Does European Integration have an Effect on the Pricing Behaviour of French Exporters?

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1 Introduction

The European Monetary Union was completed in January 1999 when eleven member states of the European Union introduced the euro as an accounting currency. In January 2002, this step was followed by the issuing of euro banknotes and coins. One decade after the Maastricht treaty, this has completed a unique experience of monetary integration among European countries. A casual look at the webpages of the European Commission and the European Central Bank shows that among the main claimed benefits of the euro are an increase in price transparency, a reduction in transaction costs and the elimination of exchange rate fluctuations.[1] In particular, the single currency is viewed as a 'natural complement to the European Union's single market' that should lead to a further deepening of market integration through monetary harmonization.

Underlying these claims are the following presumed mechanisms. Firstly, the denomination of prices in a common currency increases price transparency and thus reduces the information costs for consumers and professional arbitrageurs. They can now compare prices in different member countries of the eurozone without incurring the cost of keeping up to date with current exchange rates.[2] Secondly, the suppression of national

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[1] See http://ec.europa.eu/economy_finance/euro/benefits/benefits_2_en.htm and http://www.ecb.int/ecb/educational/facts/euint/html/ei_007.en.html.

[2] Using data on prices of identical goods sold in the same duty free shop but denominated in different currencies Asplund & Friberg (2001) provide evidence on substantial price differentials. This can be interpreted as evidence that consumers incur a currency conversion cost since other barriers to arbitrage are not present in this setup.

currencies eliminates the cost of currency conversion operations. Consumers and professional arbitrageurs can now buy and sell goods in different countries of the eurozone without having to pay the cost of converting one currency to another. Thirdly, the elimination of nominal exchange rate fluctuations in the eurozone mechanically eliminates cross-country price differentials due to price stickiness in local currencies (see Engel, 2000). Overall, the European monetary integration should have reduced the degree of market segmentation within the eurozone and therefore have impacted on firms' pricing behaviour. This should, in turn, be reflected in the level of price dispersion and in the speed of price convergence.

While the aforementioned claims appeal to common sense, economic theory indicates that the degree of market segmentation is also influenced by factors other than a common currency. In particular natural trade barriers, as for instance freight costs, and policy induced trade barriers (tariff and non-tariff barriers) influence the degree to which markets are segmented across nations. Besides, individual characteristics of the firms or the product they sell may influence their ability to discriminate national markets. To the extent that the latter determinants of market segmentation dominate the common currency determinant, it can be expected that the quantitative effect of the introduction of the euro on market segmentation and price dispersion would be small or negligible. This paper aims (i) at testing whether the European monetary integration has reduced price dispersion and accelerated price convergence in the eurozone in comparison with the rest of the world and (ii) at explaining this "EMU effect" taking into account the heterogeneity of firms in terms of pricing behaviors.

In recent years, several studies on the price impact of the euro have become available. The first type of studies (Goldberg & Verboven, 2005 and Gil-Pareja & Sosvilla-Rivero, 2005) focus on one particular sector, the European automobile market. Given that this sector is a classical example of pricing to market in which policy induced barriers to arbitrage have been reduced over the past two decades, the automobile sector represents a particularly interesting case study. The obtained result that the introduction of the euro has reduced price dispersion and increased price convergence is, however, not generalisable to other sectors. The second type of studies (Lutz, 2003 and Engel & Rogers, 2004) considers a wider range of sectors and finds that the introduction of the euro has had a small to negligible effect on price dispersion and price convergence.[3] All of these papers suffer from the drawback that they use observed retail prices as the dependent variable. Clearly, observed retail prices are contaminated by local cost factors, distribution margins and taxes. Even if the euro had actually

[3]Baye, Gatti, Kattuman & Morgan (2006) study the impact of the introduction of the euro on prices charged for different products by online retailers and find that there is no impact on price dispersion.

reduced price discrimination in the eurozone, this effect may not be observed in retail prices since it may be offset by an increase in the dispersion of local cost factors, distribution margins and taxes.[4]

This paper adds to the previous literature in (at least) three respects. Firstly, it uses firms' unit values in different export markets at the disaggregated product level as proxies for prices. Since they are derived from free on board (FOB) export values, they have the advantage to be uncontaminated by local cost factors, distribution margins or taxes and should thus reflect only firms' strategic pricing behaviour. Further, the common critique that sectoral unit value indices do not account for within product quality differences is less relevant given the way the dependent variable is constructed. Since the relative unit values used in this paper are firm and product specific they neglect within product quality differences only to the extent that firms vertically differentiate the same product across destination markets.[5] Secondly, this paper uses the (almost) exhaustive coverage of traded goods of the French customs data to answer the question of whether the results from the aforementioned sectoral case studies are generalisable or whether the effect of the euro is heterogeneous across sectors and can therefore not be easily be generalised. Thirdly, this paper relates the euro's price impact to firm-level characteristics. In particular, the firm-level dimension of the data at hand allows to distinguish between two alternative hypotheses on the euro's price impact. On the one hand, the euro's price impact may be attributable to intra firm differences in strategic pricing between destination markets within and outside the eurozone. On the other hand, the effect of the euro on prices may be due to a composition effect in the sense that firms serving intra-eurozone destination markets may be systematically different from firms serving extra-eurozone markets. In particular, it may be that firms with a high propensity to engage in price discrimination also have a high propensity to serve extra-eurozone markets. In other words, the euro's price effect may be due to an intensive margin effect, an extensive margin effect or a combination of both and the data at hand make it possible to distinguish between these alternative hypotheses.

Unfortunately the data used in this paper are not free of drawbacks. In particular the time dimension spanning the years 1998-2003 is too short to conduct a comprehensive analysis of the natural experiment of monetary integration in Europe. Since part of the price impact of the EMU process may already be reflected in 1998 prices, the use of the commonly applied difference in difference methodology would not be fully

[4]Note that Goldberg & Verboven (2005) also use retail prices. However, as they focus on a single industry, they are able to control for such differences in local costs.

[5]If firms do not vertically differentiate the same product across destination markets, the homogeneity of the product across markets allows to test the law of one price in its absolute version.

convincing.[6] Instead of using the time series dimension, results obtained in this paper therefore rely on the cross section dimension of the data. More precisely, this paper relies on comparisons of convergence speeds between eurozone destination markets and an appropriately defined control group. The three members of the European Union (EU15 in the following) that did not join the eurozone are arguably the most appropriate control group since they have undergone the same structural reforms without giving up monetary independence. Different price patterns within the eurozone and the rest of the EU15 can therefore plausibly be attributed to the European monetary integration process.

