

Exports and Exchange Rate: A Firm-Level Investigation.

Sarah Guillou

▶ **To cite this version:**

Sarah Guillou. Exports and Exchange Rate: A Firm-Level Investigation.. Workshop : International Activities and Firm Performance, Feb 2008, Nottingham, United Kingdom. hal-01053170

HAL Id: hal-01053170

https://sciencespo.hal.science/hal-01053170

Submitted on 29 Jul 2014

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Exports and exchange rate: a firm-level investigation*

Sarah Guillou†

February 2008

Abstract

This paper investigates the relation between export behaviour and the exchange rate at firm level. We use a dataset of French manufacturing firms from 1994 to 2004, to study the sensitivity of firms' export intensity and probability of entering a foreign market, to the exchange rate. This large dataset allows us to differentiate among 21 manufacturing industries. We show that for most industries, the exchange rate has an influence on export entry, but that the effect of changes in the exchange rate on export intensity is fairly neutral. The probability of entering an export market is increased by depreciation. This supports the presence of export sunk costs, which are more easily incurred by firms in periods of exchange rate depreciation. We conclude that currency appreciation is a cause for concern because it increases import penetration implying higher levels of foreign competition for domestic firms.

JEL codes: F1, F31, F32, F4

1 Introduction

The strength of the euro is increasing and, unlike the situation in the United States, growth in Europe in recent years has been substantially export led. But if the euro continues to rise and if exports get more expensive, growth will be more difficult to sustain. Exchange rate parity is a rather sensitive subject in international affairs. The euro's appreciation is worrying European leaders while the weakness of the Asian currencies is a source of annoyance to the United States and, more generally, Asian firms' competitors. Exchange rate policy is regarded as unfair policy. In concrete terms, exchange rate overvaluation is seen as being responsible for artificially decreasing competitiveness and thus cutting export trade and growth. Economic arguments over the role of the exchange rate on trade are deeply rooted in the past. But research in this field since the 1970s has focused on

*The author is particularly grateful to Lionel Nesta and Stefano Schiavo for helpful comments. All remaining errors are her owns.

†Observatoire Français des Conjonctures Économiques, Département de Recherche sur l'Innovation et la Concurrence, 250 rue Albert Einstein, 06560 Valbonne, France. E-mail: sarah.guillou@ofce.sciences-po.fr

understanding the failures of exchange rate policy. From the J curve (Masera, 1974) to the hysteresis model (Dixit, 1989), scholars have tried to find explanation for the rigidity between trade flows and changes in the exchange rate.

At the same time, the collapse of the Bretton Woods system has led the theoretical research to focus on the effect of increased volatility of the exchange rate. Exchange rate volatility is undoubtedly non-neutral (Cheong et al., 2005), but there are no consensual theoretical or empirical results related to its impact on trade. McKenzie (1999), states that "despite the best efforts of economists, a basic paradox as to the impact of exchange rate volatility on trade flows remains unresolved at both the theoretical and empirical level". Since then, exchange rate volatility has undoubtedly decreased for European members.

This is not a far cry from claiming that empirical difficulties have once again motivated new theoretical investigation. Examination of exporters' behaviour is one example. Initially, such investigations dealt with the response of relative prices to the nominal exchange rate. A seminal paper introducing the role of the exchange rate on exporters' behaviour, in a model of industrial organization, is Dornbusch (1987). An exogenous exchange rate overvaluation decreases the marginal costs (in local currency) of foreign firms relative to local firms.Dornbusch (1987) showed that in a Cournot competition, domestic currency appreciation creates a cost disadvantage that increases the foreign market share to the detriment of domestic firms. A currency appreciation decreases domestic export volumes. But a change in the exchange rate will seldom be completely passed through to local prices. Empirical studies thoroughly document this fact. It can be mainly seen in exporters' price discrimination among market destinations (Krugman, 1987; Knetter, 1989). This price-to-market behaviour also induces price rigidities to exchange rate changes. One of the main conclusions of the extensive literature on exchange rate pass-through (see for a survey Goldberg and Knetter, 1997) is that market structure and other industry characteristics have an important effect on firms' pricing behaviour in international markets.

The second issue within these investigations is the response of exports to exchange rate changes, regardless of whether relative prices have changed or not. Research on the micro-foundations of export supply response (Roberts and Tybout, 1995) addresses the question of exchange rate changes, relying on the trade hysteresis literature (Baldwin and Krugman, 1989; Baldwin, 1990). This literature starts with entry models in which sunk costs have to be incurred to enable entry to the foreign market. These sunk costs mean that exchange rate variation will affect the decision to enter, by changing the level of expected future profits from exporting. These models question the influence of exchange rate volatility. Because entry costs are likely sunk, exchange rate volatility strongly affects the decision to enter. Acting as a vector of uncertainty, exchange rate volatility can induce a wait-and-see attitude (see Darby et al., 1999). In Dixit (1989)'s model, uncertainty can deter entry even if the firm is risk neutral. Based on the theory of option pricing, a firm not currently

exporting is seen as owning an option to enter the foreign market in the future. In this case, an increase in exchange rate volatility could postpone entry because it raises the value of maintaining the option. The greater the volatility, the longer the firms already in the export market will wait to exit, and the longer it will be before non-exporting firms can enter. Thus, the higher the volatility, the wider will be the band of exchange rate changes during which no entries and no exits will occur.

Empirical studies have focused on proofs of the existence of sunk costs (Roberts and Tybout, 1997). In terms of exchange rate volatility, the empirical results are far from consensual (see for a survey, Cote, 1994; McKenzie, 1999). Taglioni (2002) asserts that even new methodologies using time series "tend in general to indicate that there is not a systematic link between exchange rate variability and trade flows".

In both cases, a promising axis of empirical research is based on firm level data. These allow theoretical models of firm behaviour to be compared with firm data and take account of firm heterogeneity by rejecting the simplifying hypothesis of a single representative firm. In fact, both exporters and non-exporters coexist in an industry.

Our paper is positioned within the literature that relies on theoretical models of exporters' behaviour and firm level data. It deals specifically with the relation between the exchange rate and exporter behaviour. There are a few recent empirical studies that focus on this relation and use firm data. Campa (2004) study considers the period 1990-1997. He finds that exchange rate volatility has no impact on Spanish exporters and that the depreciation of the domestic currency increases the domestic export volume. Bernard and Jensen (2004), focusing on participation in exporting, find that, for US plants, depreciation increases this participation. To our knowledge, the present study is the first analysis using French firm data, that deals with the question of exchange rate sensitivity. It is also the first study with sufficient observations to enable a focus on market entry (first time export participation) and differentiation among industries.

Our objective is to investigate how export intensity and export penetration by French firms are sensitive to the level and volatility of exchange rates, exploiting a database of large French manufacturing firms covering the period 1994-2004. Through this investigation we hope to contribute to the ongoing debate on the role of exchange rate policy. We find that having exported yesterday, increases the probability of exporting today. In addition, we show that, for most industries, the exchange rate has an influence on export entry whereas the effect of changes in the exchange rate on export intensity is rather neutral. The probability of entering the export market is increased by depreciation. Our results show the presence of sunk costs associated with export, which are more likely to be incurred when there is a depreciation in the domestic currency.

The next section presents the theoretical model behind our estimation. Section 3 deals with the econometric specification. Section 4 presents the data and describes the

construction of the main variables. Section 5 presents the empirical results and section 6 concludes.

