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Trade Prices and the Euro

Julien Martin & Isabelle Méjean

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NON-TECHNICAL SUMMARY

Ten years after the creation of the European Monetary Union (EMU), it becomes possible to empirically assess its economic impact. The first real effect that comes immediately to mind is to further integrate markets of the Euro zone . Market integration can manifest itself through trade creation, as discussed in many papers, following Rose (2000). Another manifestation that can be tracked down statistically, but has been less investigated in the empirical literature, is the impact of EMU on trade prices. In this paper, we ask whether and how the introduction of the European common currency has affected pricing strategies of French exporting firms.

There are three channels through which the Euro might impact trade prices. Firstly, the elimination of exchange rate fluctuations and associated risks is expected to reduce transaction costs, which should affect firms pricing strategies. Secondly, market integration is expected to enhance firms and products entry which should impact aggregate prices through composition effects. Lastly, a common currency should ease arbitrage behavior of European consumers and reduce the magnitude of price discrepancies within the Euro zone .

In order to investigate these different channels, our paper describes the effect of the Euro on i) the level, ii) the evolution and iii) the dispersion of trade prices. The empirical investigation relies on firm level data about French exports over the period 1995-2005. The bilateral dimension of the dataset helps comparing the pricing behavior of French firms toward EMU countries and the rest of the OECD. The use of individual data limits the aggregation bias associated with the use of trade unit values as proxy for prices. Besides, firm-level unit values are free on board, directly reflecting pricing strategies of firms selling goods in several export markets. Finally, this data makes it possible to disentangle the effects of the Euro on to types of flows: the flows present during the whole period and the flows which enter and/or exit the sample within the period.

Our results can be summarized as follows. First, we find that, on average, French export prices are lower toward the Euro area. This is true during the whole period, even if prices tend to increase in the Euro area at the beginning of the EMU, this price increase being driven by extensive flows. Then, we show that the Euro reduces pricing to market of French firms exporting toward EMU countries. This tends to lessen the price volatility inside the Euro zone. Finally, the extent of price discrimination is smaller toward Euro countries than toward the rest of the OECD. We use a difference-in-difference approach to investigate the dynamics underlying this stylized fact. We show that, after the introduction of the Euro in 1999, price dispersion has been reduced in the Euro zone in comparison with the rest of the OECD.

ABSTRACT
This paper describes the impact of the Euro on i) the level, ii) the evolution and iii) the dispersion of trade prices. This empirical analysis relies on firm level data about French exports over the period 1995-2005.
We find that the elimination of exchange rate fluctuations reduces the pricing to market behavior of French exporters. At the beginning of the EMU, we also observe an increase in aggregate prices for sales in the Euro zone . This price increase does not compensate for the aggregate price gap between cheaper EMU markets and more expensive non-EMU countries. Last we find that the Euro has affected firms' pricing strategies leading to a reduction of the price dispersion inside the Euro zone .

JEL classification: F12, F15
Key words: International Trade Prices, European Monetary Integration.

LES PRIX DU COMMERCE ET L'EURO

RÉSUMÉ NON-TECHNIQUE

Dix ans après la création de l'Union Monétaire Européenne (UME), il est possible d'étudier son impact économique à l'aide de méthodes empiriques. L'effet réel le plus évident est un accroissement de l'intégration des marchés de la zone euro. Cette intégration se traduit par une augmentation du commerce intra-zone, comme le montrent de nombreux articles à la suite de Rose (2000). L'effet de l'intégration sur les prix est moins étudiée. Dans cet article, nous analysons l'effet de la monnaie unique sur les stratégies de prix des entreprises exportatrices françaises.

L'euro est susceptible de modifier les prix du commerce trois canaux. Premièrement, l'élimination des fluctuations de change et des risques associés est supposée réduire les coûts de transaction ce qui devrait modifier les stratégies de prix des entreprises. Ensuite, l'intégration des marchés devrait favoriser l'entrée de nouvelles firmes et de nouveaux produits modifiant le niveau général des prix par un effet de composition. Enfin, la mise en place d'une monnaie unique devrait faciliter les comportements d'arbitrage des consommateurs et ainsi réduire la dispersion des prix à l'intérieur de la zone euro.

Pour appréhender ces différentes dimensions, notre article propose une série de résultats décrivant l'effet de l'euro sur i) l'évolution, ii) le niveau et iii) la dispersion des prix du commerce. Nous utilisons des données de firmes relatives aux valeurs unitaires des exportations françaises sur la période 1995-2005. La dimension bilatérale des données nous permet de comparer le comportement de tarification des firmes françaises vendant sur les marchés de l'UME à leur stratégie de prix dans le reste de l'OCDE. L'utilisation de données individuelles permet de limiter le biais d'agrégation associé à l'utilisation de valeurs unitaires comme approximation des prix à l'export. De plus, les valeurs unitaires calculées sont nettes des coûts de transport ; elles reflètent donc directement les stratégies de prix des entreprises vendant sur plusieurs marchés. Enfin, ces données permettent de séparer les effets de l'euro sur deux types de flux : les flux présents sur toute la période et l'ensemble des flux qui entrent et/ou sortent de l'échantillon au cours de la période d'observation.

Nos résultats peuvent être résumés de la manière suivante. Premièrement, nous montrons que, en moyenne, les prix à l'export français sont plus faibles en direction de la zone euro. Ce résultat tient sur l'ensemble de la période, même si les prix dans la zone euro ont tendance à augmenter au début de l'UME, sous l'effet de l'entrée de nouvelles firmes. Nous montrons ensuite que l'euro réduit les comportements de tarification au marché des firmes exportant dans différents pays de la zone euro. Cet effet tend à atténuer la volatilité des prix à l'intérieur de l'UME. Enfin, la discrimination en prix est de moindre ampleur dans la zone euro que dans le reste de l'OCDE. Nous utilisons une approche en doubles différences pour étudier la

dynamique de ce résultat et montrons que l'introduction de l'euro en 1999 a réduit de manière significative la dispersion des prix à l'intérieur de la zone euro par rapport à la dispersion des prix dans le reste de l'OCDE.

RÉSUMÉ COURT

Notre article décrit l'impact de l'euro sur i) le niveau, ii) l'évolution et iii) la dispersion des prix du commerce. Cette étude empirique repose sur l'utilisation de données individuelles de firmes exportatrices françaises, pour la période 1995-2005.
Nous trouvons que l'élimination des fluctuations de change a atténué les comportements de tarification au marché des entreprises françaises. Au début de l'UME, nous observons une augmentation des prix agrégés à destination de la zone euro. Cette inflation ne suffit pas à compenser l'écart de prix agrégés entre les marchés de la zone euro bénéficiant de prix plus faibles et les pays hors zone euro où les produits français sont relativement chers. Enfin, nous montrons que l'euro a affecté les stratégies individuelles entraînant une diminution de la dispersion des prix à l'intérieur de la zone euro.

JEL classification : F12, F15
Mots Clefs : Prix du commerce international, Intégration monétaire européenne.

TRADE PRICES AND THE EURO

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1 Introduction

The expected economic effect of the Euro that comes immediately to mind is to integrate markets of the Euro zone members. Market integration can manifest itself through trade creation: this is the well known *Rose effect*.[4] However another manifestation that can be tracked down statistically is the impact of EMU on export prices. Following the basic intuition of the law of one price (LOOP), an integrated market should have a unique price for each (properly defined) product. There are many explanations for why the LOOP might not be actually verified. First, LOOP deviations observed at the aggregate or sectoral level may reflect cross-country differences in the composition of consumption baskets. A recent paper by Baldwin & Harrigan (2007) shows that, on average, export prices (measured as product-level average unit values) are higher in remote and small destination markets. Their interpretation of those stylized facts is that "easy" markets (proximate and/or large) are served by a larger share of lower quality firms, which brings the average price down compared to more difficult markets. Note that in models where firms compete in technical efficiency rather than in quality (Melitz, 2003), the prediction would be reversed: easier

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[4]See the seminal paper by Rose (2000). Berthou & Fontagne (2008) empirically assess this question using the same dataset as ours.

markets are reached by less efficient (and thus higher priced) exporters on average. Cross-country price differentials can thus be explained by differences in the group of firms serving each market.

Beyond composition effects, one might also observe price discrepancies at the producer level if firms adopt discriminatory strategies. For this to be the case, there are two necessary conditions. First, the perceived elasticity of demand must be heterogeneous across countries. Under this condition, firms have an *incentive* to set different prices in different markets. The second requirement for price discrimination is that firms have the *ability* to set different prices in different markets. Said otherwise, there must be an arbitrage cost limiting the possibility for consumers to buy the good in the cheapest market.[5]

What effect can we expect from the monetary integration in terms of prices? The more direct effect of the monetary integration is a reduction in transaction costs inside the Euro area, due to the elimination of currency conversion costs and the cost of exchange rate risk. Following Melitz (2003) and Baldwin & Harrigan (2007), this should allow new firms to enter European markets. Whether this will increase or decrease average prices depends on whether selection into export markets is based on efficiency or quality.

