for firms that upgraded quality and for products sold to the European Union (in comparison to the Mercosur, used as the control group). Moreover, the treatment effect is only observed for differentiated goods (column (1) to (5)) and not for homogeneous goods (columns (6) and (7)).

Thus, a differential trend for exports to the North versus exports to the South is confirmed.

As an extension, one could also do a difference-in-differences-in-difference-in-differences (DDDD) estimation by pooling the sample of homogeneous and differentiated goods. Although, since the sample of homogeneous goods is very small compared to the one of differentiated goods, pooling the two samples does not add any further insight.

Table 7: DD: quality upgrading and market segmentation

Dependent variable: $ln(uprice)_{fcg}$	**Differentiated goods**				**Homogeneous goods**	
	(1)	(2)	(3)	(4)	(5)	(6)
Upgrade$_{f,t}$	0.0435**	0.0402**	0.0402**	0.0637*	-0.199	0.451
	(0.0183)	(0.0149)	(0.0149)	(0.0309)	(0.127)	(1.155)
$Mktshare_{fcgt}$	0.154**	0.153**	0.153**	0.216*	0.0564	2.359
	(0.0461)	(0.0475)	(0.0475)	(0.114)	(0.156)	(3.082)
$ln(Ndestinations)_{ft}$		-0.0336	-0.0336	0.0341	0.418	0.660
		(0.0614)	(0.0614)	(0.155)	(0.387)	(0.983)
$ln(Wages)_{ft}$		0.0178	0.0178	-0.0116	0.0338	-0.891
		(0.0145)	(0.0145)	(0.0581)	(0.170)	(2.026)
$ln(Nworkers)_{ft}$	0.0251	0.00962	0.00962	-0.0192	-0.0808	-0.226
	(0.0584)	(0.0176)	(0.0176)	(0.0593)	(0.0431)	(0.205)
$ln(CGDP)_{ct}$				0.720		5.741
				(0.678)		(16.05)
$ln(Gini)_{ct}$				0.238		1.123
				(0.285)		(2.333)
Constant	3.218***	3.252***	3.252***	4.805*	-4.099	-47.01
	(0.364)	(0.233)	(0.233)	(2.198)	(5.704)	(149.6)
Firm-product FE	**yes**	**yes**	**yes**		**yes**	
Firm-product-country FE				**yes**		**yes**
Period FE	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Observations	41,874	41,741	41,741	39,293	1,307	1,194
R-squared	0.933	0.934	0.934	0.988	0.918	0.968

NOTES: Standard errors are clustered at the industry level.

5.3 Placebo exercises and robustness checks:

One important critique to the quality upgrading mechanism could be that wages may be determined ex post and they would, in this case, reflect rent-sharing and not quality upgrading, as discussed in Frias, Kaplan and Verhoogen (2009). Thus, as a robustness check, I do the same analysis from Tables 7 and 8 using only the $\Delta ShareProfessionals_{ft,t-3}$ (measure for white-collar occupation) and $\Delta ShareHighEduc_{ft,t-3}$ (measure for high education), which are for sure ex ante decisions of the firm. Results reveal that using information on wages might generate an upward bias in γ_{DD} and γ_{DDD}, but the significance of the results does not change.

(to be added)

