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SEVENTH FRAMEWORK PROGRAMME

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How do multi-product exporters react to a change in trade costs?

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Abstract

Recent literature has highlighted the major contribution of multi-product firms to international trade activity. Such firms ship several product categories to foreign destinations each time they export. Our objective is to document the contribution of product selection to the reaction of firms further to a change in trade costs. For this, we make use of French firm-level export data, combined with a survey detailing exporters' characteristics. We first show that distance has a negative effect on all dimensions of firms' exports: the export decision, the number of products exported and the average value of exports by product. This contrasts with estimations using annual shipments at the country level, where distance is found to have no effect on the intensive margin. We then use the euro adoption in 1999 as a natural experiment to explore the effects of a change in trade costs over time. We find that, following this change, only the most productive firms increased the number of products that they export to eurozone destinations. No effect is found on the decision to export and the value of exports by product. Where monetary policy coordination preceded, some of the least productive firms stopped exporting or concentrated their exports over a smaller range of product categories, consistent with a tougher competitive environment on eurozone markets after 1999. Overall, our results show that firms' adjustments are made overwhelmingly through changes in the number of products exported.

JEL classification: F12, F15

Keywords: trade, firms' heterogeneity, multi-product firms, euro

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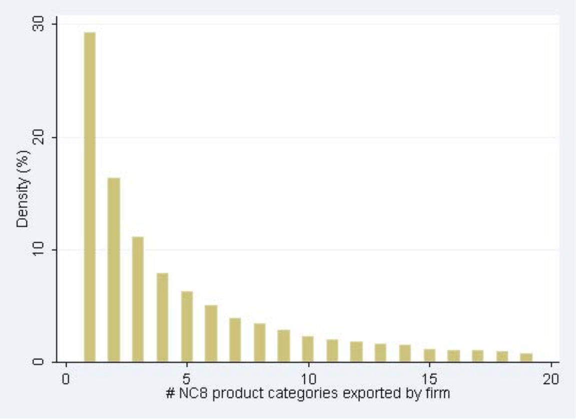
Introduction

Aggregate exports at the country level are concentrated among few - but large - firms, and those firms typically export several product categories (Bernard et al., 2007). While this high concentration of exports among a few exporters has been well documented in recent studies using European and US data (Bernard et al., 2007; Eaton et al., 2004; Mayer and Ottaviano, 2007; Muûls and Pisu, 2009), the most interesting feature is that a large proportion of firms export more than a single product and must therefore be considered to be *multi-product exporters*.

In the US firm-level data, using Harmonized System (HS) 10 digits disaggregation, 58% of exporters are found to be multi-product exporters and 26% export 5 product categories or more (Bernard et al., 2007). In the Mexican firm-level data, with 3,396 unique product categories, 48% of firms were found to be multi-product exporters (Iacovone and Javorcik, 2008).[1] The French pattern is consistent with these findings. Looking at the figures covering the main 50 destinations in Figure 1 we see that in 1998 more than 70% of French exporters exported more than a single product category, while 43% exported 5 product categories or more, representing 92% of French manufacturing exports in a year. 24% of firms representing 83% of French manufacturing exports exported 10 product categories or more. Hence, adjustments along the range of product categories exported can have large aggregate effects.

Figure 1: Distribution of the number of product categories exported by French firms over all destinations, 1998

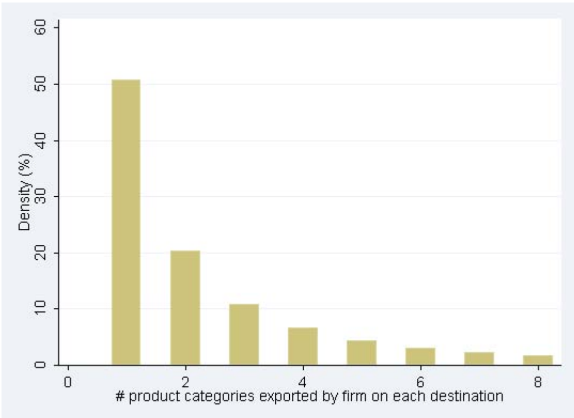


Data also show that French exporters export several product categories *on each market*. Figure 2 below refers to the actual number of products exported by firm to each destination. The Figure reveals that many French exporters are multi-product in each individual market: about 50% of firm-destination observations in a given year correspond to firms

[1] Indeed, national customs record trade flows using a country specific further break down of the international HS6 classification of products. Accordingly, international comparisons of that kind must be handled cautiously.

exporting more than a single Combined Nomenclature 8-digit (CN8) product category to a given destination.[2] These simple stylized facts are informative and give an overall picture of French firms exporting several product categories to single destinations. The mean number of products exported is 4.9, with a maximum of 556 product categories exported by a single firm to a single destination.[3] Hence *firms can adjust their exports to any given destination either through the number of product categories exported, or the value of exports by product category, or both.*

Figure 2: Distribution of the number of product categories exported by French firms to individual destinations, 1998



In a nutshell, trade statistics at the firm level consist of more than 99% zero flows: only few firms export. Only a small proportion of manufacturing firms report any international trade activity. Exporters ship goods to only a few of the possible destinations. Exporters also only sell a few product categories, among all possible products in the classification (8,482 manufacturing NC8 categories). All these stylized facts contrast with the predictions of the New Trade Theory where all firms should export to all destinations. In Melitz (2003), the introduction of heterogeneity in terms of productivity between firms helps to explain firm selection on the export market: only the most productive firms export. In Eckel and Neary (2008) and Bernard et al. (2009), the introduction of heterogeneity between products (in terms of ability or preferences) within the firm enables the determination of the range of goods that are actually produced, sold and exported by the firm. A variation in trade costs is found to affect not only the decision of firms to export, but also the range of goods produced and exported. Mayer et al. (2009) also show that firms reduce their markups in markets characterized by greater competition. On more competitive markets, sales are also more concentrated on the "core" product. Our objective in this paper is to document how trade costs affect all of the dimensions of firm-level exports: the export decision, the number of products

[2] CN8 stands for Combined Nomenclature 8-digit: this European classification comprises 8,482 different groups of manufactured products, corresponding to ISIC 311-390.

[3] These figures take into account only the main 50 destinations for French exporters.

exported and the value of exports by product.

So far the empirical literature has provided little evidence on the effects of trade costs on multi-product exporters. Bernard et al. (2009) rely on a decomposition of US bilateral exports into an *extensive margin* - the number of individual yearly shipments to each destination and an *intensive margin* - the average value of individual shipments. They show that bilateral distance has a negative effect on the extensive margin, with no effect on the intensive margin.[4]

This paper provides new evidence on the effects of trade costs on multi-product exporters. Firstly, we estimate the effect of geographical distance on the components of firm-level exports. While previous estimates show a positive or non-significant effect of distance on the average value of *annual* shipments, we ask whether this effect can be explained by the composition of exporters on each market.[5] Secondly, we investigate how a change in trade costs over time affects the components of firms' exports. In particular, we want to measure the extent of adjustments both through the selection of product categories that are shipped by each exporter and through the value of exports by product category within each firm. Finally we want to determine whether a change in trade costs affect firms in a heterogenous way, depending on their characteristics.

For this analysis, we use French firm-level export data, collected on an annual basis, over the period 1995-2003, i.e. before the EU enlargement to 10 new Member States in 2004. Hence, the period we consider is characterized by a single major shock to trade and economic integration. The data provide detailed information about the destinations and product categories exported. We also merge these data with those from the "Enquête annuelle d'Entreprise" (EAE), which provides detailed information about firms characteristics such as value added, employment, capital stock. This data enables us to calculate each firm's Total Factor Productivity (TFP).

We provide a series of new findings regarding firms' adjustment further to a change in trade costs. Firstly, we calculate the extensive margin of French exports for 50 individual destinations, which we define as the number of individual yearly shipments to each destination for each year. The intensive margin of French exports corresponds to the average value of exports by individual shipment. Cross section estimations on trade margins show that geographical distance has a negative effect on the extensive margin, with no effect on the intensive margin, as suggested by previous empirical investigations.

[4] This is confirmed by Trefler (2004). Trefler uses the Canada-US Free Trade Agreement in 1988 as a natural experiment, and provides evidence of long and short-run effects on industry-level employment and productivity.

[5] One *yearly* shipment can be defined as the value of a single product exported by a firm to one destination within a given year. Shipments have therefore a $firm \times product \times destination \times year$ dimension.

Firm-level estimations, however, show that distance reduces not only the number of exporters and the number of product categories exported by a firm, but also the value of exports by product category. Hence, the non-significant effect of distance on the average value of exports by shipment can be explained by the composition of exporters on each market.