Two sets of results are presented. The first set of estimations derives results under the assumption of homogeneous firms. Convergence regressions show that the speed of price convergence is higher within the eurozone than outside. The difference in convergence speeds is particularly pronounced when the control group is the rest of the OECD but it is still significant when comparing the eurozone with the rest of the EU15. One possible explanation would be that arbitrage pressures are stronger within the eurozone which can be interpreted as an intensive margin effect of the euro. In this case, the eurozone indicator picks up the smaller ability of firms serving eurozone markets to price discriminate between these markets. A different explanation would attribute the higher speed of convergence to self selection of firms with low convergence speeds into non-eurozone markets which can be interpreted as an extensive margin effect of the euro. In this case, the eurozone indicator picks up the fact that the proportion of firms that are able to price discriminate is higher in non-eurozone markets. To control for self selection, the second set of results presented in this paper is derived under the assumption of heterogeneous firms. They suggest that the major part of the euro effect is attributable to self selection. The degree of price discrimination is shown to be higher for larger and more productive firms which, in turn, are more likely to serve extra-eurozone destination markets. In other words, the extensive margin effect dominates the intensive margin effect of the euro.

The remainder of the paper is organised as follows. In the next Section, a simple model provides the main intuitions for the expected impact of the euro on French exporters' pricing strategies. Section 3 describes the data. Section 4 presents estimates of the euro's effect on price convergence under the assumption of homogeneous firms. Section 5 accounts for the firm-level component of pricing behaviours. Finally, Section 6 concludes.

[6] See Goldberg & Verboven (2005) and Lutz (2003) for applications of the difference in difference methodology to the European monetary integration process.

2 Concepts

2.1 The segmentation function

To illustrate the main mechanisms underlying the likely price impact of the euro, it is useful to sketch a simple partial equilibrium model of an exporter's pricing problem. Production is assumed to take place in a monopolistic competition framework in which producers have the ability to set prices above marginal costs. As standard in the New Trade literature,[7] there is a fixed cost of entering an export market. Marginal costs Mc_f are constant for a given firm but may be heterogeneous across firms. As in Melitz (2003) Mc_f will be interpreted as an inverse measure of productivity. Firms are assumed to take their pricing decision in two stages. In a first stage firms decide whether to price discriminate between export markets and in a second step they set the optimal price conditional on whether they choose to price discriminate in the first stage or not.

To simplify the first stage decision, we follow Baldwin, Anderton & Taglioni (2003) and consider only two extreme cases. In the first *Perfectly Integrated Markets* (PIM) regime, export markets are perfectly integrated at the international level. In this regime a French exporter sets the same price in all foreign markets, irrespective of differences in demands across markets. This is done by maximising profits subject to world demand. In the alternative *Perfectly Segmented Markets* (PSM) regime, international good markets are perfectly segmented precluding the re-export of imported goods by arbitrageurs. As a consequence, exporters are able to price discriminate between export markets by setting different prices in different export markets. In contrast to the PIM regime, firms in the PSM regime maximise profits for each destination market separately.

Of course, firms often face an intermediate pricing environment. They may be able to discriminate between markets to some extent, while arbitrage pressures usually prevent them from fixing prices that are too different across markets. This is what Baldwin et al. (2003) call the *Variably Segmented Markets* (VSM) regime. In this regime, markets are sufficiently segmented so as to prevent arbitrage within a band of relative prices. As long as the profit maximising price in an export market is within this no-arbitrage band, firms behave as in the PSM regime. As soon as the profit maximising price is outside the band, firms are constrained by arbitrage in setting their export price. Since the VSM can be interpreted as a variant of the PSM regime and does therefore not yield additional insights, we choose to focus on the extreme PIM and PSM regimes for the theoretical model in this Section.

[7] See the seminal paper by Krugman (1991).

Following Baldwin et al. (2003), market segmentation is assumed to be endogenous to the firm. Namely, exporters can switch from the PIM to the PSM regime by paying a fixed segmentation cost that may be market-specific. This segmentation cost can be thought as a way to differentiate products sold in different export markets so as to preclude arbitrage behaviors.[8] The two-stage pricing decision of the firm is solved by backwards induction.

Consider the PIM regime, in which the firm chooses a single price for all its foreign markets, to maximise aggregate profits. Using f and j to design the firm and foreign market respectively, the program of the firm can be summed up as:

$$\max_{P_f^{PIM}} \left[\sum_j \left(\pi_{fj}^{PIM} - F_j \right) \right]$$

with P_f^{PIM} the optimal price in the PIM regime and F_j the fixed entry cost in country j. In this expression, π_{fj}^{PIM} refers to the operational profit generated by sales in market j:

$$\pi_{fj}^{PIM} = \left[P_f^{PIM} - Mc_f \right] X_{fj}^{PIM} \tag{1}$$

with Mc_f f's marginal cost of producing and X_{fj}^{PIM} the volume of sales in j when the price is P_f^{PIM}. In the following, it is assumed that the functional form of demand involves a constant market-specific price elasticity:

$$X_{fj} = A_j P_{fj}^{-\eta_j}, \eta_j > 1 \tag{2}$$

where A_j is a scale parameter that summarises the features of j's market, including its size and the degree of competition. The price elasticity of demand is restricted to a value above one to insure positive operational profits under monopolistic competition.

In this regime, the optimal price chosen by the firm for its sales in all foreign markets can be decomposed into a cost component, that depends on the firm's productivity, and a mark-up $Mkup_f^{PIM}$ that the firm chooses conditional on aggregate demand ($\sum_j X_{fj}^{PIM}$):

$$P_f^{PIM} = Mkup_f^{PIM} Mc_f \tag{3}$$

[8]For instance, the firm may edit its products' manuals in the importing country's language only instead of publishing a multi-language document.

Note that, in this framework, $Mkup^{PIM}$ is a function of price-elasticities met by the firm in all foreign markets, the vector of $\{\eta_j\}$s. It maximises profits subject to world demand but does not maximise profits in each foreign market separately.