2 Export and irreversible costs

We follow Campa (2004) who estimates a dynamic discrete choice firm model. This model is based on the irreversible cost associated with the entry in to a foreign market. Let us assume a French exporter that potentially can produce for both the domestic market and the foreign market. The share of production that will be exported is γ_i. But this exporter can also decide not to export, in that case $\gamma_i = 0$. The more γ_i tends to one, the more the firm's export intensity will increase. The expected revenue of firm i given the level of information, Ω_{it} is:

$$V_{it}(\Omega_{it}) = \max_{I_{it},Q_{it},\gamma_{it}} E_t \left[\sum_{j=t}^{\infty} \delta^{j-t} R_{ij} \left(I_{ij}, \gamma_{ij}, Q_{it} \right) | \Omega_{it} \right] \tag{1}$$

I_{it} is a qualitative variable that takes the value 1 if firm i exports at time t; γ_{it} is the share of the production that is exported at time t, δ is the one-period discount factor. R_{it} is the expected net revenue of the firm depending on its export behaviour (exporting or not and if so, how much). Let us assume fixed costs of entry in the export market (Fi) and fixed costs of exit (Gi)[1], then the expected net revenue is:

$$R_{it}(I_{it}, \gamma_{it}, Q_{it}) = \pi_{it}^{d} \left((1 - \gamma_{it}) Q_{it} \right) + I_{it} \left[\pi_{it}^{x}(\gamma_{it}, e_{it}) - F_i(1 - I_{it-1}) \right] - G_i I_{it-1}(1 - I_{it})$$

where π_{it}^{d}, π_{it}^{x} are the gross profits from domestic production and from exporting, both depending on γ_{it}, the share of exports in production. The gross profit from exporting depends on the exchange rate, e_{it} , defined as the amount of French currency per foreign currency. The expected net revenues depends on the export behaviour: on whether the firm exported in the last period and is exporting in the current period. If the firm was an exporter in the last period ($I_{it-1} = 1$) and is still exporting ($R_{it}(I_{it}, \gamma_{it}, Q_{it}) = \pi_{it}^{d} \left((1 - \gamma_{it}) Q_{it} \right) + \pi_{it}^{x}(\gamma_{it}, e_{it})$; if the firm exited, then $R_{it}(I_{it}, \gamma_{it}, Q_{it}) = \pi_{it}^{d} \left((1 - \gamma_{it}) Q_{it} \right) - G_i$. If the firm is a prime exporter (i.e. decides to export for the first time in the current period), then $R_{it}(I_{it}, \gamma_{it}, Q_{it}) = \pi_{it}^{d} \left((1 - \gamma_{it}) Q_{it} \right) + \pi_{it}^{x}(\gamma_{it}, e_{it}) - F_i$.

From (1) and using Bellman's equation, the firm's behaviour will be such that:

[1] We are assuming here that the entry and exit fixed costs are time invariant. But European market integration and decreasing trade costs with all partners may have changed these costs during the period (1994-1998). Let us also suppose that these costs are paid once and for all. But the entry cost may have a decreasing value from the period of first entry to further periods. Finally, these costs are related to the firm and represent an aggregation of the fixed costs spent for each destination market of the exporting firm.

$$V_{it}(\Omega_{it}) = \max_{\gamma_{it}, I_{it}, Q_{it}} \left[R_{it}(I_{it}, \gamma_{it}) + \delta E_t \left(V_{it+1}(\Omega_{it+1}) \right) | I_{it} \right] \tag{2}$$

The first order condition of this problem gives the following export participation decision rule. The firm i will decide to export when:

$$\pi_{it}^{d}\left((1-\gamma_{it})Q_{it}\right) + \pi_{it}^{x}(\gamma_{it}, e_{it}) + \delta\left[E_t\left[V_{it+1}\left(\Omega_{it+1}\right)|I_{it}=1\right] - E_t\left[V_{it+1}\left(\Omega_{it+1}\right)|I_{it}=0\right]\right] \geq F_i - \left(F_i + G_i\right) I_{it-1} \tag{3}$$

The firm's entry and exit decisions depend on the current value of the exchange rate and on its conditional distribution. The current value of the exchange rate affects the expected profits from exporting in the current period. The exchange rate volatility affects the decision to enter. Whereas the export volume is only affected by the exchange rate level, both volatility and level of exchange rate affect the decision to enter or to remain in the export market. Exchange rate volatility affects the decision to enter or to exit as it is an element of uncertainty that influences future revenue flows. So the conditional distribution of the exchange rate will only have an impact on the extensive margin. It does not have any impact on the level of current exports of existing exporters.

3 Econometric specification

Our objective is to estimate the sensitivity of export intensity[2] and export status to the level and volatility of the exchange rate. As defined previously:

$$I_{it} = \begin{cases} 1 & \text{if} \quad \left[R_{it}\left(Q_{it}, I_{it}, \gamma_{it}\right)|I_{it}=1\right] \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

Where,

$$R_{it}^{*} = \pi_{it}^{d}\left((1-\gamma_{it})Q_{it}\right) + \pi_{it}^{x}(\gamma_{it}, e_{it}) + \delta\left[E_t\left[V_{it+1}\left(\Omega_{it+1}\right)|I_{it}=1\right] - E_t\left[V_{it+1}\left(\Omega_{it+1}\right)|I_{it}=0\right]\right] - F_i - \left(F_i + G_i\right) I_{it-1}$$

First, we estimate the export intensity γ_{it} of exporter i at time t.

$$\gamma_{it} = \begin{cases} \alpha_0 + \alpha_1 \mathrm{X_{it}} + \upsilon_{\mathrm{it}} & \text{if} \quad \left[R_{it}^{*}\left(Q_{it}, I_{it}, \gamma_{it}\right)|I_{it}=1\right] \geq 0 \\ 0 \quad \text{if} \quad \mathrm{I_{it}} = 0 \end{cases}$$

[2]Export volumes are difficult to obtain because of the lack of export deflators. Not only are unit values unsatisfactory price measures but they are based on product classifications meaning that an aggregation process would be necessary to obtain prices at industry level. This aggregation process increases the noise in the unit value. Thus, we concentrate on export intensity.

X_{it} are observable exogenous variables, α_0 and α_1 are the parameters, and υ_{it} is the error term. X_{it} is a vector of the two types of variables: firm characteristics and industry variables. Firm characteristics include: the previous year's export intensity, size of the firm (employment), firm's labour productivity, labour intensity (ratio of wages on sales), and capital intensity (ratio of investment on sales). The coefficient on previous export intensity should exhibit a positive and significant sign, indicating the presence of export sunk costs. Size and productivity should have a positive effect on export intensity. Labour intensity and capital intensity should have positive or non-significant signs. The industry variables are the effective exchange rate and the import rate. An increase in the effective exchange rate means depreciation. It is expected to increase export market share and thus export intensity. Changes in export intensity reveal changes in export volume among other things. Indeed, on the one hand, an increase in export intensity may be the consequence of a lag in the cycle of growth between the domestic and the foreign market. If the growth in domestic demand is low vis-à-vis the growth in foreign demand, then this could increase export intensity because the share of value added that satisfied foreign demand increases, but export volume might stay constant. On the other hand, an increase in export volume could occur without any increase in export intensity if the scale of production has increased. In any case, the sensitivity of export intensity to the exchange rate will reveal a price effect. Depreciation of the domestic currency is expected to increase export intensity [3].We should also bear in mind that export intensity is measured here, regardless of the destination market. Therefore, an increase in export intensity could result from entry into a new foreign market. The industry import rate has an unexpected effect. It will undoubtedly increase competition within the domestic market. Then, it will either induce domestic firms to become more productive (or to exit) and therefore allow them to start exporting; or it will increase the focus on the domestic market, postponing export.

Second, we estimate the probability of entering a foreign market for the first time. This requires the definition of a variable for export entry:

$$I_{it} = \begin{cases} 1 & \text{if} \quad \left[R^*_{it}\left(Q_{it}, I_{it}, \gamma_{it}\right) | I_{it} = 1\right] \geq 0 \\ 0 & \text{otherwise} \end{cases} \quad and \quad I_{it-1} = 0$$

The latent variable is:

$$R_{it} = \beta_1 Z_{it} + \beta_2 \sigma_{it} I_{it} + \varepsilon_{it}$$

$$\Pr(I_{it} = 1 / I_{it-1} = 0) = \Pr\left(R_{it} \geq 0 | I_{it} = 1, I_{it-1} = 0\right) = f\left(Z_{it}, \sigma_{it}\right) \tag{4}$$

[3]A currency appreciation is not always the sign of increased growth. Although appreciation can be linked to high interest rates and high rates of growth, numerous historical cases show the reverse to be the case. European economies are the most recent famous examples.