Secondly, we use the euro adoption by 11 European countries in 1999 as a natural experiment in decreasing trade costs. Traditionally, two effects are expected as a result of the creation of a single currency. Trade costs are expected to decrease, given the elimination of nominal exchange rate volatility and the elimination of the transaction costs associated with the exchange of currencies. Competition is also expected to increase within the "treated" destinations. We find that the net effect is channeled mainly through the number of products exported by firms to each destination. This effect however is unevenly distributed across firms. Only the most productive ones experienced an increase in the number of products exported over the period. No effect is found however on firms' export decision, or the value of exports by product. Where monetary policy coordination preceded the change, some firms stopped exporting or concentrated their exports on fewer product categories. This adverse selection effect is more important for firms with lower productivity levels before 1999 and is consistent with an increased competition on eurozone markets after 1999. Overall, our results suggest that the contribution of the number of product categories exported is important to the evolution of firm-level exports.

Our work contributes to the recent literature that attempts to test the effects of macroeconomic shocks on individual firms. Berman et al. (2009) use similar data to analyze the effects of real exchange rate movements on French exporters, although they concentrate on mono-product exporters. Muûls (2008) shows that credit constraints can prevent firms from exporting, and can distort the reaction of exporters to exchange rate variations. With regard to multi-product firms, Iacovone and Javorcik (2008) provide evidence that "product churning" within firms is an important feature of firms' dynamics. Eckel et al. (2009) show that the multi-product patterns of the firm may differ between domestic and foreign markets, with firms selling a broader range of products at home. We contribute to this literature by providing unconditional evidence on the effect of trade costs on multi-product exporters. Importantly, we are able to quantify the contribution of the selection of products on the adjustment of firm-level exports. Finally, this paper is closely related to the flourishing literature on firm dynamics (Eaton et al., 2008; Lawless, 2009; Albornoz et al., 2009). We contribute to this literature by providing a clear description of the channels through which firms adjust their exports over time.

The paper is organized as follows. Section 1 presents the data and the empirical methodology. Section 2 provides cross-sectional evidence about the effects of trade costs on multi-product exporters. In Section 3, we use the Euro introduction as a natural experiment in changing trade costs over time. The last Section concludes.

1 Data.

1.1 Individual firms' export database.

In a first step, we make use of the database provided by the French customs, which comprises all individual French firms' export flows over the period 1995-2003. We extracted records at the $firm \times destination$ level for the main 50 destinations. We make use of the product-level information provided in the database to count the number of products exported by firm to each destination. Importantly, information contained in this database is exhaustive, which enables an in-depth analysis. Though, reporting thresholds are present in the original database due to simplified declarations of small exporters towards EU destinations. The thresholds are different between exports to the European Union and non-EU destinations. For non-EU destinations, threshold is 1,000 euros per destination. For the EU destinations, the rule is that detailed declaration to the French customs is required if the value of exports by the firm to the EU exceeded the threshold over the previous year. If this is not the case, the declaration of the firm is simplified, and this firm does not enter our data. Importantly, this reporting threshold has been changing over time. We impose a threshold of 150,000 euros all years, which corresponds to the highest reporting threshold by the end of the period. All exporting firms located in France are considered in our sample. These exporters can belong to both the manufacturing and service sectors: what matters is to export a product, not a service. For our analysis, we keep only trade flows recorded ad manufacturing exports.[6] An elementary record comprises the SIREN identification number of the firm (an individual identifier), the Combined Nomenclature 8-digit (CN8) code of the product, the ISO code of the destination country, the Free on Board (FOB) value of the flow and the quantity shipped.

With some 100,000 exporters each year, with a maximum number of 50 destinations considered in our investigation and 9 years, we have potentially 45 million *firm-destination pairs* in our data set (100,000 x 50 x 9).[7] These 45 million observations correspond to the maximum number of shipments of French firms, each exporting to each market (each year), in the perspective of the traditional New Trade Theory envisaging mono-product firms. However, the French export picture is dominated by zeros: exporters

[6] We keep HS6 product categories corresponding to ISIC industries 311 to 390. When we merge the customs data with the Business Survey, we only keep firms whose main activity is in manufacturing. Thus the final database comprises manufacturing firms exporting manufactured goods from France.

[7] Notice that there is a large turnover in the sample. Each year some 20,000 new firms enter in the sample, while a similar number disappears. Accordingly, some 300,000 different firms are present at some point in the database.

only export to a few destinations and not in all years. To illustrate this, let's consider the sample of firms having exported at least once to a given destination over the period considered: we are left with only 7.5 million observations. Now, it is clear that some of these firms may have disrupted their shipments at some point. Accordingly, there are still numerous zeros among the 7.5 million observations left. Dropping all the zeros, we are left with 3.0 million positive observations. All in all, we have some 42 million zeros out of 45 million possible firm $\times$ destination pairs. On top of this, firms export in some 6,000 different headings of the product classification (corresponding to manufactured products): we leave it to the reader to figure out the universe of export possibilities, when this dimension is added. The overwhelming presence of zeros in the data not only illustrates an empirical regularity, it also strongly constraints the estimation strategy to be adopted.

1.2 Firm-level characteristics.

We use a second database - the annual business survey "Enquete Annuelle d'Entreprises" (EAE) in order to identify firm characteristics. The EAE survey targets firms with more than 20 employees, which can be exporters or non-exporters, in all manufacturing sectors. Importantly, firms' main activity is in manufacturing. This data covers a series of factors, such as the wage bill, the number of employees, the value added and investment. We use of this information to compute the Total Factor Productivity for each exporter, following the Olley-Pakes methodology. Finally, the SIREN identification number of the firm enables us to match this database with the firm-level export data provided by the French customs service. The combination of these two databases enables us to perform the econometric analysis that is described in this paper.

1.3 Other data sources.

Proceeding to the econometric analysis requires us to include a full set of control variables. In the cross section estimates, i.e. when we do not include country-pair fixed effects, we control for the bilateral distance between France and each destination. The data for bilateral distance are from the CEPII database.[8] In all estimations, we control for the real GDP of the destination. Data for real GDP are from the Penn World Tables. We also calculate a bilateral real exchange rate using the producer prices of the exporter - France - and importer countries, in the domestic currencies. The data for producer price indices come from the International Financial Statistics (IFS) of the IMF and the OECD. We also use bilateral nominal exchange rates to compute our bilateral real exchange rate, provided by the IFS.

[8]http://www.cepii.fr/anglaisgraph/bdd/distances.htm

2 Cross-sectional evidence on trade costs

We now ask how the different trade margins observed on annual individual shipments and firm-level exports are affected by the geographical distance between France and each destination.

2.1 A decomposition of aggregate trade flows

Our baseline observation in the customs data corresponds to the value of exports by $firm(f) \times product(p) \times destination(j)$ in a given year (t), which we note x_p^{fj}, omitting t for the sake of simplicity. We begin with a decomposition of firm-level exports to a given destination, into the product intensive and extensive margins at the firm-level:

$$X^{fj} = N_p^{fj} \times \overline{x}^{fj} \tag{1}$$

Where X^{fj} is the value of exports by firm f to destination j; N_p^{fj} is the number of CN8 product categories exported by firm f to destination j; $\overline{x}^{fj} = \frac{\sum_p x_p^{fj}}{N_p^{fj}}$ is the average value of exports by product category for firm f and destination j. Summing over all firms, the total value X^j of French exports to destination j can be expressed as follows:

$$X^j = \sum_f N_p^{fj} \times \overline{x}^{fj} \tag{2}$$

Alternatively, French exports to any destination j can be decomposed as follows:

$$X^j = N_{fp}^j \times \overline{x}^j \tag{3}$$

Where N_{fp}^j is the number of individual shipments - the number of $firm \times product$ observations that can be defined as the extensive margin of French exports to any destination j. $\overline{x}^j$ is the average value of exports by individual shipment. Equation 3 therefore corresponds to a decomposition of the trade margins of French exports.

Importantly, the average value of individual exports $(\overline{x}^j)$ differs from the average value of exports by product within a firm $(\overline{x}^{fj})$. $\overline{x}^{fj}$ is indeed subject to a single composition effect, related to the composition of products exported by a firm to country j and decreases as soon as firms start to export new products with a lower value. In comparison, $\overline{x}^j$ can be also influenced by the composition of exporters, and decreases as soon as new exporters ship lower values. This second composition effect occurs as soon as the selection of firms on the export market is not random, which is likely to be the case.[9]

In the next Section, we show that estimations of the effect of distance on the inten-

[9] See Mayer and Ottaviano (2007) for a compilation of stylized facts about the characteristics of European exporters.

sive margin depend to a large extent on the decomposition of aggregate exports that is adopted.