Alternatively, the firm can choose to pay the fixed segmentation cost allowing it to discriminate between markets. In this regime, one specific price is chosen for sales in each national market so as to maximise the following profit function:

$$\max_{\{P_{fj}^{PSM}\}} \left[\sum_j \left(\pi_{fj}^{PSM} - F_j - G_j \right) \right]$$

where G_j is the fixed cost to segment market j and π_{fj}^{PSM} equals:

$$\pi_{fj}^{PSM} = \left[P_{fj}^{PSM} - Mc_f \right] X_{fj}^{PSM} \tag{4}$$

The solution of this program gives market-specific optimal prices that can again be decomposed into a cost and a mark-up component, the mark-up being a function of the demand face in the destination market:

$$P_{fj}^{PSM} = Mkup_{fj}^{PSM} Mc_f \tag{5}$$

Having solved the pricing problem in each regime, consider now the first stage decision. Firm f decides to segment markets j by paying the fixed cost G_j if and only if it increases its profit in that market with respect to the PIM regime:

$$\left[P_{fj}^{PSM} - Mc_f \right] X_{fj}^{PSM} - G_j > \left[P_f^{PIM} - Mc_f \right] X_{fj}^{PIM}$$

Given demand (2), optimal prices (3) and (5), this simplifies to:

$$A_j Mc_f^{1-\eta_j} f(Mkup_{fj}^{PSM} - Mkup_f^{PIM}) > G_j \tag{6}$$

which is positive when $Mkup_{fj}^{PSM}$ maximizes operational profits in market j and increasing in the mark-up differential (in absolute terms).[9]

[9] $$f(Mkup_{fj}^{PSM} - Mkup_f^{PIM}) \equiv \left[(Mkup_{fj}^{PSM} - 1)\ Mkup_{fj}^{PSM\ -\eta_j} - (Mkup_f^{PIM} - 1)\ Mkup_f^{PIM\ -\eta_j} \right]$$

The left-hand side of this inequality denotes the benefit of segmenting market j, i.e., the rise in operational profit linked to the choice of a market-specific price instead of the world price P_f^{PIM}. The right-hand side denotes its cost. A necessary condition for segmentation to be optimal is that the operational profit generated under market segmentation is higher than the operational profit in the PIM regime. In algebric terms, this implies that $f(Mkup_{fj}^{PSM} - Mkup_f^{PIM})$ must be positive. As long as $Mkup_{fj}^{PSM}$ is optimally chosen to maximise operational profits in country j, this is always the case. In other words, discriminating markets always provides the firm with an absolute benefit as it allows it to maximise profits in each market. However, even if price discrimination increases operational profits, it may be the case that the firm prefers the PIM regime because the fixed segmentation cost is higher than the benefit. This is the case if condition (6) does not hold.

Equation (6) shows that the determinants of firms' segmentation decision is a combination of firm- and market-specific variables. Firstly, the firm's incentive to segment markets is decreasing in its marginal cost of production MC_f. More productive firms are more likely to choose to segment export markets. This is because for a given increase in prices induced by market segmentation, the increase in operational profits is higher for the more productive firms since they are exporting higher quantities. Secondly, the firm's choice may also vary according to the characteristics of the destination market. Market segmentation is more likely the lower the fixed cost of segmenting the market (G_j) is. The size of market j, summarised in A_j, also enters the decision. The higher the demand emanating from j, the more beneficial it is for the firm to segment this market by paying the fixed segmentation cost. The left-hand size of (6) is also increasing in the mark-up differential ($|Mkup_{fj}^{PSM} - Mkup_f^{PIM}|$). The benefit of segmenting markets is higher since the larger the difference between the optimal price in the PSM and the PIM regimes. In economic terms, this means that the firm has a higher incentive to segment market j if the demand from this market is structurally different from the average demand in all export markets.

2.2 Impact of the EMU on segmentation decisions

According to equation (6), there are three distinct economy specific effects through which EMU may have affected individual firms' decisions to segment markets. A modification in the distribution of market sizes ($\{A_j\}$), a change in the fixed costs of segmenting markets ($\{G_j\}$) and a change in mark-up differentials across regimes (changes in $Mkup_{fj}^{PSM} - Mkup_f^{PIM}$). Since the effect of EMU on the distribution of market sizes is

of second order it is not further considered. The most direct effect of EMU is on the fixed segmentation cost. The common currency should have made it more difficult for firms to segment European markets. In terms of the model, this means that EMU increases the cost G_j in the eurozone. One reason for this to happen is that the disappearance of national currencies increases price transparency within the eurozone as compared to non-eurozone economies, which facilitates arbitrage behaviours by consumers and professional arbitrageurs. As a consequence, firms have to pay higher differentiation costs to sustain intra-EMU price difference. This increase in the fixed cost of segmenting eurozone countries should accelerate price convergence and reduce firms' incentives to price discriminate between these markets.

Beside the potential impact on the fixed segmentation cost, EMU may also have smoothed structural demand differences across EMU markets and thus have reduced firms' incentive to price-to-market. Namely, optimal mark-ups under market segmentation (P_{fj}^{PSM}, $j \in EMU$) may have become more similar which reduces the benefit of segmenting markets according to equation (6). Increased similarity of desired mark-ups may be the consequence of several factors. Firstly, exchange rate fluctuations are well known to lead to price discrimination in the incomplete pass-through literature (see among others Knetter, 1989 and Goldberg & Knetter, 1996). By affecting the local currency price of exports, they modify the perceived elasticity of demand and the desired mark-up of the firm. As soon as countries share the same currency this source of price differentials disappears. Secondly, the monetary union may have an effect on desired mark-ups if it affects the competitive environment. One expected benefit of the introduction of the euro was indeed to foster European market integration and facilitate intra-EU trade. Provided that monetary integration has such pro-competitive effects, it is likely that the competitive environments in EMU markets has become more similar after the introduction of the euro which should lead to smaller differences in desired mark-ups.

EMU can thus be expected to reduce firms' incentives to discriminate between European export markets. However, the observed aggregate price differentiation between export markets may also be affected by composition effects. Since more productive firms are more likely to price discriminate between export markets, any difference in the productivity composition of firms entering different export markets may be reflected in the observed aggregate extent of price differentiation. In particular, this would be the case if self-selection of firms into export markets is correlated with the decision to discriminate between markets. Several recent theoretical and empirical contributions to the 'new new trade literature' have shown that the average productivity of firms

is an increasing function of the extent of entry barriers in that market. If barrriers to entry (F_j) are effectively lower in eurozone markets, a higher proportion of low productivity firms would export to EMU markets. This would imply that aggregate price differentiation between these markets is lower since higher share of low productivity firms that do not price discriminate enter these markets. Under the condition that EMU did not reduce entry barriers into eurozone markets, the lower observed aggregate extent of price discrimination in EMU markets would be unrelated to direct effects of EMU on price discrimination but would instead be attributable to differences in lower fixed export market entry costs. Using firm-level export pricing data is crucial to disentangling between direct effects of EMU on the determinants of price discrimination and composition effects unrelated to EMU.

