Price Discrimination Within and Across EMU Markets: Evidence from French Exporters

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Abstract

We study the cross-sectional dispersion of prices paid by EMU importers for French products. A third of the dispersion observed within a narrow product category is attributable to price discrepancies within a seller, i.e. exporting firms charging different prices to individual partners in their export portfolio. While lower than in the rest of the European Union, the level of such price discrimination is substantial within the euro area, with a median coefficient of variation of prices of 30%. This mostly originates from firms charging different prices to buyers within a given destination country. We document the heterogeneity across French exporters in their propensity to price discriminate. Large multiproduct exporters tend to adopt more discriminatory pricing strategies. Retailers and small exporters instead charge less dispersed and sometimes nearly uniform prices. We also find that price discrimination is stronger for more differentiated and more durable products. This heterogeneity in firms' propensity to price discriminate has important consequences in the aggregate since price dispersion at the top of the distribution of exports is more than twice larger than the magnitude of price discrepancies within small exporters.

1 Introduction

The failure of the law of one price (LOP) has been a central fact in international macroeconomics over the last 30 years. This failure has been documented for a variety of countries and product categories - including across seemingly integrated markets such as EMU countries. In a recent paper, Cavallo et al. (2014) confirm the prevalence of pricing-to-market across countries sharing different currencies, but they show that the online prices of thou-

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sands of products sold by four major retailers are almost uniform across euro-countries.[1] This result challenges the common view that the LOP fails within the euro area.

Whether firms charge a uniform price across buyers or adjust their prices to the characteristics of the destination market is a defining channel for the transmission of local and aggregate shocks to the economy. In presence of pricing-to-market, (aggregate and idiosyncratic) supply shocks are transmitted heterogeneously to final consumers. Pricing-to-market strategies thus increase the covariance of import prices with local shocks. Instead, uniform-pricing implies that sellers' shocks are transmitted uniformly to every destination while local shocks hardly affect the price of foreign goods. The degree of price discrimination is thus essential for the conduct of monetary policy.

Existing evidence of uniform pricing within the euro-area is based on online price data set by four giant retailers. A natural question is whether such price strategies are representative of what happens in other sectors and for different types of sellers.[2] To address this question, this paper exploits fine-grained data on the unit prices charged by French exporters to their European buyers over 2002-2016. The high disaggregation of the underlying data allows us to compare the price strategy of two French exporters selling the same narrowly defined product to a given EU destination as well as prices set by the same firm over different partners located in various countries. Our definition of deviations from the law of one price is based on the later comparison. We document the extent of price discrepancies for almost one million different varieties of products, sold by French firms in the EMU, over time. For each of these varieties, we observe a set of export transactions taking place within a given quarter between a particular French firm and all its partners in the European Union. The dispersion in the corresponding set of FOB unit values reflects the variance of markups recovered over these transactions and is thus a good measure of price discrimination, at the firm-level.[3] Based on this rich panel, we establish new facts on the degree and evolution of deviations from the law of one price (LOP) within the Euro area.

We start our analysis by quantifying how this source of price discrepancies participates to the overall variance of prices observed in our data. To this aim, we estimate a rich statistical decomposition of the dispersion of prices charged by French exporters within the

[1] Different forces might drive firms to price uniformly within the euro area. The single currency may facilitate arbitrage and force sellers to charge the same price across markets. Alternatively, sellers may see the Euro area as a single marketing area and adapt their pricing accordingly (Devereux et al., 2003).

[2] This question is especially natural since existing evidence based on scanner data show that even within a country, the extent of price discrepancies is substantial. See e.g. Kaplan and Menzio (2015).

[3] One may argue that LOP shall be considered at the level of consumer prices, thus including transportation costs. If arbitrage was strong enough, exporters may be forced to absorb trade costs, which would transmit into heterogeneous fob prices but homogenous cif prices. Consistent with existing evidence based on firm-to-destination export data (for instance, see Manova and Zhang, 2012; Martin, 2012, for Chinese and French data), our firm-to-firm fob prices are increasing in distance. This suggests that, if anything, the corresponding cif prices shall be more dispersed than our fob prices.

European Union over time. This exhaustive export sample comprises goods as different as airplanes, t-shirts, or wine bottles. Despite this tremendous heterogeneity in the types of goods considered (and their unit price), about 40% of the overall price dispersion comes from the *within-product* dimension, i.e. foreign importers purchasing the same narrowly defined product at heterogeneous prices in a given quarter. Within these product categories, we further show that a third of the variance is attributable to sellers price discriminating across their buyers. The rest of the analysis is dedicated to this specific dimension of price discrepancies which we refer to as *price discrimination*.

Price discrimination within the euro area is substantial. The median coefficient of variation of prices across buyers purchasing the same product to a given exporting firm in a specific quarter is as high as 30.5%.[4] While this implies systematic deviations from the LOP within the euro area, we also document that price dispersion is less severe within the EMU than in an area formed by non-euro European countries. This confirms that sharing a common currency participates to greater market integration. When the analysis is performed over two sub-periods, we find price dispersion to be consistently lower in the euro area than in the rest of the EU15, although the *level* of price dispersion has increased over time. Part of this trend is driven by composition effects across exporters that are heterogeneous in terms of their propensity to price discriminate. However, when the analysis is performed on the sub-sample of firms that we observe over both periods, we confirm that the level of dispersion has increased, although relatively less in the EMU than in the rest of the EU. This, we argue, is driven by firms expanding their network of partners, which helps them maintain large price discrepancies despite downward price pressures exerted by their existing partners, over time.

Are the price discrepancies observed within a French exporter serving various partners in the euro area driven by market segmentation across destination countries or firms discriminating across buyers both within and across countries? The firm-to-firm structure of the data offers a unique opportunity to examine this question.[5] For all firms that export a given product to at least two different partners in the EMU, we perform a variance decomposition and show that half of the dispersion in their export prices is driven by firms charging different prices to buyers within a destination. The other half is attributable to firms charging different average prices across destinations. These averages however hide a substantial amount of heterogeneity. In the extreme, a sub-sample of firms serve several

[4] This is in line with the level of dispersion documented by Kaplan and Menzio (2015) based on US consumer price data. The authors find that the dispersion in normalized prices ranges between 19% and 36% in the US Kilts-Nielsen Consumer Panel dataset.

[5] Cavallo et al. (2014) document the extent of price discrepancies across various EMU countries but cannot contrast the magnitude of this dispersion with price discrepancies across individuals within a country as online prices in their dataset are country-specific. Instead, empirical studies based on consumer price data, for instance Kaplan and Menzio (2015), document price discrepancies within a country but do not compare prices across national markets since scanner price data are available for a single country.

clients located in a single destination, in which case any price discrimination is within a country. At the other side of the spectrum, some exporters sell goods to a single firm in each destination, and solely discriminate across destinations. To refine the analysis we reproduce the decomposition over a sub-sample of firms serving at least three clients in at least three different destination markets. In this sub-sample, the average firm displays 22% higher price dispersion across than within EMU destinations. But 36% of firms (times the product they sell in a given quarter) display more dispersion in prices within than across destinations. This suggests that the forces behind price discrimination within the euro area are to a large extent driven by pricing-to-buyer rather than pricing-to-market strategies.

While the typical firm in our sample price-discriminate across buyers, a visual inspection of price dispersion reveals that a mass of firms display close to zero variance in the prices charged to their different partners. Put otherwise, a number of firms adopt a uniform pricing strategy. Over the period 2002-2006, about 14% of seller-product pairs observed within the euro area display such pricing strategy. However, this behavior is mainly attributable to small exporters serving a few clients abroad. Products priced uniformly weight for only 2% of trade in value terms. The absolute version of the LOP holds for a tiny fraction of trade flows.

We conclude the paper by identifying some characteristics of firms and products that are related to the degree of price discrimination. Less than 10% of the heterogeneity in the degree of price discrimination is related to product characteristics while 44% is attributable to firm characteristics. Among the characteristics that might explain why various firms are unequally prone to price discriminating, we find a significant effect of the firm's size and profit margin. Larger multiproduct exporters and firms with a greater market power within their sector of activity are found more likely to price discriminate. Within a firm, the propensity to price discriminate is weaker over the firm's core product while price discrepancies are important on sales of their non-core products. Finally, we find evidence of heterogeneity in price discrepancies across sectors, with retailers and wholesalers charging less dispersed prices while price dispersion is stronger for durable products.[6] Along the value chain, price discrimination is more stringent for products considered as being more specific and more downstream.

As these firm- and product-specific characteristics are unequally represented in aggregate trade, we conclude the analysis by comparing price strategies across firms at various points of the distribution of exports. We document a strong positive relationship between the extent of price discrepancies and the exporter's size. Firms in the last decile of exports display prices that are more than twice as dispersed as firms at the bottom of the distribution. These firms push up the median degree of price discrimination in the value of exports.

[6] This confirms the singular role played by durable goods in open-macroeconomics (see eg. Engel and Wang, 2011; Levchenko et al., 2010).

Taken together these facts suggest that price discrepancies are pervasive in the euro area and do not decrease in size, over time. The reason is that French exporters price discriminate their foreign partners, within and across export destinations. This is especially true of large, multi-product producers. Since these firms account for the lion's share of aggregate trade, their price strategies are likely to have important macroeconomic consequences. Supply shocks affecting individual firms are likely to transmit within the euro area in a very heterogeneous way.

Literature review. In addition to the works cited above, this paper pertains to different strands of the literature. Deviations from the LOP are often associated to market segmentation and border effects. Engel and Rogers (1996) document systematic deviations from the LOP using disaggregated consumer price indices across Canadian and US cities. Using similar data across European cities, the authors do not find evidence of price convergence after the introduction of the euro (Engel and Rogers, 2004). Within the car industry, Goldberg and Verboven (2005) find a strong positive impact of the European integration on price convergence, and a weaker impact on the level of price dispersion. We focus here on the absolute version of the LOP and document a substantial level of price discrepancies within the euro area but also within countries of the euro area.

Part of the literature relates deviations from the LOP at the consumer level to the extent of local distribution costs (Crucini et al., 2005; Crucini and Shintani, 2008). According to Gopinath et al. (2011), these distribution costs are not the main source of price discrepancies, which are instead high upstream in the value chain, at the wholesale level. Our analysis confirms their result by documenting the large degree of price discrepancies at the producer level. The evidence documented in Gopinath et al. (2011) further suggests that the price differences we document are likely to translate into price discrepancies at the consumer price level.