Table 8: DDD: quality upgrading and market segmentation

Dependent variable: *ln(uprice)$_{fcg}$*			**Differentiated goods**			**Homogeneous goods**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Upgrade$_{f,t}$ * EU	**0.114****	**0.116***	**0.0902***	**0.112****	**0.110****	0.339	-0.414
	(0.0444)	(0.0506)	(0.0455)	(0.0441)	(0.0384)	(0.400)	(0.533)
$Upgrade_{f,t}$	0.0105	0.0332	0.0423	0.0134	0.0328	-0.560	0.283
	(0.0376)	(0.0968)	(0.106)	(0.0156)	(0.0575)	(0.460)	(0.774)
EU	-0.0665	-0.0646	-0.0179			-0.391	
	(0.0590)	(0.0598)	(0.0689)			(0.348)	
$Mktshare_{fcgt}$	0.152	0.150	0.151	0.255*	0.258*	-0.0928	0.406
	(0.0863)	(0.0858)	(0.0995)	(0.133)	(0.131)	(0.0684)	(2.057)
$ln(Ndestinations)_{ft}$		-0.0474	-0.0350		-0.0975	0.589	0.401
		(0.0982)	(0.109)		(0.0732)	(0.640)	(0.754)
$ln(Wages)_{ft}$		-0.0673	-0.0826		-0.0515	0.193	-0.400
		(0.158)	(0.176)		(0.101)	(0.347)	(0.376)
$ln(Nworkers)_{ft}$	0.0647	0.0606	0.0525	0.0647	0.0656	-0.125	-0.204
	(0.0502)	(0.0327)	(0.0332)	(0.0367)	(0.0486)	(0.127)	(0.284)
$ln(CGDP)_{ct}$			-0.0393				3.548
			(0.0692)				(10.00)
$ln(Gini)_{ct}$			0.0278				1.119
			(0.137)				(3.257)
Constant	3.006***	3.748***	4.148***	2.960***	3.668***	5.984***	-29.15
	(0.314)	(1.113)	(0.835)	(0.229)	(0.570)	(0.420)	(106.2)
Firm-product FE	**yes**	**yes**	**yes**			**yes**	
Firm-product-country FE				**yes**	**yes**		**yes**
Period FE	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Observations	40,603	40,465	37,995	40,603	37,995	1,315	1,199
R-squared	0.943	0.943	0.947	0.990	0.991	0.902	0.970

NOTES: Standard errors are clustered at the industry level.

6 Conclusion

This paper uses a new approach to explain the relation between prices and quality that goes beyond cross-section analysis. I present preliminary evidence that productive firms in differentiated goods sectors segment the market and vary product quality across destinations. First, I show that differentiated goods confirm the predictions of quality sorting models, while homogeneous goods follow a different pattern. These results are robust to several specifications and support the hypothesis of quality variation across destinations.

For differentiated goods, the cross-section results suggest that firms adjust quality to more distant and richer markets, as well as to countries with higher income inequality; this effect can not be solely explained by higher markups because of higher market shares, since the market share is controlled for in different ways. Moreover, results are robust to the elasticities of substitution across countries and are higher for the firms' core product.

Second, I use a unique moment of the Brazilian economy and an increase in the incentive to exports to exploit the stylized fact that firms created export type products, products associated with higher quality and designed for high income countries. I test the hypothesis using a DDD strategy, using products exported to the European Union (treated) and to Mercosur (control group) before and after the quality treatment (1997 and 2000). A firm upgraded quality if it increased the quality of the inputs more than the median of the firms in the same industry (this assumption might underestimate the results but is relevant to rule out trends in industries). As expected, this effect is observed only for differentiated goods.

I discuss competing hyphoteses and address several issues not mentioned in the firm-price literature before and that might affect price variation across countries, as the effect of intra firm trade, the quality ladder length, the elasticity of substitution in different markets and different measures of market power and the structure of industries in different markets.

Even though further research is necessary to sort out the markup and quality effects, the empirical results suggest that, in that period of the Brazilian economy, firms in differentiated goods sectors segmented the market and created strategies of product differentiation. Thus, results suggest that, besides the well-known productivity premium, the within firm-product quality adjustment is important for firms' success.

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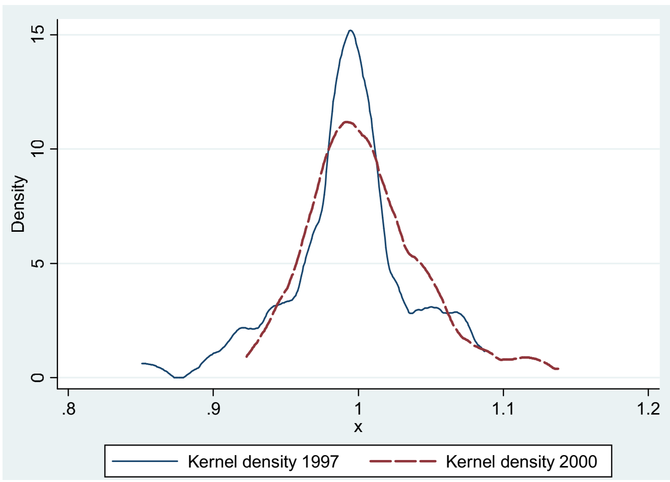
7 Appendix