Z_{it} is a vector of the variables that explain the firm's export decision. These variables are the same as the X_{it} vector except for past export intensity. We add exchange rate volatility to estimate the role of exchange rate uncertainty on export status. Past export status (one year earlier) is included when the focus is not on a prime exporter. We differentiate export status between being an exporter in year t or becoming an exporter in year t. The first status makes no hypothesis about the status for the year before. The second assumes that the firm was never an exporter before year t.

First we estimate export intensity equation using a Heckman model (Heckman, 1979) in which export status (being or not an exporter) is used as the selected equation. The Heckman two-step selection model avoids the selection bias induced by excluding non-exporters from the export intensity equation.

Second, we estimate the role of the level and the volatility of the exchange rate on the probability of entering the export market by applying a dynamic discrete choice model. Because we assume that ϵ_{it} is the sum of a permanent, firm-specific component and a white noise component: $\epsilon_{it} = \alpha_{it} + \omega_{it}$, we estimate equation (4) by a random-effects probit model.

4 Data

This paper uses firm-level data on French manufacturing production from 1994 to 2004. Data are from the annual survey of French manufacturing firms implemented by the French Ministry of Industry. This survey covers all firms with more than 19 employees, belonging to the manufacturing sector[4]. It represents annually around 17% of French exporters, and 68% of French export[5].

Table 1 shows the percentage of firms that exported in 1998, by industry and firm size. As expected, the larger the size of the firm, the higher is the percentage of exporters. Only 65.5% of small firms (20-50 employees) are exporters, whereas 97.7% of firms with more than 2,000 employees are engaged in export. The concentrations of exporters vary depending on the industry. Pharmaceuticals, chemicals, aircraft and spacecraft, and the metal industries include a large number of exporters, more than 80% of firms. Export intensity also differs by industry and by firm size. The average export intensity of small firms (20-50 employees) is 11% whereas it is 35% for large firms (1,000-2,000 employees). Contrary to Campa (2004), who studied Spanish firms, there is a positive relationship

[4]All firms belong to "D", minus the food processing and tobacco industries, i.e. from 17 to 39 of the ISIC 2digit rev-3 level.

[5]In 2004, the manufacturing industry (i.e. including also firms with less than 19 employees compared to our data) amounted to 34% of total French exporters. Small enterprises (less than 20 employees) represent 48% of this number. But manufacturing industry exports represent 73% of total exports and small enterprises represents 6% of this volume (source: French Customs, 2005).

Table 1: Percentage of firms that export in 1998 by firm size (N = number of employees)

Industry	*ISIC-rev3*	*20-49*	*50-99*	*100-249*	*250-499*	*500-999*	*1000-1999*	*2000¡N*	*All size*	*Exp. Intensity (allsize)*
Textiles, textile products, leather and footwear	17-19	63.6	70.5	81	93.3	96.3	100	100	73.6	26
Wood and products of wood and cork	20	54.9	67.1	80.9	76.9	100	100		61.5	19
Pulp, paper products, printing & publishing	21-22	62.8	73	78.8	83.9	86.7	86.7	100	68.5	11
Coke, refined petroleum products & nuclear fuel	23	81.3	60	100	33.3	60	40	100	63.9	14
Pharmaceuticals	2423	89.7	95.1	93.9	100	93.5	100	100	92.5	22
Chemicals excl. pharmaceuticals	24ex2423	85.8	91.4	93.5	96.9	95.6	100	100	90.7	33
Rubber and plastics products	25	76.4	86.2	88.5	83.8	97.4	94.1	100	82.3	18
Other non-metallic mineral products	26	50.1	66.3	72.9	92.6	93.1	88.9	100	61.2	21
Iron and steel	271+2731	87	96.7	96	88.2	100	88.9	100	92.7	32
Non-ferrous metals	272+2732	83.8	91.2	92.5	86.4	90.9	100	100	88.5	25
Fabricated metal products, except mach. & equip.	28	56.8	71.1	85.8	96.4	100	100	100	64.3	15
Machinery and equipment, n.e.c.	29	75.3	87.8	95	93.7	96	100	100	83	27
Office, accounting and computing machinery	30	61.8	100	90.9	100	100	100	100	81.3	41
Electrical machinery and apparatus, nec	31	64.4	77.2	83.8	92	97.6	100	100	75.7	24
Radio, television and communication equipment	32	62.3	68.8	70.6	86.8	100	100	92.3	69.6	27
Medical, precision and optical instruments	33	75.8	83.9	92.5	97.8	93.8	100	100	82.2	30
Motor vehicles, trailers and semi-trailers	34	66	85.5	87.3	94.6	93.3	100	91.7	79.1	23
Building and repairing of ships and boats	351	65.2	70.6	78.9	50	100	100	100	72	43
Railroad equipment & transport equipment n.e.c.	352+359	74.3	83.3	93.8	100	100	100	100	84	29
Aircraft and spacecraft	353	84.8	64.3	86.7	87.5	100	100	100	86	33
Manufacturing nec recycling	36-37	77.5	87.5	93.7	93.5	100	100	100	82.5	20
All industries	17-39	65.5	77.8	86.3	90.8	95	95.9	97.7		
Export intensity (%)		10.9	16.4	23.1	29.7	32.5	35.3	40.4		

Source :French Annual enterprises survey (1998), French Ministry of Industry, ISIC-rev3 classification

between export intensity and the size of the firm. Lastly, some industries are more export oriented. Chemicals, office machinery, shipbuilding and aircraft industries have average export intensities of over 30%.

During the 10 years from 1994, it can be seen from Table 2 that the share of exporters in French manufacturing industries has remained quite stable with the highest levels in 2000 (74.5%) and 2004. This shows that manufacturing industries have always been open to foreign markets. At the same time, average exports expressed in euros, have shown a steady increase. Compared to non-exporters, exporters have larger turnovers and higher productivity. The average sales of exporters are five to six times greater than the average sales of non-exporters'. The average labour productivity of exporters is more than 1.5 times more than that of non exporters.

Information on the destinations of individual firm's exports is not available. The export structure by destination is at industry level, extracted from the OECD trade database, and is used to weight individual bilateral exchange rates. An effective exchange rate by industry at the ISIC 2-digit level is used which leads to the hypothesis that all firms within an industry export to the same destinations. From 1994 to 2000, the bilateral exchange rates for the 23 first French partners are used (see the appendix on data). According to the industry, these 23 partners account for between 80% and 95% of French exports. An increase of this effective exchange rate represents a depreciation of the French Franc (euro since 1999) against its main partners. Exchange rate volatility is not directly observable. We opt for a two-year standard deviation of the first difference of the logarithm of the quarterly exchange rate between the destination country and France. Darby et al. (1999), Tenreyro (2007) uses a similar measure. This is a measure of short term volatility. We also control for whether the estimations are sensitive to our measure by substituting this measure of volatility by a simple mean of the quarterly coefficients of variation[6]. Both measures of bilateral volatility are aggregated using trade shares as weights to obtain what is referred to as the "industry effective volatility". This ensures that the measure of volatility is, as far as possible, linked to the exchange rate risk perceived by the firm. However, we need to account for simultaneous causality problems. As pointed by Dell'Ariccia (1998), all institutional processes aimed at cutting (or suppressing) exchange rate volatility between the trade partners in a growing integrated trade area, can induce a negative correlation between volatility and trade although no causality has come into play. The effective exchange rate volatility of the French currency undoubtedly diminished during the second half of the 1990s and has fallen dramatically since the introduction of the euro. Each industry and each firm within it, is confronted by specific changes in the exchange rate. In addition, the variability between industries is larger after than before 1999 (see table A.1 in appendix).