Because our data cover both manufacturing firms and wholesalers and retailers, we can also compare the propensity to price discriminate at different points of the value chain, within a product. While price discrepancies are large on average in all sectors, we do find some evidence of the propensity to price discriminate being smaller in the retail sector. The lower level of price discrimination by retailers is consistent with results in Cavallo et al. (2014) on the law of one price within the EMU. The paper documents the importance of uniform pricing across euro countries for products sold online by four large retailers. To our knowledge, this is the only paper documenting uniform pricing across different countries. While retailers (and non-durable goods) are found to have a lower price dispersion in our data, the prevalence of uniform pricing in our dataset is not striking. This behavior concerns about 14% of product varieties accounting for 2% of the value of trade.

The literature has also examined price discrepancies in a national context. Most papers focus on specific industries and get quite different pictures. DellaVigna and Gentzkow (2017) show that the vast majority of large US retailers charge uniform or nearly uniform

prices across their stores. Cavallo (2018) shows that the degree of uniform pricing of the largest US retailers across US locations has increased over the last ten years - which has been partly driven by on-line competition. By contrast, Adams and Williams (2019) focus their analysis on price dispersion in the home improvement industry. They find substantial price dispersion in this sector and document the granularity of zone pricing. They further show that big players in this industry adopt different pricing strategies. Our work is also related to Kaplan and Menzio (2015). They describe the distribution of prices at which identical consumer goods are sold within a market. They find substantial dispersion in consumer prices, within narrowly defined products. As discussed above, we also document a substantial heterogeneity in the pricing practices of French exporters across sectors.

Our work also contributes to the literature on pricing-to-market (PTM). PTM refers to situations where a firm charges different prices when selling the same good to different markets segmented by different currencies (see eg. Atkeson and Burstein, 2008; Fitzgerald and Haller, 2014). We document that firms charge different prices for the same product across countries even within a currency union. New to this paper is our ability to observe the unit prices charged by exporters to their buyers both across and within destinations. Our findings suggest that pricing strategies are not only segmented across markets but also across buyers within a destination country.

These findings echo two papers that examine the impact of the EU integration and the adoption of the euro on French exporters' pricing strategies. Mejean and Schwellnus (2009) document that a third of the rise in the speed of price convergence that followed the European integration has been driven by a shift in the composition of exports toward firms with a lower propensity to price discriminate. Martin and Mejean (2013) show that the introduction of the euro led to a decrease in price discrimination of the largest exporters. In comparison with these papers, our analysis digs deeper into the determinants of price discrepancies since the data at hand make it possible to quantify the relative dispersion of prices within and across export destinations. Moreover, we further investigate the heterogeneity across firms by relying on external data to correlate pricing strategies with other characteristics of the firms.

The rest of the paper is organized as follows. Section 2 describes the data used to document the extent of price discrepancies in French exports. This section is complemented with a Data appendix A defining the various variables later used in the analysis. Stylized facts on price discrepancies are then presented in three steps. Section 3 discusses the extent to which deviations from the law of one price *within a firm* contribute to the overall dispersion of prices observed in the data. In Section 4, the analysis is further focused on the within-firm dimension. We quantify the extent of price dispersion in various destination markets with a particular emphasize on differences between the EMU and the rest of the European Union. Finally, Section 5 discusses heterogeneous pricing strategies across exporters. Section 6 concludes.

2 Data and Summary Statistics

Throughout the analysis, we rely on export data provided to us by the French customs and covering the universe of export transactions from France to the rest of the European Union. A full description of the data can be found in Bergounhon et al. (2018). The originality of the data is its extreme degree of disaggregation which makes it possible to identify both parties involved into a transaction, namely the French exporter identified by its Siren number, and the European importing firm, identified by its (anonymized) VAT number.[7] This firm-to-firm dimension is useful inasmuch as it allows comparing pricing strategies across producers serving the same market and eventually the same buyer with the same product as well as prices offered by a given exporter to different partners located in the same or in different European markets. The cross-sectional richness is what we mostly exploit in the analysis.

On top of the identity of both firms involved into the export flow, transactions recorded into the dataset are characterized by a date, at a monthly frequency, a product category at the 8-digit level of the combined nomenclature, the value of the transaction and the physical quantity being traded. As the focus is on the dispersion of prices within narrowly defined products over a given period, we slightly aggregate the data over time to increase the size of the corresponding cross-sections. Namely, the panel is redefined at the quarterly frequency.

While the data are exhaustive, small exporters are allowed to fill a simplified form that does not request information on the product category or the physical quantity exported. Since these variables are key in the analysis, we have no choice but to neglect this population of firms. Between 2001 and 2006, the simplified regime concerned exporters whose annual export turnover in the European Union was below 100,000 euros. The declaration threshold has then been increased to 150,000 euros in 2007 and to 460,000 euros in 2011. This means that our working sample is censored to the left of the distribution of exporters' size and that the censoring increases over time. Censored observations on average represent 36% of exporters accounting for 13% of the value of trade during the main period of analysis, 2002-2006. We also present some results based on the 2012-2016 period, when the simplified regime represents 63% of exporters and 18% of the value of trade, on average.

The analysis mostly focuses on the cross-sectional dispersion of prices, within a given product category and a given quarter. But we also want to study how this cross-sectional dispersion evolves over time. This requires identifying time-consistent product categories which is cumbersome when working with the combined nomenclature as it continuously evolves over time. We follow Behrens et al. (2019) and harmonize product categories by

[7] These data are collected for VAT purposes and solely cover trade between firms. Direct exports by a firm to a final consumer is thus neglected from the rest of the analysis. This represents less than 1% of the value of exports in overall customs data.

nesting into broader clusters products that are connected through nomenclature updates. Since this methodology can produce relatively large clusters of products when applied over long horizons, we decided to restrict our attention to two five-year periods, 2002-2006 and 2012-2016. None of these sub-periods is affected by major revisions of the harmonized system at the root of the combined nomenclature. This limits the number of product categories that are grouped together through the harmonization algorithm. But this also means that product categories are not fully comparable across sub-periods. Whenever price strategies are compared over long periods, within a firm, the analysis is restricted to product categories that are the same in both sub-periods.

For each transaction, we recover a price proxy, defined as the unit value of the transaction:

$$p_{sb(c)pt} \equiv \frac{Value_{sb(c)pt}}{Quantity_{sb(c)pt}}$$

where the s, $b(c)$, p and t subscripts respectively refer to the identity of the seller, the buyer (which is further identified by a location country c), the product being exported and the time of the transaction. The value of the transaction, $Value_{sb(c)pt}$, is measured in euros and is free-on-board. The analysis excludes transactions below 100 euros because of rounding issues. The quantity $Quantity_{sb(c)pt}$ is either measured in kilograms or in physical units for some specific product categories. This means that unit values are not necessarily comparable across products but they are within a product category, the focus of the analysis.[8] The high disaggregation of data, that allows computing such unit values for each trade transaction, is likely to mitigate most composition effects that have been argued to reduce the quality of unit values as a proxy for prices. At that level of details, differences in unit values within a product and time period, whether observed across or within an exporter, mean that the same quantity of a given product is sold at different prices. In theory, these price differentials can be attributable to different mark-ups, different marginal costs and/or different quality levels, with the influence of the last two determinants being mechanically reduced when the focus is on price differentials observed within an exporter, across the different partners it serves in a country. Since unit values can still suffer from measurement issues when either the value or the quantity is misreported, we trim the data and remove price quotes that deviate from the median price set by the firm for this product over the considered year by more than 200%.[9]

Over 2002-2006, our dataset is composed of more than 37.7 million observations involving 70,649 exporters, 1.1 million importers located in 24 European countries and 9,400 (harmonized) product categories. Table 1 provides detailed statistics over the structure of

[8] It can happen that some product categories which quantities are defined in different units end up grouped together after the product harmonization procedure. Since the corresponding unit values are not comparable, we drop them from our sample.

[9] This may still appear as a large price range. However, Adams and Williams (2019) document that the price of Home Depot's 4' x 8' x 1/2" mold-resistant drywall ranges from 7.65 to 23.71 across locations. Kaplan and Menzio (2015) show that the price of a 36-oz plastic bottle of Heinz ketchup ranges from 0.5 to 2.99 USD.

the dataset, by destination country. It has to be noted that the period encompasses the entry of ten Eastern European countries in the EU, and thus the dataset. For this reason, we compute a number of statistics on a sample restricted to the 15 "old" members of the EU.[10] Likewise, EMU members are those that are already part of the euro-area in 2002.

3 From price dispersion to deviations from the LOP

3.1 A statistical decomposition of price dispersion

Methodology. Given the dimensionality of the data, detecting the most important sources of price variations that the analysis should focus on is a complicated task. To help us in this task, we start with a statistical decomposition of the sources of price dispersion in the data. This decomposition takes inspiration from the labor literature. Following Abowd et al. (1999), this literature has extensively used matched employer-employee data and high-dimensional fixed effect estimators to identify the sources of the dispersion in wages observed in the data. Our dataset has the same bipartite graph structure and we can thus rely on this methodology to decompose the observed variance of export prices.

The estimated model takes the following form:

$$\ln p_{sb(c)pt} = \beta \mathbf{X}_{sb(c)pt} + FE_s + FE_{b(c)} + e_{sb(c)pt} \tag{1}$$

where $\mathbf{X}_{sb(c)pt}$ is a set of control variables, FE_s is a (time-invariant) fixed effect for seller s, $FE_{b(c)}$ is a (time-invariant) fixed effect for buyer $b(c)$ and $e_{sb(c)pt}$ is a residual which captures the unexplained dispersion of prices within a seller-buyer match. As shown by Abowd et al. (1999), such equation can be estimated on panel data to recover the contribution to the dispersion in prices of i) unobserved heterogeneity across sellers absorbed into FE_s, ii) unobserved heterogeneity across buyers absorbed into $FE_{b(c)}$, iii) observable variables regarding the relationship involving seller s and buyer b $\mathbf{X}_{sb(c)pt}$ and iv) a residual $e_{sb(c)pt}$ which is specific to the seller-buyer relationship and the particular product and period under consideration. This equation can be estimated whenever the underlying bipartite graph is connected, which is largely the case in our data. Namely, the largest connected component of the graph encompasses more than 99% of all observations. In the rest of the section, we just neglect the remaining 1% of observations and estimate equation (1) on the largest connected component, which allows estimated fixed effects to be comparable.