EMU is also likely to affect individual pricing strategies. Firms' *incentive* to price discriminate should not be fundamentally modified. As European countries are relatively similar in terms of wealth and cultural habits, thus in terms of preferences, it is likely that price differentials are lower in the EMU than in other more remote countries. Anyway, determinants of price differentials such as preferences are unlikely to change after the introduction of the Euro. The only reason why the firms' incentive to price discriminate may change is if their perceived elasticity of demand is sensitive to trade costs, exchange rates and the competitive structure.[6] From a theoretical

[5] In existing models of price discrimination (Brander and Krugman, 1983, Ottaviano et al., 2008), equilibrium prices are derived assuming away arbitrage. Because of freight absorption, price differentials tend to be smaller than the transaction costs that would be incurred to arbitrage those differentials. The second condition is therefore endogenously met in these models: any level of transaction costs make discriminatory pricing possible.

[6] Brander & Krugman (1983), Melitz & Ottaviano (2008) or Hummels & Skiba (2004) are examples of models displaying a link between trade costs and the price elasticity of demand. In turn, the Pricing-to-Market literature discusses the link between optimal export price adjustments and exchange rate fluctuations. See the seminal papers by Krugman (1987) and Dornbusch (1987). Finally, Melitz &

viewpoint, it is not clear however in which direction it may affect the extent of price discrimination.

A more direct effect of EMU concerns the *ability* of firms to set different prices in different European markets. Trade cost reduction decreases the cost of arbitrage for consumers. This should in turn reduce the extent of sustainable price differentials and accelerate price convergence inside the EMU.

This paper intends to assess such effects of the Euro by looking at detailed data on firm-level prices. The use of an exhaustive sample of firm-level export prices distinguishes us from the rest of the literature that looks at whether the Euro introduction yields price convergence and smaller deviations from the LOOP using either 1) product-level price data or 2) micro-level price data for very specific industries.

In the first category, Lutz (2003) and Engel & Rogers (2004) use retail prices for a set of narrowly-defined products collected in different EU cities. Both find that the introduction of the Euro has had a small to negligible effect on price dispersion and price convergence. In the second category, there are two main products studied in the literature: i) Goldberg & Verboven (2001) and Gil-Pareja & Sosvilla-Rivero (2008) focus on the European automobile market, for which firm-level data is extremely rich mostly due to the high interest of competition authorities for this industry. They find that the introduction of the Euro has increased price convergence. ii) Baye, Gatti, Kattuman & Morgan (2005) study the impact of the Euro on prices charged for 28 electronic products by online retailers and find that there was no impact on price convergence. While cars and electronics are interesting products, the limitations of using a single kind of product are quite clear. For instance, what is the global policy message from the conflicting results on firm-level price convergence on the two products?

The first category of work using product/city level price data is even more problematic. First, it potentially has large sample composition effects. As stated above, the introduction of the Euro should change the composition of firms selling in different countries, allowing for the entry of less efficient firms and possibly also changing the mix of products sold. The change in pricing strategies, which is what we intend to capture in the end, will be less precisely estimated as a consequence. Whether the quite inconclusive results for this type of analysis come from the aggregation bias

Ottaviano (2008) discuss the potential "pro-competitive" effect linked to a change in the structure of competition.

just mentioned or from the true absence or small magnitude of the economic effect of the Euro is quite unclear. The aggregation bias can however be filtered out using individual pricing data.

Another very strong advantage of using firm-level unit values is that those are *free-on-board* (fob) prices, directly reflecting pricing strategies by firms on different markets, contrary to studies where national differences in retail prices arise in part because different producers sell there... possibly different products.[7] Also, observed retail prices are affected by local cost factors, differences in the organization of distribution and taxes. Even if the Euro had actually reduced price discrimination in the Euro zone , this effect may not be observable statistically in retail prices, if the dispersion in local cost factors, which is very stable over time, is a first order explanation of the retail price level.

A last, but important, advantage of individual data is that the *level* of our measure of prices is meaningful. While a large share of the previous literature focuses on the time path of relative prices, we are able to study the impact of EMU on price levels. This allows to test the kind of effect suggested by Baldwin & Harrigan (2007) and identify the mechanisms at work, distinguishing between the extensive and intensive margins.

One drawback of this paper is that we consider only French exporters. Thus our analysis describes the effect of the Euro on a specific EMU member, and should be generalized to other EMU members with extreme cautious. For the moment, this drawback cannot be overcome since highly disaggregated firm level data are not available for other Euro zone countries.

To summarize, the paper provides results that help understanding the effect of the Euro on the level, evolution and dispersion of trade prices. We use the individual dimension of French export data to systematically distinguish composition effects from changes in firms' pricing strategies. We have in this paper three different exercises allowing us to study the level and evolution of export prices, in the Euro zone and in the rest of the OECD. All technical details concerning our methodology are provided in Appendix A, along with a description of our dataset.

We first compare *price levels* across different regions. To this aim, we compute a statistic based on the level of unit values. For bilateral export prices to be compa-

[7] Beside, bilateral transport costs may have change differently over the period. This would induce country-specific price differences that are nearly orthogonal to firms' pricing strategies.

rable across firms, we however have to control for product-specific determinants of prices. Our approach consists in normalizing bilateral unit values by the mean price charged by the firm over the whole set of destination markets (that we restrict to OECD countries). We call this statistic the price deviation with respect to the OECD mean. Averaging over goods for a given country/region provides us with an information about the average price gap with respect to the overall mean. This allows us to see whether prices are higher or lower, on average, in a given country/region. Results are presented in Section 2.

In the second part of the paper, we aggregate individual bilateral prices into price indices using the geometric chained Laspeyres formula.[8] The behavior of the export price index provides us with information on the *time evolution* in the price of the aggregate export basket. Computing it for different destination markets allows us to compare price evolutions in a geographic dimension in Section 3. Provided that the European monetary integration has helped reducing the macroeconomic volatility and increasing the cross-country correlation among the different members of the Euro area, it should be the case that price evolutions are different in the EMU and in the rest of the OECD.

Last, we also try to identify the consequence of the European monetary integration on the dispersion of French export prices in the Euro area. To this aim, we use a statistic that is very similar to the one used to compare price levels across countries. The only difference is that the bilateral unit value is normalized by the average price in the area under consideration. Namely, we look at the average dispersion of prices in the Euro zone and in the rest of the OECD by comparing (i) the average price gap of Euro zone unit values with respect to the Euro zone mean and (i) the average price gap of unit values in the rest of the OECD, with respect to the rest of the OECD mean. This amounts to investigate the EMU effect in terms of σ-convergence. It is similar in spirit to Crucini, Telmer & Zachariadis (2005). Results are presented in Section 4.

Throughout the analysis, we try to separate composition effects from changes in pricing strategies. In particular, we will often compare results obtained on the whole sample of bilateral flows and sub-samples of "intensive" and "extensive" flows. Our definition of "intensive" flows is somewhat narrower than in the standard literature.

[8]The use of a Laspeyres formula justifies itself by the fact it is decomposable into different sub-indices. The decomposition helps understanding the behavior of aggregate prices. See details in Appendix A.2.

Namely, we call intensive a bilateral flow (identified by a firm number, a product category and a destination market) that is present in the data over the whole period. The extensive sub-sample is the set of such bilateral flows that cover less than eleven years. This includes new bilateral relations, i.e. new firms and new destination markets served by a given firm, as well as disappearing flows, i.e. exits by firms of some markets, or of certain products on some markets.[9] The comparison allows us to distinguish the dynamic of prices at the intensive and the extensive margins.

Our results can be summarized as follows. First, we show that French firms tend to set lower prices in the Euro area. This result holds true even once easiness of market and wealth effects are controlled for. Moreover, price differences tend to increase throughout the period. Our results also suggest that, by reducing exchange rate risk, EMU tends to lessen firms' incentive to price-to-market, which stabilizes intra-EMU aggregate prices. Once exchange-rate effects are controlled for, price indices confirm French export prices increase in the Euro zone at the beginning of the monetary union. This price inflation is mainly driven by new firms entering EMU markets. However, it is not sufficient to compensate for the aggregate price gap between EMU and the rest of the OECD. Finally, price discrimination is shown to be smaller in the Euro zone than in the rest of the OECD, over the whole sample, but even more since 1999.