[6]See Appendix for details

Table 2: Main statistics on French exporters

		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Exporting firms	Number	5956	5859	5877	5922	5622	5546	5453	5718	5619	5420	5150
	Avg. sales (M€)	26761.27	28762.81	29806.32	31823.89	33223.29	35117.88	39773.69	41173.25	39807.22	40308.3	42254.21
	Avg. exports(M €)	8627.98	9477.11	10185.21	11589.01	12393.55	13105.38	15251.79	15724.14	15460.23	15989.29	16965.61
	% firms	73.30%	73.40%	73.00%	72.70%	74.20%	74.30%	74.50%	73.40%	73.60%	73.90%	74.40%
	Avg.Int. exp.	19.40%	20.00%	20.60%	21.30%	21.80%	22.20%	22.70%	23.10%	23.30%	23.50%	23.70%
	% total sales	92.80%	92.60%	93.00%	92.10%	93.40%	92.40%	93.20%	93.00%	93.80%	93.90%	93.90%
	% employ.	88.20%	88.20%	88.30%	87.70%	88.70%	86.00%	86.70%	86.70%	89.00%	89.10%	89.30%
	Productivity	138.4	151	176.9	170.2	192.8	186.9	205.4	190.5	195.1	251.5	237
	Exports (M €)	141	154	162	183	200	210	243	248	242	245	254
	Effective Exch. rate	106.3	110.3	110	105.5	106.4	104.4	100	100.4	101.7	106.2	107.6
Non-exporting firms	Number	16376	16207	15926	15806	16170	16012	15961	15759	15648	15334	14976
	Avg. sales	5703.72	6331.77	6254.3	7244.41	6747.68	8191.03	8449.08	8528.22	7264.18	7360.59	7930.48
	Productivity	88.5	94.6	91.3	155.9	101.1	145.8	114.3	118.8	124.4	128.3	132.8
Total	Number	22332	22066	21803	21728	21792	21558	21414	21477	21267	20754	20126

Source : French Annual enterprises survey (1994-2000), French Ministry of Industry, IFS for exchange rate index.

5 Results

5.1 Presence of sunk costs and sensitivity of export intensity

Table 3 presents the results of the Heckman selection model estimation on export intensity where the sample selection equation is the export status. The first column gives the results for the probability of being an exporter and the second column the results for export intensity. The first row shows the estimation results for the pooled sample. Subsequent rows show the results for firms pooled by industry.

We find that the intensity of past exporting activity increases the current intensity of exports, and that past export status increases the current propensity to export. These results support the presence of sunk costs: as expected, past export behaviour is a significant predictor of current export behaviour. The size and labour productivity of a firm has the expected significant influence. An increase in size (or in productivity) implies an increase in export intensity while bigger size (or greater productivity) raises the probability of being an exporter. The influence of size and productivity has a more significant impact on export status than on export intensity. In terms of export intensity, no sensitivity to a change in the exchange rate was found. Changes in exchange rates are expected to impact foreign market share as a result of changes in local prices. However, we did not find any market share effect. This result must be linked to firms' pricing behaviour, which prevents changes in local prices (see Goldberg and Knetter, 1997). However, export intensity is strongly determined by past export intensity. This hysteresis in export intensity is coherent with the hypothesis of sunk costs. We find a low positive significance only for the Paper Products industry, and a rather surprising negative significant coefficient for the Motor Vehicles industry. This latter result may be associated with the international organisation of the production from this industry, and the fact that most products are imported before assembly. Domestic depreciation inflates the import costs and this effect reduces the firms' profitability and could act to decrease the volume of exports and export intensity. However, with the exception of these two cases, our results show inertia in export intensity to the exchange rate level. For export status, six industries have a positive and significant coefficient (at the 5% level) meaning that a depreciation increases the probability of being an exporter. Remember, that an increase in the effective exchange rate means a depreciation of the French Franc. Firms in most industries other than these six seem to be neutral vis-à-vis the level of the exchange rate, with the exception of Railroad Equipment where the coefficient is significantly negative. Numerous industries show a significant and positive sign on import rate. This means that the more the industry imports, the more its firms will be exporters. In these industries, import rate is an indication of the degree of openness, i.e. the degree of globalisation of their production. The positive sign indicates a positive correlation between an industry's export and import rates.

Table 3: Export intensity - Heckman Model 1994-2004

	To Be exporter						EXPORT Intensity					
	I_{it-1}	Size	Prod	ER	Vola	Import	γ_{it-1}	Size	Prod	ER	Import	Obs.
All industries 17-37	9.57***	0.33***	0.45***	-0.69**	-0.09***	0.39***	0.80***	0.05***	0.11***	-0.13	-0.05	147968
Textiles 17-19	4.63***	0.29***	0.44***	3.47***	0.58***	0.75***	0.80***	0.06***	0.17***	0.41	-0.13*	21528
Wood 20	4.69***	0.29***	0.40***	4.77	0.28***	1.77*	0.82***	-0.06	0	1.78	-1.08	4323
Paper products 21-22	4.98***	0.33***	0.26***	-1.33	0.23***	3.53***	0.82***	0.07***	0.04	1.73*	-0.93*	16655
Petroleum prod. 23	17.78	0.15	1.16	3.55	2.50*	4.66	0.96***	0.01	-0.08	0.39	-0.11	410
Pharmaceuticals 2423	10.72**	0.22***	0.03	6.16	1.25*	1.01	0.85***	0.02	0.07	0.88	-0.04	1864
Chemicals excl. 24ex2423	5.85***	0.20***	0.47***	1.48	0.66***	3.77***	0.86***	-0.01	-0.05	-0.01	-0.11	6497
Rubber plastics 25	4.97***	0.20***	0.43***	5.02***	0.21***	1.40*	0.75***	0.09***	0.12	0.26	0.32	10178
Oth. non-metallic prod. 26	6.03***	0.40***	0.25**	-0.44	0.47***	2.80***	0.89***	0.03	0.04	-1.11	0.01	7081
Iron and steel 271+2731	5.93***	0.59***	-0.04	5.82***	0.22	-0.41	0.80***	-0.01	0.28	-2.6	0.14	1607
Non-ferr. metals 272+2732	5.40***	0.21***	0.47**	4.37***	1.06***	-3.02*	0.78***	0.10***	0.16	-0.83	-0.22	1392
Fabricated metal prod. 28	5.11***	0.42***	0.51***	-0.99	0.43***	2.69***	0.74***	0.13***	0.23***	-0.62	0.18	30588
Machinery & equip. 29	4.94***	0.43***	0.23***	-1.92	0.96***	3.63***	0.76***	0.04**	0.18***	0.31	-0.47	15565
Office & comput. mach. 30	5.52**	0.32**	0.86**	12.21*	1.34***	1.28	0.79***	0.02	-0.01	-2.12	0.52	502
Electrical machinery 31	5.10***	0.31***	0.30**	3.32*	0.62***	1.24*	0.79***	0.04*	0.14**	-0.31	-0.08	5106
Radio, TV & comm. 32	4.77***	0.18***	0.69***	5.21***	0.83***	1.02	0.81***	0.03*	0.19**	-0.82	-0.06	3708
Medical & optical inst. 33	4.72***	0.25***	0.58***	1.49	0.97***	1.41*	0.79***	0.06***	0.13**	-0.47	0.28	6177
Motor vehicles 34	5.22***	0.30***	0.19	5.04***	0.24***	1.03	0.82***	0.02	0.06	-2.2***	-0.80*	4290
Ships and boats 351	4.99***	0.30***	0.12	0.4	0.99***	0.73**	0.64***	0.15**	0.52**	1.28	-0.04	657
Railroad equipm. 352+359	4.33***	0.50***	0.47	-12.6**	0.15	5.05***	0.82***	0.05	0.29*	-0.36	-0.75	664
Aircraft & spacecraft 353	5.90***	0.24**	0.82*	-1.78	1.80**	0.26	0.62***	0.05	0.06	0.2	-0.15	704
Manuf. nec; recycling36-37	5.37***	0.39***	0.19*	1.86	1.03***	1.04**	0.84***	0.02	0.16***	-0.71	0.29	8472

Significativity: $* < 0.1$; $** < 0.05$; $*** < 0.01$. Robust standard errors available upon requests.

All models include industry dummies.

Exchange rate volatility has a weak but significant and positive effect for all industries but two. This sign indicates that export firms are also risk takers and that an increase in volatility rather creates profit opportunities for firms.

Export intensity is not sensitive to the level of the exchange rate, indicated by the low variability in export volumes. Export intensity is mainly determined by firms' past export intensity and thus mainly by firms' characteristics. At the same time, in a third of manufacturing industries, we can see that the probability of being an exporter rises in the case of depreciation. This result suggests that changes in the exchange rate may affect the decision to become exporter. In order to investigate this point, we need to focus on first time exporters.