Results. Table 2 reproduces the results. The set of controls systematically includes a product×period effect which absorbs the mean price set by French firms in the product market for this particular quarter. These fixed effects control for the effect of inflation on

[10] When working on the later 2012-2016 period, we also neglect transactions involving importers in Romania, Bulgaria and Croatia since these countries have joined the EU recently.

prices and also absorb any difference induced by unit values being defined with respect to different physical quantities for some products. The list of regressors also includes i) the *Seller's experience* in the destination as measured by the number of years over which it has been exporting to the destination, ii) the *Age of the relationship* defined by the number of years since the first transaction between the seller and the buyer (over this particular product), iii) the *Transaction size* measured in euros, and iv) the *Distance* separating the firm and the buyer. As we do not know the precise location of a buyer in a destination, this distance is a population-weighted average of distances between the seller's commuting zone in France and the destination's main cities.[11] The bottom panel of the table reports a variance decomposition of the overall dispersion of prices in the data into the share explained by observables, the share attributable to the variance in mean prices across product×period, the respective contributions of unobserved heterogeneity across sellers and across buyers and the residual dispersion which is specific to a seller-buyer match observed over a particular product×period.

In comparison with similar statistical decompositions applied to matched employer-employee data, the parameters of this model are well-identified in this panel of almost 40 millions transactions. Namely, product×period fixed effects are identified on average on 226 price quotes (=37,470,412/165,730) while seller and buyer components are measured on respectively 30 and 2.3 price quotes per period, on average. As expected, product×period fixed effects explain a substantial share (more than 60%) of the overall price dispersion. This is mainly due to the product dimension, which naturally induces a strong degree of heterogeneity in export prices. In the rest of the analysis, we focus on the remaining 40% of the variance, observed in the cross-section of prices set by exporters of a given product in a given quarter. Would the law of one price hold, this variance would be equal to zero since arbitrage would limit price discrepancies paid by various importers to the amount of transportation costs, which does not affect FOB data. The fact that 40% of the dispersion in prices is observed in this dimension thus confirms a well-known stylized fact of the literature, namely that the (absolute) law of one price does not hold, including in integrated markets such as the European Union. In this dimension, seller fixed effects absorb half of the variance and the rest is to a large extent due to variations in prices within a seller-buyer match.

Observables explain a limited share of the residual variance. The most important variable, in terms of predictive power, is the size of the transaction, which is positively correlated with the unit value. The negative coefficient estimated on the age of the relationship suggests that repeated transactions between a seller and a buyer give rise to downward price renegotiation. The seller's experience in the destination is instead positively correlated with prices, which may be explained by sellers' expanding their portfolio

[11] This measure of distance is taken from Laboureau (2018). We also tested with an alternative measure of distance, namely the driving time between the commuting zone and the destination's main cities. Results were qualitatively unchanged.

of buyers over time, and setting high prices on new buyers. Finally, distance is positively correlated with prices, consistent with evidence based on more aggregated firm-level data (Manova and Zhang, 2012; Martin, 2012).

The limited role of buyer fixed effects relative to the seller-buyer (observed and unobserved) components suggests that buyers characteristics - such as buyer-specific elasticities - are not the main determinant of price discrepancies. Instead the importance of the seller and the match components suggests that prices mostly vary based on the characteristics of the seller (eg. productivity or market power) and the characteristics of their relationships with foreign importers. This is consistent with a model in which firms charge variable markups to their buyers, and eventually adjust these markups, over time.

The variance decomposition thus emphasizes important patterns regarding the sources of price variations in the data. In the rest of the analysis, we further dig into some of these dimensions. Namely, we study the sources of price discrepancies in the cross-section and for a particular product, i.e. we focus on the 40% of the variance which is not explained by product×period fixed effects. In this dimension, we emphasize the between versus within seller dimension. This allows quantifying the extent to which price discrepancies are attributable to the differentiation of products across exporters versus price (or quality) discrimination within a seller, across its European partners.

3.2 Variance decomposition

Methodology. From now on, the object of interest is the cross-sectional dispersion of prices, within a narrowly defined product category, which we measure as:

$$Var_{pt}^{scb(c)}(p_{sb(c)pt}) = \frac{1}{N_{pt}-1}\sum_{s}\sum_{c}\sum_{b(c)}\left(p_{sb(c)pt} - \bar{p}_{pt}^{scb(c)}\right)^2$$

where $\bar{p}$ and $Var(p)$ respectively refer to the first and second moments of the cross-section of prices and N_{pt} is the number of price quotes in the corresponding cross-section. Subscripts refer to the dimensionality of the corresponding variable while superscripts are used to denote the dimension in which the corresponding moment is calculated. $Var_{pt}^{scb(c)}(p_{sb(c)pt})$ thus denotes the variance of prices computed across sellers, buyers and countries, for a particular product×period. Since the variance is increasing in the average level of prices, we use a normalized measure of dispersion, namely the coefficient of variation:

$$CV_{pt}^{scb(c)}(p_{sb(c)pt}) = \frac{\sqrt{Var_{pt}^{scb(c)}(p_{sb(c)pt})}}{\bar{p}_{pt}^{scb(c)}}$$

What is the share of these price discrepancies attributable to different exporters selling a given product at different prices versus exporters price discriminating their partners in the European Union? To answer this question, we further decompose the dispersion of prices into a "Within" and a "Between" components. The "Within" component is a weighted average of the variance of prices within an exporter s and the "Between"

component measures variations in the mean prices set by various exporters of the same good. By definition:

$$Var_{pt}^{scb(c)}(p_{sb(c)pt}) = \underbrace{\sum_{s} \frac{N_{spt}-1}{N_{pt}-1} Var_{spt}^{b(c)}(p_{sb(c)pt})}_{Within} + \underbrace{wVar_{pt}^{s}\left(\bar{p}_{spt}^{b(c)}\right)}_{Between} \quad (2)$$

where N_{spt} is the number of buyers connected to seller s, $Var_{spt}^{b(c)}(p_{sb(c)pt})$ is the variance of prices that this exporter sets on transactions with different partners

$$Var_{spt}^{cb(c)}(p_{sb(c)pt}) = \frac{1}{N_{spt}-1} \sum_{c} \sum_{b(c)} \left(p_{sb(c)pt} - \bar{p}_{spt}^{cb(c)}\right)^2$$

and

$$wVar_{pt}^{s}\left(\bar{p}_{spt}^{b(c)}\right) = \sum_{s} \frac{N_{spt}-1}{N_{pt}-1} \left(\bar{p}_{spt}^{b(c)} - \bar{p}_{pt}^{scb(c)}\right)^2$$

is the variance of exporter-specific average prices. The ratio of the Within component over the overall variance of prices is thus a measure of how much the cross-sectional dispersion of prices within a product is attributable to deviations from the law of one price, within a seller.

Results. Figure 1 shows the evolution over time of the average coefficient of variation recovered for each quarter, using various country samples, namely the EU25, the subset of countries that were already members of the EU in 2002 ("EU15"), the twelve "historical" EMU countries and the three members of the EU which do not participate to the common currency. The top panel corresponds to the 2002-2006 period and the bottom one is for 2012-2016. The dispersion of prices is relatively stable over each sub-period but the mean level of price discrepancies is found higher in 2012-2016 than over 2002-2006. As expected, the coefficient of price variations is lower in the EMU sub-sample than in the whole European Union. But the most striking difference is observed in the sub-sample of non-EMU members, in which the recovered coefficient of variation is an order of magnitude lower. This is in part mechanical since this sample is made of three countries (the UK, Denmark and Sweden) which are not the most popular destinations for French exports. We further dig into this result in Section 4.1, when the analysis is restricted to the dispersion of prices within a seller and we can compare the dispersion in prices, conditional on a number of partners.

Table 3 provides further details on the distribution of the product- and period-specific coefficients of variation recovered from data covering the 2002-2006 period.[12] As expected, the *level* of price dispersion varies substantially since various products are unequally prone to price discrepancies. The mean coefficient of variation is thus equal to 1.3 in the EU25 but the median is substantially lower, at .8. More interesting is the second panel of

[12] Statistics are based on the sub-sample of coefficients of variation computed on at least 5 price quotes. Results are qualitatively similar over 2012-2016.

the table which provides statistics on the extent to which the within-exporter dimension contributes to the overall price dispersion. On average, the contribution of the within component is equal to 31% and the interquartile range is [.07,.50]. This confirms results in Section 3.1 that the unobserved heterogeneity across sellers, which materializes here into a sizable between component, is a key driver of the dispersion of prices in French export markets. But the dispersion of prices within a particular seller, our measure of deviations from the LOP, is also substantial. This is true even though the analysis is extremely granular, much more than in most of the related literature. Price discrepancies are indeed recovered from transactions within narrowly defined products that take place in a given quarter. At this level, almost 50% of sellers (×period) display zero within variance, because they serve a single client in the European Union. While these firms will later be dropped from the analysis of price discrimination within a firm, they contribute to the overall dispersion of prices, within a product. As such, they are included in the statistics of Table 3. By definition, they solely contribute to the between-firm component, thus mechanically inflating its contribution to the overall dispersion. This explains that, at the product×period level, the contribution of the within-firm component is negatively correlated with the share of sellers interacting with a single firm, with a correlation coefficient of -43%. The fact that, despite the prevalence of these sellers, we continue to observe a sizeable contribution of the within-seller dispersion implies that, conditional on serving several partners, price discrimination must be substantial. This is what we will now focus on.

4 Deviations from the LOP in the EU

4.1 Price discrimination within and outside the EMU

Figure 2 plots the distribution of the coefficients of variation of prices, measured within a seller, product and time period:

$$CV_{spt}^{cb(c)} \equiv \frac{\sqrt{Var_{spt}^{cb(c)}(p_{sb(c)pt})}}{\bar{p}_{spt}^{cb(c)}} \tag{3}$$

$$\text{with} \quad Var_{spt}^{cb(c)}(p_{sb(c)pt}) = \frac{1}{N_{spt}-1}\sum_{c}\sum_{b(c)}\left(p_{sb(c)pt} - \bar{p}_{spt}^{cb(c)}\right)^2$$

where N_{spt} is the number of partners the firm is connected to in this particular time period, $\bar{p}_{spt}^{cb(c)}$ the mean price of its export transactions and $Var_{spt}^{cb(c)}(p_{sb(c)pt})$ the variance of prices set by seller s, computed across all transactions with partners located in various countries. This statistics is thus defined for the 50% of French exporters that interact with at least 2 European firms within a given quarter. In Figure 2 and Table 4, the analysis is further restricted to firms serving at least 5 partners in a given quarter, around 40% of the overall distribution. This restriction will be removed once the analysis will control for

the number of partners involved into the corresponding cross-section.

Figure 2 shows a distribution of coefficients which is bi-modal. About 10% of product-seller pairs have a coefficient of variation which is below 2%. The corresponding firms do not discriminate across partners, within a product. We examine this extreme form of pricing in more details in Section 4.3. The rest of the distribution exhibits a substantial level of price discrimination with a peak around 25%. Table 4 provides additional summary statistics over the distribution of the coefficients of variation of prices, measured within a seller, product and time period for different samples of countries. Column (1) is based on the whole country sample, as is Figure 2. Columns (2), (3) and (4) are then restricted to importers located in the EU15, the EMU and the non-EMU members of the European Union, respectively.

