Revisiting exchange-rate exposure through a microeconomic approach: French manufacturing firms’ profits and the euro

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Abstract

Introducing a formal derivation between gross manufacturing profits and currency swings, this paper seeks to reconcile previous empirical market-based approaches and microfounded theoretical models in their quest to resolve the exchange-rate exposure puzzle. This approach delivers a theoretical time-varying and firm-specific operating exposure - that is the sensitivity of operating profits to exchange-rate fluctuations - which depends on both the firm’s characteristics and the features of the product markets where it sources its inputs and sells its output. Consistent with the preliminary works of Clarida (1997) and Campa and Goldberg (1999), this microfounded exposure implies that all firms are subject to exchange-rate fluctuations that impact both their export and domestic revenues - through a price-volume effect and/or a translation effect depending on the extent of their pass-through - as well as their inputs costs. Using a sample of French manufacturing firm-level data over the 1999-2007 period, the second part of this paper implements this theoretical exposure. This allows to assess the sensitivity of firms’ operating cash-flows directly, contrasting with market-based approaches that rather examine exposure by studying how a firms’ market value responds to changes in exchange rates. This also implies that we are able to assess the relative magnitude of the operating exposure channels for all firms in the economy, which can be a valuable tool for managers and policy-makers trying to determine and manage exposure.

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1 Introduction

The increasing globalization of business activity makes exchange rate fluctuations a key component of corporate strategy. All firms, whether involved in international markets or purely domestic, are affected by changes in currency values. While exchange-rate swings form a basic component of price-competitiveness and investment choices for firms involved in commercial and financial foreign operations, and thus make foreign exchange exposure management a crucial part of their strategy, even firms with no foreign currency transactions, debt or assets can be exposed to foreign exchange risk: a change in the exchange rate may alter export opportunities and/or the level of competition from foreign competitors; the domestic firms’ customer base may include importing or exporting firms whose activities are affected by exchange rate changes etc. (Bodnar and Marston (2001)). Therefore, understanding how and to what extent persistent currency changes might affect corporate profits is fundamental for the competitiveness and welfare path of an entire economy, as well as the economic decisions made by managers and policy-makers.

In technical terms, the concept of economic exposure refers to the degree to which the value of a company, as measured by the present value of its expected cash flows, is affected by exchange rate changes. While theoretical studies predict - and empirical studies document - significant effects of exchange rate changes on firms’ volumes of sales (e.g., Baggs et al. (2009, 2011, 2013)), pricing strategies (e.g., Goldberg and Knetter (1997) or Goldberg and Hellerstein (2008) for a survey of pass-through literature) and cost structure (e.g, Amiti and Konings (2007) or Colantone and Crinò (2014)) - and thus overall on competitive positions in product markets (e.g., Campa and Goldberg (1995, 2001) or Williamson (2001)) - empirical studies have tended to document extremely low levels of exposure to exchange rate swings for most firms, even when the firms examined have significant foreign operations. Muller and Verschoor (2006), Bartram and Karolyi (2006) and Hutson and

\[1\] Dominguez and Tesar (2001b) and Aggarwal and Harper (2010) document that, on average, the foreign exchange exposure of domestic companies is greater than the exposure faced by multinational firms. This may reflect the fact that firms the most engaged in trade are also the most aware of exchange rate risk, and therefore, are the most likely to hedge their exposure. Using a sample of 953 US firms for the period 1999-2009, Hutson and Laing (2014) found a significant inverse U-shaped relationship between a firm’s foreign exchange exposure and the extent of their multinationality (a proxy for operational hedging): high-multinationality firms have lower exposure than domestic firms, and those with intermediate levels of international engagement have the highest exposure.

\[2\] This is to differentiate it from translation exposure, also known as accounting exposure or balance-sheet exposure, which arises from the need, for purposes of reporting and consolidation, to convert the financial statements of foreign operations from the local currencies involved to the home currency. The measurement of accounting exposure is retrospective in nature, and its resulting exchange gains and losses are determined by accounting rules and are paper only. As such, it does take into account a company’s future cash-flows that our prospective approach is seeking to encompass. Furthermore, as noted by Shapiro (2008), economic exposure can itself be divided into two components: an operating exposure, which measures the extent to which currency fluctuations can alter a firm’s operating cash flows, that is its future revenues (domestic sales and exports) and costs (domestic and imported inputs), and a transaction exposure which results from commercial or financial transactions that give rise to known, contractually binding future foreign-currency-denominated cash inflows or outflows, and thus encompasses some items included in translation exposures. This paper is focusing on the former.

O’Driscoll (2010), to the extent of our knowledge the only three studies focusing on the Euro area, report for instance significant - and still very low - incremental foreign exchange rate exposures for only 10% to 15% of the European firms in their sample. This has been considered somewhat of a puzzle (Bartram and Bodnar (2007)).

However, none of these studies are based explicitly on a model of firm behavior, such that it is difficult to interpret their findings of low exposure in terms of economic behavior. Furthermore, since cash flows are difficult to measure, this large empirical - and mostly financial - literature have examined exposure by studying how a firm’s market value responds to changes in exchange-rates (Bodnar et al. (2002)). While this market-based approach has its benefits, such as its flexible and forward-looking-based-expectation formation of the overall impact of exchange-rate risk on a firm’s value, it also has many limitations as a tool for assessing and managing exposure. One major difficulty arises because, by using the capital market to assess exposure, there is heavy reliance upon the market to accurately use available information, while in reality, many factors may contribute to impeding capital markets in their efforts to assess exposure. To put it differently, empirical results based on stock market data and documenting small measures of exposures must simply indicate that the stock market may not recognize the extent to which firms are involved in exchange-rate sensitive activities. They do not allow the conclusion that they actually are not. Another significant difficulty of empirical market-based approaches arises because, by definition, their sample are limited to quoted and large companies, leaving out SME – or even larger firms not priced on stock markets – which are highly likely to have different economic behaviors and/or hedging management strategies. As such, they do not allow for a complete and representative assessment of the exchange-rate exposure channels and their magnitude for all firms in the economy. Using French firm-level data over the 1999-2007 period, this article seeks to contribute in filling these theoretical and empirical gaps in the exchange-rate economics literature and to respond to the following question: to what extent and how French manufacturing firms’ profits had been hurt by euro appreciation during this period?