5.2 Exchange rate and entry to the export market

Only first time exporters and non-exporters are included in our sample.In this case, export propensity is the probability of becoming an exporter. All other variables are the same as in the previous estimations. Table 4 shows the influence of each variable on the probability to enter the foreign market for the first time. The results presented are for the whole pooled sample of manufacturing firms and for every industry.

Size and productivity have the expected sign in the pooled regression. An increase in size or/and an increase in productivity, increase the probability to enter a foreign market for the first time. In terms of size, this is true for 13 out of 21 manufacturing industries. For productivity, this is true for 15 out of 21 industries (with the exception of a negative sign for Other Non-metallic Products). For industries where the coefficients for size and productivity are non-significant this may indicate that the supply characteristics are outweighed by the demand dynamics in the decision to enter a foreign market. The level of the exchange rate has a positive impact on the export propensity of French firms. This is true for the pooled sample and for the 11 individual industries. Also, for most manufacturing industries, depreciation increases the probability to become an exporter. Contrary to the probability of continuing to be an exporter, the probability of becoming a first time exporter is positively linked to depreciation in most industries. Calculating the marginal change from the estimated coefficients leads to the conclusion that a marginal change in the exchange rate implies an increase in the probability of becoming an exporter by 12 percentage points. This reinforces the hypothesis of the existence of sunk costs in exporting. These sunk costs are more likely to be incurred when the exchange rate depreciates. Depreciation offers a cost advantage over foreign firms already insiders. Cost of entry is incurred more easily. The sign on Aircraft and Spacecraft is significant and negative sign , except where variable for volatility changes (see annex A.3). The entry to export of firms from some industries is non-sensitive to the exchange rate. These are: Pharmaceuticals, Chemicals, Iron and Steel, Non-ferrous Metals, Office and Computing

Machinery; Motor Vehicles, Ships and Boats; Railroad Equipment, Manufacturing nec. and Recycling.

Industry characteristics seem to play a significant role in this relationship and further research on this area is necessary. . Volatility has a positive impact on the probability that a firm will enter the export market. Fifteen industries show this positive influence of volatility. This supports the idea that French firms are risk takers. Volatility seems to be perceived by firms as creating opportunities for profits. This is not consistent with the Dixit (1989)'s model of hysteresis in which increasing volatility induces firms to postpone entry. Our result, however, is sensitive to the measure of volatility used. If we apply the coefficient of variation for past exchange rates, only half of the industries in our sample have a significant positive coefficient. In other words, volatility in this case has no influence on half of the manufacturing industries. Nevertheless, whatever the specification, the sign is never negative. Exchange rate depreciation acts as a disguised export policy, aimed at encouraging firms to enter foreign markets.

The import rate is negatively significant for the whole sample. By industry, the sign is mostly negative: eight industries display a negative significant sign. For these industries, an increase in the industry import rate decreases the probability to enter the foreign market. An import rate rise implies stronger foreign competition in the domestic market. This stronger competition discourages any attempt to conquer new market. French firms will likely choose to focus on the domestic market to protect their market share. They will be less motivated to export. More generally, an increase in an industry's import rate is an indication of the openness of the industry, but also the decline of the industry, notably a cut in its contribution to domestic production. There are two different explanations for the propensity to continue to be an exporter or to become an exporter for the first time. One is related to the exchange rate level and the other to the import rate. While the level of the exchange rate cannot explain export status, it is an indicator of future market penetration. Depreciation makes entry to a foreign market easier. While being an exporter is positively related to the industry import rate, becoming an exporter is negatively correlated with it. The former correlation demonstrates that globalisation results in greater openness; the latter that this process increases competition.

We next introduce interaction variables to consider the effects of the import rate, the institution of the EMU (European Monetary Union), and firm size on the sensitivity of the probability to export to the exchange rate. Three dummies are defined for : (i) a high industry import rate - more than 47%; (ii) years after 1999 (date of creation of EMU); and (iii) large sized firms - more than 249 employees. We constructed three interaction variables that multiply the effective exchange rate by the dummy. The regressions (I to IV) introduce these three variables first successively and then simultaneously. The results show significant interaction coefficients.

Table 4: Random effect Probit Model of export participation 1994-2004

	Size		Prod		ER		Vola		IC		Import		Obs.	MaxLik
All industries 17-37	0.64***	[0.03]	1.35***	[0.03]	5.80***	[0.82]	2.03***	[0.08]	0.13***	[0.01]	-1.62***	[0.28]	47716	-14799.1
Textiles 17-19	0.58***	[0.07]	2.22***	[0.07]	9.91***	[2.07]	1.73***	[0.41]	0.05*	[0.03]	-2.07**	[0.82]	7036	-2006.39
Wood 20	0.68***	[0.19]	1.86***	[0.26]	37.01***	[12.90]	0.72	[0.59]	0.13*	[0.08]	-9.22***	[3.34]	1793	-635.43
Paper products 21-22	0.38***	[0.08]	1.39***	[0.08]	18.79***	[3.68]	1.71***	[0.34]	0.10***	[0.04]	-4.68***	[1.73]	5914	-1918.13
Petroleum prod. 23	-0.29	[0.35]	0.61	[0.61]	-18.02	[24.16]	4.55**	[2.31]	-0.16	[0.21]	6.36	[4.68]	131	-35.96
Pharmaceuticals 2423	0.06	[0.12]	-0.08	[0.20]	11.02	[8.79]	3.50**	[1.53]	0.25***	[0.09]	3.13	[2.36]	467	-104.65
Chemicals excl. 24ex2423	0.54***	[0.10]	0.02	[0.10]	11.99**	[4.67]	2.32**	[0.94]	-0.04	[0.06]	-2.26	[5.16]	1557	-356.23
Rubber plastics 25	0.21**	[0.10]	0.64***	[0.15]	14.04***	[5.38]	1.29***	[0.43]	0.17***	[0.05]	-6.35**	[2.67]	2719	-781.29
Oth. non-metallic prod. 26	1.14***	[0.13]	-0.90***	[0.15]	9.01***	[3.46]	0.43	[0.61]	0.1	[0.06]	-6.63***	[2.31]	3135	-943.2
Iron and steel 271+2731	0.18	[0.17]	0.42	[0.34]	22.31	[13.96]	2.08***	[0.66]	-0.1	[0.14]	-1.1	[2.90]	347	-65.38
Non-ferrous metals 272+2732	0.3	[0.25]	0.59*	[0.31]	14.67	[9.55]	2.58***	[0.84]	0.01	[0.14]	-0.48	[5.13]	346	-72.99
Fabricated metal prod. 28	1.29***	[0.09]	1.36***	[0.10]	11.40***	[2.43]	1.38***	[0.43]	0.16***	[0.03]	-6.24***	[2.00]	10654	-3621.25
Machinery & equip. 29	0.43***	[0.08]	1.30***	[0.13]	11.91***	[2.71]	1.54***	[0.49]	0.21***	[0.04]	-6.52***	[1.86]	4281	-1223.23
Office & computing mach. 30	0.49	[0.31]	0.5	[0.33]	15.28	[14.22]	0.56	[1.37]	0.32*	[0.18]	-2.56	[2.86]	181	-48.14
Electrical machinery 31	0.90***	[0.14]	1.57***	[0.20]	14.80***	[5.12]	2.31***	[0.72]	0.09	[0.08]	-1.77	[1.91]	1562	-483.72
Radio, TV & comm. 32	0.43***	[0.14]	1.52***	[0.21]	14.62***	[4.93]	2.67***	[0.57]	0.37***	[0.09]	-5.70*	[3.28]	1419	-495.08
Medical & optical inst. 33	1.14***	[0.17]	1.95***	[0.17]	10.14**	[4.88]	3.30***	[0.49]	0.15**	[0.06]	-3.14	[2.32]	1851	-484.91
Motor vehicles 34	0.31***	[0.10]	1.34***	[0.23]	10.23	[9.00]	1.22***	[0.39]	0.25***	[0.07]	-4.3	[3.00]	1138	-313.91
Ships and boats 351	0.34	[0.37]	1.46***	[0.48]	3.43	[8.64]	1.32	[2.68]	0.39**	[0.18]	-0.53	[1.36]	253	-82.48
Railroad equipment 352+359	0.54	[0.52]	0.72	[0.52]	-12.94	[17.02]	0.89	[2.41]	0.06	[0.25]	3.17	[2.24]	149	-23.71
Aircraft and spacecraft 353	0.15	[0.26]	1.60***	[0.56]	-7.83**	[3.40]	0.9	[2.27]	0.54**	[0.24]	3.12	[3.33]	196	-54.44
Manuf. nec; recycling36-37	0.73***	[0.11]	1.15***	[0.12]	1.83	[3.29]	3.62***	[0.59]	0.03	[0.05]	0.87	[1.45]	2587	-785.11

Industry geometric effective exchange rate and volatility with constant scheme.All models include industry dummies.