2.2 Distance and individual yearly shipments.

As suggested above in Equation (3), the value of French exports to any destination j can be decomposed as the product of the number of individual shipments and the average value of exports by individual annual shipment. Taking logs, the total value of French exports to destination j can be expressed as a linear combination of the two components. We follow Bernard et al. (2009) and estimate a simple gravity equation on each of those components.

$$ln(N^j_{fpt}) = \mu_0 + \mu_1 ln(RGDP_{jt}) + \mu_2 ln(Dist_j) + \mu_3 \kappa_t + \epsilon_{jt} \tag{4}$$

$$ln(\overline{x}^j_t) = \nu_0 + \nu_1 ln(RGDP_{jt}) + \nu_2 ln(Dist_j) + \nu_3 \kappa_t + \epsilon_{jt} \tag{5}$$

Where $RGDP_{jt}$ is the real GDP of the destination, $Dist_j$ is the bilateral distance, κ_t is a set of time dummies, and ϵ_{jt} is the error term. We use the cross-section dimension of the panel to investigate the effect of distance on the intensive and extensive margins. Data are pooled over the 1995-2003 period. Estimation results are reported in Table 1.

Table 1: Individual shipments, pooled data (1995-2004)

Sample	Main 50 destinations			
Estimator	OLS		Poisson	
Dependent variable	$ln(N^j_{fpt})$	$ln(\overline{x}_{jt})$	N^j_{fpt}	$\overline{x}_{jt}$
$RGDP_{jt}$	0.580***	0.262***	0.409***	0.225***
	(0.025)	(0.018)	(0.022)	(0.026)
$Dist_j$	-0.772***	-0.026	-0.762***	-0.026
	(0.026)	(0.016)	(0.029)	(0.022)
Nb Observations	500	500	500	500
R-squared	0.73	0.45	0.78	0.33

Note: Significance levels: *10%, **5%, ***1%. All variables - with the exception of dummy variables - are in logarithms. Robust standard errors in parentheses.

Estimation results reported in Table 1 show that market size has a positive influence on the number of individual shipments and the average value of exports by individual flow. Bilateral distance has a negative effect on the number of individual shipments, but no significant impact on the average value of exports by flow. This result is very much in line with Bernard et al. (2009). One issue is that taking the logs of the dependent variable, in the presence of heteroskedasticity, can lead to biased estimates. Silva and Tenreyro (2006) recommend to alternatively use a Poisson estimator. Importantly, the Poisson estimator is also more appropriate to "count" the number of individual shipments, which follows a discrete distribution. We therefore proceed to a robustness check by using a Poisson estimator rather than the OLS estimator. Estimation results reported in Table 1 show very similar coefficients when we use the Poisson estimator.

As suggested in Section where we discuss the decomposition of trade flows, the non-significant effect of bilateral distance on the intensive margin could be the result of the composition of exporters, and the composition of products exported by the firm. We next proceed to firm-level estimations, in order to determine whether the non-significant effect of distance on the average value of exports by annual shipment can be attributed to the composition of exporters on each market.

2.3 Distance and firm-level exports

Using firm-level exports rather than individual annual shipments data enables us to determine whether the ambiguous effect of distance on the intensive margin disappears when the average value of exports by product, within firm, is considered - i.e. when results cannot be driven by composition effects.

Equation (1) shows that the value of exports by firm can be expressed as the product of the number of CN8 categories exported by the firm, and the average value of their exports. Taking the full sample of potential exporters, the expected value of exports by any individual firm f to destination j at time t can be expressed as the product of the probability of export $Prob(X_t^{fj} > 0)$ to market j, the expected number of product categories exported $E(N_{pt}^{fj}|X_t^{fj} > 0)$ to that market and the expected average value of exports by the firm $E(\overline{x}_t^{fj})$.[10]

$$E(X_t^{fj}) = Prob(X_t^{fj} > 0) \times E(N_{pt}^{fj}|X_t^{fj} > 0) \times E(\overline{x}_t^{fj}|X_t^{fj} > 0) \quad (6)$$

In our empirical approach, we estimate a gravity-like equation on each of those components and isolate the effect of trade costs. We first exploit the cross-section dimension of the panel over the period 1995-2003 to estimate the effect of distance, and estimate the following equation:

$$T_t^{fj} = \alpha_0 + \alpha_1 ln(RGDP_{jt}) + \alpha_2 ln(Dist_{jt}) + \alpha_3 ln(TFP_{t-1}^f) + \alpha_4 \kappa_k + \alpha_5 \kappa_t + \epsilon_{fjt} \quad (7)$$

Where T_t^{fj} is a dummy variable that is equal to one when firm f exports to destination j in t, and zero otherwise. In addition to destination and country pair characteristics, we control for the one-year lagged firm-level Total Factor Productivity (TFP). Finally, we use information contained in the EAE business survey to control for the main activity of the firm κ_k; specification also includes year dummy variables. With this first specification, we use a logit estimator to estimate the marginal effect of each regressor

[10]Remember that we consider only French firms exporting at least once over the period considered. However for each given market, not all firms export. This is why we use the concept of potential exporters.

on the probability of export.

We then estimate the following two similar equations by taking the number of products exported by a firm, and the average value of exports by product as dependent variables, for positive values of trade.

$$N_{pt}^{fj} = \beta_0 + \beta_1 ln(RGDP_{jt}) + \beta_2 ln(Dist_{jt}) + \beta_3 ln(TFP_{t-1}^{f}) + \beta_4 \kappa_k + \beta_5 \kappa_t + \epsilon_{fjt} \quad (8)$$

$$\overline{x}_t^{fj} = \gamma_0 + \gamma_1 ln(RGDP_{jt}) + \gamma_2 ln(Dist_{jt}) + \gamma_3 ln(TFP_{t-1}^{f}) + \gamma_4 \kappa_k + \gamma_5 \kappa_t + \epsilon_{fjt} \quad (9)$$

if $X_t^{fj} > 0$ Working with data on the number of products exported by firm raises a major issue: even though many firms are multi-product, they export a discrete number of products each time that they export. The mean of the number of product categories exported by firm to each destination, is 4.9. Taking the log therefore reduces considerably the variance of the dependent variable. We therefore use the Poisson estimator for the firm-level regressions to count the number of products. In a robustness exercise, we also provide estimation results using a within-FE estimator.

Using firm-level data variables raises a first major issue: variables which are not firm-specific generate as many observations as the number of firms within the panel. We therefore need to cluster standard errors by destination in each estimation. A second major issue is related to the size of the sample of firms. As indicated above, in the EAE business survey firm-level information such as TFP and main activity is only available for firms with more than 20 employees. We therefore rely on a substantially reduced sample of exporters each time we control for firm-level characteristics. Hence, we report estimation results with and without controlling for firm-level characteristics. Table 2 below reports estimation results at the firm-level: the first three columns use the full universe of French exporters, while the last three columns are restricted to French exporters with more than 20 employees due to the control for lagged TFP.

Table 2: Firm-level exports, pooled data (1995-2004)

Sample	All destinations					
Estimator	Logit	Poisson		Logit	Poisson	
Dependent variable	T_t^{fj}	N_{pt}^{fj}	$\overline{x}_t^{fj}$	T_t^{fj}	N_{pt}^{fj}	$\overline{x}_t^{fj}$
$Dist_j$	-0.508***	-0.229***	-0.314***	-0.397***	-0.232***	-0.395***
	(0.102)	(0.023)	(0.072)	(0.063)	(0.018)	(0.040)
$RGDP_{jt}$	0.206***	0.105***	0.373***	0.276***	0.146***	0.405***
	(0.072)	(0.024)	(0.058)	(0.057)	(0.020)	(0.038)
TFP_{t-1}^{f}				0.395***	0.293***	0.642***
				(0.016)	(0.014)	(0.019)
Nb observations	7,505,486	3,013,935	3,013,876	1,729,113	1,020,152	1,020,130
Fixed effects	*year*			*year, industry*		

Note: Significance levels: *10%, **5%, ***1%. All variables - with the exception of dummy variables - are in logarithms. Robust standard errors in parentheses. Standard errors are clustered by destination.

First of all, it is important to clarify the number of observations that we use for each estimation. Considering the first panel of Table 2 with the full sample of French exporters, we see that 7.5 million observations are used to estimate the logit. These observations correspond to the maximum number of $firm \times destination$ observations over the period (including zero and positive values of trade), with selected pairs associated to at least one positive trade flow during the period 1995-2003 (i.e. we drop $firm \times destination$ pairs for which we have no positive trade flow over the period 1995-2003). Regarding the Poisson estimates over the number of products exported by firm and the average value of exports by product, we only keep the 3 million positive values for trade flows in order to differentiate firm-selection from within-firm adjustment by exporter. As discussed above, we have fewer observations (respectively 1.7 versus 1.0 million) when we control for TFP^f_{t-1} in the second panel of Table 2, since we only observe this variable for firms with more than 20 employees. Note however that results remain quantitatively unchanged in this case and we keep a large number of observations.