7.1 Descriptive Statistics for the cross-section

As an illustration for price variation, Figure 1 shows the Kernel density of firm-product price variation across destinations measured in 1997 and 2000. The example in Figure 1 is of the leather industry [28]. Two important facts emerge from Figure 1: (i) in the cross-section, there is firm-product price dispersion across countries, which represents 0.107 in terms of average standard deviation for a firm-product pair in the cross-section 2000 for all goods; (ii) price dispersion varies over the years that follow trade liberalization. This variation in prices is only conditional on firm-product pairs and does not (necessarily) mean quality variation. I am interested in the causes of this price variation, what is studied throughout the paper.

Figure 1: Kernel density: firm-product price variation across countries. Comparison 1997-2000 for the leather industry.



Description of the main variables from Table 1:

$Quant_{gfc}$ refers to the firms' *intensive margin*, i.e., the quantity exported of each variety (higher quantities imply lower prices). Micro-evidence on quantity-based price discrimination is found by Cohen(2000) and Busse and Rysman(2002). Cohen(2000) finds that prices of paper towels vary according to the package size. Busse and Rysman(2002)

[28] Price deviation is calculated as $Pd_{cfg} = \frac{P_{cfg}}{\frac{1}{n}\sum_{i=1}^{n} P_{ifg}}$ and represents the price gap of good g exported by firm f to country c with respect to the mean price of fg to all countries. All prices are free on board (f.o.b.).

study prices of Yellow Pages advertising and find that the price per square inch is lower for larger advertisements - according to the authors, this indirect price discrimination strategy can not be explained by cost factors. Since I have information on the quantity exported, I can control for the intensive margin.

$Dist_c$ refers to the distance to the destination country. There is no consensus with respect to the effect of distance on prices. According to the IO literature on reverse dumping, firms would adjust markups to more distant markets. In an opposite direction, the IO literature on dumping as well as the trade literature on efficiency sorting would argue that prices decrease with distance. The empirical evidence from Manova and Zhang (2009) show prices decreasing with distance, while results from Bastos and Silva (2010) reveal a positive relation between prices and distance. Further empirical evidence from the IO literature are, e.g., Degryse and Ongena(2005) for the case of lending banks. They find that loan rates decrease with the distance between the firm and the lending bank, which is an evidence of *spatial price discrimination.* In a cross-country perspective, Verbogen(1996) and Goldberg and Verbogen(2001) find evidence of spatial price discrimination of automobiles across European countries.

$CGDP_c$ refers to the country's GDP per capita. Many studies have found positive relationship between prices and the country's GPD per capita. Fieler(2008) studies both demand and supply side and find that unit prices increase both with importer and exporter income per capita, i.e., *for the same commodity category, unit prices from the same source country increase with importer income per capita.* This result indicates that countries with higher income produce and consume goods of higher quality (Fieler, 2008). Although, all those studies are at the country level; recent firm level studies as the ones mentioned from Manova and Zhang (2009) and Bastos and Silva (2010) also find positive relation between GDP per capita and prices and attribute this result to variation in quality.

$Ndest_{gf}$ refers to the firms' *extensive margin of entry*, i.e., to how many destinations the firm exports. Following the IO literature, the effect may go in different directions according to the fixed entry costs theory or to the market power and scale effects approach. Each market is subject to a fixed entry costs; although, the IO literature also shows that there might be learning and scale effects within the firm once the firm exports to a second destination. In the trade context, the participation on the same trading block could be used as a proxy for a learning effect (if a firm exports to one European country it might be easier to enter another European country than to enter the Asian market).