Significativity based on the test of Student: $* < 0.1$; $** < 0.05$; $*** < 0.01$

Standard errors in brackets.

Table 5: Interaction effect coefficients

	I	II	III	IV
size	0.64***	0.64***	0.70***	0.69***
prod	1.35***	1.35***	1.36***	1.37***
ER	6.14***	3.98***	5.74***	4.35***
vola	2.00***	2.31***	2.02***	2.27***
ic	0.14***	0.14***	0.14***	0.14***
import	-1.62***	-1.90***	-1.64***	-1.90***
ER*high imp	1.39***			1.06***
ER*EMU		-0.99***		-0.91***
ER*Large firms			0.60***	0.59***
Observations	47716	47716	47716	47716
Likelihood	-14785.37	-14771.13	-14794.59	-14758.64

Firms from industries with a high import rate are more sensitive to changes in the exchange rate. A high import rate is allied to strong foreign competition. Strong competition leads to greater vulnerability to exchange rate shocks. EMU reduced the sensitivity to exchange rate variations of the probability of entry. This is an example of heteroskedasticity. There is less sensitivity to low levels of exchange rate changes, than to high one. EMU has resulted in lower effective exchange rate changes. Thus, the probability of entering the export market has been less sensitive to exchange rate changes since 1999 (EMU). This could also result from the lack of enough time since 1999. Reducing the sample period to 1999-2004 results in a much small number of new exporters. Larger firms are more sensitive to the exchange rate. Larger firms are more internationalised, i.e. more export oriented, but also more multi-located. In other words, greater international exposure renders firms more sensitive to exchange rate changes.

6 Conclusion

The main result of this paper is that changes in the exchange rate have an impact on entry into exporting. Firms are incited to enter foreign markets when their domestic currency depreciates. This result provides strong support for the presence of sunk costs, which likely explain the high hysteresis in firms' export intensity. Changes in the exchange rate do not have much effect on a firm's export intensity, which is mainly determined by past export intensity. Thus, we found no market share effect of exchange rate changes. At firm level, a change in the exchange rate induces a supply adjustment. Because entry to and exit from foreign markets are costly, depreciation, if of sufficient magnitude, enables

firms to incur entry costs. We can conclude, then, that generally depreciation accelerates entry into foreign markets. There are, however, some industries that appear indifferent to exchange rate changes. In these industries, entry cost is not one of the variables determining entry into a foreign market. // Overall, it can be said that appreciation of the euro appears problematic for some industries, first, because it increases domestic competition and reinforces the positions of non-European firms, and second, because it reduces the rate of participation of European firms in world exports.

References

Baldwin, R. (1990), 'Hysteresis in trade', *Empirical Economics* **15**(2), 127–142.

Baldwin, R. and Krugman, P. (1989), 'Persistent trade effects of large exchange rate shocks', *The Quaterly Journal of Economics* **104**(4), 635–654.

Bernard, A. B. and Jensen, B. (2004), 'Why some firms exports', *The Review of Economics and Statistics* **86**(2), 561–569.

Campa, J. M. (2004), 'Exchange rates and trade: how important is hysteresis in trade?', *European Economic Review* **48**, 527–548.

Cheong, C., Mehari, T. and Williams, L. V. (2005), 'The effects of exchange rate volatility on price competitiveness and trade volumes in the uk: A disaggregated approach', *Journal of Policy Modeling* **27**, 961–970.

Cote, A. (1994), 'Exchange rate volatility and trade'.

Darby, J., Hallett, A. H., Ireland, J. and Piscitelli, L. (1999), 'The impact of exchange rate uncertainty on the level of investment', *The Economic Journal* **109**, 55–67.

Dell'Ariccia, G. (1998), 'Exchange rate fluctuations and trade flows: evidence from the european union'.

Dixit, A. (1989), 'Entry and exit decisions under uncertainty', *Journal of Political Economy* **97**(3), 620–638.

Dornbusch, R. (1987), 'Exchange rate and prices', *American Economic Review* **77**, 93–106.

Goldberg, P. K. and Knetter, M. M. (1997), 'Goods prices and exchange rates: what have we learned?', *Journal of economic Literature* **35**(3), 1243–72.

Heckman, J. (1979), 'Sample selection bias as a specification error', *Econometrica* **47**(1), 153–161.

Knetter, M. M. (1989), 'Price discrimination by u.s. and german exporters', *American Economic Review* **79**(1), 198–210.

Krugman, P. (1987), Pricing to market when the exchange rate changes, *in* S. Arndt and D. Richardson, eds, 'Real-Financial Linkages among open Economies', MIT Press, Cambridge MA, pp. 49–70.

Masera, F. (1974), 'The j curve: Uk experience after the 1967 devaluation', *Metroeconomica* .

McKenzie, M. D. (1999), 'The impact of exchange rate volatility on international trade flows', *Journal of Economic Surveys* **13**(1), 70–106.

Roberts, M. J. and Tybout, J. R. (1995), 'An empirical model of sunk costs and the decision to export'.

Roberts, M. J. and Tybout, J. R. (1997), 'The decision to export in columbia:an empirical model of entry with sunk costs', *American Economic Review* **87**(4), 545–564.

Taglioni, D. (2002), 'Exchange rate volatility as a barrier to trade: new methodologies and recent evidence', *Economie Internationale CEPII* **89-90**, 227–259.

Tenreyro, S. (2007), 'On the trade impact of nominal exchange rate volatility', *Journal of Development Economics* **82**, 485–508.

Appendix A Data source

Firm data are taken from the Annual Enterprises survey of French manufacturing firms with more than 19 employees. These data are observed from 1994 to 2004.

Industry import rates and industry export weights are calculated from the STAN Trade Database using the ISIC rev3 classification. We consider the export share by industry of the top 24 French partners: Austria, Belgium, Canada, Denmark, Finland, Germany, Greece, Ireland, Italy, Japan, Korea, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States, China, Taïwan, Hong Kong, Singapore. Export shares are

Appendix B Description of variables

Appendix B.1 Firms'variables

Size: the size of the firm given by its employment Prod: the firm's labour productivity X_{it}: the export intensity level for the previous year LI: labour intensity (ratio of wages on sales) IC: capital intensity (ratio of investment on sales).

Appendix B.2 Industry variables

ER: effective exchange rate

The industry effective exchange rate is calculated at the 2-digit industrial classification level (ISIC rev3). For 1994 to 2000, we use the export shares of the top 24 French partners. We retain constant weights in order to reinforce the exogeneity of export behaviour to the industry exchange rate. The effective exchange rate, then, is a geometric mean of each bilateral exchange rate weighted by the export share. We consider both a constant (1995) and a variable weighting scheme. We also calculate an effective exchange rate based on an arithmetic mean.

Vola: effective exchange rate volatility

Exchange rate variability between country j and France in year t, is denoted by σ_{jt} , is:

$$\sigma_{jt} = \left[\frac{1}{8} \sum_{i=0}^{7} \left(\Delta \log e_{jt,8-i} \right)^2 \right]^{1/2}$$

where e_{jtq} is the bilateral exchange rate of the quarter q relative to year t for the French Franc (the euro since 1999) and the currency of country j. An alternative measure of volatility was also used: the average of the quarterly coefficients of variation for the previous eight quarters. This means that a coefficient of variation was calculated for each quarter (over the past eight quarters). Yearly volatility is the mean of the four quarterly coefficients of variations.