The estimation results reported in Table 2 show that Total Factor Productivity (TFP) positively affects the decision to export, the number of products exported by individual firms and the average value of exports by product within firms. The results show that bilateral distance has a negative effect both on the decision to export, and on the number of products exported by firm. Also, the average value of exports by product category, for each firm, is lower for more distant destinations. This suggests that between-firm composition effects are important: larger firms tend to export to more remote markets, which increases the average value of exports of individual shipments by construction. On the contrary, distance reduces the average value of exports by product category, within each firm. The non-significant effect of distance on the intensive margin, when we consider annual shipments, is therefore the result of the composition of exporters on each destination market. Results also show that in the cross section, higher trade costs are associated with fewer exporters a smaller range of products exported by firm and a lower values by variety.

While distance is useful in identifying the effect of trade costs at a point in time, we are also interested in the dynamic adjustment of exporters. In the next Section, we consider the effects of a natural experiment to explore the adjustment of firm-level exports to a change in trade costs over time.

3 The Euro introduction as a natural experiment.

3.1 Rationale.

The second objective of this paper is to provide a precise description of the *dynamic* adjustment of firm-level exports further to a decrease in trade costs. This requires a point in time where trade costs can be clearly seen to have decreased, for a sample of destinations. We consider the euro adoption by 11 European countries in 1999 as a natural experiment. Using this shock has several advantages. Firstly, we can clearly identify a point in time where some trade costs have been eliminated.[11] Secondly, all potential exporters to eurozone destinations - i.e. all potential French exporters - face the same shock. Nominal exchange rate volatility and transaction costs associated with the exchange of currencies have been traditionally considered to be major sources of trade costs.[12] In this perspective, the adoption of a single currency by 11 European economies in 1999 was expected to generate two effects: firstly, promote trade in goods and services within the eurozone and secondly increase competition within that region.

Empirical analysis performed on aggregate trade data have confirmed the trade creation effect of the euro (Flam and Nordström, 2003; Micco et al., 2003; Baldwin, 2006). Micro-level investigations have relied mostly on product-level trade data (Baldwin and Di Nino, 2006; Flam and Nordström, 2007).[13] Results show some evidence of a trade creation effect through the export of new product categories. At the level of the firm, descriptive statistics have been provided for Belgium and France by Baldwin et al. (2008), indicating that the number of products exported by French firms to eurozone destinations increased in 1999, compared to other destinations. Nitsch and Pisu (2008) use sequentially aggregate, sectoral and firm-level data for Belgium, in order to disentangle the effects of the euro. They find a positive effect of the euro through an increase in the number of varieties exported.

Finally, there is evidence that competition effects are quantitatively important. Ottaviano et al. (2009) use European data to calibrate a model of trade with heterogenous firms and endogenous markups *à la* Melitz and Ottaviano (2008). Their results show that greater integration increases competitive pressure, leading to a reallocation of production towards more productive firms. Firms with the lowest productivity disappear. This results in an increase in the average productivity.

We develop an empirical methodology that enables us to identify the contribution of the different channels through which firms can adjust their exports: the *decision to ex-*

[11] Those trade costs can be thought of as being sunk, fixed or variable.

[12] See Anderson and van Wincoop (2004).

[13] These studies make use of the UN COMTRADE data where trade flows are identified at the level of the product, within the Harmonized System 6-digit nomenclature (5,000 product categories).

port, the *number of product categories exported* and the *value of exports by product*. We also investigate whether the dynamic adjustment of firm-level exports along these three dimensions is influenced by firm characteristics, in particular their productivity. The next Section provides a full description of our methodology.

3.2 Methodology.

Estimation strategy.

As discussed above, we take the euro as a natural experiment to test the effect of a change in trade costs on multi-product exporters. We are interested in measuring the dynamic adjustment of firm-level exports through the decision to export, the number of products exported, and the average value of exports by product. We rely on a difference-in-difference approach. The treatment group is composed of countries that entered the euro area in January 1999. The control group is composed of countries that never entered the euro during the period covered by our data. We discuss the composition of this control group below. Greece is not included in the sample, since it only joined the euro in 2001.[14]

We first estimate the euro effect on the probability that a firm exports to a foreign market. In our estimation strategy, we make use of a *conditional FE logit*, which estimates the effect of each independent variable on the probability that the firm "switches" from the non-exporter to the exporter status. Hence, the estimation procedure drops all observations that correspond to non-switching firms, i.e. firms that continue exporting to a given destination market over the whole 1995-2003 period. Accordingly, we begin by estimating the following equation with the conditional FE logit:

$$T_t^{fj} = \alpha_1 EZ_{99-03} + \alpha_2 ln(RER_{jt}) + \alpha_3 ln(RGDP_{jt}) + \alpha_4 ln(TFP_{t-1}^f) + \alpha_5 \kappa_{fj} + \alpha_6 \kappa_t + \epsilon_{kjt} \tag{10}$$

$EZ_{1999-2003}$ is a dummy variable, which is equal to one during the period 1999-2003 when the destination country is a member of the eurozone, and zero otherwise. RER_{jt} is the real exchange rate. $RGDP_{jt}$ is the real GDP. κ_{kj} is the fixed effect $firm \times destination$, which correspond to our individuals in the panel. κ_t is the set of year dummy variables. TFP_{t-1}^f if the total factor productivity of firm f. We lag this variable by one year to avoid reverse causality. Recall that controlling for TFP requires us to rely on a reduced sample of firms in this case (those with more than 20 employees). However controlling for TFP is necessary: euro adoption may indeed have affected firm productivity. What we attempt to capture is the euro effects on French exporters, independent of the evo-

[14]Destination countries treated by the euro introduction in 1999 are accordingly: Austria, Finland, Germany, Italy, Ireland, The Netherlands, Spain, Portugal, Belgium and Luxembourg - the latter two countries correspond to the same aggregated destination for our trade data. Within the EU15, the United-Kingdom, Denmark and Sweden declined to adopt the euro. In 2009, the euro area is made up of 16 Member states, including Malta, Cyprus, Slovenia and Slovakia.

lution of their productivity.

Having estimated the effects of the euro on the firm's decision to export to a given destination, we investigate the euro effect on the remaining components of the value of exports by each individual firm on each destination: the number of products exported and the average value of exports by product. We rely on a conditional FE Poisson estimator, which allows for $firm \times destination$ fixed effects. Here, the choice of the Poisson estimator, rather than OLS or within-FE, is motivated by the nature of the dependent variable: most firms export only a few product categories. Taking the logarithm of the number of products exported by the firm would dramatically reduce the variance of this variable. We also rely on a Poisson estimator when the average value of exports by product category is the dependent variable, to keep the results comparable.

We keep the control variables that were reported in Equation (10) and estimate the effect of the euro on the number of products exported N_{pt}^{fj} and on the average value of exports by product $\overline{x}_t^{fj}$, using the conditional FE Poisson estimator. Importantly, only positive values of trade are included (we drop all zeros) in order to isolate the adjustment within firms from the decision to export.[15]

$$N_{pt}^{fj} = \beta_1 EZ_{99-03} + \beta_2 ln(RER_{jt}) + \beta_3 ln(RGDP_{jt}) + \beta_4 ln(TFP_{t-1}^{f}) + \beta_5 \kappa_{fj} + \beta_6 \kappa_t + \epsilon_{kjt} \quad (11)$$

$$\overline{x}_t^{fj} = \gamma_1 EZ_{99-03} + \gamma_2 ln(RER_{jt}) + \gamma_3 ln(RGDP_{jt}) + \gamma_4 ln(TFP_{t-1}^{f}) + \gamma_5 \kappa_{fj} + \gamma_6 \kappa_t + \epsilon_{kjt} \quad (12)$$

if $X_t^{fj} > 0$. We discuss below some empirical issues associated with the estimation of the euro effects on French firms, which we address in our estimation strategy.

Choice of the control group.

Table 12 in the Appendix provides a complete description of the countries that are used for the difference-in-difference estimation. Ideally, the control group should be only composed of EU15 destination countries, which have been affected by all EU policies during the period, with the exception of the euro. We end up with three countries in the control group - the United Kingdom, Sweden and Denmark. We also consider OECD countries as an alternative group of control. Accordingly, we rely alternatively on a sample of OECD or EU15 destinations.