In contrast to the previous market-based methods, this article offers a microeconomic and cash-flow based approach which has the major benefit not to require the assumption that the market accurately assesses the impact of exchange rate changes on cash-flows. Rather, our approach focuses on the sensitivity of companies’ operating cash-flows directly. This sensitivity is measured through a formal derivation between a company’s gross manufacturing profits and the exchange-rate, inspired by Clarida (1997) and Hung (1992), and providing with a time-varying and firm-specific theoretical operating exposure designed to be calibrated. To the extent of our knowledge, previous theoretical work attempting to develop a microeconomics approach of exchange rate exposure can be decomposed into two parts. Preliminarily works focused either on pass-through (Dornbusch (1987), Krugman (1986), Froot and Klemperer (1989), Feenstra et al. (1996), Yang (1997)) or exposure (Shapiro (1975), Adler and Dumas (1984), Hekman (1985), Flood Jr and Lessard (1986), von Ungern-Sternberg and von Weizsäcker (1990), Levi (1994), Campa and Goldberg (1999), Marston 37 developed and emerging countries from 1994 to 2006, and found more significant results than empirical studies focused on a single country.

4The result is, more precisely, 10% for the sample of Bartram and Karolyi (2006), while 13% of the sample of Muller and Verschoor (2006) - consisting of 817 European multinational firms - experienced significant exposure effects to the Japanese yen, 14% to the US dollar and 22% to the UK pound.
but none has studied this two phenomena together. Yet, because pricing directly affects profitability, characteristics that determine pricing behavior should also govern the exposure of firms' profits. Being aware of this fact, Bartram et al. (2010), extending the previous work of Bodnar et al. (2002), develop a more realistic model of the exchange-rate exposure of a global firm that can compete and produce in both a foreign and local competitive market, and which explicitly incorporates pass-through behavior and industry competition. While these theoretical contributions provide invaluable insights to understand how profits might be affected by currency swings, they tend to impose strict assumptions and functional forms in their empirical implementation, as they lead to derive optimal price or quantity behaviors either in a pricing or quantity competition model. Some of these functional forms do not vary over time, implying in particular constant mark-up, limite the potential margins of price and quantity adjustments according to the selected type of competition, and rule out the possibility of heterogeneous behavior between firms. While keeping in mind their strong theoretical background, this paper seeks to develop a more flexible approach, that particularly considers both prices and quantities as simultaneous substantial variables of adjustment following currency shocks, as suggested by recent empirical evidence. In this regard, Berman et al. (2012b) show indeed that, even if larger firms tend to absorb more exchange-rate movements in their mark-up, the average exporter increased both its export price (in euro) and volume by around respectively 0.8% and 4% following a 10% depreciation. This approach also considers the impact of exchange-rate changes on the foreign competition's pricing and quantity behaviors, and incorporates a formal modelling of imported input substitution into firms' production functions, as both of these impacts might constitute a crucial channel through which currency swings affect firms' profitabilities, particularly domestic.

In the first section of this paper, we address these issues by introducing a formal derivation of a firm's operating exposure to exchange-rate fluctuations without adhering to specific functional forms, and thus, avoiding several specification problems that the market-based approaches and previous microfounded models are subject to. The resulting time-varying theoretical exposure depends on both the firm's specific characteristics and the features of product markets where it sources its inputs and sells its output. Consistent with the preliminary works of Clarida (1997) and Campa and Goldberg (1999), this theoretical economic-exposure implies that a firm is subject to exchange-rate fluctuations through several channels, affecting its export revenues, domestic revenues and input costs. More precisely, it implies that (i) an appreciation of the domestic currency always hurts export profits regardless of a firm's pricing behavior, either by lowering the volume of exports (price/volume effect) and/or by translating its foreign currency revenues into fewer euros (translation effect); (ii) an appreciation of the domestic currency always reduces its domestic revenue, regardless of its foreign-competitors' pricing behavior, either by lowering the volume of its domestic sales (a price/volume effect) and/or by lowering its unit profit, and (iii) this negative impact of an appreciation might be

\[ \text{(2001)} \] for most of these models, which do not consider pass-through when estimating exchange-rate exposure, the structural background is that of a monopoly firm whose revenues and expenses are exposed to changes in exchange rates. This demonstrates that exposures are related to net foreign currency revenues and profit margins.

\[ \text{Their model thus tends to generate an inverse relationship between pass-through and exposure only through the fact that these are both a function of product substitutability : for any given market share, higher product substitutability lowers pass-through and raises exposure.}\]

\[ \text{Contrasting with previous work, but consistent with recent empirical findings, our theoretical approach indeed assumes that firms also reduce their domestic prices following currency fluctuations, even if this decline is less important}\]
mitigated by the decline of imported intermediate costs, which prevents the decline in the (euro) profit margin of its good solds either/both at home and abroad.