Table A1: Statistics on Volatility

	vola		cv	
	Bef 99	Aft 99	Bef 99	Aft 99
Textiles 17-19	0.0131	0.0074	0	0.0171
Wood 20	0.0096	0.0029	0.024	0.0072
Paper products 21-22	0.0107	0.0044	0.0283	0.0104
Petroleum prod. 23	0.0136	0.0087	0.0348	0.0202
Pharmaceuticals 2423	0.0123	0.0062	0.032	0.0148
Chemicals excl. 24ex2423	0.0123	0.006	0.0328	0.0144
Rubber plastics 25	0.0105	0.004	0.0277	0.0095
Oth. non-metallic prod. 26	0.0121	0.0058	0.032	0.0141
Iron and steel 271+2731	0.0112	0.0042	0.0302	0.0099
Non-ferrous metals 272+2732	0.0124	0.0059	0.034	0.0137
Fabricated metal prod. 28	0.0112	0.0052	0.0293	0.0127
Machinery & equip. 29	0.0136	0.0074	0.0364	0.0181
Office & computing mach. 30	0.0115	0.005	0.0303	0.0122
Electrical machinery 31	0.0124	0.0059	0.0334	0.0143
Radio, TV & comm. 32	0.0141	0.0076	0.0378	0.0183
Medical & optical inst. 33	0.0141	0.0085	0.0374	0.0207
Motor vehicles 34	0.0105	0.0036	0.0286	0.0087
Ships and boats 351	0.0135	0.008	0.0379	0.0199
Railroad equipment 352+359	0.0122	0.0064	0.0343	0.015
Aircraft and spacecraft 353	0.0194	0.016	0.0522	0.0409
Manuf. nec; recycling 36-37	0.0137	0.0085	0.0355	0.0203
Mean	0.0126	0.0065	0.0319	0.0158
Sd	0.002	0.0027	0.0092	0.007
Cv=Sd/mean	0.1619	0.4201	0.2895	0.4438

Table generated by Excel2LaTeX from sheet 'Feuil1'

Import

Industry import rates are calculated from production and imports using ISIC-rev3 classification.

Appendix C Complementary Results

Table A2: Arithmetic effective exchange rate and volatility with Constant weighting scheme

	Size		Prod		ER		Vola		IC		Import		Obs.	MaxLik
All industries 17-37	0.64***	[0.03]	1.35***	[0.03]	3.19***	[0.51]	2.13***	[0.09]	0.13***	[0.01]	-1.67***	[0.28]	47716	-14804.47
Textiles 17-19	0.58***	[0.07]	2.22***	[0.07]	5.55***	[1.69]	1.82***	[0.41]	0.05	[0.03]	-2.38**	[0.99]	7036	-2011.98
Wood 20	0.68***	[0.19]	1.85***	[0.26]	27.02***	[8.27]	0.68	[0.58]	0.13*	[0.08]	-14.72***	[4.26]	1793	-634.4
Paper products 21-22	0.38***	[0.08]	1.39***	[0.08]	8.42***	[1.79]	1.74***	[0.35]	0.10***	[0.04]	-5.98***	[1.74]	5914	-1920.04
Petroleum prod. 23	-0.29	[0.35]	0.62	[0.61]	-8.14	[10.65]	4.19	[2.57]	-0.16	[0.21]	4.86	[4.11]	131	-35.99
Pharmaceuticals 2423	0.06	[0.12]	-0.08	[0.20]	8.61	[5.75]	3.42**	[1.53]	0.25***	[0.09]	1.98	[2.60]	467	-104.31
Chemicals excl. 24ex2423	0.54***	[0.10]	0.02	[0.10]	6.28**	[2.60]	2.00**	[0.89]	-0.04	[0.06]	-5.75	[5.12]	1557	-356.58
Rubber plastics 25	0.21**	[0.10]	0.64***	[0.15]	6.32***	[2.35]	1.34***	[0.44]	0.17***	[0.05]	-7.76***	[2.54]	2719	-781.09
Oth. non-metallic prod. 26	1.14***	[0.13]	-0.90***	[0.15]	5.36***	[2.06]	0.32	[0.60]	0.1	[0.06]	-7.93***	[2.46]	3135	-943.18
Iron and steel 271+2731	0.18	[0.17]	0.42	[0.34]	11.63	[7.70]	2.60***	[0.92]	-0.1	[0.14]	-1.6	[3.06]	347	-65.51
Non-ferrous metals 272+2732	0.31	[0.25]	0.59*	[0.31]	6.59	[5.42]	2.70***	[1.04]	0.01	[0.14]	0.05	[5.37]	346	-73.42
Fabricated metal prod. 28	1.29***	[0.09]	1.36***	[0.10]	5.60***	[1.32]	1.25***	[0.42]	0.16***	[0.03]	-7.61***	[2.15]	10654	-3623.44
Machinery & equip. 29	0.43***	[0.08]	1.29***	[0.13]	7.94***	[1.84]	1.47***	[0.49]	0.21***	[0.04]	-7.88***	[2.07]	4281	-1223.61
Office & computing mach. 30	0.5	[0.31]	0.49	[0.33]	6.96	[7.47]	0.61	[1.39]	0.31*	[0.18]	-2.6	[2.94]	181	-48.29
Electrical machinery 31	0.90***	[0.14]	1.57***	[0.20]	8.68***	[2.96]	2.24***	[0.71]	0.09	[0.08]	-3.11	[2.05]	1562	-483.54
Radio, TV & comm. 32	0.43***	[0.14]	1.52***	[0.21]	10.09***	[3.51]	2.77***	[0.58]	0.37***	[0.09]	-7.96**	[3.79]	1419	-495.36
Medical & optical inst. 33	1.15***	[0.17]	1.94***	[0.17]	3.63	[3.75]	3.35***	[0.52]	0.16**	[0.06]	-1.51	[2.67]	1851	-486.54
Motor vehicles 34	0.31***	[0.10]	1.34***	[0.23]	1.73	[3.76]	1.06**	[0.49]	0.25***	[0.07]	-5.51*	[3.05]	1138	-314.39
Ships and boats 351	0.34	[0.37]	1.46***	[0.48]	1.67	[5.24]	1.22	[2.82]	0.39**	[0.18]	-0.58	[1.38]	253	-82.51
Railroad equipment 352+359	0.54	[0.51]	0.71	[0.51]	-5.7	[8.01]	1.07	[2.33]	0.06	[0.25]	2.91	[2.08]	149	-23.74
Aircraft and spacecraft 353	0.14	[0.27]	1.63***	[0.56]	-7.17**	[3.03]	0.72	[2.28]	0.55**	[0.24]	3.2	[3.32]	196	-54.29
Manuf. nec; recycling 36-37	0.73***	[0.11]	1.15***	[0.12]	0.83	[3.06]	3.67***	[0.58]	0.03	[0.05]	1.01	[1.86]	2587	-785.22

Table A3: Geometric effective exchange rate and coefficient of variation volatility