3 Data

The data provided by the French customs administration contain annual exports by country of destination at the firm and product level for the period 1998-2003.[10] In contrast to many other sources of firm-level information, the French customs data are (almost) exhaustive.[11] Any firm selling goods abroad is supposed to report the FOB value and the volume of any individual product for every destination market separately. Each observation is thus identified by a firm number (f), a product identifier at the 8-digit level of disaggregation (p), a destination country (c) and a time period (t). From this, bilateral unit values are computed as ratios of value over volume and used as proxies for FOB export prices: $P_{fpct} = Val_{fpct}/Vol_{fpct}$ with Val_{fpct} the value of the flow in euros and Vol_{fpct} its volume.

Two measures of volumes are available in the French customs dataset. The first measure is the physical weight of the product in kilograms and is reported for (almost) all export flows in the dataset. The second measure, physical units of the exported product, is only reported for a subset of the export flows in the dataset. Note that using weights instead of physical units to calculate unit values may result in a less precise proxy for prices.[12] However, this problem can be dealt with by using unit values at the firm-product level in relative

[10] We are grateful to the customs administration for kindly making these data available. Particular thanks go to Agnès Topiol who provided many detailed explanations of the dataset.

[11] In fact, there is a threshold under which a firm is not forced to declare its exports. Moreover, this threshold is not the same towards European countries and in the rest of the world. This may be a serious problem when comparing pricing behaviors in the EMU and in the rest of the OECD. This is no more the case however when the comparison bears on prices in the eurozone and in the rest of the European Union.

[12] For instance, using weights as measures of volumes, two computers of equal value would have different unit values if they differ

terms. More specifically, every unit value within a firm-product category can be divided by an appropriately chosen reference unit value within the same firm-product category. This removes the measurement error that is common to the same firm-product category and makes relative unit values comparable across firm-product categories. Given that the imprecision of unit values computed using physical weights can thus be reduced, it is decided to use physical weights on the grounds of their better availability in the French customs dataset.

A further common critique of the use of unit values as a proxy for prices is that quality differences between goods are not accounted for (see Kravis & Lipsey, 1974). When using absolute unit values, this induces measurement error. However, the use of relative unit values at the firm-product level also reduces this measurement error since the component that is common to all importing markets is removed. As a consequence, the only remaining measurement error is due to firms vertically differentiating products across markets.[13]

There are several conceivable choices for the reference unit value used in the calculation of the relative prices. The average unit value, the unit value in the cheapest market or the unit value in a reference market at the firm-product level are the most obvious out of these. Under the first two choices the reference country is allowed to vary over time which makes the relative unit value of a given destination sensitive to the sample entry or exit of destinations. On these grounds, it is chosen to use the unit value in a reference market for the calculation of relative unit values at the firm-product level. A natural choice for the reference market is Belgium: It is the main French export destination in terms of number of flows and thus maximises the number of observations on relative unit values.[14] The relative unit value used as the dependent variable in the regressions reported below is thus defined as: $q_{fpct} = p_{fpct} - p_{fpBELt}$ where p_{fpct} is the logarithm of P_{fpct}.

Two further choices are made in the construction of the estimation sample. Firstly, it is decided to restrict the sample to OECD export destinations. The reason is that, because of differences in economic structure, export destinations outside the OECD cannot be considered as an appropriate control group for eurozone export destinations. Secondly, given that the use of relative unit values removes only the component of measurement error that is common to a given firm-product category across destination markets, further effort is put into cleaning them from market specific measurement error. To this end, following Crucini et al. (2005), unit values

in weight.

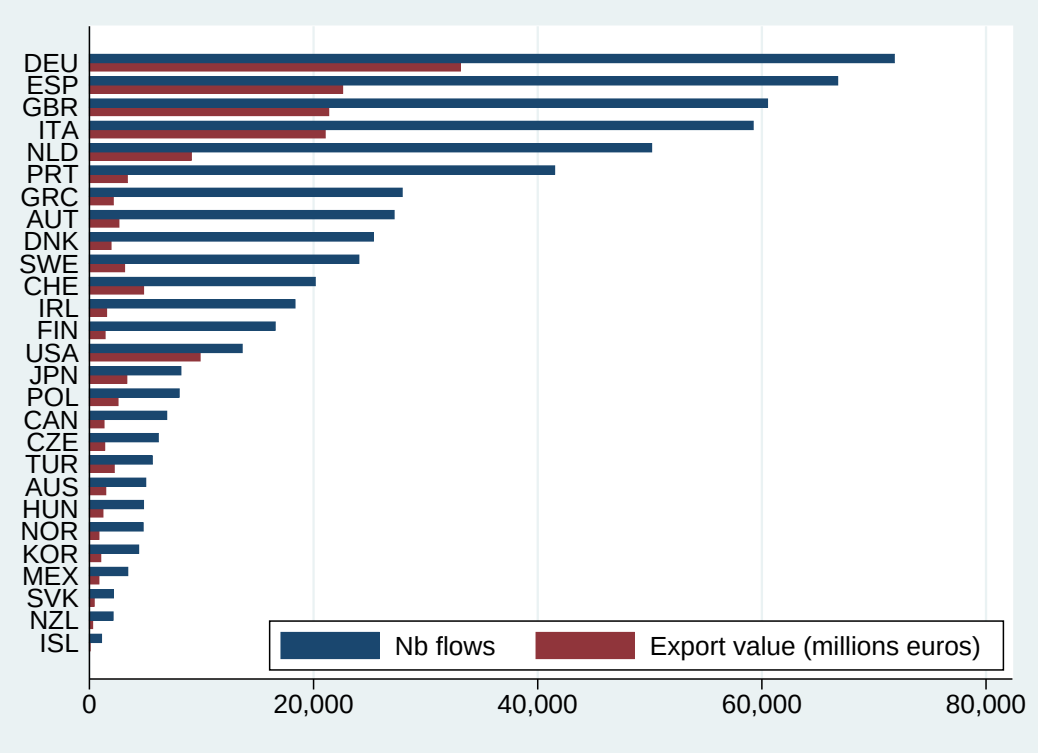
[13] It is not possible to distinguish between firms that set different national prices for identical products from firms that vertically differentiate their products across destination markets. In any case, price differentials reflect some degree of market segmentation which the introduction of the euro may have affected.