This theoretical exposure is then calibrated for a sample of, precisely, 25579 french manufacturing firms over the 1999-2007 period. Estimates of parameters are based on precious methodologies developed by previous body of works into the international economics literature, such as Goldberg and Hellerstein (2008), Andrade et al. (2010) or Campa et al. (2005) for estimates of, respectively, export and import pass-through. We show that [...estimates in progress]

The rest of the paper is organized as follows. Section 2 introduces the formal derivation of the linkage between a manufacturing company’s operating profits and exchange-rate changes and establishes a strategy for estimating the parameters needed to measure the firm’s exposure, that is the firm-specific and time-varying domestic and export pass-through, price-elasticities of demand in domestic and export markets and exchange-rate elasticity of unit costs. Section 3 implements this strategy for a sample of French manufacturing firms, while Section 4 reports the estimated firms’ exposure and analyzes the relative magnitude of its channels.

2 A formal derivation of the linkage between gross manufacturing profits and the exchange rate

2.1 General settings

In order to determine to what extent and how a change in the euro’s value affects French export and domestic profits, this section introduces a formal derivation of the linkage between gross manufacturing profits and the exchange rate. Consider the example of a French manufacturing firm which, to keep things simple, is a single-product firm. Let’s $i \equiv \{f; g\}$ denotes the index identifying a unit good $i$ defined as a good of type $g$ produced by a particular firm $f$ and, divide this French firm’s gross manufacturing profits in euro terms $\Pi_i$, into two components : profits accrued from domestic sales, $\Pi^d_i$, and profits accrued from export sales on each market destination $l$, $\Pi^x_{i,l}$.

$$\Pi_i = \Pi^d_i + \sum_{l \in L} \Pi^x_{i,l}$$

with

$$\Pi^d_i = P^d_i Q^d_i - C_i Q^d_i$$

and

$$\Pi^x_{i,l} = \frac{P^x_{i,l}}{E_l} Q^x_{i,l} - C_i Q^x_{i,l}$$

where $E_l$ is the nominal exchange rate between France and country $l$, defined as the foreign currency $l$ price of one unit of euro, so that an increase in the exchange rate mean an appreciation of the euro. $Q^d_i$ and $Q^x_{i,l}$ are respectively the firm’s output volume sold domestically and its export volume to country $l$, while $P^d_i$ and $P^x_{i,l}$ respectively designate the associated (euro) unit price of its output sold domestically and the (foreign currency $l$) unit price of its exports to $l$. Finally, the unit variable cost of the French firm’s manufactured output, $C_i$, is supposed to be the same whatever the than the decline in the (euro) imports price of its foreign competitors. Indeed, (i) the intensified foreign price competition is likely to force domestic firms to align their prices and (ii) empirical works, such as Berman et al. (2012a) have shown that there tends to be a positive correlation between sales, and thus pricing and volumes of sales, across foreign and domestic markets through both a short-run liquidity channel and the existence of increasing returns
market destination where the firm sell its output. Profits are thus the difference between the firm’s revenues, i.e the product of each sales volume with its associated price, and its costs. However, each one of this component may be affected by exchange rate swings.

Let’s first discuss on exchange-rate pass-through. As usually, in an imperfect competition setting, firms set the optimal net prices in euro for their good sold either/both domestically and on each market destination \( l \) (resp. \( P^d_i \) and \( P^x_{i,l}/E_l \)) at a level that equalises the product of a markup, specific to each firm and market destination (resp. \( \phi^d_i \) and \( \phi^x_{i,l} \)), over their marginal cost (\( C_i \)) :

\[
P^d_i = \phi^d_i C_i \tag{2}
\]

\[
P^x_{i,l} = E_l \phi^x_{i,l} C_i \tag{3}
\]

On the exports side, the incompleteness of exchange rate pass-through says that when the euro appreciates against the currency \( l \), French exporting firms may absorb part of the exchange rate change by lowering the export price denominated in the exporting currency \( l \). Thus the price of exports denominated in foreign currency \( l \) increases by a magnitude less than the appreciation of the euro against currency \( l \). This absorption may result either from a “pricing to market” strategy, that is the firm absorbs part of the exchange-rate appreciation by reducing its markup in order to remain competitive in foreign markets, or because its marginal cost falls thanks to cheapest imported intermediates.

On the import-competing side, we assume symmetrically that foreign firms that sell their output into French domestic markets are not neither likely to lower the (euro) price of their goods to the full extent of the euro appreciation. As a consequence, the pass-through elasticity of French import prices (in euro terms) in the market \( k \) which the good \( g \) belongs, \( P^m_m \), with respect to exchange rate is ranging between -1 and 0. Furthermore, we assume that the (euro) unit price of French firms’ output sold domestically also respond to euro changes. Indeed, French firms are likely to reduce the price of their goods following a euro appreciation either/both because their marginal cost are reduced thanks to cheapest imported intermediates, or because they seek to remain competitive against an increased foreign price-competition and thus, reduce their domestic markup. Formally, these three assumptions on the pass-through elasticities of French export, domestic and import prices with respect to the nominal exchange rate \( E_l \) can be expressed as follows :

\[
\xi^l_{P^x_{i,l}} = \frac{\partial P^x_{i,l}}{\partial E_l} E_l P^x_{i,l} = 1 + \xi^l_{\phi^x_{i,l}} + \xi^l_{C_i} \in [0; 1] \tag{4}
\]

\[
\xi^l_{P^d_i} = \frac{\partial P^d_i}{\partial E_l} E_l P^d_i = \xi^l_{\phi^d_i} + \xi^l_{C_i} \in [-1; 0] \tag{5}
\]

\[
\xi^l_{P^m_k} = \frac{\partial P^m_k}{\partial E_l} E_l P^m_k \in [-1; 0] \tag{6}
\]

\[
\xi^l_{C_i} = \frac{\partial C_i}{\partial E_l} E_l C_i \in [-1; 0]: \quad \xi^l_{\phi^x_{i,l}} = \frac{\partial \phi^x_{i,l}}{\partial E_l} \phi^x_{i,l} \in [-1; 0] \quad \text{and} \quad \xi^l_{\phi^d_i} = \frac{\partial \phi^d_i}{\partial E_l} \phi^d_i \in [-1; 0]
\]