[15] Ideally, a Heckman procedure should be implemented here. To the best of our knowledge, however, this is not feasible with the Poisson estimator. Here we adopt an alternative methodology and only keep positive values of exports for estimation when the dependent variables are N_{pt}^{fj} and $\overline{x}_t^{fj}$. Again, the Poisson is implemented to deal with the discrete distribution of the first dependent variable, rather than to solve the issue of zeros.

Heterogenous response of firms.

We are interested in determining whether productivity interacts with the euro effect on French exporters. For each firm, we compute the average TFP over the period 1996-1998[16]. We then generate four quartiles according to the firms' average productivity over the same period, and also generate interaction variables between the EZ_{99-03} variable, and quartiles Q1, Q2, Q3 and Q4. The EZ_{99-03} is then omitted in the estimation, so that the euro effect on firms, for each TFP quartile, is directly measured by the coefficient on $EZ_{99-03} \times Q_1$, $EZ_{99-03} \times Q_2$, $EZ_{99-03} \times Q_3$ and $EZ_{99-03} \times Q_4$ variables.

Table 3: Number of products exported by destination

TFP quartile	Mean	Standard deviation
1^{st} quartile	3.63	8.26
2^{nd} quartile	3.87	8.07
3^{rd} quartile	4.15	9.67
4^{th} quartile	5.64	12.85

Table 3 shows descriptive statistics about the number of product categories exported by firm, according to the productivity quartiles. Firms with a larger productivity export more product categories to each partner. For the fourth quartile we also observe a larger standard deviation, which suggests that changing the number of products exported to each destination can be an important source of adjustment at the firm-level. This is also consistent with previous estimations in Table (2), where productivity is also found to be positively related to the number of products exported by the firm. However, firms in the first quartile of TFP also export several product categories to each destination, which implies that adjustment through the number of products exported is also possible for those firms.

The endogeneity issue.

Finally, the self-selection of firms into the treatment and control groups can introduce some bias in our estimates. Indeed and as suggested above, different firms can react differently further to a shock on trade costs. Ideally, we would like to identify the effects of the euro introduction by using a sample of firms with similar characteristics, which export both to destinations inside and outside the eurozone. We therefore proceed to a robustness check by selecting, in our sample of exporters, only firms that export to both eurozone and non-eurozone (EU15) destinations, during the sample period. With this specification, the effects of the euro are identified on similar treatment and control groups, in terms of firm characteristics.

[16]It is possible to calculate TFP from the EAE data since 1995, but data were very scarce in 1995.

3.3 Euro adoption and firm-level adjustment.

Baseline estimation.

In this section, we present panel estimations of the euro effects on the export decision of the firm (T_t^{fj}), the number of products it exports when exports are positive (N_{pt}^{fj}) and the average value of exports by product within firms ($\overline{x}_t^{fj}$). In each table, we present estimation results that rely on a sample of OECD or EU15 non-eurozone countries in the control group. We cluster standard errors by destination. When the export decision (T_t^{fj}) is the dependent variable, we only report the coefficient from the estimation with the conditional FE logit, rather than the marginal effect. Estimation results are detailed in Table 4 below.

Table 4: Euro effects on the components of firm-level exports

Control group	OECD non-eurozone			EU15 non-eurozone		
Treatment group	All eurozone destinations			All eurozone destinations		
Estimator	Cond. FE logit	Cond. FE poisson		Cond. FE logit	Cond. FE poisson	
Dependent variable	T_t^{fj}	N_{pt}^{fj}	$\overline{x}_t^{fj}$	T_t^{fj}	N_{pt}^{fj}	$\overline{x}_t^{fj}$
$EZ_{1999-2003}$	-0.134*	0.019	0.013	-0.058	0.000	-0.009
	(0.080)	(0.015)	(0.032)	(0.045)	(0.010)	(0.041)
RER_{jt}	-1.570***	-0.229***	-0.317*	-0.735	-0.167*	-0.847*
	(0.479)	(0.084)	(0.189)	(0.783)	(0.086)	(0.445)
$RGDP_{jt}$	2.009***	0.440***	0.474	1.148**	0.388***	0.203
	(0.677)	(0.118)	(0.479)	(0.479)	(0.099)	(0.644)
TFP_{t-1}^{f}	0.150***	0.059***	0.126***	0.072	0.061***	0.107***
	(0.020)	(0.006)	(0.029)	(0.045)	(0.007)	(0.034)
Nb observations	493,090	621,988	621,978	184,528	373,602	373,592
Fixed effects	Firm × destination, year			Firm × destination, year		

Note: Significance levels: *10%, **5%, ***1%. All variables - with the exception of dummy variables - are in logarithms. Robust standard errors in parentheses. Standard errors are clustered by destination. When T_t^{fj} is the dependent variable, we report estimation coefficients, but not the marginal effect.

Firstly, the results indicate that lagged productivity has a positive effect on all components of firm-level exports, with the exception of the decision to export, in the sample of EU15 destinations, where the coefficient on TFP turns non-significant. Hence, a positive shock on firm's productivity has a larger effect on firm's export status when less integrated destinations are considered, consistent with a lower productivity premium for exporting to EU15 destinations. An increase in the real GDP of any destination country positively affects both the decision to export and the number of product categories exported. However, variations in the real GDP have no effect on the average value of exports by product category, within each firm, suggesting that new exported varieties are associated with lower values of shipments. The recent literature on firms dynamics indeed suggest that firms start exporting with small shipments, and then expand in the following years (Lawless, 2009; Albornoz et al., 2009). Also, this is consistent with the fact that firms start exporting their "core" variety and then expand the range of goods they export towards marginal varieties.

Real exchange rate movements affect all components of firm-level exports when we consider the OECD sample of destinations. The effect though is much reduced when the sample of EU15 destinations is considered. By 1999, nominal exchange rate variations are indeed only observed for the United Kingdom, Denmark and Sweden, which reduces the extent of real exchange rate variations. Table 13 in the Appendix provides descriptive statistics for a selected sample of countries on the standard deviation of the annual growth rate of the real exchange rate and real GDP. It is not surprising to see that the standard deviation for these two variables is reduced for the EU15 and eurozone samples. Firstly, those samples are composed of fewer countries, which reduces the number of observations used for the estimation. Secondly, there is no variation in nominal exchange rates within the eurozone after 1999, and annual variations of the real exchange rates are only due to changes in the producer price index in the domestic currency for both countries. The standard deviation of the growth rate of real exchange rate is indeed four times larger in the OECD sample, than in the eurozone sample. This issue of the variance of real exchange rate variations is important. In a dynamic model of export decision, Baldwin and Krugman (1989) show that lower real exchange rate variations are associated with fewer export opportunities, when new exporters have to pay a sunk cost. This can explain here the lower effect of real exchange rate movements when EU15 destinations are considered.

The results regarding the euro effects on the components of firm-level exports are more provocative. Results presented in Table 4 show that, *on average*, no significant effect of euro adoption is found on the number of products exported by firm and the average value of exports by product within firms. We also find a weak but negative effect of euro adoption on firm export decision. However, this effect disappears in the EU15 sample estimations. The absence of a euro effect on French exporters, *on average*, is not contradictory with the positive effect that is found at the aggregate level in previous literature (Micco et al., 2003). The marginal effect may actually differ according to firms characteristics. This issue is important, since more productive and larger firms represent a large proportion of aggregate French exports.

The heterogenous response of exporters.

In this section, we test whether exporters with different levels of productivity have reacted differently to the adoption of the euro. We define four productivity quartiles according to the distribution of total factor productivity of French exporters before 1999 and generate four dummy variables that indicates whether firms belong to the first, second, third or fourth quartile of TFP before 1999. We then interact these four dummy variables with the euro dummy, in order to determine whether the reaction of French exporters to euro adoption in 1999 was heterogenous across firms. Estimation results are reported for the OECD and EU15 samples in Table 5 below.