2 Average Price Levels

In this section, we investigate differences in average *price levels* for sales in the Euro zone and in the rest of the OECD. To this aim, we first construct a reference price, which is the average export price to OECD countries, for each firm and each product it sells. We then compute price deviations with respect to the reference for Euro zone, the rest of the EU15 and the rest of the OECD respectively (the same three exclusive sub-samples as above). Those are therefore average firm-level price deviations with respect to an average price set by the firm in rich countries.[10]

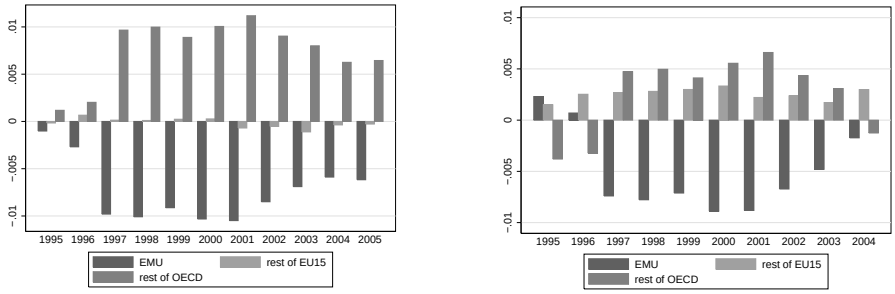
[9] The reason why we use this definition of trade margins is that, in the data, there is a substantial number of firms that switch several times from the exporter to the non-exporter status in a given market. Tracking the evolution of export prices of these particular flows is difficult. This explains why we chose to aggregate them in a "residual" sample and focus our analysis on the comparison of the whole sample and the "intensive" one.

[10] See equation (A.1) in appendix.

2.1 Whole sample

The average price gap with respect to the OECD mean in the EMU, the rest of the EU and the rest of the OECD is presented in Figure 1, panel (a). First of all, note that the average deviations are very small, lying between -1% and 1%. The reason is that these figures aggregate positive and negative price deviations, which compensate each other. This can be seen in Figure 2 that shows the kernel density of price deviations measured in 2000. In both the EMU and the rest of the OECD, there are many positive *and* negative (sometimes large) price deviations.

Figure 1: Average price differentials



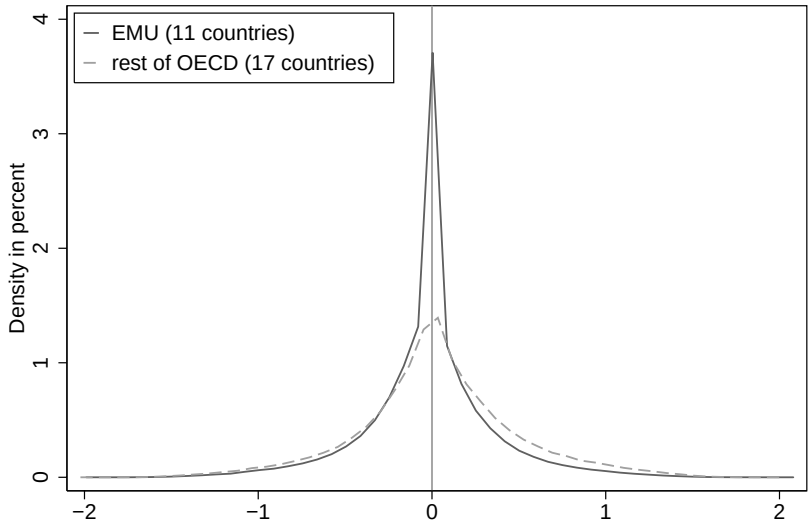
(a) Raw data (b) Controlling for "easiness" and wealth of market

Mean price deviation (in %) with respect to the OECD average. Price deviations purged from GDP over distance and GDP per capita effects in panel (b)

Still however, the average price gap in the Euro zone is always negative meaning that prices are on average smaller than the reference price, once individual determinants of prices are controlled for. By contrast, it is positive or close to zero in both the rest of the EU and the rest of the OECD.[11] During this period the French export price level is about 2% higher in the rest of the OECD than in the Euro zone .
A possible explanation of the lower aggregate price *level* in the Euro zone is that

[11] One can verify this result in Figure 2. The right tail of the kernel density is thinner for the EMU sample while positive price deviations are more likely in the rest of the OECD. This explains why, on average, prices are lower in the Euro area.

Figure 2: Kernel density of price differentials with respect to the OECD mean, 2000



Distribution of the log of the price gap calculated as the log of a price (country, product and firm specific) divided by the average price of this good over OECD countries.

EMU members are closer to France than other countries in the rest of the OECD. According to Baldwin & Harrigan (2007), this should change aggregate prices because of composition effects: a larger number of firms are able to make it into the Euro zone, where selection through trade costs is less tough. Therefore if different firms produce goods with different qualities, only high quality and high price goods will be sold in more difficult markets, i.e. the rest of the OECD in the present case. We would then observe a lower level of average prices inside the Euro zone under this explanation. Note though that there are counter-arguments. Should firms be characterized by different levels of physical productivity rather than quality, then worse firms that can export to Euro zone but not to the rest of the OECD would have higher prices, not lower. This would be consistent with evidence discussed in the previous section. Also if firms have the possibility to price-discriminate, they would tend to practice higher prices in easy markets, as explained above.

To investigate this, we regress the (log of) unit values on i) a measure of easiness of destination markets: GDP over distance and ii) income per capita of the country. Results are provided in Table A.2 in Appendix. As expected, they suggest prices are higher toward richer countries. On the other hand, they are lower in "easy" markets. The predicted residuals of this first-stage regression can be interpreted as the price purged from 'easiness of market' and wealth effects. Panel (b) of Figure 1 presents the average deviation when easiness of market and wealth are controlled for. Accounting for these determinants of country-specific prices does not change the qualitative nature of our results but average price differentials are further reduced.
To sum up, export prices are driven by (at least) two channels. First, easy markets face lower prices and second, rich markets face higher prices. Euro zone markets are both rich and easy for French exporters, but controlling by these two characteristics, they remain cheaper than the rest of the EU15 and the rest of the OECD. This motivates our first fact:

Fact 1: At the individual level, export prices toward Euro zone countries are lower, on average, than in the rest of the OECD. This remains true when controlling for easiness of market and wealth.

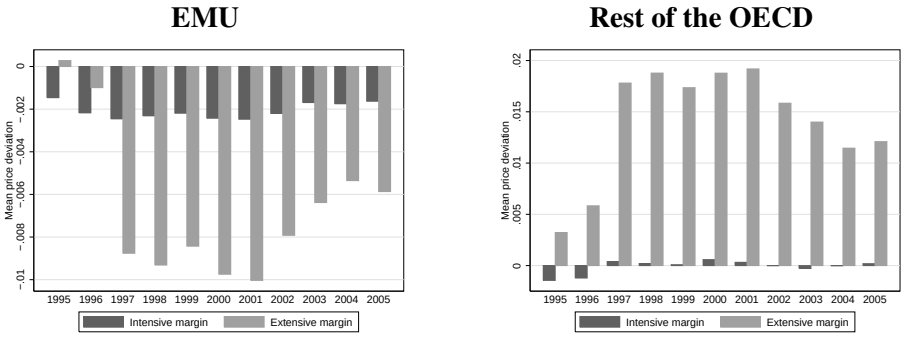
2.2 Intensive and extensive margins

Recent studies suggest that a large share of the EMU impact on aggregate trade volumes goes through the extensive margin, i.e. changes in the number of firms serving different export markets.[12] To see whether extensive margin effects are important as well in explaining the behavior of French export prices, we separate our sample into two sub-samples called "intensive" and "extensive". As explained in Appendix A.1, we call intensive a firm-product-destination combination that is present in the data over the whole period. All other flows are called extensive.
Figure 3 illustrates the average price gap with respect to the OECD mean in the EMU (left-panel) and in the rest of the OECD (right-panel), distinguishing between intensive and extensive flows. Note that each sample is weighted by the number of observations to obtain a correct decomposition of the results in Figure 1, panel (a). This explains why the bars referring to the intensive sample are smaller than

[12] See Berthou & Fontagne (2008) using the same data as ours.

for the extensive one. The left panel of Figure 3 shows that prices are relatively low

Figure 3: Average price differentials, intensive versus extensive samples



Mean price deviation (in %) with respect to the OECD average, computed on intensive and extensive flows.

in the EMU, both at the intensive and at the extensive margins. By contrast, prices on intensive flows towards the rest of the OECD are not systematically higher than the average. The relatively high price level in this region is thus driven by extensive flows. This motivates our second fact:

Fact 2: In the Euro zone , export prices are lower on average, both at the intensive and the extensive margins. In the rest of the OECD however, prices are relatively high because entering firms exert a positive pressure on the average price level.