\footnote{Goldberg and Hellerstein (2008) use a structural approach and firm-product level data in the U.S beer industry, and find that on average 54.1 percent of the incomplete exchange rate pass-through is due to local non-traded costs, 33.7 percent to markup adjustment, and 12.2 percent to price adjustment costs. However, marginal costs here are specific to a firm but does not vary across destinations so local non-traded costs are excluded from the cost function.}
Let’s now discuss volume of sales and price-elasticity of demand. We assume that the demand for French firm’s manufactured good on each domestic and foreign markets is a function of both, the French and foreign activities, as well as the price competitiveness of French manufactured goods relative to their competitors on each market \( k \). On the export volume side, an increase in the foreign country \( l \) activity, \( Y^*_l \), or a decrease in the ratio of (foreign currency \( l \)) export price to foreign \( l \) price \( \left( \frac{P^x_i,l}{P^*_k,l} \right) \), where \( P^*_k,l \) is the average price index on the foreign market \( k \) in country \( l \), would increase the volume of export sales to \( l \). Similarly, on the importing side, an increase in French activity, \( Y^*_i \), or in the ratio of import prices to French prices \( \left( \frac{P^m_k}{P^d_i} \right) \), would increase the volume of domestic sales. Formally, these assumptions on the price-elasticity of demand and the sensitivity of sales to economic activity can be expressed as follows:

\[
Q^x_{i,l} = Q^x_{i,l} \left( \frac{P^x_i,l}{P^*_k,l}; Y^*_l \right)
\]

with \( \lambda^x_{i,l} = \frac{\partial Q^x_{i,l}}{\partial \left( \frac{P^x_i,l}{P^*_k,l} \right)} \frac{P^x_i,l}{Q^x_{i,l}} < 0 \) and \( \gamma^x_{i,l} = \frac{\partial Q^x_{i,l}}{\partial Y^*_l} \frac{Y^*_l}{Q^x_{i,l}} > 0 \)

\[
Q^d_i = Q^d_i \left( \frac{P^m_k}{P^d_i}; Y \right)
\]

with \( \lambda^d_i = \frac{\partial Q^d_i}{\partial \left( \frac{P^m_k}{P^d_i} \right)} \frac{P^m_k}{Q^d_i} > 0 \) and \( \gamma^d_i = \frac{\partial Q^d_i}{\partial Y} \frac{Y}{Q^d_i} > 0 \)

From the above consideration about the pass-through elasticities, the price-elasticities of demand and the sensitivity of firms’ marginal cost to exchange rate, it can be easily demonstrated that French firms’ revenues are always harmed by an euro appreciation. Indeed, if the exporting and/or import-competing firm has market power, it can try to minimize its revenue loss by choosing the extent to which the price of its goods adjusts to a euro appreciation. However, this strategy can only mitigate, but not eliminate, the negative impact of an euro appreciation since this loss in price-competitiveness will reduce the demand for its products and thus, its volume of sales. To put it another way, an euro appreciation would always induce a decrease in French firms’ revenue either because profit margin would decrease at a given sales volume and/or because sales volume would decrease at a given profit margin. The only way firms’ profit can be positively affected by an euro appreciation remain if its positive impact on their marginal cost - through imported intermediates - overcompensates these negative impacts on firms’ revenue. Formally, these effects of euro appreciations against currency \( l \) on French firms profits can be demonstrated by deriving equation 1 with respect to the nominal exchange-rate \( E_l \), and by assuming that the average price index in the foreign country \( l \) is not affected by an appreciation in the value of the home currency \( ^9 \).

This is done in Appendix 1 which provides us with the following French firms’ domestic and export profits elasticities with respect to the nominal exchange \( E_l \):

\[
^9 \text{That is, by assuming that } \frac{\partial P^*_k,l}{\partial E_l} \frac{E_l}{P^*_k,l} = 0
\]
Equation 7 indicates that, from the perspective of a French exporting firm, an appreciation in the euro always reduce its revenue, regardless of its pricing behavior, that is, whether or not the euro appreciation results in an increase in its foreign currency export prices. If the French firm chooses a strategy of “complete pass-through” and raises the foreign currency price of exports to the full extent of the euro’s appreciation ($\xi_{i,l}^F = 1$), it leaves the unit euro revenue of its exports unchanged by holding its euro export price fixed. However, it becomes less price competitive relative to its foreign competitors, and as a consequence, its export volume drops. Its export revenues will thus fall proportionally to the price elasticity of foreign demand for its exports, that is $\lambda_{i,l}^F \%$. If the French firm choose a strategy of “zero-pass-through” and keep the foreign currency price of its exports unchanged ($\xi_{i,l}^F = 0$), the euro price of its exports falls to the same extent that the euro has appreciated. With this strategy, the firm prevents its export volume and thus, its revenues measured in foreign currency terms from declining. However, these foreign currency revenues will translate into fewer euros: a 1 percent euro appreciation will reduce the euro export price ($P_{i,l}^x/E_l$) by 1% and a translation effect of 1% euro appreciation will be equal to the ratio of export revenues to $l$ into its total profits. In general, the exchange rate pass-through is likely to be incomplete but more than zero ($\xi_{i,l}^F \in ]0;1[), so that an appreciation of the euro hurts export profits both by lowering the volume of exports and by translating (foreign currency) revenues into fewer euros. There is, in fact a trade-off between the price/volume effect and the translation effect: as the exchange rate pass-through to French export prices becomes larger, a given appreciation of the euro hurts exports profits more through a loss in the volume of sales but less through a euro translation effect.