Table 5: Euro effects according to initial TFP

Control group	OECD non-eurozone			EU15 non-eurozone		
Treatment group	All eurozone destinations			All eurozone destinations		
Estimator	Cond. FE logit	Cond. FE poisson		Cond. FE logit	Cond. FE poisson	
Dependent variable	T_t^{fj}	N_{pt}^{fj}	$\overline{x}_t^{fj}$	T_t^{fj}	N_{pt}^{fj}	$\overline{x}_t^{fj}$
$EZ_{1999-2003} \times Q1$	-0.100	-0.007	-0.034	-0.059	-0.027**	-0.056
	(0.083)	(0.015)	(0.043)	(0.056)	(0.011)	(0.048)
$EZ_{1999-2003} \times Q2$	-0.117	0.020	0.013	-0.075	0.000	-0.009
	(0.080)	(0.016)	(0.057)	(0.049)	(0.011)	(0.059)
$EZ_{1999-2003} \times Q3$	-0.122	0.001	0.012	-0.079	-0.019*	-0.010
	(0.086)	(0.015)	(0.027)	(0.058)	(0.011)	(0.034)
$EZ_{1999-2003} \times Q4$	-0.097	0.051***	0.035	-0.055	0.031***	0.012
	(0.080)	(0.014)	(0.045)	(0.038)	(0.011)	(0.053)
RER_{jt}	-1.595***	-0.225***	-0.374**	-0.765	-0.168*	-0.927**
	(0.489)	(0.085)	(0.189)	(0.720)	(0.086)	(0.445)
$RGDP_{jt}$	1.932***	0.434***	0.504	1.246***	0.375***	0.261
	(0.676)	(0.117)	(0.488)	(0.465)	(0.096)	(0.656)
TFP_{t-1}^{f}	0.151***	0.059***	0.105***	0.128***	0.062***	0.079***
	(0.021)	(0.006)	(0.027)	(0.026)	(0.007)	(0.030)
Nb observations	477,579	580,485	580,474	160,236	342,758	342,747
Fixed effects	Firm × destination, year			Firm × destination, year		

Note: Significance levels: *10%, **5%, ***1%. All variables - with the exception of dummy variables - are in logarithms. Robust standard errors in parentheses. Standard errors are clustered by destination. When T_t^{fj} is the dependent variable, we report estimation coefficients, but not the marginal effect.

Compared to the results in Table 4, the results in Table 5 show that, while no effect of euro adoption can be observed *on average* when we consider all EU15 destinations, the response of French exporters is actually highly heterogenous across firms. We find no significant effect of the euro on firm selection, for any productivity quartile. Within firms, the average value of exports by product category is not affected either. However, results indicate that the euro increased the number of product categories exported by firms, but only for most productive amongst them ($Q4$). On the contrary, results show a negative effect of the euro on the number of product categories exported by those firms reporting a lower productivity level before 1999. This is especially the case for the least productive amongst them ($Q1$). Remember that in Table 3, we can see that firms from the first quartile of TFP also export several product categories to each destination. It is not surprising, therefore, that the adjustment of the least productive firms (first quartile) can also be channeled through the number of product categories exported.

Overall, our results show that firms reacted to euro adoption through adjustments in the number of product categories exported to eurozone destinations. The most productive firms increased the number of products exported. The least productive firms decreased the number of products exported, consistent with increased competition on foreign markets.

Robustness tests.

As discussed in the empirical methodology Section, we test the robustness of our results with two strategies. Firstly, we ask whether the self-selection of exporters into the treatment and control group can affect our results. We replicate the previous estimates, but this time, we only keep in the sample of exporters those that export to both eurozone and non-eurozone (EU15) destinations at least once over the period. Hence, the identification of the euro effects relies on samples of exporters, which share similar characteristics in the treatment and control groups. The results of this sensitivity analysis are presented in Table 6. These results are in line with previous estimations: only the most productive exporters show a positive reaction to the adoption of the euro. This effect is channeled exclusively through the number of products that are exported. However, the negative selection effect that we find in the previous estimates for the least productive ones vanishes in this exercise: the coefficient on the euro variable turns non significant, when we consider the number of products exported by least productive firms. As in previous estimates, the euro effect on the average value of exports by product, within the firm, remains non significant.

Table 6: Robustness: firms exporting both to eurozone and non-eurozone (EU15) destinations

Control group	EU15 non-eurozone		
Treatment group	All eurozone destinations		
Dependent variable	T_t^{fj}	N_{pt}^{fj}	$\overline{x}_t^{fj}$
Estimator	Cond. FE logit	Cond. FE poisson	
$EZ_{1999-2003} \times Q1$	-0.061	-0.017	-0.048
	(0.059)	(0.010)	(0.047)
$EZ_{1999-2003} \times Q2$	-0.062	-0.006	0.006
	(0.049)	(0.010)	(0.057)
$EZ_{1999-2003} \times Q3$	-0.079	-0.016	-0.001
	(0.058)	(0.011)	(0.033)
$EZ_{1999-2003} \times Q4$	-0.051	0.033***	0.007
	(0.038)	(0.011)	(0.051)
RER_{jt}	-0.719	-0.143*	-0.734*
	(0.738)	(0.08)	(0.441)
$RGDP_{jt}$	1.154**	0.383***	0.277
	(0.456)	(0.095)	(0.651)
TFP_{t-1}^{f}	0.102***	0.047***	0.038
	(0.030)	(0.008)	(0.041)
Nb observations	157,220	329,354	329,344
Fixed effects	Firm × destination, year		

Note: Significance levels: *10%, **5%, ***1%. All variables - with the exception of dummy variables - are in logarithms. Robust standard errors in parentheses. Standard errors are clustered by destination. When T_t^{fj} is the dependent variable, we report estimation coefficients, but not the marginal effect.

Secondly, we test the sensitivity of our results to the choice of estimator. The choice of the Poisson estimator was indeed motivated by the fact that firms export a discrete number of product categories. Using the log of the number of products therefore considerably reduces the variance of the dependent variable, while the poisson takes the

Table 7: Robustness: within FE estimations

Control group	EU15 non-eurozone	
Treatment group	All eurozone destinations	
Estimator	Within FE	
Dependent variable	$ln(N_{pt}^{fj})$	$ln(\overline{x}_t^{fj})$
$EZ_{1999-2003} \times Q1$	-0.006	0.007
	(0.007)	(0.055)
$EZ_{1999-2003} \times Q2$	0.004	0.001
	(0.006)	(0.046)
$EZ_{1999-2003} \times Q3$	-0.007	0.007
	(0.005)	(0.043)
$EZ_{1999-2003} \times Q4$	0.013*	0.023
	(0.007)	(0.042)
RER_{jt}	-0.114	-0.399
	(0.068)	(0.539)
$RGDP_{jt}$	0.208**	0.766
	(0.086)	(0.666)
TFP_{t-1}^{f}	0.042***	0.154***
	(0.004)	(0.015)
Nb observations	371,972	371,96
Fixed effects	Firm × destination, year	

Note: Significance levels: *10%, **5%, ***1%. All variables - with the exception of dummy variables - are in logarithms. Robust standard errors in parentheses. Standard errors are clustered by destination. When T_t^{fj} is the dependent variable, we report estimation coefficients, but not the marginal effect. Dependent variables are expressed in logs for within FE estimations.

dependent variable in levels. Nevertheless, we replicate the previous estimations using, alternatively, a within Fixed Effects estimator, to test the robustness of previous estimations. The results are provided in Table 7, where the dependent variable is taken in natural logarithms this time. Those results confirm that the coefficients that were provided in the previous estimates are not qualitatively influenced by the choice of the estimator. We still find a positive effect of the euro, although only for the most productive exporters, which channels only through the number of product categories exported. In Table 7 however, the elasticity on the euro variable is smaller, with a lower level of significance. The effect of euro on the number of products also turns non-significant for the least productive exporters. This can be explained by the fact that taking the log of the number of products exported by firm considerably reduces the variance of this variable. As in previous estimates, we also find that euro adoption had no significant effect on the average value of exports by product within each firm.

These robustness checks confirm that product selection within firms is an important feature of the dynamics of firm-level exports. In the next Section, we ask whether our estimation results may be influenced by the past monetary cooperation between countries that adopted the Euro in 1999.

3.4 Past monetary coordination.

Historical perspective.

We may expect different effects of the euro for different destinations in the *treatment* group. Due to past monetary cooperation through the European Monetary System (EMS), the extent of the reduction of the nominal exchange rate volatility may have been particularly low for French firms exporting to certain eurozone destinations.