3 Price Evolutions

Another way to investigate the price impact of the Euro is to compare aggregate price evolutions in the Euro zone and in an appropriate control group. To this aim, we compare Laspeyres price indices between the EMU and the rest of the OECD.

A convenient analytical property of the geometric Laspeyres index is that it can be broken down into several sub-indices (see appendix A.2). This allows us comparing the price evolution of flows present over the whole period (intensive flows) with the price evolution of extensive flows.

3.1 Whole sample

Figure 4 illustrates the evolution of aggregate export prices toward the Euro zone , the rest of the EU15 and the rest of the OECD.[13] Export price indices are computed using fob prices expressed in the exporter' currency i.e. in Euros.[14] Detailed results are provided in Table 1, columns "PCP". Overall, aggregate French prices remain stable in the Euro zone , while they are much more volatile in the rest of the OECD, following the ups and downs of the Euro. Interestingly, the relative stability of French prices toward EMU members still holds when comparing them with the rest of the European Union. The explanation of the price stability is thus probably related to the monetary union.

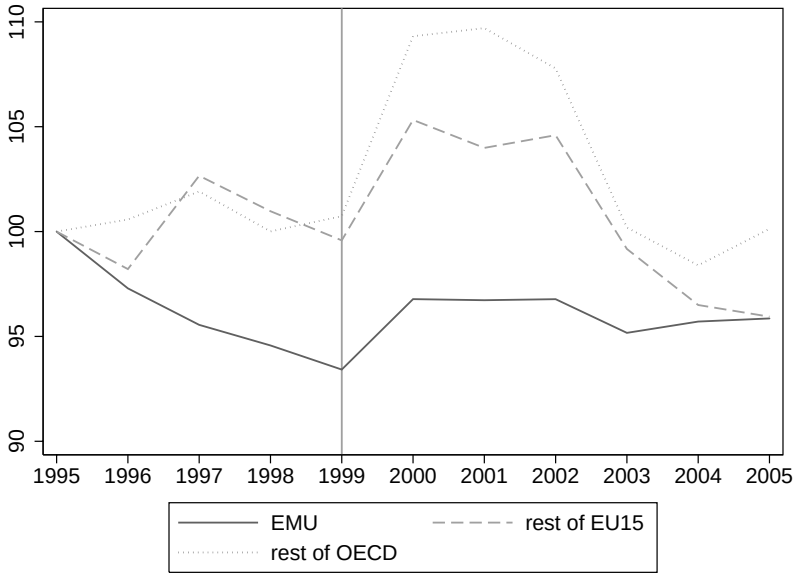
One of the main objectives of monetary union is the elimination of exchange rate fluctuations between European currencies. Since 1999, French exporters are free from exchange rate risk when selling goods in the Euro zone . Even before the formal introduction of the common currency, the exchange rate mechanism (ERM II) had helped reducing exchange rate movements. The elimination of exchange rate risks is likely to have modified firms' pricing behavior. According to the "Pricing-to-Market" literature (see Krugman (1987) and Dornbusch (1987) for instance), part of the exchange rate risk is absorbed into markup adjustments when imperfectly competitive firms want to preserve their market share abroad. This induces a correlation between price change (in the exporter's currency) and exchange rate movements which *disappears within a monetary union.*

Figure 5 illustrates the correlation between price variations (in Euro) and exchange-rate movements. It compares the Euro-denominated export price index and the effective nominal exchange rate index (expressed in foreign currency per Euro) vis-à-

[13] The sample of countries we consider in the Euro zone is composed of Austria, Belgium (merged with Luxembourg in the data), Finland, Germany, Greece, Ireland, Italy, Netherlands, Portugal and Spain. The "rest of EU15" sample is composed of the United Kingdom, Denmark and Sweden.

[14] Before 1999, export data in French francs are converted into Euros by the customs using the current nominal exchange rate.

Figure 4: Export price indices toward EMU, the rest of the EU15 and the rest of the OECD

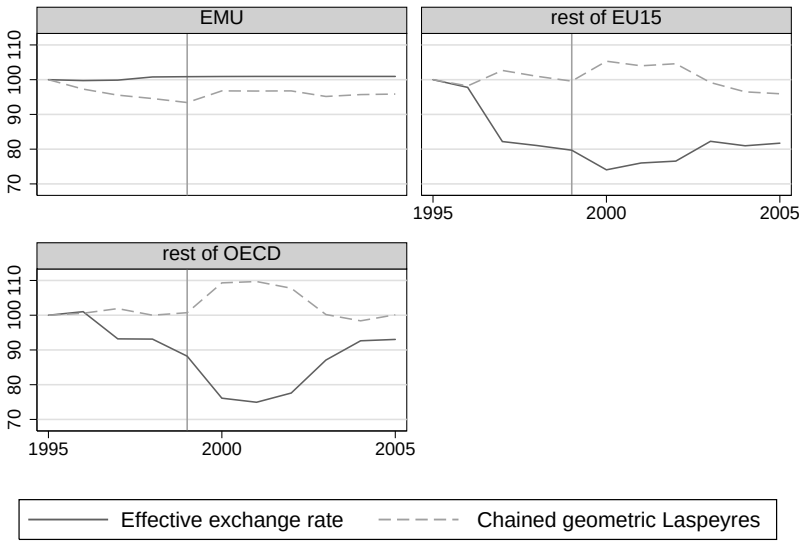


Chained geometric Laspeyres price index, 100=1995. Export prices in current Euro for France.

vis the EMU (top, left-panel), the non-EMU members of the European Union (top, right-panel) and the rest of the OECD (bottom-panel).[15] The clear negative correlation between exchange rates and price indices vindicates the pricing-to-market assumption. During the second part of the 90s, the French currency (French Franc before 1999, Euro since then) tends to depreciate against its main extra-EMU partners. This mechanically improves the competitiveness of French products in foreign markets. French exporters take advantage of the competitiveness gain and increase

[15]We only consider the United States, Japan and Switzerland in the computation of the effective nominal exchange rate for the rest of the OECD. In 2000, they represent about 70% of French exports outside the European Union. The weighting parameters used to aggregate bilateral nominal exchange rates are based on traded values as recorded in the custom data.

Figure 5: Correlation between export price changes and exchange rate movements



Chained geometric Laspeyres price index. Effective nominal exchange rates computed using Chelem data. 100=1995. Rest of the EU15 : Denmark, United Kingdom and Sweden. Rest of the OECD : United States, Japan and Switzerland.

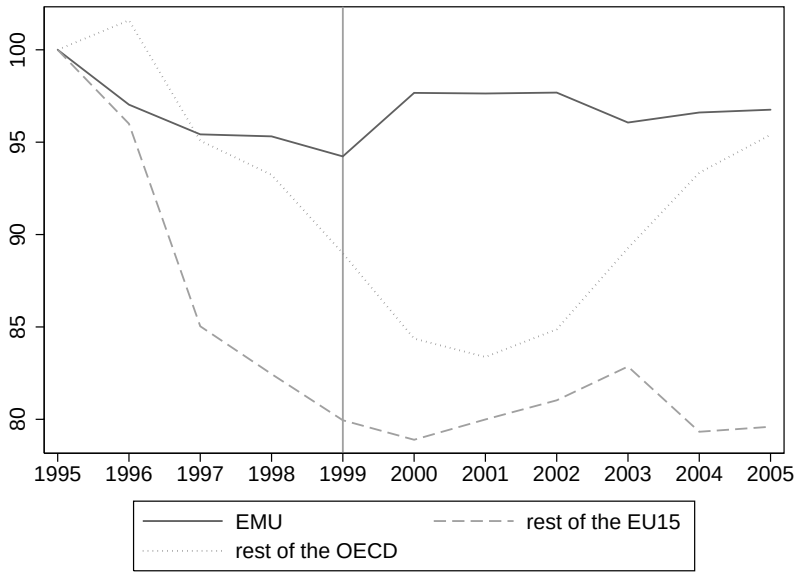
their markup, which explains the price increase. On the contrary, export prices tend to decrease since 2001, in coordination with the appreciation of the Euro. The natural interpretation from the pricing-to-market literature is that exporters reduce their markups to smooth the effect of exchange rate changes.[16] Naturally those changes are brought to zero with the EMU and Euro zone export prices no more reflect such exchange-rate-smoothing behaviors.

This motivates our third fact:

[16]Note that the previously described pricing-to-market mechanism is reinforced by the impact of exchange rate movements on production costs. Firms that use imported inputs in their production process face increasing marginal costs when their money depreciates. This tends to increase their export prices as well. However, this cost effect also affects intra-EMU prices and is unlikely to explain the different behavior of EMU and extra-EMU aggregate prices.