[14] Of all firm-product categories exported to OECD markets approximately one third include Belgium as a destination. For firm-product categories that are exported to more than one OECD market this share increases to over 50 percent. Future versions of this study will check the robustness of the obtained results with respect to the choice of reference country

that are more than five times lower or higher than the median unit value within a firm-product category are dropped from the sample.[15]

The resulting estimation sample contains observations on the 3,455,760 relative unit values (henceforth denoted as relative prices) of 45,872 firms spanning 10,314 8-digit product categories in 27 destination markets over the period 1998-2003.[16] Figure 1 shows the number and the value of export flows by destination country.

Figure 1: Geographical distribution of French exports in 2003



4 Descriptive Statistics

Figure 2 shows the mean of the absolute price deviation (from Belgium) in logarithms for the full sample, the eurozone and non-eurozone OECD economies. On average, prices appear to deviate less from the Belgian price within the eurozone than for non-eurozone OECD economies. Moreover, the gap between eurozone and

[15] Approximately three percent of the unit values are dropped.

[16] The 30 members of the OECD minus France, Belgium (the reference country) and Luxembourg which is reported separately in the French customs data only after 1998.

non-eurozone prices seems to be quite stable over the sample period.

Figure 2: Mean deviation from Belgian price

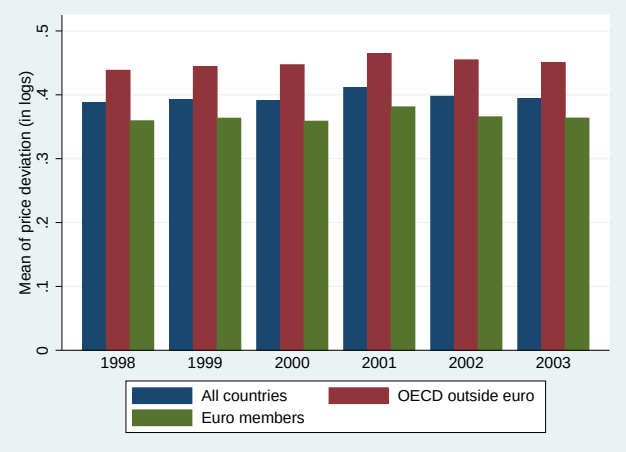


Figure 2 does neither account for country specific determinants export unit values nor sectoral composition effects. With respect to the former, sing data from the US Customs Service, Baldwin & Harrigan (2007) find that export unit values increase, among others, with distance from the exporting country. If this statistical correlation also holds in the French data, the higher mean deviations from the Belgian price for non-eurozone markets in figure 2 may not be directly related to differences in the degree of market segmentation resulting from monetary integration in the eurozone. Instead, they may be attributable to firms setting higher prices in non-eurozone markets due to their higher average distance from France. To provide statistically more rigorous evidence on whether the pattern of mean deviations in figure 2 is attributable to distance and other observable price level determinants, sectoral composition effects, or to differences in the degree of market segmentation between eurozone and non-eurozone countries, the following strategy is adopted. In a first stage, the relative unit values are purged of their systematic price level components. In practice this is implemented through a first stage regression of the relative unit values on log distance, log real GDP, log real GDP/capita and a vector of sector dummies. The results from this first stage regression are reported in Table 7 of the appendix. It can be seen that relative unit values increase with distance, real GDP and real GDP/capita. The absolute value of the residual from this regression is the deviation from the Belgian price that remains unexplained by observable systematic determinants and is therefore akin to a measure of market segmentation.

In a second stage, this measure of market segmentation is regressed on an indicator variable for membership

in the eurozone, year indicators and the set of resulting interaction terms. The coefficient on the indicator variable for membership in the eurozone captures differences in the average absolute deviation from the Belgian price within the eurozone and the rest of the sample in 1998. The coefficients on the interaction terms can be interpreted as difference in difference estimators of the effect of monetary integration on market segmentation: Essentially, they capture whether over the sample period absolute deviations from the Belgian price exhibit a different pattern within the eurozone than in the rest of the sample.

Table 1: Second stage regression

Dependent Variable	abs value log rel uv	
Sample	OECD	EU15
Euro	-0.075***	-0.006***
	(0.001)	(0.001)
Euro*1999	-0.002	-0.003
	(0.002)	(0.002)
Euro*2000	-0.007***	-0.004*
	(0.002)	(0.002)
Euro*2001	-0.003	-0.005**
	(0.002)	(0.002)
Euro*2002	-0.010***	-0.005**
	(0.002)	(0.002)
Euro*2003	-0.009***	-0.005***
	(0.002)	(0.002)
Year Effects	Yes	Yes
N	3,421,940	2,842,805

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

From Table 4 it can be seen that eurozone prices deviate by less from the Belgian price than outside, independently of the choice of control group. This is reflected in the negative coefficient on the euro dummy in columns (1) and (2). While absolute deviations from the Belgian price in the eurozone are lower by approximately 7.5% than in the rest of OECD economies, they are also 0.6% lower than in the non-eurozone 'old' member states of the EU. Of course the fairly large difference in average deviations between the eurozone and the rest of the OECD cannot be fully attributed to monetary integration. In particular, a reduction in market segmentation through the Single Market Program in the late 1980s and the early 1990s may have led to a reduction in price deviations within the eurozone. The estimates reported in the second column of Table 4 can be considered as a more precise measure of the effect of monetary integration on market segmentation and price deviations since the non-eurozone EU15 members have been subject to the same Single Market Program measures as the eurozone members.[17] The statistically significant but fairly small estimated coefficient on the

[17]Using this restricted control group has the additional advantage that the reporting thresholds are the same irrespective of the

eurozone indicator in the second column therefore indicates that pre 1998 monetary integration in the eurozone has, at best, had a small effect on market segmentation and the pricing strategies of French exporters. A slightly different picture emerges from the comparison of the time patterns of absolute price deviations within the eurozone and in the rest of the sample: Absolute deviations from the Belgian price appear to have decreased within the eurozone when compared to the extra-eurozone control group, irrespective of the choice of control group.

5 Homogeneous Firms Estimates

While the previous section has provided descriptive evidence on differences in relative prices within and outside the eurozone, this section deals with the issue of whether European monetary integration has had an effect on the speed of price convergence. To this aim, a standard price convergence equation is estimated, augmented with an interaction between the price lag and the dummy variable for membership in the eurozone:

$$\Delta q_{fpct} = \beta_1 q_{fpct-1} + \beta_2 Euro \times q_{fpct-1} + \varepsilon_{fpct} \tag{7}$$

In this equation, the coefficient on the price lag (β_1) captures the speed of convergence for non-eurozone countries. The coefficient on the interaction (β_2) measures whether there is a difference in the speed of convergence between non-eurozone OECD economies and the eurozone. Before this however, a basic convergence regression without euro effect shows that in the data under consideration the LOOP in its absolute version actually holds.[18] Results using different estimation methods are presented in columns (1)-(3) of Table 2.