As expected, the level of price dispersion is an order of magnitude lower once we focus on the within-exporter dimension. However, price discrepancies are still quantitatively important, the standard deviation being slightly above 35% of the mean level of prices, on average. This is in the range of what is found by Kaplan and Menzio (2015) for consumer goods sold in various US stores. Restricting the country sample to increasingly integrated markets as we do from Column (1) to Column (3) implies a distribution that is shifted to the left. This is consistent with the view that price discrepancies are reduced in more integrated markets. Instead, the distribution recovered from the non-EMU countries is slightly shifted to the right, thus suggesting that firms exporting to these destinations tend to set more dispersed prices.

Table 5 further digs into this result. Namely, we construct a panel of coefficients of variations in which each observation is identified by the firm exporting, the product being exported and the period of analysis (the *spt* triplet), the country sample over which price discrepancies are recovered (either EU25, EU15 or EMU) and the period of analysis (2002-2006 or 2012-2016). Controlling for exporter×product×period fixed effects, one can use the resulting dataset to compare i) the mean dispersion in various country samples, ii) its evolution over time and iii) its evolution, within a firm, over the sub-sample of firms (× the product they sell) that we observe over both periods.

Consider first columns (1) and (2) that compare the mean dispersion of prices across country sub-samples. Consistent with Table 4, results show that price discrepancies are on average larger in the complete sample than in the sample restricted to the 15 historical members of the European Union while lower in the EMU than in the EU15. This is true in both periods, although the difference between the EU25 and the EU15 is not statistically different from zero over 2002-2006.[13] Mean differences across country samples within a firm are quantitatively important since prices within the EU25 are on average 10% more

[13] One possible reason for the lack of significance of the EU25 dummy in Column (1) is the size of the sample used to identify the coefficient. Our dataset does not cover bilateral data prior to countries' entry into the European Union. As a consequence, the coefficient on the EU25 dummy for the 2002-2006 period is de facto identified over observations recovered from 2004-2006 data.

dispersed than within the EU15 while 14% less dispersed in the EMU than in the EU15. Column (3) further tests whether these differences evolve over time. One may indeed expect the impact of a common currency on the convergence of prices to increase over time. While the negative coefficient calculated over the EMU dummy is indeed larger (in absolute value) over 2012-2016 than over 2002-2006, the difference is not statistically different.

Regressions in Column (1)-(3) are based on a specification with exporter×product×period fixed effects, that identifies differences in price discrepancies within a firm in the cross-section. However, the interaction between country sample dummies and the Post 2012 dummy in column (3) is not identified within a firm, over time, as a consequence. To further test how price discrepancies have evolved over time within a firm, Columns (4)-(5) test another specification with exporter×product fixed effects.[14] Results are qualitatively similar, although now the coefficient on the interaction between the EMU and the Post 2012 dummies is significantly negative when the sample is restricted to firms observed in the data over both periods (column (5)). This result is consistent with the dispersion of prices within a firm being lower in the EMU than in the EU15 sample, the difference increasing over time. Note however that this does not imply that prices have converged since the *overall* dispersion is on average larger in the second period, as indicated by the positive and significant coefficient estimated on the Post 2012 dummy. Within a firm, price discrepancies increase over time, less so in the EMU than in the rest of the EU15.

4.2 Price discrimination within a country

Following the same logic as in Section 3.2, price discrepancies within an exporter can further be decomposed into a within and a between components according to:

$$Var_{spt}^{cb(c)}(p_{sb(c)pt}) = \underbrace{\sum_{c} \frac{N_{scpt}-1}{N_{spt}-1} Var_{scpt}^{b(c)}(p_{sb(c)pt})}_{Within} + \underbrace{wVar_{spt}^{c}\left(\bar{p}_{scpt}^{b(c)}\right)}_{Between} \quad (4)$$

where N_{scpt} is the number of buyers connected to seller s in country c, $Var_{scpt}^{b(c)}(p_{sb(c)pt})$ is the variance of prices that this exporter sets on transactions with these buyers and

$$wVar_{spt}^{c}\left(\bar{p}_{scpt}^{b(c)}\right) = \sum_{c} \frac{N_{scpt}-1}{N_{spt}-1}\left(\bar{p}_{scpt}^{b(c)} - \bar{p}_{spt}^{cb(c)}\right)^2$$

is the variance of mean prices set by seller s, across destination countries. The "Within" term in equation (4) thus captures the variance component attributable to the seller price discriminating across buyers within a destination country. The "Between" component instead measures discrepancies in mean prices across destinations, i.e. the pricing-to-market component. Here as well, the decomposition is calculated for each firm serving at

[14] These specifications are thus restricted to the subsample of products which definition has not changed between 2002-2006 and 2012-2016.

least two partners in the European Union, the within (resp. between) component being mechanically equal to zero if the firm serves a single buyer within each destination (resp. a single destination, but at least two partners there).

The second panel in Table 4 provides statistics over the contribution of the "Within" component to the overall dispersion of prices set by an exporter. On average, in the EU25, half of the price dispersion is attributable to exporters setting different prices on their different partners located in the same EU country. The remaining 50% are due to the firm applying different mean prices across destinations, and in particular across EMU and non-EMU destinations. Note that the contribution of the within component naturally raises when the analysis is restricted to smaller country samples but this is just the consequence of the between term being computed over a smaller cross-section.

While these numbers are indicative of the average contribution of the within and between components of price discrimination in the data, they hide a substantial amount of heterogeneity. In particular, differences across firms in their export patterns can mechanically induce a substantial dispersion between firms that mostly export to a single destination, which residual price discrepancies are solely within a country, and firms that serve few buyers in many different destinations, that we consider as mostly price discriminating across markets. To control for this heterogeneity, we conducted an experiment whereby the dataset is restricted to the 10% of firms (×product×period) that export to at least three partners in three different destinations. In this sub-sample, we randomized to recover three price quotes per destination and three price quotes in three different destinations. Based on this, it is possible to compute measures of price dispersion within and across destinations that are fully comparable within a firm, as they are based on the exact same number of price quotes, with the location of the partners being the only source of variation. Within a firm (×product×period), the dispersion of prices recovered from three partners located within a given destination is found to be 22% lower that the corresponding statistics based on three random partners located in three different locations, on average. Market segmentation is thus a significant source of price discrepancies. However, within-country price discrepancies are also substantial, in this sub-sample as in the overall population of French exporters. For the mean firm in the considered population, the within-country dispersion recovered from the randomization is indeed as high as 25% of the mean unit value, not so much below the coefficient of 36% found for the average firm in the overall EMU.

The within-country dimension is to a large extent new to this paper since data typically used to study price dispersion across countries do not allow to compare prices set by the same exporting firm over different partners located in the same country. Table 6 further digs into this particular dimension by correlating the dispersion of prices within a country with various observables. All specifications include an exporter×product×period fixed effect so that determinants of within-country price dispersion are solely identified across countries and do not absorb the impact of various firms being more or less prone to

price discriminating. This dimension is the focus of next section. We also control for a measure of the size of the cross-section used to compute the corresponding coefficient of variation, i.e. how many importers the firm serves in the destination. Our measure of price dispersion indeed increases with the number of price quotes almost systematically.

Beyond these controls, price dispersion is found larger in destinations which import demand of the product is strong and increases over time, within an exporter (see the positive coefficient on the "Experience" variable that measures the number of years since the firm has first exported to the destination). This result might seem surprising at first view, since one would expect arbitrage to induce a convergence of prices, over time. What we see in the data is that this convergence takes place within a seller-buyer relationship, which explains that prices are negatively correlated with the age of the relationship in Table 2. However, more experienced exporters also expand their network of foreign partners (Lenoir and Patault, 2019), and manage to maintain important price discrepancies within this network. Finally, the last column in Table 6 introduces dummy variables for new member states and non-EMU members of the EU15, the control group being the EU15. None of these dummies are found significantly different from zero. This suggests that French exporters do not discriminate more across importing firms located in various destinations within and outside the EU15/the EMU. What drives the significant differences across country sub-samples in Table 5 is indeed attributable to price discrepancies *across countries* within and outside the common currency area.

4.3 Uniform pricing within the EMU

So far, the analysis has focused on a continuous measure of the pricing strategy of individual exporters, the coefficient of variation of prices. One extreme case of price discrimination is when a firm charges a uniform price to all its buyers, i.e. the coefficient of variation is nil. Uniform pricing has recently attracted new scrutiny as several papers have documented that large retailers tend to adopt such strategy in the US market, and in the euro area (Cavallo et al., 2014; DellaVigna and Gentzkow, 2017). The facts documented above show that the coefficient of variation of prices is far above zero on average, both between and within countries, when the analysis is performed at the level of individual exporters interacting with European partners. Uniform pricing is clearly not very common in our sample. However, the mass around zero in Figure 2 shows that there is a sub-sample of exporters that do adopt such pricing strategies. We now study this population into more details.

Methodology. Our unit values are proxies for prices. Both values and quantities might be subject to measurement errors and rounding approximations. A strict measure of uniform pricing focusing on coefficients of variation exactly equal to zero would thus likely underestimate the prevalence of uniform pricing. We instead follow DellaVigna and Gentzkow (2017) and compute a measure of nearly uniform pricing based on close to zero

coefficients of variation. Namely, we define a dummy variable which is equal to one for firms adopting near uniform pricing strategies:

$$NUP_{spt} = \mathbb{1}\left[CV_{spt}^{cb(c)} < .01\right] \tag{5}$$

We examine the prevalence of near uniform pricing within the euro area and within euro countries.

Results. The top panels of Figure 3 describe the prevalence of near uniform pricing (NUP) within the euro area over the periods 2002-2006 and 2012-2016. Over 2002-2006, about 14% of the products exported by French firms to their euro-area buyers are priced nearly uniformly (solid line, top panel, left-hand side). And almost 10% are priced nearly uniformly while exported to at least two EMU destinations. This is a significant result that has not been documented using trade price data to our knowledge. The prevalence of near uniform pricing is twice lower, around 7%, but still significant over 2012-2016 (Top panel, right-hand side). While a significant share of products is priced uniformly, these account for a more modest share of trade in value terms. The dotted lines in Figure 3 show that NUP weights about 2% of French exports toward euro trade partners in 2002-2006 and a lower 1.7% in the more recent period.[15]

NUP does not account for a large share of trade within the EMU. We now consider the possibility that firms choose to price uniformly within a market but not across destinations which would be consistent with zone pricing (Adams and Williams, 2019).[16] The prevalence of NUP within EMU countries is summarized in the bottom panels of Figure 3.