	Size		Prod		ER		Vola		IC		Import		Obs.	MaxLik
All industries 17-37	0.657***	[0.027]	1.322***	[0.034]	1.832**	[0.775]	0.575***	[0.038]	0.130***	[0.013]	-4.357***	[0.244]	47716	-14998.16
Textiles 17-19	0.58***	[0.07]	2.22***	[0.07]	11.79***	[2.00]	0.18	[0.13]	0.05*	[0.03]	-4.79***	[0.51]	7036	-2014.48
Wood 20	0.68***	[0.19]	1.85***	[0.26]	38.65***	[13.54]	0.03	[0.24]	0.13*	[0.08]	-12.69***	[2.35]	1793	-636.16
Paper products 21-22	0.39***	[0.08]	1.39***	[0.08]	12.37***	[3.38]	0.36***	[0.10]	0.10***	[0.04]	-10.22***	[1.13]	5914	-1925.73
Petroleum prod. 23	-0.28	[0.35]	0.76	[0.62]	-17.7	[16.69]	2.83*	[1.44]	-0.17	[0.21]	5.77	[4.04]	131	-37.53
Pharmaceuticals 2423	0.07	[0.12]	-0.07	[0.20]	8.02	[8.66]	0.19	[0.50]	0.26***	[0.09]	-1.21	[1.47]	467	-107.24
Chemicals excl. 24ex2423	0.53***	[0.09]	0.02	[0.10]	7.08*	[4.18]	0.13	[0.21]	-0.04	[0.06]	-13.11***	[2.63]	1557	-359.03
Rubber plastics 25	0.22**	[0.10]	0.64***	[0.15]	5.45	[4.32]	0.17	[0.13]	0.17***	[0.05]	-12.14***	[1.57]	2719	-784.81
Oth. non-metallic prod. 26	1.14***	[0.13]	-0.91***	[0.15]	9.02***	[3.44]	0.07	[0.19]	0.1	[0.06]	-7.86***	[1.18]	3135	-943.41
Iron and steel 271+2731	0.21	[0.17]	0.39	[0.33]	10.77	[12.88]	0.76**	[0.32]	-0.14	[0.14]	-3.98	[2.75]	347	-67.49
Non-ferrous metals 272+2732	0.37	[0.24]	0.52*	[0.30]	-1.5	[7.16]	0.58	[0.39]	-0.03	[0.13]	-3.06	[5.19]	346	-76.63
Fabricated metal prod. 28	1.14***	[0.13]	-0.91***	[0.15]	9.02***	[3.44]	0.07	[0.19]	0.1	[0.06]	-7.86***	[1.18]	3135	-943.41
Machinery & equip. 29	0.21	[0.17]	0.39	[0.33]	10.77	[12.88]	0.76**	[0.32]	-0.14	[0.14]	-3.98	[2.75]	347	-67.49
Office & computing mach. 30	0.37	[0.24]	0.52*	[0.30]	-1.5	[7.16]	0.58	[0.39]	-0.03	[0.13]	-3.06	[5.19]	346	-76.63
Electrical machinery 31	1.30***	[0.09]	1.35***	[0.10]	11.66***	[2.49]	0.06	[0.09]	0.16***	[0.03]	-11.88***	[0.99]	10654	-3626.41
Radio, TV & comm. 32	0.43***	[0.08]	1.30***	[0.13]	13.67***	[2.78]	0.08	[0.13]	0.21***	[0.04]	-11.14***	[1.24]	4281	-1227.9
Medical & optical inst. 33	0.49	[0.31]	0.5	[0.33]	14.21	[13.90]	0.26	[0.44]	0.31*	[0.18]	-2.88	[2.16]	181	-48.04
Motor vehicles 34	0.90***	[0.14]	1.56***	[0.20]	12.00**	[5.09]	0.36*	[0.21]	0.08	[0.08]	-6.02***	[1.29]	1562	-487.35
Ships and boats 351	0.44***	[0.13]	1.53***	[0.21]	12.91**	[5.02]	0.76***	[0.21]	0.35***	[0.09]	-12.22***	[2.99]	1419	-500.09
Railroad equipment 352+359	1.20***	[0.16]	1.91***	[0.17]	-1.44	[5.51]	0.62***	[0.23]	0.13**	[0.06]	-3.48	[2.99]	1851	-505.36
Aircraft and spacecraft 353	0.32***	[0.10]	1.33***	[0.22]	-2.71	[6.97]	0.43**	[0.20]	0.25***	[0.07]	-8.78***	[2.45]	1138	-316.49
Manuf. nec; recycling 36-37	0.35	[0.37]	1.43***	[0.48]	-1.33	[6.15]	-0.44	[0.60]	0.37**	[0.18]	-1.47*	[0.77]	253	-82.33

Table A4: Arithmetic effective exchange rate and coefficient of variation volatility

	Size		Prod		ER		Vola		IC		Import		Obs.	MaxLik
All	0.66***	[0.03]	1.33***	[0.03]	-0.75*	[0.45]	0.55***	[0.04]	0.13***	[0.01]	-3.78***	[0.26]	47716	-14999.4
Textiles	0.58***	[0.07]	2.23***	[0.07]	7.36***	[1.59]	0.21	[0.13]	0.05*	[0.03]	-5.48***	[0.68]	7036	-2020.74
Wood	0.67***	[0.19]	1.84***	[0.26]	28.84***	[8.90]	-0.03	[0.23]	0.13*	[0.08]	-18.79***	[3.77]	1793	-635.07
Paper products	0.39***	[0.08]	1.38***	[0.08]	5.37***	[1.61]	0.37***	[0.11]	0.10***	[0.04]	-10.94***	[1.29]	5914	-1927.01
Petroleum prod.	-0.28	[0.35]	0.76	[0.62]	-11.38	[9.19]	2.12	[1.61]	-0.17	[0.21]	4.92	[3.97]	131	-37.25
Pharmaceuticals	0.06	[0.12]	-0.07	[0.20]	7.41	[5.76]	0.14	[0.50]	0.26***	[0.09]	-2.32	[1.91]	467	-106.84
Chemicals excl.	0.53***	[0.09]	0.02	[0.10]	4.37*	[2.42]	0.13	[0.21]	-0.04	[0.06]	-14.68***	[3.14]	1557	-358.84
Rubber plastics	0.22**	[0.10]	0.64***	[0.15]	2.54	[1.88]	0.19	[0.13]	0.17***	[0.05]	-12.76***	[1.78]	2719	-784.7
Oth. non-metallic miner. prod.	1.14***	[0.13]	-0.91***	[0.15]	5.46***	[2.04]	0.07	[0.19]	0.1	[0.06]	-8.80***	[1.37]	3135	-943.29
Iron and steel	0.22	[0.17]	0.4	[0.33]	0.86	[5.99]	0.68*	[0.38]	-0.15	[0.14]	-2.93	[3.17]	347	-67.83
Non-ferrous metals	0.36	[0.24]	0.53*	[0.30]	-3.17	[3.55]	0.42	[0.40]	-0.03	[0.13]	-4.06	[5.27]	346	-76.25
Fabricated metal prod.	1.30***	[0.09]	1.35***	[0.10]	5.94***	[1.33]	0.06	[0.09]	0.16***	[0.03]	-12.82***	[1.18]	10654	-3627.6
Machinery & equip.	0.43***	[0.08]	1.30***	[0.13]	9.14***	[1.85]	0.09	[0.13]	0.21***	[0.04]	-12.45***	[1.45]	4281	-1227.73
Office & computing mach.	0.49	[0.30]	0.49	[0.33]	6.44	[7.20]	0.28	[0.44]	0.31*	[0.18]	-2.94	[2.39]	181	-48.17
Electrical machinery	0.90***	[0.14]	1.56***	[0.20]	7.71***	[2.94]	0.39*	[0.21]	0.09	[0.08]	-7.16***	[1.55]	1562	-486.66
Radio, TV & comm.	0.44***	[0.13]	1.53***	[0.21]	10.17***	[3.71]	0.87***	[0.22]	0.35***	[0.09]	-15.32***	[3.83]	1419	-499.61
Medical & optical inst.	1.17***	[0.16]	1.91***	[0.17]	-11.27***	[3.78]	0.85***	[0.23]	0.14**	[0.06]	5.28	[3.37]	1851	-500.95
Motor vehicles	0.32***	[0.10]	1.34***	[0.22]	-3.07	[2.57]	0.29	[0.22]	0.25***	[0.07]	-9.17***	[2.36]	1138	-315.85
Ships and boats	0.34	[0.36]	1.43***	[0.48]	-1.08	[3.61]	-0.46	[0.61]	0.37**	[0.18]	-1.45*	[0.77]	253	-82.3
Railroad equipment	0.54	[0.52]	0.69	[0.52]	-9.05*	[4.96]	-0.04	[0.65]	0.1	[0.25]	3.62**	[1.52]	149	-23.84
Aircraft and spacecraft	0.15	[0.27]	1.63***	[0.56]	-7.54**	[3.16]	-0.01	[0.70]	0.53**	[0.24]	4.01*	[2.43]	196	-54.34
Manufacturing nec; recycling	0.77***	[0.11]	1.13***	[0.12]	-1.83	[3.32]	0.35*	[0.18]	0.03	[0.05]	-2.59	[1.98]	2587	-803.68