Column (1) reports the results of regressing the first difference of the log price deviation on the lagged log price deviation. This benchmark regression corresponds to a test of the absolute version of the LOOP. It can be seen that the data clearly reject a unit root in the log price deviation data.[19] The speed of convergence to the LOOP in its absolute version is high with a half life of deviations of around 0.75 years or 9 months.[20] Only few studies report estimates of the speed of convergence to the LOOP in its absolute version. The most relevant in terms of comparability with the present study is Goldberg & Verboven (2005) who report estimates

destination market. Reporting thresholds differ between intra EU and extra EU destination markets which may bias the results of the estimations on the whole OECD sample.

[18] See Goldberg & Verboven (2004), Imbs, Mumtaz, Ravn & Rey (2005) or Choi, Mark & Sul (2006) for details on the methodology.

[19] t-statistics are lower than -600 which is far below the critical values reported in Levin & Lin (1992) at the 1% significance level.

[20] The half life of a deviations can be computed as $t_{1/2} = ln(0.5)/ln(\beta + 1)$

Table 2: Dynamic homogeneous firms estimates

Dependent variable	First difference of log price deviation						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Plag	-0.605^{***}	-0.611^{***}	-0.608^{***}	-0.541^{***}	-0.645^{***}	$-.575^{***}$	-0.622^{***}
	(0.001)	(0.001)	(0.003)	(0.001)	(0.002)	(.012)	(.009)
Euro_Plag				-0.117^{***}	-0.013^{***}	-0.058^{***}	-0.007
				(0.001)	(0.002)	(.013)	(.010)
Euro				0.021^{***}	0.025^{***}		
				(0.002)	(0.002)		
N	1,806,857	1,806,857	1,806,728	1,806,857	1,523,937	1,806,728	
R-squared	0.30	0.30		0.31	0.33		
RMSE	0.50	0.50		0.50	0.49		
Market fixed effects	No	Yes	Yes$^{(a)}$	Yes	Yes	Yes	Yes
Sample	OECD	OECD	OECD	OECD	EU15	OECD	EU15
Method	Pooled OLS	Pooled OLS	Mean Group	Pooled OLS	Pooled OLS	Mean Group	Mean Group

Standard errors in parentheses, obtained by bootstrapping in column (3).

* significant at 10%, ** significant at 5%,*** significant at 1%.

$^{(a)}$ Market $\times$ sector (at the SITC3 level) fixed effects.

ranging from 2.2 years to 8.3 years using a cross country dataset on car prices. The reason that the speed of convergence to the absolute version of the LOOP is far higher in this study is probably linked to the fact that the data are not contaminated by local cost factors, distribution margins or taxes. Column (2) shows that the results are essentially not affected by the introduction of market fixed effects. Absolute convergence rather than convergence conditional on market specific characteristics appears to be the relevant convergence concept for French export prices. Column (3) provides results obtained from a mean group (MG) estimator that accounts for cross sector heterogeneity in the speed of convergence. As shown by Imbs et al. (2005), using pooled OLS and ignoring this heterogeneity may lead to an overestimate of the persistence of price deviations. The MG estimator estimates the convergence speed for each three digit sector separately and then takes the arithmetic mean of the sectoral convergence speeds. Standard errors are obtained by a bootstrapping procedure. Figure A.1 in the Appendix reports the sectoral convergence speeds and shows that persistence coefficients do indeed vary across sectors. However, this cross sector heterogeneity does not seem to generate a bias of the pooled OLS estimator.

Columns (4) and (5) test more specifically whether the speed of convergence differs between members and

non-members of the eurozone. To this end, the euro dummy already used in Section 4 is interacted with the price lag and introduced in the convergence equation. The estimated coefficients on the price lag and on the interaction term in column (4) imply that the speed of convergence in the whole OECD sample is around 11 months as compared to around 8 months when the sample is restricted to EU15 countries. Note that it would be erroneous to conclude that the European monetary integration process is the only determinant of this difference. Instead, the negative coefficient on the interaction term may simply reflect that general market integration is higher in the eurozone. Column (5) reports the same specification as column (4), the only difference being that the control group is restricted to non-eurozone EU15 members. The results are qualitatively similar to the ones in column (4) but the magnitude of the euro effect is much smaller: The half life of price deviations is on average 0.3 months lower for members of the eurozone than for non members.

These results thus suggest that price convergence has been faster within the eurozone than in the rest of the EU15 over the whole 1998-2003 period. Since the rest of the EU15 has been subject to the same policy measures aimed at increasing market integration as the eurozone, it appears that this difference cannot be explained by the market integration process preceding the period under consideration. Instead, the negative and significant coefficient on the interaction between the euro dummy and the price lag in column (5) can plausibly be interpreted as an effect of monetary integration on the speed of price adjustment: For instance, through stronger arbitrage pressures or through the reduction of exchange rate fluctuations after the Maastricht Treaty which may have reduced price dispersion due to local currency price rigidities.

All of these interpretations implicitly rely on the assumption that convergence speeds are homogeneous across sectors and firms. However, the mean group estimates of columns (6) and (7) suggest that part of the euro effect is driven by sectoral composition effects. In column (6) the effect of the euro on the speed of price convergence is reduced by approximately one half with respect to the estimates relying on the assumption of a homogeneous convergence speed across sectors in column (4). In other words, half of the euro effect in column (4) of Table 2 can be attributed to the fact that intra-eurozone trade is skewed towards sectors in which the speed of price convergence is high. In column (7), where the control group is composed of non-eurozone EU15 members, the effect of the euro on the speed of price convergence even vanishes after controlling for differences in convergence speeds across sectors.

Carrying the analysis one step further, the following section analyses to which extent the observed euro

effect can be attributed to firms adopting different pricing strategies across destination markets or to self-selection of firms with different pricing strategies into different destination markets. In other words, firms that price discriminate more may also be more likely to serve non-eurozone destination markets. In this case, price dispersion outside the eurozone would be larger, the speed of convergence lower and the euro effect could be attributed to differences in the composition of firms serving eurozone and extra-eurozone markets.