Fact 3: The EMU insulates exporters from exchange rate risk. This reduces pricing-to-market behavior and stabilizes aggregate prices.

Figure 6: Local currency price indices toward EMU, the rest of the EU15 and the rest of the OECD



Chained geometric Laspeyres price index, 100=1995. Rest of the EU15 : Denmark, United Kingdom and Sweden. Rest of the OECD : United States, Japan and Switzerland.

Once the impact of exchange rates is controlled for, the behavior of export prices is quite different. Figure 6 and Table 1, columns "LCP", illustrate the evolution of French prices, once converted into the importer's currency. Before the introduction of the Euro, the price of French products tends to decrease in all three areas: EMU, rest of the EU15 and rest of the OECD. In 1999 however, a trend reversal can be observed in the Euro zone , where prices increase by 3.6%. In the meantime, they continue to

decline in the rest of the OECD until the beginning of the Euro appreciation in 2001. The result is consistent with Hobijn, Ravenna & Tambalotti (2006), that justify the jump in restaurant prices after the introduction of the Euro in terms of menu costs.[17] This motivates our fourth fact:

Table 1: Price variations (in percent) in Euros (PCP) and in the importer's currency (LCP)

	EMU		Rest of the EU15		Rest of the OECD	
year	PCP	LCP	PCP	LCP	PCP	LCP
1996	-2,7	-3,0	-1,8	-4,0	0,6	1,6
1997	-1,8	-1,7	4,5	-11,4	1,3	-6,4
1998	-1,0	-0,1	-1,6	-3,0	-1,9	-1,9
1999	-1,2	-1,1	-1,4	-3,0	0,7	-4,6
2000	3,6	3,6	5,8	-1,3	8,5	-5,2
2001	-0,1	0,0	-1,3	1,4	0,4	-1,2
2002	0,1	0,1	0,6	1,3	-1,8	1,8
2003	-1,7	-1,7	-5,2	2,3	-7,0	5,2
2004	0,6	0,6	-2,7	-4,3	-1,8	4,6
2005	0,2	0,2	-0,6	0,3	1,8	2,2

Fact 4: French export prices increased in the Euro area at the beginning of the monetary union.

3.2 Intensive and extensive margins

As in Section 2, we now ask whether previous results are driven by extensive or intensive flows. The (geometric) Laspeyres price index can easily be broken down

[17] The argument in Hobijn et al. (2006) is that producers know they will have to adjust their price at the time of the Euro introduction. Thus, when price adjustments are costly, they have an incentive to wait before adjusting their price, even if, say, their marginal cost has increased. In that case, one can expect a strong price increase in the aftermath of the Euro because producers re-optimize and compensate for price adjustments they have delayed before the introduction of the Euro.

into an intensive and an extensive components. Namely, the total index can be shown to be the sum of the "intensive" and "extensive" Laspeyres, weighted by the share of each sub-sample in the total export value.[18] Figure 7 illustrates this breakdown in the case of the Euro-denominated price index computed from Euro zone export flows (left-panel) or using exports toward the rest of the OECD (right-panel).
While the behavior of both indices is broadly similar for the rest of the OECD sample, intra-EMU price evolutions are quite different at the intensive and the extensive margins. Namely, the "extensive" price is more volatile than the price index computed on the intensive margin. In the rest of the OECD, both price indices are dominated by the kind of exchange rate effects discussed earlier.

Figure 7: The margins of export price evolution (in Euro)

Chained geometric Laspeyres price index, 100=1995.
* rest of the EU15 included

Table 2 presents price variations in the different subsamples. It shows that the disconnection between price variations of the two types of flows in the Euro zone started in 2000. This point is particularly noticeable when observing that this disconnection does *not* exist for exports to the rest of the OECD. Therefore, the introduction of the Euro affected in a different way the two margins.
On Euro markets, Euro prices of continuing flows continually increase since the in-

[18] See details in Appendix A.2.

troduction of the Euro. By contrast, prices of the extensive flows increase a lot between 1999 and 2000 and decline after 2002. These price evolutions can be related to changes in the composition of the extensive sample. Between 1998 and 1999, the number of extensive flows increases by about 5% (see Table A.1). This is consistent with evidence provided by Berthou & Fontagne (2008) in favor of a large trade effect of the Euro at the extensive margin. On the contrary, the size of the sample significantly shrinks between 2002 and 2003. A possible explanation of the behaviour of extensive prices is thus likely to be found in the behaviour of those firms that switch from the non-exporter to the exporter status, and the other way around.

The price increase observed at the extensive margin between 1999 and 2000 may reflect the fact that new firms increased their price the year following their entry. What may explain such a pricing strategy? One hypothesis is that new firms entered Euro zone markets with a relatively low initial price allowing them to grab a sizeable market share. This is confirmed in the data: On average, the price of a typical entering firm in 1999 is 30% lower than the average price of firms of the same sector that are present over the whole period in the market. Once these firms are in the market, they increase their price: in 2000, the gap between their price and the average shrinks to 22%.

The price increase is all the easier since the competitive environment is favorable: the depreciation of the Euro protects European firms from outside competition. On the contrary, the Euro appreciation beginning in 2001 mechanically increases competitive pressures from the rest of the world. This induces the more fragile firms to leave European markets: the number of extensive flows is reduced by 7% between 2002 and 2003 (see Table A.1). In the meantime, those firms that can stay in the market are forced to reduce their price. Firms at the intensive margin, that are more strongly anchored in European markets, are less sensitive to these changes in the competitive environment.

This motivates our fifth fact:

Fact 5: Inside the Euro zone , price variations are mainly drawn by extensive margin effects. The introduction of the common currency makes new firms enter the market which tends to increase the aggregate price index in 2000.

Table 2: Percentage price variations (in Euro)

year	EMU				rest of OECD (rest of EU incl.)			
	All	Intensive	Extensive	Δ # flows Ext (%)[a]	All	Intensive	Extensive	Δ # flows Ext (%)[a]
1996	-2.70	-0.81	-1.90	+6.3	-0.43	0.49	-0.92	+3.1
1997	-1.79	-0.64	-1.15	+12.1	2.65	1.58	1.07	+26.6
1998	-1.026	-0.41	-0.62	+2.9	-1.78	-0.59	-1.18	+3.7
1999	-1.22	-0.69	-0.52	+5.0	-0.16	0.02	-0.18	+5.8
2000	3.59	0.65	2.94	+5.1	7.38	2.52	4.86	+1.6
2001	-0.05	0.17	-0.22	+0.3	-0.28	0.00	-0.28	-1.8
2002	0.05	0.07	-0.02	+0.8	-0.85	-0.25	-0.59	+1.2
2003	-1.66	0.08	-1.74	-6.7	-6.29	-1.65	-4.64	+1.8
2004	0.57	0.39	0.18	+11.8	-2.15	-0.26	-1.89	+5.8
2005	0.16	0.19	-0.04	+0.6	0.86	0.28	0.58	+2.4

[a] Variation in percent in the number of extensive flows.

4 Price Discrimination

In this section, we ask whether the introduction of the Euro has impacted the magnitude of price discrimination across EMU markets. To this aim, we compare the *dispersion* of French export prices in the Euro zone to the dispersion in the rest of the OECD. We also "zoom" inside the Euro zone , looking at price deviations across this set of countries.

As explained in the appendix, equation (A.2), our measure of price dispersion is based on the average price gap with respect to the firm-specific mean price in the considered area. This slightly differs from the price discrepancy computed in the previous section because the reference price is now the average in each specific area, while the reference was the whole OECD in Section 2. We use these price ratios to compare the dispersion of prices in the Euro zone with that in an appropriate control group.

4.1 Whole sample

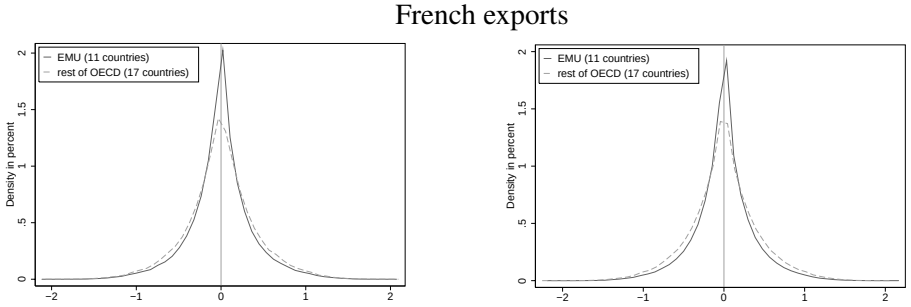
As a first description of price discrimination, Figure 8 illustrates the distribution of the (log of the) price deviation in the EMU and the rest of the OECD, for France in 1995 and 2005. With deviations in log, the distributions are centered around zero. A positive (negative) deviation means a price above (below) the average price of the area. Given the definition of our statistic, a density which is more concentrated around zero indicates a smaller dispersion of prices in the considered area.