$Scope_{fc}$ is the firms' *scope*, i.e., how many products the firm sells in each destination. If a firm already exports a product to a specific destination, it is less costly to introduce a second product in that market; moreover, multiproduct firms have advantages of scale with respect to single product firms. The IO literature also points out to a negative effect due to fixed entry costs.

$Mktshare_{gfc}$ represents the market share, measured by the value exported by one firm compared to the value exported by all firms, i.e., $export_{gfc}/export_{gc}$, for f the firm and c the destination country of product g. I also create additional measures of market share using the NBER-UN World Trade data, as shown in Table 1.

$Nfirms_{gc}$ is a measure of competitiveness. It controls for how many Brazilian firms export one specific product to a market.

SECEX Data for the year 2000: steps for data construction:

Some importants steps taken to build the SECEX data for the cross-section 2000 follow:

- I keep only manufacturing firms: remove 11,192 observations that refer to agricultural and mining firms, as well as commercial intermediates.

- I remove all observations with zero exporting value, which correspond to reporting errors or shipments of commercial samples (as described in Arkolakis and Mündler(2010)). As in Arkolakis and Mündler(2010), 484 observations are removed.

- I remove all observations for which there is no information on quantities, which correspond to 37,903 observations. Without this information I can not construct unit values, defined as $p_{fcg} = \frac{Value_{fcg}}{Quantity_{fcg}}$, for f the firm, g the product and c the destination country of the f.o.b. exported value $Value_{fcg}$l and quantity $Quantity_{fcg}$. [29] [30].

In the final data, there are 114,916 observations, classified according to the Rauch(1999) classification of goods.

Table 9 presents the descriptive statistics of the main variables in the SECEX data and

[29] This lack of information is not systematic in a sector or type of product. Thus, there is no selection effect.

[30] I use data trimming in a second step, after estimations using the whole sample. Trimming the data I remove observations for which the unit value p_{fcg} is either 5 times above or 5 times below the median unit price by product g. This second step drops 19,960 observations 5 times above and 18,184 observations 5 times below the median.

other control variables for the cross-section 2000.

Table 10 presents a brief summary of average number of destinations and number of products by firm. Column 2 shows that firms that export to more than 10 destinations export on average 26.29 different NCM 8 digit products. And, from Column 3, firms that export more than 10 products export to 8.77 destinations on average.

Table 9: Descriptive Statistics for the Year 2000

	Obs	**Mean**	**Std.Dev.**	**Min**	**Max**
Quantity exported fcg	114916	22229.2	425121.8	1	8.35e+07
Value exported fcg	114916	263901.4	4781979	1	1.03e+09
Unit Price fcg	114916	8592.94	521232.90	.0017994	1.05e+08
GDP c	104503	1.38e+12	3.39e+12	5.74e+07	1.25e+13
CGDP c	104503	12556.78	14927.95	123.32	77651.95
Dist c	111676	5442.31	4258.91	1134.649	18821.26
FTA c	105335	.44	.50	0	1
N. products f	114916	58.44	85.67	1	305
N. destinations f	114916	18.85	18.80	1	98
N. firms in cg	114916	14.50	27.00	1	226

Notes: f is the firm, c is the destination country and g is the product
The high number of products (s. max number of products) refers to enterprises in the automobile industry.
As a robustness check I also check the results without these enterprises.

Table 10: Average number of destinations and number of products by firm

	Average number of products by number of destinations	**Average number of destinations by number of products exported**
1	2.83	1.70
2	3.40	2.84
3	4.25	3.84
4	5.04	4.62
5	6.21	5.57
10+	26.29	8.77
Average	4.69	1.70

7.2 Robustness checks for the cross-section

Table 11: Robustness checks: estimations only for EU countries. **Total trade** (homogeneous, differentiated and reference priced goods): variation in firm-product export prices across countries