6 Heterogeneous Firms Estimates

As shown in Section 2, productive firms tend to price discriminate more than unproductive firms. Recent trade models with heterogeneous firms (see Melitz, 2003) also show that productive firms have a higher propensity to select into markets with high fixed entry costs. If fixed entry costs for French firms are higher in non-eurozone markets than in eurozone markets, among others because of their higher average distance from France, then the assumption of a homogeneous convergence speed across firms may bias the euro effect upwards: Firms that discriminate more have a higher propensity to select into non-eurozone markets. To eliminate this selection bias and to obtain unbiased estimates of the euro effect, it is therefore crucial to control for productivity in the price convergence regressions.[21] In Melitz (2003) type of models there is a one to one mapping between productivity and the size of firms as measured by their employment. To keep as close to theory as possible, it is therefore decided to use firm-level employment as the main proxy for productivity in the following price convergence regressions. As a robustness check, we also present the estimation results using the ratio of value added over employment as a proxy for labour productivity.

Table 3 confirms our intuitions. Column (1) first presents the homogeneous firms estimate of the euro effect for the reduced sample in which firm-level employment is available. It can be seen that the coefficient on the euro indicator remains negative and significant in this reduced sample. The size of the coefficient is reduced by approximately one half with respect to the homogeneous firms estimate, which is in line with our expectations. Since the French industry survey from which the employment data are drawn only contains firms with greater or equal 20 employees, the smallest firms are dropped from our estimation sample which alleviates the selection bias. Column (2) shows that there is a positive coefficient on the interaction between the price lag

[21] Note that self-selection in the model in Section 2 is based on productivity, an observable variable. In contrast to models in which selection is based on unobservable variables and a selection model has to be estimated (see Heckman, 1990**?** among others), here it is therefore sufficient to control for the selection variable.

and the firm's employment level. This indicates that price deviations of larger firms are indeed more persistent than price deviations of smaller firms. In column (3) the specification in column (2) is augmented by the interaction between the price lag and the euro indicator. It can be seen that in contrast to the homogeneous firms specification in Table 2 the coefficient on the euro dummy is no more significant in this specification. This suggests that the euro effect is indeed driven by selection: After controlling for the selection of firms with low convergence speeds into non-eurozone markets the euro effect vanishes. In other words, there is no evidence in the French export data that the same firm engages in different pricing strategies within and outside the eurozone. Columns (4) and (5) check the robustness of the obtained results to the choice of the productivity proxy. Namely, column (5) shows that the speed of price convergence decreases with productivity if labour productivity instead of employment is chosen as productivity proxy. Column (6) shows that the euro effect disappears if it is controlled for selection into export markets by including labour productivity.

Table 3: Convergence regressions controlling for firm-level determinants

Dependent variable	First difference of log price deviation					
	(1)	(2)	(3)	(4)	(5)	(6)
Plag	-0.618^{***}	-0.705^{***}	-0.697^{***}	-0.605^{***}	-0.650^{***}	-0.668^{***}
	(.002)	(.004)	(.007)	(.006)	(.007)	(.014)
ln employment×Plag		0.015^{***}	0.014^{***}			
		(.001)	(.001)			
ln productivity×Plag					0.007^{***}	0.012^{***}
					(.002)	(.003)
Euro × Plag	-0.006^{***}		-0.009	0.005		0.023
	(.002)		(.009)	(.007)		(.017)
Euro × ln empl× Plag			0.001			
			(.001)			
Euro × ln prod× Plag						-0.007^{*}
						(.004)
N	805,883	805,883	805,883	81,380	801,147	801,147
R-squared	0.31	0.31	0.31	0.31	0.31	0.31
RMSE	0.51	0.51	0.51	0.53	0.51	0.51
Sample	EU15	EU15	EU15	EU15	EU15	EU15
Level dummies	Yes	Yes	Yes	Yes	Yes	Yes
Method	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS

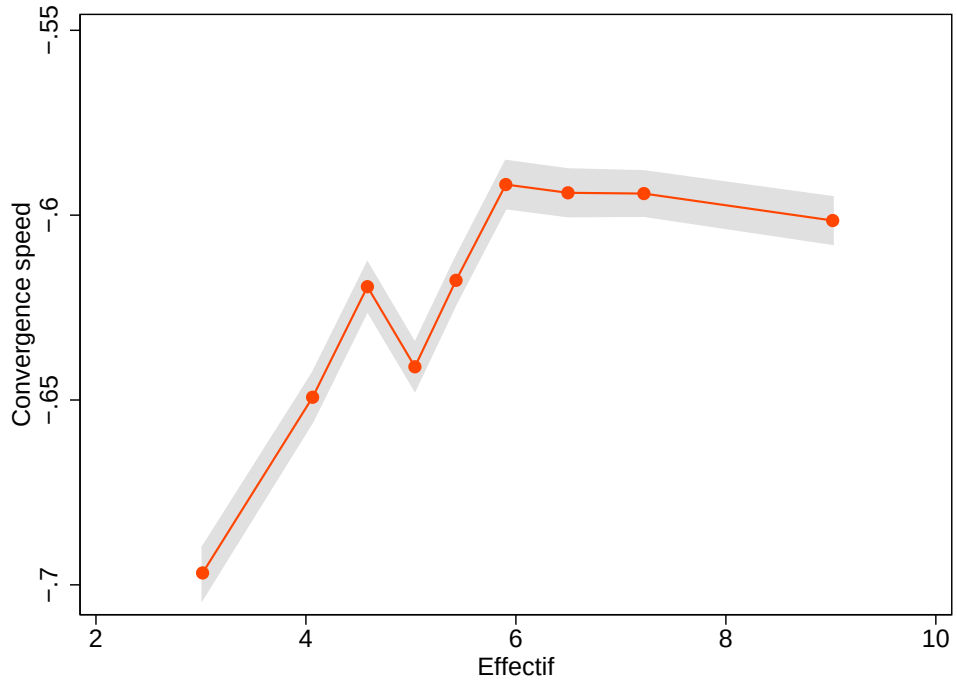
Standard errors in parentheses.

* significant at 10%, ** significant at 5%,*** significant at 1%.