Eight members of the European Community entered the European Monetary System in 1979.The UK entered in 1990 in the EMS with a large fluctuation band and left in 1992 during the EMS crisis. The EMS required that nominal exchange rate fluctuations between participants should not exceed +/- 2.25%, before the 1992-1992 crisis. However, this period of low volatility is only relevant for a few European countries. Indeed, the Italian Lira entered the EMS with a larger fluctuation band (+/- 6%). The Irish Punt was devaluated by 10% in 1993, further to the crisis in the EMS in 1992-1993. Further to that crisis, fluctuation bands were enlarged and allowed more or less 15% nominal exchange rate fluctuations by 1993. Countries that did not devalue during the 1992-1993 period (France, Belgium, Luxembourg, Netherlands, Germany and Denmark) and took part to the EMS from the beginning, were identified as being part of a D-Mark zone.[17]

Countries that were part of the so-called "D-Mark zone" have a history of low nominal exchange rate volatility. We illustrate this by computing measures of nominal exchange rate volatility between the French Franc and other European currencies, for the period 1995-1998, i.e. before Euro adoption. For each year in our sample, we compute the volatility of the exchange rate by taking the standard deviation of the monthly variation of the nominal exchange rate:

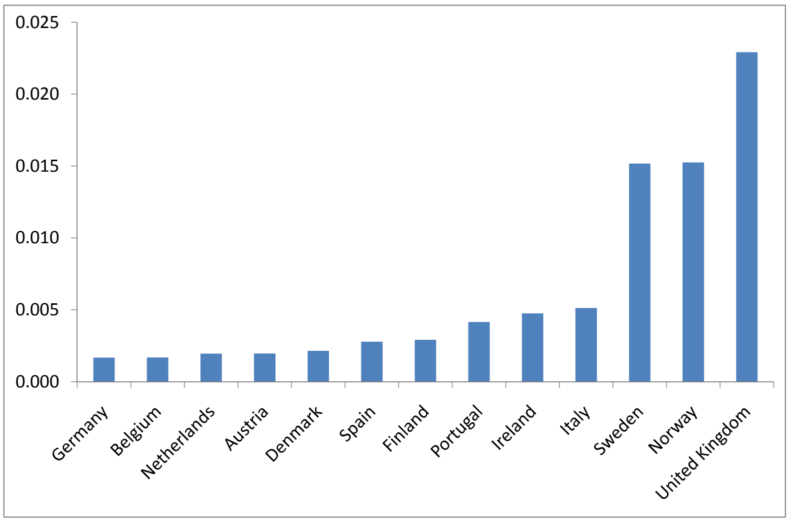
$$Vol_{jt} = Std.Dev. \left(\frac{e_{jt,m} - e_{jt,m-1}}{e_{jt,m-1}} \right)$$

With $m = 1...12$. Vol_{jt} is the yearly volatility of the monthly nominal exchange rate of the French Franc against the foreign currency. Figure 3 shows the nominal exchange rate volatility, between the French Franc and the other EU currencies, over the period preceding the introduction of the euro. Within European countries, the nominal exchange rate volatility of the French Franc, before 1999, is much larger with respect to European countries that did not adopt the euro in 1999 (Sweden, Norway and the United Kingdom). The exception is Denmark that did not enter the eurozone but had a low nominal exchange rate volatility before 1999, due to monetary cooperation. Some eurozone countries also have higher nominal exchange rate volatility before the Euro adoption (Spain, Portugal, Ireland and Italy). Finally, D-Mark zone destinations also

[17] See McKinnon (2002) for a complete discussion on this. This term of D-Mark zone was initially used to characterize the core group of countries that did not leave the "snake in the tunnel".

report a lower nominal exchange rate volatility before 1999, which is not surprising given the past monetary cooperation in the EMS. The numbers reported in Figure 3 show that, before 1999, nominal exchange rate volatility between the French Franc and the Italian Lira was three times the volatility between the French Franc and the Deutsch Mark. Nominal exchange rate volatility with respect to Austrian Schilling is also low before 1999. This is not surprising given its *de facto* peg to the D-Mark.

Figure 3: Volatility vis-a-vis French Franc, 1995-98



Authors calculations based on "Ecowin" data

Accordingly, we can expect that the effect of euro adoption on French exporters to be heterogenous across destinations. Given the low nominal exchange rate volatility with respect to D-Mark zone destinations before 1999, we can expect a lower decrease in trade costs for French firms potentially exporting to those destinations. In order to account for this history of monetary cooperation and exchange rate stability, we replicate our estimations by considering the D-Mark zone and eurozone destinations outside the D-Mark zone separately in the "treatment group". The composition of these two groups of countries is detailed in Table 12. Given the peg between the Austrian Schilling and the D-Mark before 1999, we also include Austria in the D-Mark zone. We end up with a *de jure* and a *de facto* (including Austria) D-Mark zones.

Baseline estimations.

We first proceed to our estimations by excluding the de jure and *de facto* D-Mark zone countries from the treatment group. Denmark was also in the D-Mark zone and was removed from the control group for this reason. Hence, our sample of eurozone destinations is now composed of Italy, Spain, Ireland, Portugal, Finland (and Austria in a first step), for which we expect a larger decrease in trade costs. Results are provided in Table 8 below.

Table 8: Euro effects on firm-level exports, D-Mark Zone destinations excluded

Control group	EU15 non-eurozone			EU15 non-eurozone		
Treatment group	Eurozone excluding de jure D-Mark zone			Eurozone excluding de facto D-Mark zone		
Estimator	Cond. FE logit	Cond. FE poisson		Cond. FE logit	Cond. FE poisson	
Dependent variable	T_t^{fj}	N_{pt}^{fj}	$\overline{x}_t^{fj}$	T_t^{fj}	N_{pt}^{fj}	$\overline{x}_t^{fj}$
$EZ_{1999-2003}$	0.016	0.021**	0.021	0.034	0.023***	0.042
	(0.040)	(0.009)	(0.055)	(0.056)	(0.008)	(0.054)
RER_{jt}	-0.239	-0.045	-0.818	-0.077	-0.022	-0.582
	(0.814)	(0.077)	(0.783)	(0.879)	(0.075)	(0.715)
$RGDP_{jt}$	0.727	0.207**	0.104	0.563	0.194**	0.039
	(0.465)	(0.081)	(0.685)	(0.474)	(0.076)	(0.696)
TFP_{jt-1}	0.082	0.064***	0.089*	0.081	0.065***	0.084
	(0.055)	(0.008)	(0.051)	(0.065)	(0.009)	(0.053)
Nb observations	141,516	236,116	236,116	121,557	212,470	212,464
Fixed effects	Firm × destination, year			Firm × destination, year		

Note: Significance levels: *10%, **5%, ***1%. All variables - with the exception of dummy variables - are in logarithms. Robust standard errors in parentheses. Standard errors are clustered by destination. When T_t^{fj} is the dependent variable, we report estimation coefficients, but not the marginal effect.

Results reported in the left panel of the Table 8 are obtained by excluding the *de jure* D-Mark zone destinations. Note that the number of observations is considerably reduced since D-Mark zone destinations correspond to major destinations for French exports. As discussed in the previous section, annual variations of the real GDP and real exchange rate offer a lower variance than in the OECD sample. Real GDP variations mostly affect the number of products exported. Real exchange rate variations now have no significant effect on any component of French firms' exports.[18] As in previous estimations, TFP variations have no effect on export decision and mostly affect firm-level exports.

Coefficients on the $EZ_{1999-2003}$ variable are now larger than in previous estimations. Most importantly, the coefficient on the euro variable is now highly significant when N_{pt}^{fj} is the dependent variable: euro adoption increased the number of product categories exported by French firms to eurozone located outside the D-Mark zone. We find however no significant effect of the euro on the export decision, and the average value of exports by product category within firms. Results reported in the left panel of the Table are obtained by excluding *de facto* D-Mark zone destinations (e.g. *de jure* destinations plus Austria).

We now consider de jure D-Mark zone destinations in the treatment group. As in previous estimations, the control group is only composed of United Kingdom and Sweden. We remove Denmark from the control group, since it is part of the D-Mark zone. This enables us to keep the same control group as for the previous estimation. Estimation

[18] However the coefficient remains negative. The clustering of standard errors by destination increases these standard errors, which leads to non-significant coefficients.

Table 9: Euro effects on firm-level exports, treatment group with only D-Mark Zone destinations

Control group	EU15 non-eurozone		
Treatment group	De jure D-Mark zone only		
Estimator	Cond. FE logit	Cond. FE poisson	
Dependent variable	T_t^{fj}	N_{pt}^{fj}	$\overline{x}_t^{fj}$
$EZ_{1999-2003}$	-0.212***	-0.021***	-0.042
	(0.024)	(0.008)	(0.033)
RER_{jt}	-0.773***	-0.155***	-0.391**
	(0.227)	(0.028)	(0.163)
$RGDP_{jt}$	0.656	0.241**	-0.235
	(0.828)	(0.099)	(0.409)
TFP_{jt-1}	0.102**	0.063***	0.127***
	(0.042)	(0.009)	(0.039)
Nb observations	75,992	202,142	202,137
Fixed effects	Firm × destination, year		

Note: Significance levels: *10%, **5%, ***1%. All variables - with the exception of dummy variables - are in logarithms. Robust standard errors in parentheses. Standard errors are clustered by destination. When T_t^{fj} is the dependent variable, we report estimation coefficients, but not the marginal effect.

results are reported in Table 9. As in the previous estimations, real GDP variations affect only the number of product categories exported. Total Factor Productivity now has a positive effect on the export decision. The coefficient for real exchange rate turns highly significant for all dimensions of firm exports.