Over 2002-2006, 13% of varieties exported by French firms in a given destination are priced uniformly. This is about the same magnitude as the prevalence observed in the whole euro area. However, the economic weight of NUP within a destination is about twice as large as in the overall euro area, at almost 4%. Here as well, the prevalence of NUP seems to decrease over time, in terms of both frequency and exported value. This is consistent with the overall evidence that prices have become more dispersed in the euro area over the last two decades.

The within destination results suggests that the causes of this increasing amount of dispersion are not (mainly) rooted in a change in cross-countries integration. Instead, increasing dispersion is part of a more global trend that has seen dispersion increasing

[15] Part of the discrepancy explains by the largest firms being relatively less likely to adopt near uniform pricing. When the analysis is performed conditional on the number of partners served in the EMU, we observe that NUP is relatively more prevalent among firms serving two to four buyers in the EMU, which are not the largest ones. We explore in more depth the determinants of this heterogeneity in section 5.

[16] Such zone pricing has also been documented to some extent by Cavallo et al. (2014) who show that Zara has a pricing strategy specific to Spain and Portugal on the one hand, and other euro countries on the other hand.

within destinations as well. Overall, the decreasing importance of NUP over time and its quantitatively limited influence suggest that technological changes such as the development of online trade has not shifted the pricing behavior of French exporters, or that this shift has been compensated by other forces.

5 Heterogeneity in pricing strategies

Methodology. We conclude this analysis of price discrepancies in the euro area by focusing on the heterogeneity in pricing strategies *across* exporters. To this aim, the following equation is first estimated:

$$\ln CV_{spt}^{cb(c)} = \beta X_{spt} + FE_s + FE_{pt} + e_{spt} \tag{6}$$

where FE_s and FE_{pt} refer to seller-specific and product×period fixed effects, respectively. X_{spt} is a vector of correlates, that necessarily vary across product and time within a seller, so that the coefficients entering β can be identified. In a second step, the estimated fixed effects are used to study the determinants of price discrepancies that are i) specific to an exporting firm and ii) product-specific. Results of the first and second stages are presented in Tables 7- 9. Details on the construction of the different explanatory variables can be found in Appendix A.

Sources of heterogeneity. Results of the first stage estimation are reproduced in Table 7. The model in equation (6) explains about 56% of the variance in the data, most of it being attributable to the fixed effects. Namely, heterogeneity in coefficients of variation across product×periods explains 10% of the variance while as much as 44% is attributable to unobserved heterogeneity across sellers. This confirms the high degree of heterogeneity across exporting firms in terms of their propensity to price discriminate. Once this heterogeneity is controlled for, price dispersion is found larger over large trade flows, even conditional on the number of partners served, but relatively less pronounced for the firm's core product. Finally, price dispersion tends to increase with the firm's experience as an exporter of the product. This again is consistent with the view that exporters manage to expand their network to new buyers that they can charge with high prices, which compensates the impact on price discrepancies of downward price pressures over time, within a firm-to-firm relationship.

Seller characteristics and price discrimination. Heterogeneity across exporters is investigated in Table 8 where the estimated seller fixed effects recovered from equation (6) are regressed on various firm-level variables. In column (1), the estimated fixed effects are regressed against the seller's sales (normalized by the median firm's sales in the industry). The coefficient is highly significant and the R^2 is equal to 6.8% suggesting that

firm size is an important determinant of the degree of price discrimination. The positive coefficient means that large firms tend to display larger coefficients of variation, i.e. they price-discriminate more. In column (2), the explanatory variable if the normalized markup of the firms. The coefficient is positive and significantly different from zero suggesting that firms with a higher market power adopt more discriminatory pricing pratices. The R^2 is low however, below 1%. In column (3), dummies indicating whether the seller is a wholesaler or a retailer are considered. Both variables enter negatively, meaning that wholesalers and retailers tend to price discriminate less across their foreign partners. The R^2 of this regression is however below 1% even though these sectors represent 35 and 7% of the firms in the sample, respectively. This suggests that heterogeneity in pricing strategies is strong, even within these sectors. Not all retailers adopt near uniform pricing strategies. In column (4), the variable of interest is the number of products exported by the firms. We find that multiproduct firms are more likely to discriminate across buyers. This is line with the previous result that large firms have more ability to price discriminate across buyers and they do so more intensively over their non-core products. In the specification of column (5), all the explanatory variables of columns (1) to (4) are introduced. The sign and level of significance of the variables does not change. Together, these variables explain 11.5% of the variance in estimated seller fixed effects.

The seller fixed effects are estimated conditional on product fixed effects and the number of buyers served by the firm for each product sold in the EMU. The main result that large multiproduct firms discriminate more is not driven by product-composition effects or by a mechanical impact of the number of partners on price dispersion. Instead, this finding suggests that large firms have more marketing resources or more talented managers that allow them to adopt finer pricing policies.

Product characteristics and price discrimination. In Table 9 and Figures 4 and 5, we characterize the heterogeneity across products, in the degree of price discrimination. Histograms in Figures 4 and 5 report the mean level of price dispersion, across industries and broad economic categories, respectively.[17] In both cases, the ranking of products appears consistent with expectations. Prices are found relatively less dispersed in industries producing relatively homogenous goods such as petroleum, food products, minerals and some chemicals. The largest average levels of price discrepancies are instead found within highly differentiated industries, e.g. Machineries and Professional equipments. The same ranking between primary and processed goods is found when products

[17] Statistics in Figures 4 and 5 are recovered from the following second stage regression:

$$\hat{FE}_{pt} = Class_p + FE_t + e_{pt}$$

where $Class_p$ is a full set of industry (Figure 4) or BEC categories (Figure 5). Since the left-hand side variable of the first stage is a log, numbers can be interpreted in percentage change from the omitted category in each Figure.

are classified according to the BEC classification in Figure 5. The least dispersed prices are found for primary goods. At the other side of the distribution, the highest average coefficients of variation are obtained for durables and capital goods. This is consistent with the view that the differentiation of products facilitates price discrimination of consumers. Engel and Wang (2011) argue that trade in durable goods is key to understand the volatility and comovement of exports and imports in open macroeconomic models. Our findings further highlight the central role of durable goods for the level of price discrimination associated to exports.

This intuition is broadly confirmed by the multivariate regressions in Table 9. In columns (1) to (5), the product fixed effects estimated in equation (6) are regressed against measures of products durability, input specificity, upstreamness, product complexity, and relationship stickiness. Column (1) confirms that price discrimination is more pronounced in sector classified as durables in the BEC classification. Column (2) also confirms that prices are more dispersed across buyers for more differentiated products as measured by Nunn (2007). Column (3) shows that there is less discrimination among products with a more upstream position in value chains, upstreamness being defined as in Antras et al. (2012). Column (4) shows that firms selling more complex products (based on Hausmann and Hidalgo (2014)'s definition) tend to have a higher level of price discrimination. And Column (5) implies a positive correlation between price discrimination and the level of stickiness of relationships (estimated by Martin et al. (2019) across HS6 product categories). These results are still valid in a multivariate regression including all the variables (column (6)). Together, these variables explain almost 16% of the dispersion in the level of price discrimination across HS6 product categories. Most of this is explained by Nunn's measure of input specificity confirming the role of product differentiation on firms' pricing strategies.

Macro implications of individual heterogeneity. The previous exercise highlights the heterogeneity in the degree of price discrimination across firms and products. Large multiproduct firms and firms active in more durable and differentiated products tend to charge more dispersed prices to theirs buyers. These are likely to account for a large share of price dispersion. On the other hand, retailers and wholesalers tend to have a lower level of price discrimination. However, retailers and wholesalers account for less than 5% and 15% of French exports to EU countries respectively. The average or median dispersion documented in the paper may thus not be representative of aggregate exports.

To account for the unequal share of various firms in overall exports, we calculate the extent of price discrimination in various subsets of firms characterized by their contribution to overall exports. More specifically, we group every firm-product pair of the first quarter of year 2002 into percentiles based on the value of their exports to the EMU.[18] We then compute the mean dispersion of prices in each percentile. Figure 6 summarizes the results.

[18] Results are virtually unchanged when we use a different time period.

As suggested by our econometric analysis, price dispersion is increasing with the value of exports of firm-product pairs. The average coefficients of variation range from .15 in the lowest bins constituted of small exporters to almost 40% at the top of the distribution. The median dispersion is .28, close to the 30% obtained over the whole population of EMU exporters in Table 4. If one instead computes the weighted median - with weights based on the contribution of each percentile to the value of exports - the dispersion reaches 37%, the upper horizontal line in Figure 6. The difference is largely triggered by firms in the last decile of the distribution of exports, which display average coefficients of variation above this number. This is consistent with the view that large firms, which also tend to be large exporters, are more prone to price discriminating. This tends to increase the amount of price discrepancies in aggregate exports.

6 Conclusion

This paper exploits fine grained information on the unit price charged by French exporters to their European buyers. We document a significant level of price dispersion both within product categories across exporters and within exporters across buyers. This latter source of price discrepancies is indicative of significant deviations from the law of one price - even within the euro area.

The level of price dispersion within the euro area is highly heterogeneous. The median coefficient of variation of prices set by a French exporter over the different partners in its portfolio is 30%. But a fraction of (mostly small) exporters adopt a near uniform pricing strategy charging about the same price to all their buyers. Instead, large multiproduct firms and firms exporting differentiated products, in particular durable ones, tend to charge prices that are strongly heterogeneous across their buyers. This heterogeneity is to some extent compensated by downard price renegotiations within a relationship, over time. Our results suggest that large exporters nevertheless maintain high average mark-up rates, by increasing their customer base and charging new buyers with high prices. This explains the large cross-sectional price dispersion observed in the data.

The level of price discrimination uncovered in our analysis and the limited role of the buyer component in our statistical decomposition suggest that French exporters charge variables markups to their buyers within the EMU. The heterogeneity in markups across buyers depends on characteristics of the traded products (durability, differentiation), of the sellers (market power, product scope), and of the relationship (age, size). These results have potentially important implications for the international transmission of shocks. A supply shock hitting French exporters might be passed through EMU partners in a different way depending on the industrial structure of exports but also based on the underlying distribution of exporters and the characteristics of their relationships with foreign buyers. The transmission of supply shocks may thus be dampened or amplified if these characteristics vary across countries and over the business cycles. We plan to examine

this question in future research.

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A Data Appendix

This section provides additional information regarding the various variables used as controls in the analysis.