Figure 8 shows that densities are more concentrated around zero inside the EMU than in the rest of the OECD. This means that price differentials for French products across EMU countries are lower, on average, than across countries of the rest of the OECD. A possible explanation is that, in the EMU, arbitrage costs are lower and French firms cannot discriminate between markets as much as they would like. This explains why prices are more concentrated there than in the rest of the OECD. However, the comparison of both panels, respectively obtained on 1995 and 2005 data $i.e.$ before and after the implementation of the Euro, shows that this gap is not strongly affected by the monetary integration. This probably means that most of goods market integration already occurred before the implementation of the monetary union.

Panels (a) of Figure 9 illustrates the time evolution of the average price deviation (in absolute value) for different geographic areas (namely the EMU, the rest of the OECD, and the rest of the EU15). Using the absolute value of the price deviation amounts treating positive and negative deviations from the mean in a symmetric way. Figure 9 thus illustrates the *dispersion* of the distribution of prices depicted in Figure 8.

On average, there is a gap of 30% between the price of a French good in an OECD country and the average price of this good in the whole OECD. The variance is marginally smaller in the Euro zone and even more in the EU15, where the average price gap is about 22%. At first sight, it seems surprising that the dispersion of prices is higher in the EMU than inside the rest of the EU15. The counter-intuitive result however disappears once easiness of market and wealth effects are controlled for (Panel (b) of Figure 9). Heterogeneity among EMU markets in terms of market access thus explain why the dispersion of crude prices is (marginally) higher than in the rest of the European Union. Once these structural factors are controlled for, our computations suggest, as expected, that the dispersion of prices is the smallest in the

Figure 8: Distribution of price deviations



(a) 1995 (b) 2005

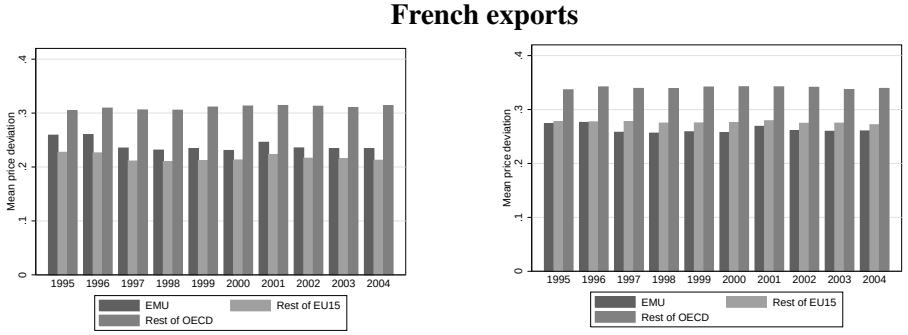
Distribution of the log of the price discrimination calculated as the log of a price (country, product and firm specific) divided by the average price of this good over countries of the considered area.

EMU, followed by the rest of the European Union and the rest of the OECD. This motivates our sixth fact:

Fact 6: Price discrimination is smaller, on average, in the Euro zone and in the rest of the EU15 than in the rest of the OECD. Once easiness of market and wealth effects are controlled for, the dispersion of prices is the smallest in the Euro area.

This sixth fact seems to hold throughout the period. However, Figures 10 depicting the distribution of *intra-EMU price differentials* over countries and time shows a process of gradual convergence. In these graphs, each bar gives the average price deviation with respect to the EMU average for the corresponding member of the Euro zone . Both negative and positive country-specific deviations become smaller over time.
This suggests that the magnitude of price discrimination in the Euro zone gradually occurs over time. In the following, we ask whether the introduction of the Euro has amplified the discrepancy between EMU and non-EMU members using a regression analysis.

Figure 9: Mean absolute price deviation, EMU vs rest of the OECD



(a) Raw data

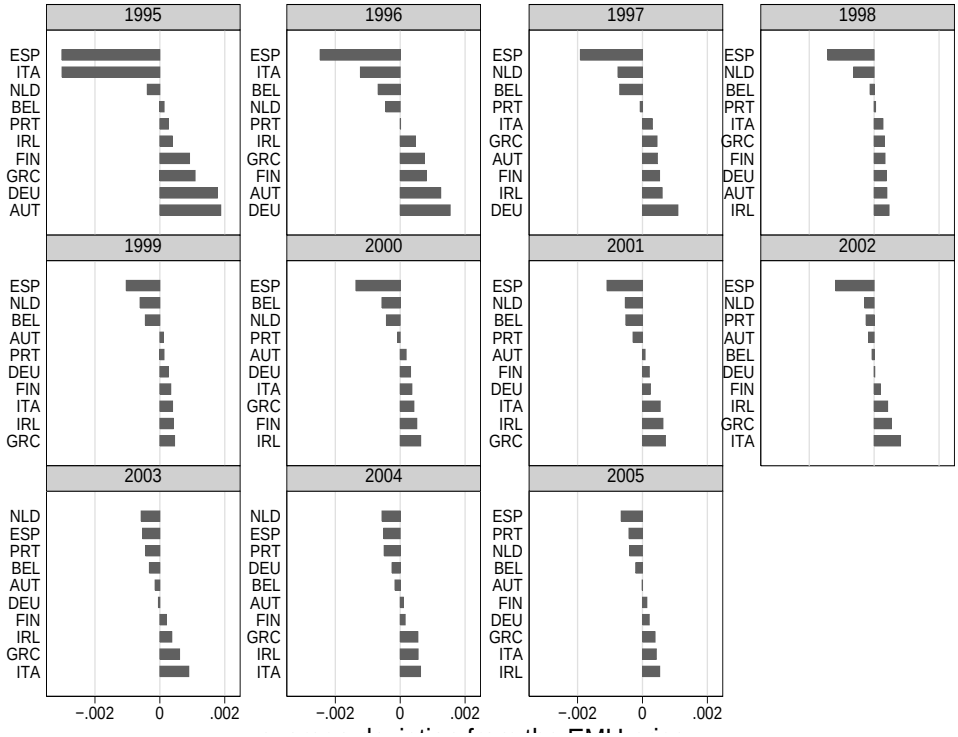
(b) Controlling for easiness of market and wealth

Mean absolute price deviation (in %) with respect to the sample average. Price deviations purged from GDP over distance and GDP per capita effects in the panel (b)

We adopt a difference-in-difference (DIID) strategy. Details on the method are provided in Appendix A.1. The DIID estimation is a useful tool when asking for the quantitative impact of a shock (here, the introduction of the Euro) on a specific group (EMU members). The method accounts for global trends that are disconnected from the measure using information concerning a control group that is not directly affected by the shock. In the following, we successively take the rest of the OECD and the non-EMU members of the European Union as control group. The latter group is probably more suited because these countries have experienced the same economic policies aimed at increasing market integration as EMU members. Thus, differences in the dynamics of price dispersion between this group and the Euro zone can more safely be attributed to monetary integration.

Results are presented in Table 3. The first two columns correspond to the regressions using non-Euro OECD members as a control group whereas the last two columns consider the rest of the EU15 as a control group. For each sample, we first run a "naive" regression where the DIID dummies are the only right-hand side variables.

Figure 10: Price deviations with respect to the EMU mean, French sample



Results are presented in columns (1) and (3). We also control for unobserved determinants of price dispersion using fixed effects for each product-country combination. Results are provided in columns (2) and (4).

The constant lies between 0.203 and 0.286 in all regressions. This means that, outside the Euro zone and before 1999, prices deviate by around 23 ($= exp(0.203)$) to 33% from the sample mean. Before the introduction of the Euro, price discrimination by French exporters is 5% weaker in the Euro zone than in the rest of the OECD (first column, line $Euro$ of Table 3), but 3% higher than in the rest of the European Union (third column). Last, the implementation of the Euro has had a negative impact on

Table 3: Impact of Euro on French price (whole sample) discrimination

Dependent variable:	log of absolute price deviation from the group-specific mean			
	(1)	(2)	(3)	(4)
Post99	0.010^a	0.006^a	0.007	-0.002
	(5.30)	(3.10)	(1.44)	(-0.98)
Euro	-0.051^a		0.030^a	
	(-6.38)		(3.87)	
Euro×Post99	-0.017^a	-0.015^a	-0.014^b	-0.006^c
	(-6.29)	(-4.94)	(-2.51)	(-2.14)
Constant	0.286^a	0.251^a	0.205^a	0.233^a
	(43.26)	(328.54)	(33.97)	(270.62)
fixed effects	no	pc	no	pc
control group	rest of the oecd	rest of the oecd	rest of the EU15	rest of the EU15
Observations	5,490,417	5,490,417	4,451,939	4,451,939
R^2	0.013	0.000	0.001	0.000
rho		0.326		0.281

Clustered *t* statistics in parentheses. pc means product-country fixed effects.
^{c} $p < 0.1$, ^{b} $p < 0.05$, ^{a} $p < 0.01$

price discrimination by French exporters. In quantitative terms, deviations from the mean price in the Euro zone are about 1% smaller after the introduction of the single currency in French data. This result is robust to the different specifications we use. Overall, these DIID regressions suggest that the price dispersion was already smaller in the Euro zone than in the rest of the OECD before 1999. Moreover, the fixing of exchange rates in 1999 has increased the gap.