Dependent variable: $ln(uprice)_{fcg}$	EU countries				EU countries currency		EU countries without Netherlands		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(7)**	**(8)**	**(9)**	**(10)**
$ln(CGDP)_c$	**0.0620****	**0.0720****	**0.0556***	**0.0255**	**0.0750****	**0.0714****	**0.0599***	**0.0707****	**0.0508**
	(0.0297)	(0.0297)	(0.0318)	(0.0422)	(0.0326)	(0.0356)	(0.0313)	(0.0312)	(0.0337)
$ln(GDP)_c$	-0.0189***	-0.0250***	-0.0189**	-0.0202**	-0.0193**	-0.0205**	-0.0196**	-0.0260***	-0.0186**
	(0.00730)	(0.00724)	(0.00767)	(0.00858)	(0.00811)	(0.00853)	(0.00761)	(0.00749)	(0.00800)
$ln(Dist)_c$				0.150					
				(0.129)					
$Mktshare_{fcg}$	0.0176***				0.0179***		0.0183***		
	(0.00537)				(0.00657)		(0.00574)		
$ln(firms)_{cg}$			-0.0251**			-0.0206			-0.0293**
			(0.0121)			(0.0141)			(0.0128)
$ln(Gini)_c$				-0.0408					
				(0.123)					
Constant	3.134***	3.158***	3.195***	2.282*	3.049***	3.108***	3.160***	3.184***	3.228***
	(0.301)	(0.301)	(0.305)	(1.385)	(0.333)	(0.342)	(0.308)	(0.308)	(0.312)
Firm-product FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	9,002	9,002	9,002	7,485	7,754	7,754	8,363	8,363	8,363
Number of pairs	5,568	5,568	5,568	4,783	5,063	5,063	5,345	5,345	5,345

Table 12: Robustness checks: estimations for firms without foreign ownership status. **Total trade** (homogeneous, differentiated and reference priced goods): variation in firm-product export prices across countries

Dependent variable: $ln(uprice)_{fcg}$	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
$ln(Dist)_c$	0.0171***	0.0168***	-0.00313	0.00682	0.00857
	(0.00490)	(0.00544)	(0.00527)	(0.00604)	(0.00604)
$ln(GDP)_c$	-0.00738***	-0.00756***	-0.00121	-0.00317	-0.00551**
	(0.00203)	(0.00227)	(0.00210)	(0.00219)	(0.00218)
$ln(CGDP)_c$	0.0121***	0.0130***	0.0113***	0.0114***	0.0120***
	(0.00373)	(0.00450)	(0.00373)	(0.00372)	(0.00372)
$ln(Gini)_c$		0.0259			
		(0.0201)			
$ln(Mktshare)_{fcg}$			0.0176***	0.0198***	
			(0.00190)	(0.00213)	
$ln(Nfirms)_{cg}$				0.0132***	-0.00890**
				(0.00465)	(0.00414)
Constant	2.867***	2.761***	2.934***	2.883***	2.907***
	(0.0473)	(0.108)	(0.0477)	(0.0491)	(0.0493)
Firm-product FE	Y	Y	Y	Y	Y
Observations	51335	49074	51335	51335	51335
Number of pairs	18508	18182	18508	18508	18508

7.3 Descriptive Statistics for the DDD analysis

Table 13: Robustness checks: rule out *region effects*. **Total trade** (homogeneous, differentiated and reference priced goods): variation in firm-product export prices across countries