A.1 Variables constructed using the Customs data

Size. Various measures of the "size" of trade relationships are used as controls in the analysis. Throughout the paper, the size of a trade relationship is measured as the value of exports recorded in the Customs database. In the raw data, the variable is available for each transaction involving a seller s, a buyer $b(c)$ over a particular product p and for a specific period t. This is what is used as control in Table 2 and refered to as the "Transaction Size". In Table 6, the same variable is used to measure the value of the "Country's imports". Here, transactions are aggregated within a product and time period, across all exporters and all importers located in a particular destination country. The aggregate variable thus measures the value of the bilateral trade flow from France to the destination, for a product×period pair. Finally, Table 7 uses the value of trade as a measure of the size of the exporti firm. In that case, transactions are aggregated within an exporter×product×period, across all partners the firm is connected to.

Age and Experience. The duration of trade relationships is also constructed using the panel dimension of the data. The "Seller's experience" measures the experience of the firm as an exporter. In Tables 2 and and 6 it is measured as the number of years since the firm has started serving the destination. In Table 7, the focus is on the overall dispersion of prices within a seller and product and experience is thus measured as the number of years since the firm has started exporting this particular product in the EMU. Finally, the "age" of a relationship used as control in Table 2 is measured in difference with the date of the first transaction involving the seller and its foreign partner for a particular product.

Core Product. In Table 7, we introduce a dummy variable identifying the firm's "Core" product. For each firm and product, we first aggregate exported values across all partners, all destinations and all periods. The core product is then defined as the most important product generating at least 30% of the firm's overall sales. We also tested with the firm's main product (in value terms) without imposing that it represents at least 30% of the firm's sales but results were qualitatively the same since more than 75% of multi-product firms have their core product that represents at least a third of their exports. Finally, note that the "Core" product dummy is normalized to zero for firms that export a single product.

Count Products. In Table 8, Column (4), we control for the number of products that the firm is exporting. Here as well, the variable is recovered from aggregated trade across all periods and destinations, within a firm.

A.2 Variables recovered from external sources

In Table 8, various firm-level variables are used to document the heterogeneity in pricing strategies across French firms. We rely on the INSEE-Ficus dataset which provides balance-sheet data covering the universe of French firms. We merge the dataset with the trade variable using the French firm Siren identifier.

Sector. Based on the balance-sheet data, we can recover information on the firm's sector of activity, as defined in the NAF nomenclature. We use this information to construct the "Wholesaler" and "Retailer" dummies introduced in Column (3) of Table 8.

Relative Sales. The "Relative Sales" variable is measured as the ratio of the firm's overall turnover divided by the median turnover of firms active in the same sector of activity. We get rid of the time dimension by calculating this ratio for a single cross-section, namely 2006. The variable thus capture the relative size of the firm, in its sector.

Relative Market Power. The "Relative Market Power" variable is defined based on information on the ratio of the firm's gross operating surplus over its value added, expressed in relative terms with respect to the median firm in the sector. Here as well, the variable has no time dimension and 2006 is used as reference.

Distance. The "Distance" variable used in Table 2 is recovered using the database constructed by Laboureau (2018). Because we are working with trade flows restricted to the European Union, the mean distance with France is relatively low and little heterogeneous across countries. In such a restricted geographic area, the precise location of the firm in France becomes an important source of variation in distances to various destinations. This is the reason why Laboureau's dataset dominates more standard ones such as the CEPII's *distance* database which provides various measures of bilateral distances between all countries in the world. In Laboureau's dataset, distance is measured between a precise commuting zone and a given destination using a weighted average of bilateral distances with the country's most important cities. This can be merged with the firm-level data using information on the firm's location provided by INSEE. The variable used in Table 2 is measured in kilometers but we also checked with the driving time to the destination, recovered from the Google Map API.

Table 1: ***Dimensionality of the data***

		Number of		
	Transactions	Exporters	Importers	Relationships
	$sb(c)pt$	s	$b(c)$	$sb(c)p$
	(1)	(2)	(3)	(4)
All	37,796,239	70,649	1,103,275	8,626,857
Austria	893,889	14,924	31,638	232,339
Belgium	6,329,954	46,765	128,592	1,397,788
Cyprus	63,891	3,061	2,271	19,906
Czech Republic	261,788	8,601	8,101	50,723
Denmark	697,829	15,106	17,968	159,829
Estonia	53,873	2,283	1,617	12,498
Finland	404,946	9,287	9,978	83,978
Germany	6,661,428	40,437	228,985	1,414,047
Greece	825,919	13,514	25,577	235,831
Hungary	203,617	6,873	5,884	40,803
Ireland	532,835	11,297	12,898	138,614
Italy	5,134,450	34,992	188,556	1,290,050
Latvia	53,164	2,546	1,796	14,281
Lithuania	60,250	3,420	2,342	16,187
Luxembourg	941,590	19,289	18,226	254,588
Malta	44,014	2,395	1,279	12,454
Netherlands	2,286,535	28,684	63,231	506,606
Poland	431,354	11,956	16,664	95,659
Portugal	1,717,826	20,974	42,307	394,948
Slovak Republic	79,645	4,008	2,913	18,491
Slovenia	110,763	3,548	2,760	20,896
Spain	5,355,890	36,395	164,399	1,230,907
Sweden	767,925	13,547	19,947	156,392
United Kingdom	3,882,864	32,049	105,346	829,042

Notes: Column (1) is the number of transactions recorded over 2002-2006. Columns (2) and (3) respectively report the number of French exporters and European importers involved in these transactions. Finally, Column (4) is the number of exporter×importer×product triplets. The ratio of column (4) and (1) allows to recover the mean number of transactions observed over time for a particular firm-to-firm relationship and a particular product.

Table 2: ***Results of the fixed-effect decomposition of the price dispersion***

	Dep.Var: ln price $p_{sb(c)pt}$			
	(1)	(2)	(3)	(4)
Seller's experience		.005^a	.001^a	.002^a
		(.000)	(.000)	(.000)
Age of the relationship		-.003^a	-.009^a	-.009^a
		(.000)	(.000)	(.000)
ln Transaction size			.039^a	.037^a
			(.000)	(.000)
ln Distance				.008^a
				(.001)
# observations	37,470,412	37,470,412	37,470,412	35,143,089
Adj R^2	.891	.891	.892	.892
Within R^2	.000	.000	.006	.005
# Estimated FE				
Seller	62,497	62,497	62,497	55,471
Buyer	808,383	808,383	808,383	777,965
Product×Period	165,730	165,730	165,730	164,507
	Share of price dispersion explained by			
Observables		.000	-.002	-.002
Product×period FE	.652	.651	.647	.647
Seller FE	.197	.197	.202	.201
Buyer FE	.045	.045	.047	.048
Match residual	.106	.106	.105	.105

Notes: The table reports results of the estimation of equation (1), over 2002-2006. The last panel is a variance decomposition of observed price discrepancies into the components entering equation (1).

Table 3: ***Summary statistics on the coefficient of variation, within a product and quarter***

	EU25	EU15	EMU	non-EMU
	(1)	(2)	(3)	(4)
	Coefficient of variation $CV_{pt}^{scb(c)}(p_{sb(c)pt})$			
Mean	1.293	1.280	1.236	0.998
Median	0.790	0.785	0.774	0.722
10th percentile	0.331	0.330	0.325	0.312
90th percentile	2.753	2.720	2.595	2.007
	Contribution dispersion within s			
Mean	0.312	0.312	0.304	0.286
Median	0.265	0.264	0.253	0.203
10th percentile	0.006	0.006	0.005	0.002
90th percentile	0.704	0.705	0.696	0.725
Count obs	142,266	141,521	138,354	75,669

Notes: The table reports summary statistics on the dispersion of prices within a product and period, in various country sub-samples. The first panel reports statistics on the distribution of coefficients of variations:

$$CV_{pt}^{scb(c)}(p_{sb(c)pt}) = \frac{\sqrt{Var_{pt}^{scb(c)}(p_{sb(c)pt})}}{\bar{p}_{pt}^{scb(c)}}$$

using the notations in equation (2). The second panel corresponds to the contribution of the within component also described in this equation. Statistics are based on the 2002-2006 period. Statistics computed on the distribution of variation coefficients recovered from at least 5 points.

Table 4: ***Summary statistics on the coefficient of variation, within a seller, product and quarter***

	EU25	EU15	EMU	non-EMU
	(1)	(2)	(3)	(4)
	Coefficient of variation $CV_{spt}^{cb(c)}(p_{sb(c)pt})$			
Mean	0.364	0.362	0.357	0.365
Median	0.314	0.311	0.305	0.307
10th percentile	0.027	0.026	0.027	0.058
90th percentile	0.761	0.758	0.749	0.760
	Contribution dispersion within c			
Mean	0.506	0.526	0.580	0.839
Median	0.551	0.581	0.656	0.941
10th percentile	0.000	0.001	0.020	0.505
90th percentile	0.950	0.957	0.979	1.000
Count Obs	863,275	835,386	716,780	104,410

Notes: The table reports summary statistics on the dispersion of prices within an exporter, product and period, in various country sub-samples. Price dispersion is measured as:

$$CV_{spt}^{cb(c)}(p_{sb(c)pt}) = \frac{\sqrt{Var_{spt}^{cb(c)}(p_{sb(c)pt})}}{\bar{p}_{spt}^{cb(c)}}$$

using the notations in equation (3). The second panel corresponds to the contribution of the within component described in equation (4). The period of analysis is 2002-2006. Statistics computed on the distribution of variation coefficients recovered from at least 5 points.

Table 5: ***Dispersion of prices, within a seller: EMU versus EU15 versus EU25***

	Dep. Var: ln Coefficient of variation $CV^{cb(c)}_{szpt}(p_{sb(c)pt})$				
	2002-2006	2012-2016	2002-2016	2002-2016	2002-2016
	(1)	(2)	(3)	(4)	(5)
EU25 dummy	.082	.104^{c}	.082	.081^{c}	.091^{b}
	(.049)	(.035)	(.049)	(.021)	(.015)
EMU dummy	-.140^{a}	-.141^{b}	-.140^{a}	-.103^{a}	-.079^{a}
	(.013)	(.033)	(.013)	(.005)	(.004)
Post 2012 dummy				.175^{a}	.186^{a}
				(.018)	(.008)
EU25 Post 2012			.022	.006	-.025^{b}
			(.014)	(.005)	(.005)
EMU Post 2012			-.001	-.002	-.009^{c}
			(.021)	(.007)	(.003)
# Observations	2,199,861	2,743,556	4,943,417	4,259,469	1,899,926
Fixed Effects	Product×period×seller			siren×product	
# FE	1,097,153	1,270,701	2,367,854	278,388	46,748
Adjusted R^2 (overall)	.935	.873	.908	.619	.461

Notes: The LHS variable is the log of the coefficient of variation, across buyers within a seller (for each product and quarter), calculated for a specific zone z, the EU25, the EU15 or the EMU. The sample thus has a maximum of three observations per firm×product×period. We further impose a minimum of two osbervations, i.e. the sample is restricted to firms that serve different partners in at least two zones in a given period. Columns (1)-(3) include firm×product×period fixed effects and thus solely use this dimension of heterogeneity. Columns (4)-(5) instead include a smaller number of firm×product fixed effects to also use the variation over time for identification. Column (5) is further restricted to firms (× their product) that are observed at least once in each sub-period. Standard deviations are clustered within each zone.