Estimation results show that when we only consider D-Mark zone destinations in the treatment group, the coefficient on the euro variable turns negative for the export decision. The euro also has a negative and significant effect on the number of products exported. Fewer French firms export a lower range of products to the D-Mark zone after 1999. This suggests that for the most integrated destinations, where the decrease in trade costs is expected to be low, the effect of increased competition dominates over the reduction in trade costs. The euro effects on the average value of exports by product remains non-significant.

Heterogenous response of exporters.

We now test whether the response of exporters is heterogenous across firms. We start by considering separately eurozone destinations outside the D-Mark zone in the treatment group. Estimation results are reported in the left-hand panel of Table 10 below. The numbers reported in Table 10 clearly confirm previous findings: all of the euro effect is channelled through the number of product categories exported by the most productive French firms.

Results keeping D-Mark zone destinations in the treatment group are reported in the right-hand panel of Table 10. Firstly, euro had a negative effect on the export decision for all types of firms. Though, the coefficient is significantly lower for the most productive firms than for firms reporting a lower productivity before 1999. We find also

Table 10: Euro effects according to initial TFP, D-Mark zone issue

Control group	EU15 non-eurozone			EU15 non-eurozone		
Treatment group	Eurozone excluding de jure D-Mark zone			De jure D-Mark zone only		
Dependent variable	T_t^{fj}	N_{pt}^{fj}	$\overline{x}_t^{fj}$	T_t^{fj}	N_{pt}^{fj}	$\overline{x}_t^{fj}$
Estimator	Cond. FE logit	Cond. FE poisson		Cond. FE logit	Cond. FE poisson	
$EZ_{1999-2003} \times Q1$	0.013	-0.007	0.051	-0.192***	-0.045***	-0.128***
	(0.059)	(0.011)	(0.042)	(0.064)	(0.011)	(0.037)
$EZ_{1999-2003} \times Q2$	0.009	0.021	0.075	-0.245***	-0.020**	-0.080
	(0.041)	(0.014)	(0.047)	(0.037)	(0.009)	(0.070)
$EZ_{1999-2003} \times Q3$	0.016	0.003	0.011	-0.279***	-0.043***	-0.035
	(0.053)	(0.010)	(0.038)	(0.045)	(0.011)	(0.042)
$EZ_{1999-2003} \times Q4$	-0.007	0.052***	-0.009	-0.131***	0.010	0.024
	(0.047)	(0.009)	(0.078)	(0.014)	(0.011)	(0.062)
RER_{jt}	-0.284	-0.044	-0.845	-0.741***	-0.163***	-0.449***
	(0.771)	(0.077)	(0.777)	(0.224)	(0.028)	(0.169)
$RGDP_{jt}$	0.795*	0.199***	0.100	0.635	0.222**	-0.143
	(0.449)	(0.076)	(0.666)	(0.910)	(0.094)	(0.530)
TFP_{t-1}^{f}	0.160***	0.064***	0.086*	0.089*	0.065***	0.089***
	(0.023)	(0.009)	(0.052)	(0.047)	(0.009)	(0.028)
Nb observations	135633	225639	225631	73,314	192,840	192,835
Fixed effects	Firm × destination, year			Firm × destination, year		

Note: Significance levels: *10%, **5%, ***1%. All variables - with the exception of dummy variables - are in logarithms. Robust standard errors in parentheses. Standard errors are clustered by destination. When T_t^{fj} is the dependent variable, we report estimation coefficients, but not the marginal effect.

a negative effect on the number of products exported by firm (Q_1, Q_2 and Q_3), and on the average value of exports by product for the least productive firms only (Q_1). The number of products, or value of exports by product, is not affected for the most productive exporters (Q_4).

Those results are consistent with increased competition in D-Mark zone destinations after 1999, as suggested by Ottaviano et al. (2009). Euro adoption indeed increased competition, to the detriment of the least productive firms. Our results suggest that this increased competition effect can be also seen among exporters. This is not surprising, since many French exporters are small, report a low productivity, and do not differ much from the pure domestic firms. The competition effect dominates where countries are already highly integrated: the expected reduction in trade costs is low for those countries, while competition increases. Importantly, dynamic adjustment through the number of products exported appears to be a major channel through which firms react to a change in trade costs.

Robustness

We finally discuss the sensitivity of previous results to the choice of the estimator. We therefore estimate the euro effects by using a within FE estimator. Results are reported in Table 11 below.

These results are in line with previous estimations. When we consider the eurozone

Table 11: Robustness: within FE estimations

Control group	EU15 non-eurozone		EU15 non-eurozone	
Treatment group	Eurozone excluding D-Mark zone		De jure D-Mark zone only	
Estimator	Within FE		Within FE	
Dependent variable	$ln(N_{pt}^{fj})$	$ln(\overline{x}_t^{fj})$	$ln(N_{pt}^{fj})$	$ln(\overline{x}_t^{fj})$
$EZ_{1999-2003} \times Q1$	0.009	0.078	-0.022***	-0.060
	(0.007)	(0.072)	(0.004)	(0.037)
$EZ_{1999-2003} \times Q2$	0.015	0.045	-0.008**	-0.039
	(0.009)	(0.062)	(0.002)	(0.041)
$EZ_{1999-2003} \times Q3$	0.004	0.045	-0.021***	-0.027
	(0.006)	(0.052)	(0.002)	(0.040)
$EZ_{1999-2003} \times Q4$	0.023***	0.056	0.002	-0.006
	(0.006)	(0.054)	(0.009)	(0.043)
RER_{jt}	-0.063	-0.153	-0.040**	-0.115
	(0.095)	(0.754)	(0.010)	(0.292)
$RGDP_{jt}$	0.115	0.469	0.079**	0.548
	(0.073)	(0.714)	(0.019)	(0.676)
TFP_{jt-1}	0.044***	0.178***	0.046***	0.126***
	(0.005)	(0.016)	(0.006)	(0.014)
Nb observations	225639	225631	192,840	192,835
Fixed effects	Firm × destination, year		Firm × destination, year	

Note: Significance levels: *10%, **5%, ***1%. All variables - with the exception of dummy variables - are in logarithms. Robust standard errors in parentheses. Standard errors are clustered by destination. When T_t^{fj} is the dependent variable, we report estimation coefficients, but not the marginal effect. Dependent variables are expressed in logs for within FE estimations.

outside the D-Mark zone, we find a positive effect of the euro that channels through the number of product categories exported by the most productive exporters, with no effect for lower TFP quartiles. The effect on the average value of exports by product, within the firm, remains non-significant. Considering the D-Mark zone, results confirm that the number of products exported by the least productive firms fell, with no effect for the most productive firms.

4 Conclusion.

The majority of exporters are multi-product. However, we know little about the importance of firm-adjustment through the number of products exported. Relying on French firm-level export data and on an annual business survey of individual firm characteristics, we provide new evidence about how firms react to a change in trade costs, where we disentangle all channels of adjustments : the export decision, the number of products exported and the value of exports by product.

We start with an analysis of the effects of bilateral distance in cross section estimations. Our results confirm previous findings that bilateral distance has a negative effect on the number of annual shipments, but no effect on the average value of exports by shipments. Turning to firm-level estimations however, we find a negative effect of distance on the decision to export, the number of products exported and the average value of exports by product. This suggests that the ambiguous effect of distance on the average value of exports by annual shipments is a reflection of the composition of exporters on each market.

We then use euro adoption as a natural experiment, in order to analyze the dynamic adjustment of firms further to a change in trade costs. Adjustment through the number of products exported dominates. Positive effects however are concentrated amongst the most productive exporters. No effect is found on average on the export decision or the value of exports by product. Where monetary cooperation preceded the adoption of the euro, the least productive firms stopped exporting or decreased the number of product categories they export, consistent with increased competition on eurozone markets.

Overall, our results show that the dynamic adjustment of exporters through the number of products dominates over the adjustment through the entry or exit of firms. This suggests that the fixed entry costs to export a new product are lower than the fixed entry costs to enter a new market.

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Appendix

Table 12: Sample of countries for euro estimations

Treatment/control group	Destination type	Country
Treatment group	Eurozone excluding D-Mark zone	Spain Finland Ireland Italy Portugal
	Eurozone D-Mark zone	Belgium Austria Germany Netherlands
Control group	EU15 excluding eurozone	United Kingdom Sweden Denmark
	OECD excluding EU15	Australia Canada Switzerland Czech Republic Hungary Japan Korea Mexico Norway New-Zealand Poland Slovakia Turkey United States

Table 13: Average growth rate of real exchange rates and real GDP: standard deviation within selected groups of destinations

	Groups of destinations		
Std. dev. of growth rate	OECD	EU15	Eurozone
Real exchange rate	0.105	0.036	0.026
Real GDP	0.026	0.021	0.023