Equation 8 indicates that, from the perspective of a French import-competing firm, an appreciation in the euro is greatly likely to reduce its domestic revenue, regardless of its foreign competitors pricing behavior ($\xi_{i,m}^F$). As long as foreign exporters lower the euro price of their products more than domestic producer ($|\xi_{i,m}^F| > |\xi_{i,d}^F|$), French import-competing firms’ domestic revenues will be lowered by the euro’s appreciation because they will become less price-competitive relative to foreign goods. Through this price/volume effect, a 1% euro appreciation would thus decrease French import-competitors’ revenues by $\left(\xi_{i,m}^F - \xi_{i,d}^F\right) \times \lambda_{i}^F \%$. Furthermore, as long as the French firm reduces the euro price of its output sold domestically following the euro appreciation ($\xi_{i,d}^F < 0$), we should also observe a decrease in its revenue due to this loss in unit profit: a 1 percent euro appreciation that reduces the euro domestic price, and so the unit profit, by $\xi_{i,d}^F \%$ will thus induce a decrease in the total revenue by $\frac{P_{i,d}^x}{E_i} \times \xi_{i,d}^F \%$.

Whether French manufacturing firms are only import-competing or exporters, the negative impact of euro appreciations on their profits still might be mitigate since the latter also induce a decline in imported intermediate costs. The resulting reduced marginal costs would indeed allow them to prevent the decline in the (euro) profit margin of their goods sold both/either in France and abroad. Formally, equation 7 and equation 8 together indicate that a 1% euro appreciation against
currency $l$ that reduces the euro unit cost by $\xi_C^I\%$ will induce a total decrease in French firms’ production costs, and thus an increase in their profits, that equalise the product of this exchange-rate elasticity of unit costs and the share of the production costs into total profits, that is by $\frac{C_iQ_i\xi_C^I}{\Pi_i}\%$. As a consequence, the greater French firms’ manufacturing costs are sensitive to changes in the foreign currency $l$’s euro value, and the larger the production costs into total profits, the lower will be the decline of French firms’ profits following an euro appreciation. Further assumptions of French manufacturing firms’ production function and costs structure, will be made in Section 2.2.

To summarize, equation 7 and equation 8 allow to measure how and to what extent French manufacturing firms’ profits are hurt by euro appreciation, whether the latter are exporters, importers or purely domestics. Of course, since some of the parameters and variables involved - such as the pass-through elasticities of French export and domestic prices, as well as the exchange-rate elasticity of unit costs, the market destination (and thus the nominal exchange rate considered), the share of exports, domestic sales and imported intermediates costs into total profits - are firm-specific, the analyze should provide us with a great heterogeneity of French firms’ profits responses to exchange rate, even within narrowly defined industries. However, in order to accurately assess all of these effects, we still need to estimate the parameters involved in the above formal derivation, namely, (i) the price-elasticities of demand ($\lambda^{x}_{il}$ and $\lambda^{d}_{i}$), and the pass-through elasticities of French export and domestic prices ($\xi^{l}_{P^{x}i,t}$ and $\xi^{l}_{P^{d}i,t}$) specific to each firm and market destination, (ii) the pass-through elasticities of French import prices specific to each French domestic markets $k$ ($\xi^{l}_{P^{m}k}$), as well as (iii) the exchange-rate elasticity of unit costs ($\xi^{l}_{C}C_{i,t}$) specific to each firm.

### 2.2 Strategies for estimates of parameters

As mentioned above, an imperfect competition setting implies that firms set the optimal net price of their product at a markup over their marginal cost. Markups are both, firm and market destination specific, while marginal costs are firm-specific. Consequently, the yearly pass-through elasticities of a firm’s export and domestic prices, with respect to the nominal exchange rate $E_l$, are given by $\xi^{l}_{P^{x}i,t} = 1 + \xi^{l}_{\phi^{x}_{i,t}} + \xi^{l}_{C_{i,t}}$ and $\xi^{l}_{P^{d}i,t} = \xi^{l}_{\phi^{d}_{i,t}} + \xi^{l}_{C_{i,t}}$ - where $\xi^{l}_{\phi^{x}_{i,t}}$ and $\xi^{l}_{\phi^{d}_{i,t}}$ denote the yearly elasticities of the firm-specific markups on, respectively, the foreign $l$ and domestic markets, and $\xi^{l}_{C_{i,t}}$ the firm-specific elasticity of unit-costs with respect to the nominal exchange rate $E_l$. What we need to do then, is thus to estimate both, the response of the firm and market-specific markups, as well as the response of the firm-specific marginal cost to change in the euro value.