Table 6: ***Determinants of the dispersion of prices, within a seller and a destination***

	Dep. Var: ln $CV^{b(c)}_{scpt}(p_{sb(c)pt})$		
	(1)	(2)	(3)
ln # Partners	$.297^a$	$.294^a$	$.294^a$
	(.011)	(.010)	(.010)
ln Country's imports	$.037^a$	$.032^a$	$.032^a$
	(.003)	(.004)	(.003)
Experience		$.011^a$	$.014^a$
		(.003)	(.003)
New EU Member			.045
			(.028)
non-EMU Member			.006
			(.024)
# Observations	2,897,251	2,897,153	2,897,153
Fixed Effects	Product×period×seller		
# FE	1,362,379	1,362,347	1,362,347
Adjusted R^2 (overall)	.701	.701	.701

Notes: The LHS variable is the log of the coefficient of variation, across buyers within a seller and destination (for each product and quarter):

$$CV^{b(c)}_{scpt}(p_{sb(c)pt}) = \frac{\sqrt{Var^{b(c)}_{scpt}(p_{sb(c)pt})}}{\bar{p}^{b(c)}_{scpt}}$$

"ln # Partners" is the log of the number of price quotes used to compute the variance of prices. "ln Country's imports" in the value of imports from France, aggregated across all importers within a product×period. "'Experience" is the number of years since the firm has been exporting in the destination. "New EU Member" and "non-EMU Member" are dummy variables for new members of the European Union and non-EMU members of the EU15 (UK, Denmark and Sweden), the reference being the EU15 members. Standard deviations are clustered in the country dimension.

Table 7: ***Determinants of the dispersion of EMU prices, within a seller: Seller-product determinants***

	Dep. Var: ln Coef of var $CV^{b(c)}_{spt}(p_{sb(c)pt})$			
	(1)	(2)	(3)	(4)
ln # Partners	.327^a	.390^a	.417^a	.323^a
	(.002)	(.002)	(.002)	(.002)
ln Size	.055^a			.057^a
	(.001)			(.001)
Experience (product)		.030^a		.028^a
		(.000)		(.000)
Core Product			-.081^a	-.167^a
			(.004)	(.004)
# Observations	1,945,787	1,930,934	1,945,787	1,930,934
Fixed Effects	Product×period, Exporter			
# pt	126,124	125,786	126,124	125,786
# s	42,614	42,237	42,614	42,237
Adjusted R^2 (overall)	.559	.557	.558	.558
Within R^2	.040	.041	.039	.043

Notes: The LHS variable is the log of the coefficient of variation, across EMU buyers within a seller (for each product and quarter) as in equation (6). "ln # Partners" is the log of the number of price quotes used to compute the variance of prices. "ln Size" is the log of the value of the seller's overall exports in the EU, during this particular period and for this particular product. "Experience (product)" is the number of years since the firm has been exporting the product in the EMU. "Core Product" is a dummy equal to one if the product under consideration is the exporter's main source of export revenues. Standard deviations are clustered in the exporter dimension. In column (4), product×period fixed effects explain 10% of the overall variance and the contribution of exporter fixed effects is equal to 44%.

Table 8: ***Determinants of the dispersion of EMU prices, within a seller: Seller-specific determinants***

	Dep. Var: Seller Fixed Effect $\hat{FE}_s$				
	(1)	(2)	(3)	(4)	(5)
ln Relative Sales	.330[a]				.264[a]
	(.006)				(.008)
ln Relative Market Power		.066[a]			.081[a]
		(.015)			(.014)
Wholesaler			-.072[a]		-.102[a]
			(.024)		(.028)
Retailer			-.203[a]		-.281[a]
			(.045)		(.052)
ln Count products				.507[a]	.387[a]
				(.009)	(.011)
# Observations	35,091	28,042	39,227	42,240	27,851
Adjusted R^2	.069	.001	.001	.076	.115

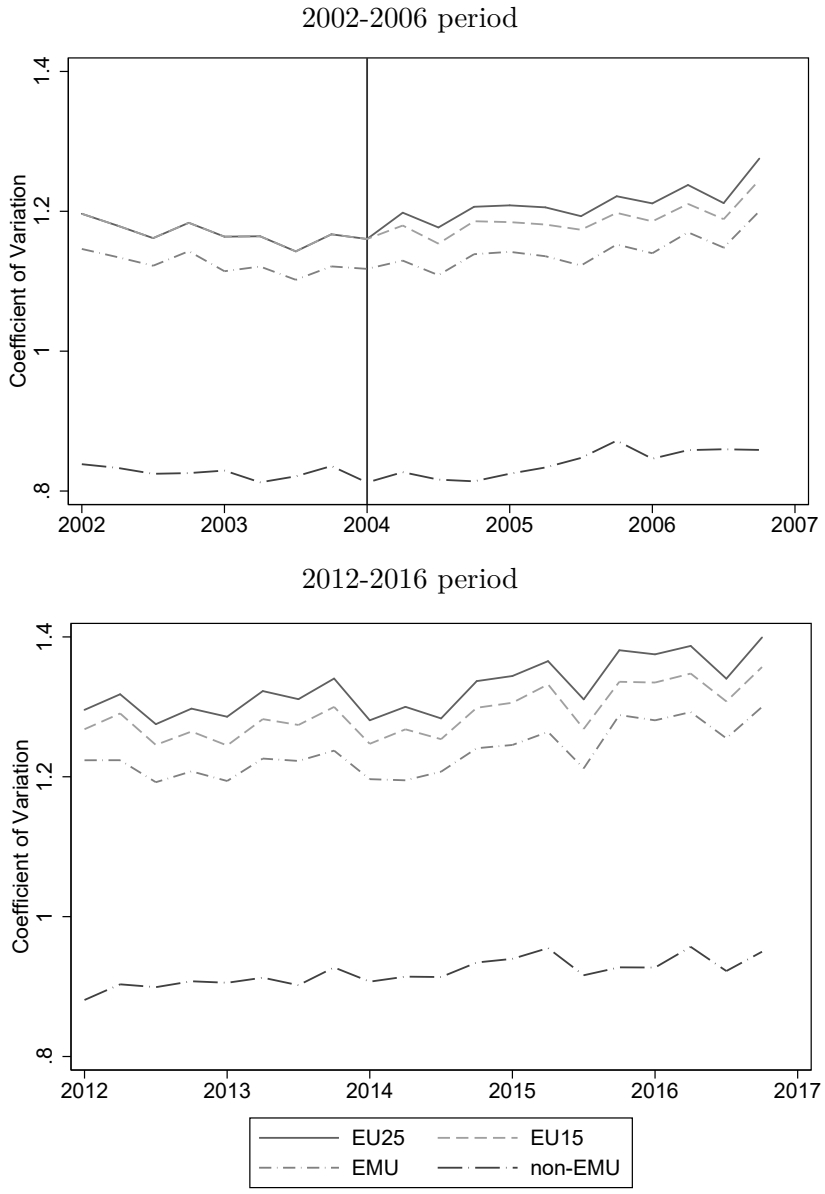
Notes: The LHS variable is the estimated seller fixed effect recovered from the estimation of equation (6). "ln Relative Sales" if the (log of) the seller's turnover in 2006, normalized by the median firm's sales in the sector of the firm. "ln Relative Market Power" is a measure of the seller's relative market power, in comparison with the median firm in its sector, where a firm's market power is proxied by the ratio of gross operating surplus over value added, in 2006. "Wholesaler" and "Retailer" are dummy variables for sellers belonging to the wholesaling and retailing sectors, respectively. "ln Count products" is the (log of) the number of products the firm exports in the EMU.

Table 9: ***Determinants of the dispersion of EMU prices, within a seller: Product-specific determinants***

	Dep. Var: Product fixed effect $\hat{FE}_{pt}$					
	(1)	(2)	(3)	(4)	(5)	(6)
Durables dummy	.633^a					.024^a
	(.009)					(.009)
Share of differentiated inputs		1.825^a				1.276^a
		(.014)				(.020)
Upstreamness			-.300^a			-.160^a
			(.003)			(.004)
Product complexity				.156^a		.136^a
				(.003)		(.004)
Relationship stickiness					.097^a	.012
					(.008)	(.004)
# Observations	125,786	108,685	124,330	112,419	125,775	102,162
Fixed Effects				period		
# t	20	20	20	20	20	20
Adjusted R^2	.044	.147	.061	.023	.005	.157

Notes: The LHS variable is the estimated product×period fixed effect recovered from the estimation of equation (6). The "Durables dummy" is an indicator variable that takes the value one for products classified as durables in the BEC classification (i.e. durable consumtion goods and capital goods). "Share of differentiated inputs" is the percentage share of inputs used to produce the corresponding product that are classified as "differentiated" according to Rauch (1999) classification. This corresponds to the measure of "Input specificity" in Nunn (2007). "Upstreamness" measures the product's average position in value chains and is taken from Antras et al. (2012). "Product complexity" is a measure of the complexity of the product as measured by Hausmann and Hidalgo (2014). Finally, "Relationship stickiness" is the level of stickiness of relationships estimated by HS6 product categories in Martin et al. (2019). All regressions include a period fixed effect so that coefficients are identified across products, within a quarter.