Fact 7: The introduction of the Euro in 1999 has affected French firms' pricing strategies, leading to a reduction of about 1% in the price dispersion inside the Euro zone .

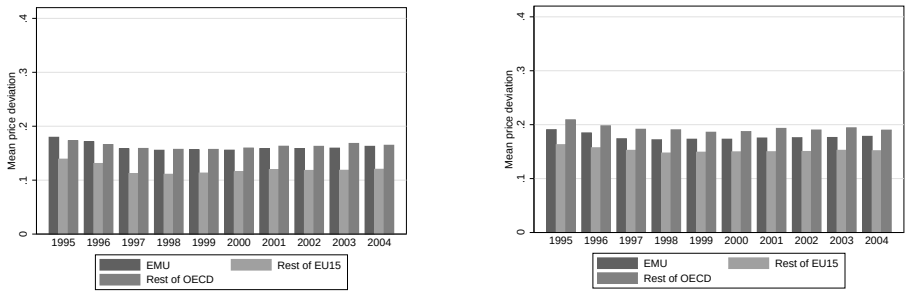
4.2 Extensive and intensive margins

Again, results presented in the previous section are likely to be strongly influenced by extensive flows. In particular, the standard deviations we analyze are not necessarily computed on the same number of countries and products, which may bias results. In this section, we test the robustness of previous results on the sub-sample of intensive flows.

Figure 11 reproduces evidence in Figure 9, panels (a) and (b), once the sample is restricted to intensive flows. To ease comparisons, the scale of both figures is forced to be the same. This shows that the standard deviation of prices is strongly reduced once focusing on intensive flows.

There are two possible explanations of this. First, results in Figure 9 may be biased by composition effects across firms with firms entering/exiting markets during the period being more prone to adopt discriminatory pricing strategies. Second, this may reflect a within firms differentiation of pricing strategies. For instance, it may be the case that firms entering a new market systematically set a lower price there to gain market shares.

Figure 11: Mean absolute price deviation, EMU vs rest of the OECD (intensive sample)



(a) Raw data (b) Controlling for easiness of market and wealth

Mean absolute price deviation (in %) with respect to the sample average. Price deviations purged from GDP over distance and GDP per capita effects in Panel (b)

At the intensive margin, it is no longer the case that price discrimination is less pronounced in the Euro zone . The standard deviation of EMU prices is comparable to that in the rest of the OECD while higher than in the rest of the European Union. This result still holds once controlling for easiness of market and wealth effects. This motivates our Fact 8:

Fact 8: About half of the price dispersion is driven by extensive flows. On the sub-sample of intensive flows, the dispersion of unit values is not larger in the EMU than in the rest of OECD.

Table 4 reproduces the DIID regression of Table 3 on the intensive sub-sample. Note that the intensive margin includes only the flows present across the whole period. Therefore, the deviation from the mean at the firm and product level is computed on the same number of observation each year.
The constant lies between 0.112 and 0.168 meaning that, before 1999 and outside the Euro zone , the average price deviation is between 11% and 17%. This is much below the average price deviation in the whole sample (between 20% and 29%). This is consistent with Fact 8. In this sample, price discrimination is not significantly lower in the Euro zone than in the rest of the OECD (first column, line Euro), but is still higher than in the rest of the European Union (third column, line Euro). Finally, the introduction of Euro marginally reduced the price dispersion in the Euro zone with respect to the rest of the OECD (columns (1) and (2), line Euro$\times$Post99). The impact remains negative with respect to the rest of the EU15, but is not significantly different from zero (columns (3) and (4), line Euro$\times$Post99).
In a nutshell, these regressions shows that price discrimination is lower at the intensive margin. The impact of Euro is also weaker. Thus, the results obtained from the whole sample are mainly driven by the extensive margin $i.e.$ the entry and exit of new flows.

5 Conclusion

Ten years after the creation of the European Monetary Union, it becomes possible to empirically assess its economic impact. Such an ex-post evaluation is important because expectations on these economic effects were used as arguments in favor of the

Table 4: Impact of Euro on price discrimination (intensive sample)

Dependent variable:	log of absolute price deviation from the group-specific mean			
	(1)	(2)	(3)	(4)
Post99	0.007	0.004^{b}	0.009	0.001
	(1.58)	(2.59)	(1.08)	(0.88)
Euro	-0.006		0.051^{b}	
	(-0.34)		(2.61)	
Euro×Post99	-0.010^{c}	-0.005^{b}	-0.012	-0.002
	(-1.79)	(-2.57)	(-1.29)	(-1.21)
Constant	0.168^{a}	0.164^{a}	0.112^{a}	0.155^{a}
	(13.13)	(271.80)	(6.79)	(239.65)
fixed effects	no	pc	no	pc
control group	rest of the oecd	rest of the oecd	rest of the EU15	rest of the EU15
Observations	849653	849653	709033	709033
R^2	0.001	0.000	0.006	0.000
rho		0.350		0.330

Clustered *t* statistics in parentheses

^{c} $p < 0.1$, ^{b} $p < 0.05$, ^{a} $p < 0.01$

monetary integration. Ex-post validating them may thus decide other EU countries to join EMU. This paper takes part to the debate, using firm-level data on export prices set by French firms to gauge the price impact of the European monetary integration. Our results suggest that the Euro indeed affects overall price levels through several channels.

First, we show that, on average, firms set export prices that are 2% lower toward EMU countries than toward other non-EU OECD countries. The price gap can be observed over the whole period. Even if it is not significantly higher after the introduction of the Euro in 1999, prices are however shown to be lower in the Euro area than in the rest of the European Union. This suggests that part of these price differentials is

linked to the market integration improvement due to the monetary union that seems to further trigger competition.

Price differentials may also be linked to the impact of exchange rate fluctuations on price strategies. We investigate this question in the second section of the paper. As expected, we show that EMU helps lowering price volatility in the Euro zone. When selling goods outside the Euro zone, French exporters adjust their markups in order to smooth the impact of exchange rates on local currency prices. Such "pricing-to-market" behaviors disappear inside the EMU, as exchange rate fluctuations are reduced to zero. This does not mean however that EMU prices are not sensitive to exchange rate fluctuations of the European currency. Once converted into local currency prices, intra-EMU export prices are indeed shown to be correlated with the Euro effective exchange rate, though less than in the rest of the OECD. A more detailed analysis shows that firms at the extensive margin are more sensitive to exchange rate changes than firms at the intensive margin. Our interpretation of this result is that the Euro appreciation with respect to its partners' currency enhances competitive pressures from extra-EMU firms exporting in the Euro zone. This forces the weakest French exporters to compress their markup or leave the market. Reversely, Euro depreciation reduces competitive pressures from extra-EMU producers allowing French exporters to increase their markup and new firms to enter the market at higher prices. Finally, our results suggest the elimination of currency conversion and related transaction costs impacts the extent of price discrimination inside the Euro zone. While the dispersion of firm-level prices was already lower in the Euro zone than in the rest of the OECD before the formal introduction of the Euro, French exports' price dispersion has been further reduced after 1999. This suggests that stronger arbitrage pressures have made exporters adapt their price strategy towards less discrimination. This also was one of the expected effects of the monetary union.

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A Appendices

A.1 Data and Methods

In this paper, we use the individual database of export flows provided by the customs to the CEPII. The dataset covers the 1995-2005 period, which allows us studying export prices before and after the introduction of the Euro. Data are disaggregated by firm and product, at the 8-digit of the Combined Nomenclature (CN8). The raw data cover 305,661 firms and 13,507 products for a total exported value of 3.16 trillion Euros.

Our measure of export prices is based on unit values, defined as the ratio of value over quantity of each bilateral flow:

$$P_{fkjt} = \frac{Val_{fkjt}}{Qty_{fkjt}}$$

where f, k, j and t respectively design a firm, a CN8 product, a destination market and a year between 1995 and 2005. Using firm and product data is particularly convenient when working on unit values because this price proxy is well-known to be biased by composition effects (see Kravis & Lipsey (1974) for instance). The more disaggregated trade data are, the more accurate the price proxy.