Let’s begin by the variability of markups in response to exchange-rate movements. As noted by Goldberg and Hellerstein (2008), reduced-form approach, which consider the intensity of competition in the destination market as the only determinant of incomplete pass-through - and thus which frequently use the case of a monopolist who faces a CES demand - do not allow markup changes in response to an exchange rate fluctuations. For a model to be able to fully assess incomplete pass-through, it is important to allow for functional forms that do not - by construction - imply constant markups. As in Andrade et al. (2010), the firm’s markups are thus assumed to be linked to the associated price-elasticities facing by the firm on each foreign market $l$ and on the domestic market, $\lambda^{x}_{il}$ and $\lambda^{d}_{i}$. These price-elasticities of demand are allowed to be a general unspecified function of three variables which cover several models of imperfect competition on international markets: the sectoral specific elasticities of demand ($\lambda_{k}$); the intensity of competition on the market $k$ in locality $l$ ($\eta^{k}_{m,l}$ and $\eta^{l}_{k}$), and other firms’ characteristics ($Z_{f}$):
that the production of a final good assume theoretically, as in Feenstra and Hanson (1996) and Grossman and Rossi-Hansberg (2008), by change in the euro’s value through imported intermediates. In order to capture this effect, we costs are equal to unit costs. However, French manufacturing firms’ unit costs still might be affected production of one more unit of a good does not engender structural adjustments so that marginal inputs used in firms’ production process and, (iii) decreasing returns to scale implying an upward sloping marginal cost curve. However, as in the original model of Knetter (1989), we work on f.o.b prices such that marginal costs are firm- but not destination-specific, and local non-traded costs are excluded from the cost function. Furthermore, in order to keep things simple, we assume that the specific fixed effects that allow to assess at each period the existence of local, non-traded costs (ii) imported and other firms characteristic - that are not related to exchange-rate changes, and for which we postulate the following general decomposition: $\Delta u_{i,t}^d = \delta_{k,t} + \delta_{k,d,t} + \delta_{f,t} + \delta_t + u_{i,t}$, with $E\{u_{i,t}\mid \delta_{k,t}, \delta_{k,d,t}, \delta_{f,t} = 0\}$, and $\Delta u_{i,t}^d = \delta_{k,t} + \delta_{k,d,t} + \delta_{f,t} + \delta_t + u_{i,t}$, with $E\{u_{i,t}\mid \delta_{k,t}, \delta_{k,d,t}, \delta_{f,t} = 0\}$. The resulting time-varying firm-specific’s elasticities of markups with respect to the nominal exchange rate are thus given by $\xi_{\phi_{i,t}^d} = \sum_{i=1}^4 \alpha_{i,t}^d$ and $\xi_{\phi_{i,t}^d} = \sum_{i=1}^4 \alpha_{i,t}^d$.

As explained above, this strategy for estimates of both $\phi_{i,t}^d$ and $\phi_{i,t}^d$, as well as the resulting $\xi_{\phi_{i,t}^d}$ and $\xi_{\phi_{i,t}^d}$, may be implemented only if marginal costs are initially computed. As noted in Goldberg and Hellerstein (2008), three complementary reasons may explained why marginal costs can be affected by the exchange-rate: (i) the existence of local, non-traded costs (ii) imported inputs used in firms’ production process and, (iii) decreasing returns to scale implying an upward sloping marginal cost curve. However, as in the original model of Knetter (1989), we work on f.o.b prices such that marginal costs are firm- but not destination-specific, and local non-traded costs are excluded from the cost function. Furthermore, in order to keep things simple, we assume that the production of one more unit of a good does not engender structural adjustments so that marginal costs are equal to unit costs. However, French manufacturing firms’ unit costs still might be affected by change in the euro’s value through imported intermediates. In order to capture this effect, we assume theoretically, as in Feenstra and Hanson (1996) and Grossman and Rossi-Hansberg (2008), that the production of a final good $i$ - that is a good of type $g$ produced by a particular firm $f$ - requires a set of intermediates $j \in J$, that can be sourced from either the home country or a foreign country $l$ (for instance, french and foreign wood), and whose respective price and quality are exogenous. Let’s denote $I_{i,j}^d$ and $I_{i,j}^d$ the domestic and imported intermediates (from country
price elasticities faced on domestic and each foreign
and firm-specific parameters. The only two left, namely, the French manufacturing firm-specific
imported intermediates sourced from different countries of provenance.
fluctuations affect French manufacturing firms’ unit costs and profits through different types of im-
can be computed from our database so that equation 14, allows us to evaluate to what extent euro
that, neither foreign competitors’ markups nor their marginal costs are observable. However, in
(9) and (10). The only parameter which is not firm but sector- specific, that is the pass-through
inferred from firm and destination time-varying markups (resp. \( \xi_{l,t} \)) of type
intermediates
The resulting time-varying elasticity of unit costs for a particular firm with respect to the nominal
exchange rate \( E_t \), in year \( t \), is then given by :
where \( w_i, r_i, p_{i,t}^d \) and \( p_{i,t}^m \) denote respectively the prices of one unit of labor (wage), capital,
domestic (in euro) and imported intermediates of type \( j \) from country \( l \) (in foreign currency \( l \)).
The resulting time-varying elasticity of unit costs for a particular firm with respect to the nominal
exchange rate \( E_t \), in year \( t \), is then given by :
\[ \xi_{C_{i,t}} = - \sum_{j \in J} \chi_{j,t} I_{j,t} \times \xi_{I_{i,j,t},t} \]  
(14)
with \[ \xi_{I_{i,j,t},t} = \frac{a_{i,j,t}^m \left( \frac{p_{i,t}^m}{E_t} \right)^{\rho_j - 1} + \sum_{l \in L} a_{i,j,l,t}^m \left( \frac{p_{i,t}^m}{E_t} \right)^{\rho_j - 1}}{a_{i,j,t}^d \left( \frac{p_{i,t}^d}{E_t} \right)^{\rho_j - 1} + \sum_{l \in L} a_{i,j,l,t}^d \left( \frac{p_{i,t}^d}{E_t} \right)^{\rho_j - 1}}. \]
As expected \( \xi_{C_{i}} \) is negative, that is, a raise in the euro’s value reduced French manufacturing
firms’ unit costs (and thus increase their unit profit), and this effect depend on both (i) the share of
intermediates \( j \) in total output \( (\chi_{j,t} I_{j,t}) \), as well as (ii) the share of the firm’s expense in intermediates
of type \( j \) imported from \( l \) in its minimum weighted cost function associated with purchasing its
basket of intermediates \( (\xi_{I_{i,j,t},t}) \), such that \( \xi_{C_{i}} \in [-1; 0] \). Both of these firm-specific parameters can be computed from our database so that equation 14, allows us to evaluate to what extent euro fluctuations affect French manufacturing firms’ unit costs and profits through different types of imported intermediates sourced from different countries of provenance.
Together, equations (2), (3), (9), (10), (11), (12) and (14) allow to estimate all the time-varying
and firm-specific parameters. The only two left, namely, the French manufacturing firm-specific
price elasticities faced on domestic and each foreign \( l \) markets (resp. \( \chi_{i,t}^d \) and \( \chi_{i,t}^l \)) can indeed be
inferred from firm and destination time-varying markups (resp. \( \phi_{i,t}^d \) and \( \phi_{i,t}^l \)) according to equations
(9) and (10). The only parameter which is not firm but sector- specific, that is the pass-through
elasticities of French import prices on each domestic market \( k \), \( \xi_{k,t}^m \) is difficult to estimate given that,
neither foreign competitors’ markups nor their marginal costs are observable. However, in
\footnote{This relative quality is mostly reflected in the relative marginal productivity of intermediates and can be approximated by their respective share in total intermediate costs.}
In order to obtain estimates of $\xi_{P_{k,l,t}}^{l}$ as accurate as possible, we employ the methodology of Campa et al. (2005). This consists in estimating the following empirical model:

$$
\Delta P_{k,l,t}^{m} = \beta_1 \Delta E_{l,t} + \delta_{k,t} + \beta_2 \left( \delta_{k,t} \ast \Delta E_{l,t} \right) + \delta_t + \beta_3 \left( \delta_t \ast \Delta E_{l,t} \right) + \beta_4 \left( \Delta w_{k,l,t}^{*} \ast \Delta E_{l,t} \right) + \beta_5 \Delta w_{k,l,t}^{*} + \epsilon_{k,l,t}^{m}
$$

(15)

The first term to the left of equation (15) accounts for the "currency translation" effects, and generates the expectation of $\beta_1 \in [-1; 0]$. Besides, foreign competitors from country $l$ may also absorb part of an euro appreciation at a given period $t$, by increasing their markup ($\phi_{P_{k,l,t}}^{m}$) on the French $k$ market were they sell their output into. Since foreign competitors’ markups for their sales in the domestic market $k$ are assumed to depend on both - time-varying and sectoral-specific - price elasticity of demand and structure of competition, their variability can be split into two components: (i) a year-industry fixed effect exogenous to exchange rate movements ($\delta_{k,t}$) which captures changes in the price-elasticity of demand or structure of competition that are not related to euro fluctuations; and (ii) a second component which is correlated with exchange-rate movements ($\delta_{k,t} \ast \Delta E_{l,t}$). Finally, changes in French import prices may also occur because foreign competitors’ marginal costs ($C_{k,l,t}$) fall, and this fall may be or not related to changes in the euro’s value. Indeed, if we assume that foreign marginal costs are a positive function of demand conditions in the French economy, but a negative function of foreign real wages (in foreign currencies and denoted $w_{k,l,t}^{*}$), the variability of foreign firms’ marginal costs from country $l$ competing in the sector $k$ is also split into four components: (i) a time-fixed effect which captures changes in the French economy that are common to all foreign competitors ($\delta_t$), but exogenous to euro’s fluctuations, (ii) the variation in real wages specific to each sector $k$ in the foreign country $l$ ($\Delta w_{k,l,t}^{*}$), but also exogenous to euro’s fluctuations; and finally, changes in (i) and (ii) that are correlated with changes in the euro value ($\delta_{t} \ast \Delta E_{l,t}$ and $w_{k,l,t}^{*} \ast \Delta E_{l,t}$). Globally, the time-specific pass-through elasticities of French import prices with respect to currency $l$ in sector $k$ is thus given by $\xi_{P_{k,l,t}}^{l} = \sum_{t=1}^{4} \beta_t$.

3 Calibration of the Model

3.1 The data

The theoretical predictions of firms’ profits exchange-rate exposure are calibrated using a large database on French firms coming from two different sources. The first one is a business survey called the “Enquête Annuelle d’Entreprise” (EAE). It is produced by the French Statistical Institute (INSEE) and available to us over the 1999–2007 period. This is an annual survey of all French firms with more than 20 employees, which provides us with relevant firm-level information including sales, value added, employment, capital, intermediate consumption, wages, sector of main activity, and other balance-sheet. We complete this database with a second source coming from the French Directorate-General of Customs and Indirect Taxes (DGDDI) which reports both exports and imports data for each firm located on the French metropolitan territory, by destination and year. More precisely, this database reports the volume (in tons) and value (in euros) of exports and imports for each 8-digit product (combined nomenclature) and country of destination and/or provenance, for each firm located on the French metropolitan territory. Unit values used in this paper are simply
computed as the ratio of export (resp. import) value divided by export (resp. import) volume.