Figure 1: ***Evolution of the mean dispersion of prices, over time***

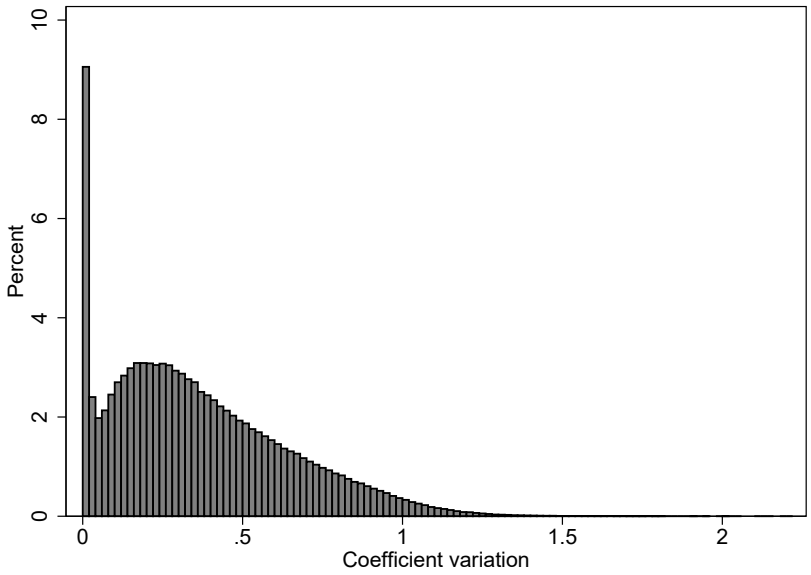


Notes: This figure plots the evolution of the mean coefficient of variation of prices, computed for each product and quarter, i.e. the mean across products of:

$$CV_{pt}^{scb(c)}(p_{sb(c)pt}) = \frac{\sqrt{Var_{pt}^{scb(c)}(p_{sb(c)pt})}}{\bar{p}_{pt}^{scb(c)}}$$

using the notations in equation (2). Coefficients of variation are computed across exporters, countries and importers, in the whole sample ("EU25") and in three sub-samples restricted to EU15, EMU and non-EMU EU15 member countries. The vertical line in the top panel corresponds to the EU enlargement.

Figure 2: ***Distribution of coefficients of variations, across exporters, product and time***

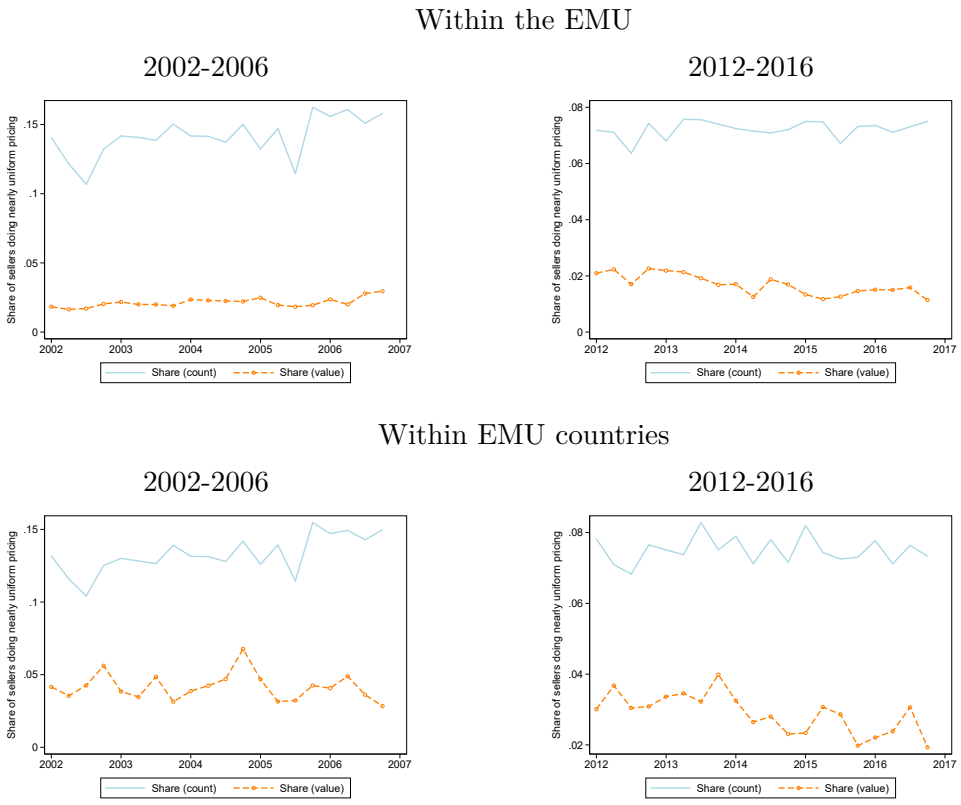


Notes: This figure plots the distribution of variation coefficients, computed for each exporter×product×period according to equation (3):

$$CV_{spt}^{cb(c)}(p_{sb(c)pt}) = \frac{\sqrt{Var_{spt}^{cb(c)}(p_{sb(c)pt})}}{\bar{p}_{spt}^{cb(c)}}$$

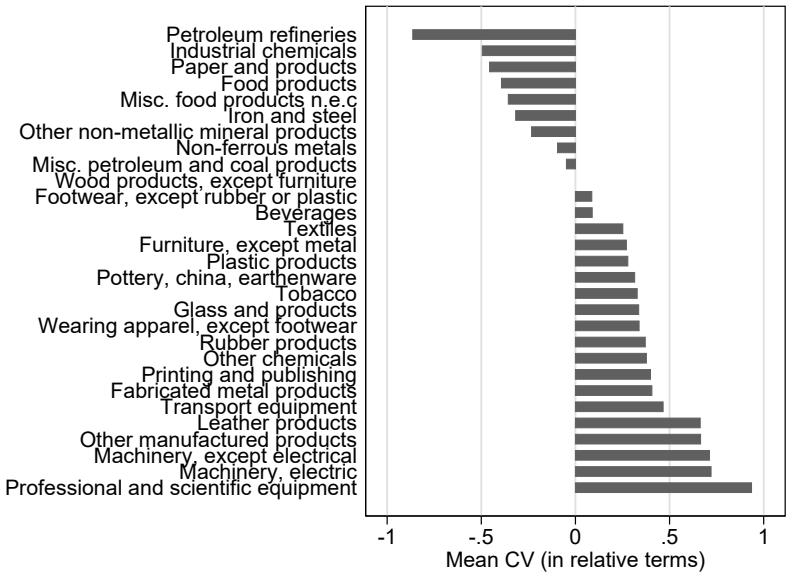
The analysis is restricted to statistics based on at least 5 points. Results are for the EU25 and the 2002-2006 period.

Figure 3: ***Near uniform pricing within the EMU***



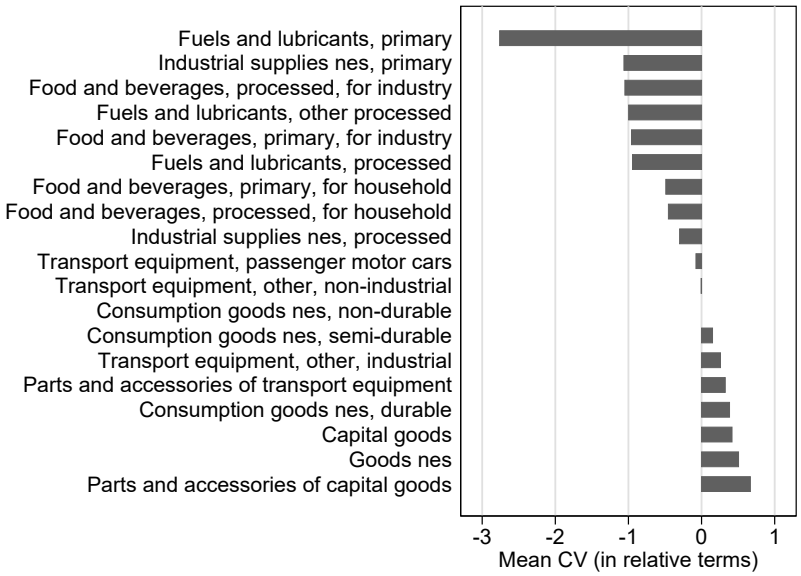
Notes: This figure reports the share of near uniform pricing within the euro area. Near uniform pricing is defined in equation (5). The top panels report the prevalence of NUP within the EMU; 2/3 of the firms doing NUP are selling their product to more than one destination within the EMU. The bottom panels report the prevalence of NUP within EMU destinations.

Figure 4: ***Mean dispersion of prices, across industries***



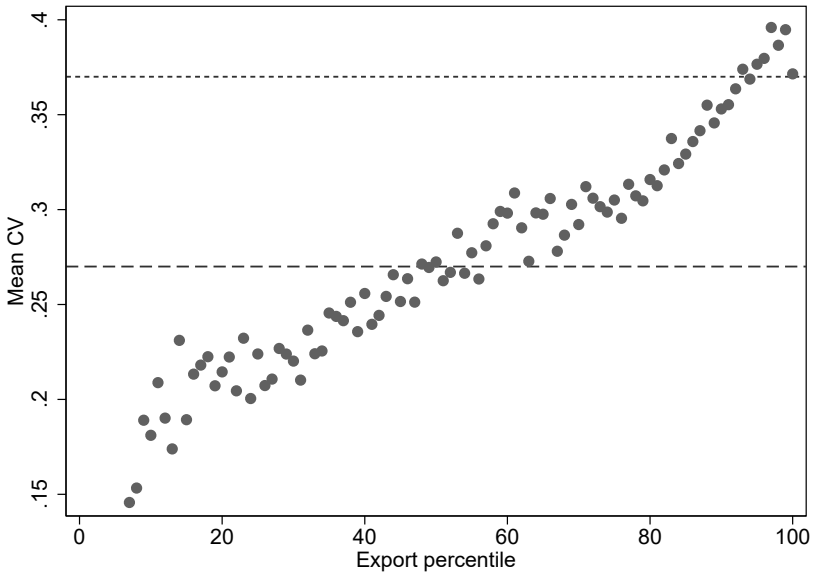
Notes: This figure reports the mean coefficient of variation per broad industry, in relative terms with respect to the sector producing wood products. These statistics are recovered by regressing the product×period fixed effects of equation (6) on a set of time and sector dummies. The sector dummies are reported on the graph. Since the left-hand side variable of equation (6) is in log, the y-axis can be interpreted in percentage terms.

Figure 5: ***Mean dispersion of prices, across BEC categories***



Notes: This figure reports the mean coefficient of variation per category of the BEC classification. Results are expressed in relative terms with respect to non-durable consumption goods. These statistics are recovered by regressing the product×period fixed effects of equation (6) on a set of time and BEC category dummies. The estimated coefficients on the BEC categories are reported on the graph. Since the left-hand side variable of equation (6) is in log, the y-axis can be interpreted in percentage terms.

Figure 6: ***Mean dispersion of prices, across export percentiles***



Notes: This figure reports the mean coefficient of variation per percentile of firm size, where the size of a firm is measured by its contribution to overall exports. The long dash horizontal line represents the dispersion at the 50^{th} percentile. The short dash line represents the size-weighted median. Data are for the first quarter of 2002.