Dependent variable: $ln(uprice)_{fcg}$	without US		without Argentina		without EU		without Mercosur	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
$ln(Dist)_c$	0.0277***	2.33e-05	0.0187***	-0.0117**	0.0308***	0.00431	0.00792	-0.0231***
	(0.00447)	(0.00495)	(0.00503)	(0.00550)	(0.00453)	(0.00503)	(0.00692)	(0.00742)
$ln(GDP)_c$	-0.0192***	-0.0121***	-0.0151***	-0.00629***	-0.0198***	-0.0123***	-0.0167***	-0.00826***
	(0.00223)	(0.00229)	(0.00215)	(0.00224)	(0.00211)	(0.00220)	(0.00224)	(0.00233)
$ln(CGDP)_c$	0.0190***	0.0176***	0.0197***	0.0182***	0.0250***	0.0253***	0.0252***	0.0238***
	(0.00353)	(0.00352)	(0.00358)	(0.00357)	(0.00390)	(0.00389)	(0.00380)	(0.00380)
$Mktshare_{fcg}$		0.0218***		0.0234***		0.0217***		0.0224***
		(0.00179)		(0.00184)		(0.00185)		(0.00200)
Constant	3.008***	3.130***	2.994***	3.101***	2.930***	3.017***	3.144***	3.265***
	(0.0466)	(0.0472)	(0.0434)	(0.0439)	(0.0431)	(0.0437)	(0.0626)	(0.0632)
Firm-product FE	Y	Y	Y	Y	Y	Y	Y	Y
Observations	63,119	63,119	59,650	59,650	60,633	60,633	48,871	48,871
Number of pairs	20,625	20,625	19,852	19,852	20,948	20,948	17,095	17,095

Table 14: Robustness checks: total trade without automobile industry. **Total trade** (homogeneous, differentiated and reference priced goods): variation in firm-product export prices across countries

Dependent variable: $ln(uprice)_{fcg}$	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
$ln(Dist)_c$	0.00990**	-0.00644	0.00938*		0.00238
	(0.00492)	(0.00488)	(0.00491)		(0.00563)
$ln(GDP)_c$	-0.0123***	-0.00697***	-0.0179***	-0.0104***	-0.00865***
	(0.00207)	(0.00195)	(0.00366)	(0.00184)	(0.00204)
$ln(CGDP)_c$	0.0204***	0.0174***	0.0198***	0.0175***	0.0176***
	(0.00394)	(0.00333)	(0.00391)	(0.00328)	(0.00333)
$ln(Gini)_c$	0.0439**				
	(0.0181)				
$ln(Mktshare)_{fcg}$		0.0132***			0.0154***
		(0.00185)			(0.00207)
$ln(Gini_c * GDP_c)$			0.00149**		
			(0.000687)		
$ln(Nfirms_{cg})$				-0.00539*	0.0120***
				(0.00305)	(0.00427)
Constant	2.844***	3.079***	3.019***	3.092***	3.032***
	(0.0978)	(0.0430)	(0.0477)	(0.0365)	(0.0445)
Firm-product FE	Y	Y	Y	Y	Y
Observations	59675	62443	59675	64138	62443
Number of pairs	22454	22822	22454	23181	22822

Table 15: Robustness checks: the long and short of quality ladders. **Trade in selected sectors** according to the classification from Khandelwal (2009). Variation in firm-product export prices across countries

Dependent variable: $ln(Uprice)_{fcg}$	**SHORT quality ladders**			**LONG quality ladders**		
$ln(Dist)_c$	-0.00972	-0.0333**	-0.0436***	0.000191	-0.0197	-0.00830
	(0.0117)	(0.0133)	(0.0121)	(0.0110)	(0.0162)	(0.0118)
$ln(gdp)_c$	-0.00592	-0.000500	0.00424	0.00218	0.00660	0.00490
	(0.00425)	(0.00460)	(0.00438)	(0.00352)	(0.00435)	(0.00356)
$ln(CGDP)_c$	0.0176**	0.0175**	0.0162**	0.0302***	0.0317***	0.0307***
	(0.00723)	(0.00721)	(0.00712)	(0.00872)	(0.00898)	(0.00876)
$ln(NFirms)_c$		-0.0227***			-0.0154*	
		(0.00756)			(0.00837)	
$Mktshare_{fcg}$			0.0294***			0.00725**
			(0.00422)			(0.00345)
Constant	3.319***	3.427***	3.450***	1.870***	1.953***	1.895***
	(0.103)	(0.104)	(0.101)	(0.0939)	(0.101)	(0.0954)
Firm-product FE	Y	Y	Y	Y	Y	Y
Observations	12,675	12,675	12,675	5,322	5,322	5,322
Number of pairs	4,522	4,522	4,522	1,387	1,387	1,387

Figure 2: Difference-in-Difference-in-Differences