6.1 Plausibility

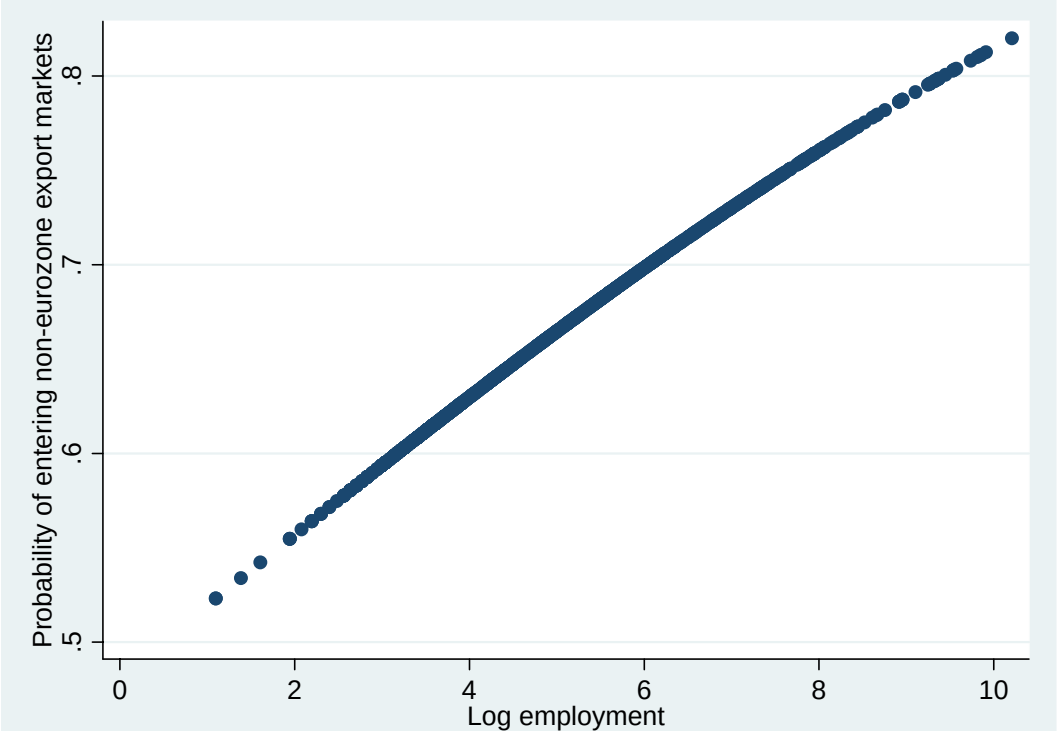
The mechanism we propose to explain the disappearance of the euro effect on the speed of price convergence once it is controlled for firm-level productivty relies on two elements. Firstly, large and more productive firms are assumed to price discriminate more between export markets. This has already be shown in column (1) of Table 2. Figure 3 shows the positive relationship between employment and the speed of price convergence graphically.

Figure 3: Estimated speed of convergence and firms' employment



The second element our proposed mechanism relies on is a higher propensity of high productivity firms to enter non-eurozone export markets. This can be verified by estimating a probit model in which the dependent variable is a firm-level indicator that takes the value one if the firm exports to non-eurozone markets and takes the value zero if it exports exclusively to the eurozone and the explanatory variable is employment. Table 7 in the appendix shows the results from this estimation. Figure 4 illustrates the positive relationship between the probability to export to non-eurozone markets and employment graphically.

Figure 4: Probability to export and firms' employment



7 Further Research

We conclude with three directions for further research. Firstly, future versions of this paper will check whether the obtained results are robust to the choice of an alternative reference country. Secondly, we will check whether the results are robust to the choice of alternative productivity measures, namely measures of total factor productivity. Thirdly, we will further check the plausibility of our results by restricting the sample to firms that export both to eurozone and non-eurozone markets. Similarly as controlling for productivity this should reduce selection bias in the estimation of the euro effect.

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Table A.1: First stage regression

Dependent variable	log rel uv
log distance	0.047***
	(0.000)
log real GDP	0.001***
	(0.000)
log real GDP/capita	0.067***
	(0.001)
Sector Effects	Yes
N	3,421,940

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Figure A.1: Kernel density of sectoral convergence speeds

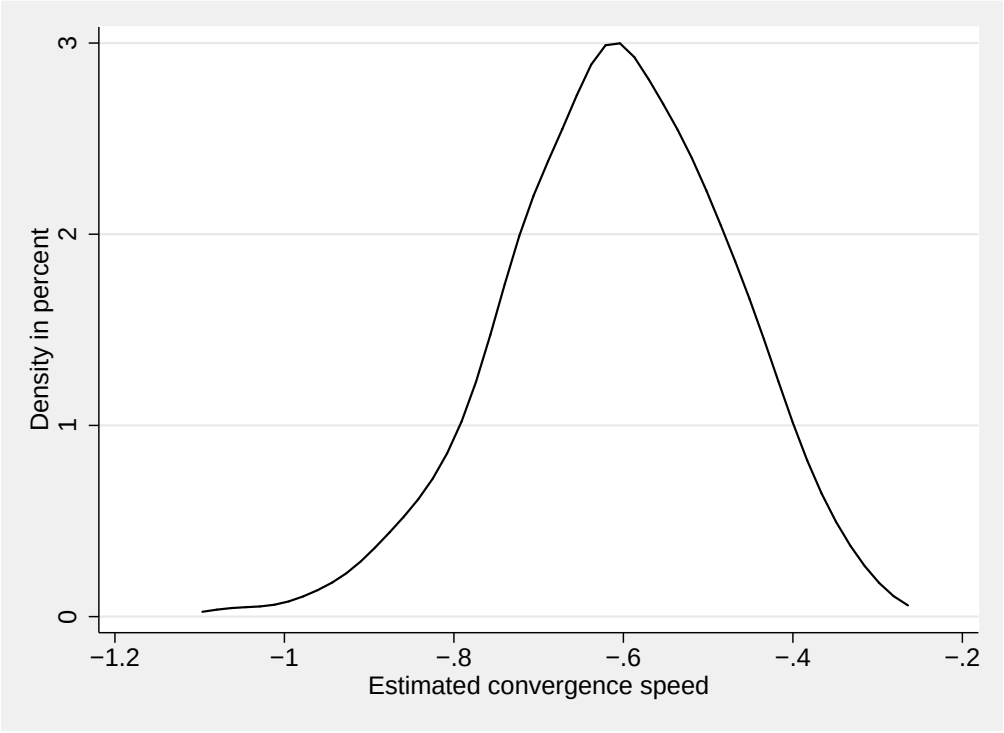

Table A.2: Probit for extra-eurozone exports

Dependent variable	Non-eurozone exports: Yes/No
Log employment	0.094***
	(0.014)
Constant	-0.045
	(0.063)
N	288,050

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%