In a first step, we reduce the sample, only keeping OECD destinations. Since we want to compare export prices toward the Euro zone with that of an appropriate control group, it is convenient to keep countries of comparable development level. The resulting sample includes 205,689 firms declaring a total export value of 2.59 trillion Euros.

Even when working at the firm and product level, it may be the case that export unit values are biased. For instance, mis-declarations by French firms or reporting errors by the customs are likely to be transmitted into unit value errors. To account for this, we first apply an outlier treatment procedure to the raw data. Namely, we compute the median unit value for each product declared by a given firm in a particular year. We then delete unit values that are 5 times higher or lower than the firm and product-specific median. At this stage, the database contains 14,177,234 observations, over 11 years (1995-2005), covering 28 countries (OECD less France and Luxembourg, which is merged with Belgium in the customs data), 205,688 firms and 13,466 products. The total export value is 2.53 trillion Euros.

Crude unit values computed at the firm-product level are not directly comparable. Two methods allow aggregating these individual prices. The first one used in section 3 is based on the time variation of individual prices. The construction of price indices aggregates price ratios of the form:

$$\frac{P_{fkjt}}{P_{fkjt-1}}$$

The aggregation is done across firms, products and destinations. In log, each ratio measures the annual price growth of a specific product and can be compared with the price change of another good. Details on the aggregation method are provided in Appendix A.2.

The second method used in sections 2 and 4 consists in normalizing unit values by a "reference" price that is specific to each firm and product. This allows controlling for firm-specific determinants of prices. In this case, the analysis focuses on the variability of prices observed on the cross-section of destinations served by a single firm.

In section 2, the reference is the mean price in the OECD and the aggregation is done

on the following price ratios:

$$\frac{P_{fkjt}}{\frac{1}{N_{fkt}}\sum_{j\in OECD} P_{fkjt}} \tag{A.1}$$

where N_{fkt} is the number of OECD countries importing good k sold by firm f in year t. Each ratio can be interpreted as the price gap of good k sold by f in country j with respect to the mean price of the same good, sold by the same firm in the OECD. A ratio higher (lower) than one means that the price in country j is relatively higher (lower) than in other OECD countries. Averaging across goods sold in a particular area indicates whether French exports are on average cheaper or more expensive in this area, in comparison with the whole OECD.

The statistic used in section 4 is similar to the previous one. However, the reference price is the price in the area under consideration rather than in the whole OECD. The price ratios at the root of the aggregation are defined as:

$$\frac{P_{fkjt}}{\frac{1}{N^r_{fkt}}\sum_{j\in r} P_{fkjt}} \tag{A.2}$$

where r is the considered region, ie EMU, rest of the EU15 or rest of the OECD. Again, a ratio higher (lower) than one indicates whether the price in country j is higher (lower) than the average in the considered area. Taking the absolute value and averaging across goods sold in the area amounts to measure the standard deviation of prices in the area.

These price ratios are first averaged to get stylized facts concerning the impact of EMU on the price evolution, the level of price and the magnitude of price discrimination. In section 4, we also use a more rigorous regression analysis based on a difference-in-difference (DIID) strategy.

The DIID strategy compares the evolution of price dispersion in the Euro zone with that of an appropriately defined control group. This allows to control for global trends in pricing behavior that are disconnected from the introduction of the Euro. The control group has to be as similar as possible to the treatment group (the Euro area). We successively take the rest of the OECD and the non-EMU members of the European Union (i.e. Denmark, Sweden and the United Kingdom). The latter group is better because these countries have experienced the same economic policies aimed at

increasing market integration as EMU members. However, the number of countries composing the reference group is small which may induce a bias.

In the DIID methodology, the variable of interest (the absolute price deviation here) is regressed on an intercept and three binary variables. The first dummy variable, called Euro, is set equal to one for EMU members. The second one (Post99) takes a value of one in the years following the introduction of the Euro.[19] Last, the third dummy (Euro×Post99) interacts the Euro and Post99 binary variables. It is thus equal to one for EMU members since the introduction of the Euro.

The interpretation of the estimated coefficients is the following. The constant gives the average size of price discrimination for non EMU countries before 1999. The Post99 dummy corresponds to the general trend of price discrimination after 1999. The Euro dummy captures the characteristics shared by all EMU members that should make price discrimination lower within this set of countries over the pre-1999 period. Last, the Euro×Post99 dummy captures the impact that the introduction of the Euro has had on price discrimination toward EMU members.

A.2 Dissection of a geometric Laspeyres index

The geometric Laspeyres index (gL) is a geometric average of price variations weighted by the share of each flow in the total trade:

$$gL = \prod_k \left(\frac{p_{k,t}}{p_{k,t-1}} \right)^{w_{k,t-1}} \tag{A.3}$$

or, in log:

$$\ln gL = \sum_k w_{k,t-1} \ln \left(\frac{p_{k,t}}{p_{k,t-1}} \right) \tag{A.4}$$

[19] Here, we consider that the introduction of the Euro takes place in the beginning of 1999, i.e. when European exchange rates have been irrevocably fixed. An alternative date for the treatment could be January 2002, when bank notes and coins have been introduced. We ran the DIID regressions with this treatment date. However, results are less accurate in this case because the treatment period is strongly reduced.

where $w_{k,t-1}$ is the share of good k in the total value of trade measured in period $t-1$:

$$w_{k,t-1} = \frac{v_{k,t-1}}{\sum_k v_{k,t-1}}$$

We decompose this price index into two elements : the extensive and the intensive margins. The intensive margin (I) refers to the share of the aggregated price evolution triggered by trade flows recorded in the data over the whole period. The extensive margin (E) refers to the aggregated price evolution due to trade flows appearing or disappearing during the period.
Equation A.4 can be rewritten as:

$$\ln gL = \sum_{k \in E} w_{k,t-1} \ln \left(\frac{p_{k,t}}{p_{k,t-1}} \right) + \sum_{k \in I} w_{k,t-1} \ln \left(\frac{p_{k,t}}{p_{k,t-1}} \right) \tag{A.5}$$

Defining the weight $w_{M,t-1}$ of each margin in the total trade:

$$w_{M,t-1} = \frac{\sum_{k \in M} v_{k,t-1}}{\sum_k v_{k,t-1}}, \quad M \in \{E, I\} \tag{A.6}$$

equation A.5 becomes:

$$\ln gL = w_{E,t-1} \sum_{k \in E} \frac{w_{k,t-1}}{w_{E,t-1}} \ln \left(\frac{p_{k,t}}{p_{k,t-1}} \right) + w_{I,t-1} \sum_{k \in I} \frac{w_{k,t-1}}{w_{I,t-1}} \ln \left(\frac{p_{k,t}}{p_{k,t-1}} \right) \tag{A.7}$$

$$\Leftrightarrow \ln gL = w_{E,t-1} \ln gL_E + w_{I,t-1} \ln gL_I$$

The geometric Laspeyres index is thus the sum of the geometric Laspeyres indices computed on each margin, weighted by the share of the margins in the total value of trade.
Table A.1 gives the evolution of these weights over time.

Table A.1: Repartition of flows between intensive and extensive margins

year	EMU				Rest of the OECD			
	Share in value (%)[a]		Nb of flows		Share in value[a]		Nb of flows	
	Intensive	Extensive	Intensive	Extensive	Intensive	Extensive	Intensive	Extensive
1995	29.5	70.5	27,932	368,566	31.0	69.0	65,896	530,051
1996	29.9	70.1	27,932	391,623	31.5	68.5	65,896	546,329
1997	30.0	70.0	27,932	439,096	30.2	69.8	65,896	691,886
1998	30.1	69.9	27,932	451,930	30.9	69.1	65,896	717,402
1999	29.2	70.8	27,932	474,497	30.0	70.0	65,896	759,319
2000	27.8	72.2	27,932	498,519	28.8	71.2	65,896	771,107
2001	27.8	72.2	27,932	500,011	29.7	70.3	65,896	757,302
2002	26.7	73.3	27,932	504,220	30.1	69.9	65,896	766,472
2003	28.1	71.9	27,932	470,230	30.3	69.7	65,896	780,409
2004	28.2	71.8	27,932	525,697	28.6	71.4	65,896	825,952
2005	26.1	73.9	27,932	528,761	26.7	73.3	65,896	845,747

[a] Share in the total exported value

Table A.2: Results of the first-stage regression of export prices

Dep. Variable	ln price
ln GDP/Distance	-0.120[a]
	(.000)
ln GDP per capita	0.301[a]
	(.001)
Observations	12,708,898
R^2	.01

Standard errors in parentheses. [a] $p < 0.01$

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