[Problem with multi-product firms : When testing our predictions, the existence of multi-product firms must be taken into account. One solution is to restrict the sample to firms that only produce and/or export one product to a given destination. The composition issue vanishes, but the disadvantage of this solution is to reduce importantly the coverage of the sample, since single product/destination observations represent a small share of total French exports. In order to minimize this representativeness issue, another solution would consist to sum all flows for a given exporter but the product composition problem would then be maximized.]

[Data description]

3.2 Computing parameters

In order to implement the theoretical operating exposures provided by the model introduced in Section 2, we first begin by computing basic firm-level variables provided by the EAE and the trade database described above, that is the yearly \( t \) unit values and volumes of domestic sales and exports for each firm \( f \) producing the manufactured good \( g \) sold in the market destination \( l \) (\( P_{d,f,g,t} \), \( P_{x,f,g,l,t} \), \( Q_{d,f,g,t} \) and \( Q_{x,f,g,l,t} \)), their associated unit cost of production (\( C_{f,g,t} \)) and, finally, their domestic and export time-varying and destination-specific markups (\( \phi_{d,f,g,t} \) and \( \phi_{x,f,g,l,t} \)) given by equations (2) and (3). The latter allow to compute the time-varying price-elasticities facing by the firm on the domestic and each foreign market \( l \) (\( \lambda_{d,f,g,t} \) and \( \lambda_{x,f,g,l,t} \)), according to equations (9) and (10).

The first parameters of the firms’ profits exposure to exchange-rate estimated is the pass-through elasticities of French domestic and exports prices with respect to the nominal exchange rate \( E_{l} \) (\( \xi_{l} P_{d,f,g,t} \) and \( \xi_{l} P_{x,f,g,l,t} \)) that require to estimate the response of the firm and market-specific time-varying markups (\( \xi_{l} \phi_{d,f,g,t} \) and \( \xi_{l} \phi_{x,f,g,l,t} \)), as well as the response of the firm-specific marginal cost (\( \xi_{l} C_{f,g,t} \)) to change in the euro value according to equations (4) and (5). The former require econometric implementation such as described in Section 2.2, and thus, the empirical estimates of equations (11) and (12). The latter is simply computed through equation (14) by using information about the share of intermediates of type \( j \) in the total costs of production (\( \chi_{f,g,t}^{j} \)), as well as the unit price of the imported intermediate \( j \) from country \( l \) and its share in total intermediates of type \( j \) (\( P_{m,f,g,j,l,t} \) and \( a_{m,f,g,j,l,t}^{n} \)) provided by our firm-level trade database. Note that computing \( \xi_{l} C_{f,g,t} \) also requires to get estimates for the degree of substitution between varieties of intermediates of type \( j \) sourced either domestically or abroad(\( \rho_{j} \)). To this purpose, we use the estimates of imported trade elasticities provided by Broda et al. (2006) which used 6-digit HS import data (1992 classification system) from the ComTrade database, over the 1994 - 2003 period, for 73 countries in the world, and extract the elasticities that concern all inputs markets \( j \) in France. The distribution of these elasticities is illustrated by Figure A in the appendices.

Finally, the only parameter which is not firm but sector specific, that is the pass-through elasticities of French import prices on each domestic market \( k \) (\( \xi_{l} P_{m,k,t} \)) also involves a regression of equation (15) described in Section 2.2. Note that this empirical implementation requires to obtain information about import prices by sector \( k \) and country \( l \) of provenance (\( P_{m,k,l,t}^{n} \)), as well as the unit cost (in foreign currencies) also specific to each sector \( k \) and each French firms trading partners \( l \) (\( w_{k,l,t}^{*} \)). To this end, we use the database ComExt produced by the European Statistic Institutes (Eurostat)
which provides us with information about the value (in euros) and volume of French imports data for exactly 134 4-digit industries and 245 trading partners over the 1999-2007 period. We complete this database by adding information on sectoral unit labor costs at a 2-digit level for each importer country, sourced from the International Labor Organization database. The latter leave us with estimates of time-varying and sector-specific French imports pass-through at a 4-digit level based on a sample of imports price and costs data covering 67 trading partners countries over the 1999-2007 period.

\[
\Delta P_{m,k,l,t} = 0.257^{** *} + 0.167^{** * } \Delta w_{k,l,t} - 0.259^{** * } \Delta E_{l,t} + 0.036^{*} \Delta w_{k,l,t} \times \Delta E_{l,t}
\]

\[
+ \hat{\beta}_{k,t} (\delta_{k,t} \times \Delta E_{l,t}) + \hat{\beta}_{t} (\delta_{t} \times \Delta E_{l,t}) + \delta_{k,t} + \delta_{k,l,t} + \hat{e}_{k,l,t}
\]

(16)
Table 1: Estimates for elasticities of exchange-rate pass-through into French import prices

<table>
<thead>
<tr>
<th>2-digit Industry</th>
<th>Average 2000-2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food products and beverages</td>
<td>0.69</td>
</tr>
<tr>
<td>Tobacco products</td>
<td></td>
</tr>
<tr>
<td>Textiles</td>
<td>0.70</td>
</tr>
<tr>
<td>Wearing apparel; dressing and dyeing of fur</td>
<td>0.78</td>
</tr>
<tr>
<td>Tanning and dressing of leather</td>
<td>0.73</td>
</tr>
<tr>
<td>Wood and of products of wood, cork, straw and plaiting materials</td>
<td>0.66</td>
</tr>
<tr>
<td>Paper and paper products</td>
<td>0.65</td>
</tr>
<tr>
<td>Publishing, printing and reproduction of recorded media</td>
<td>0.54</td>
</tr>
<tr>
<td>Coke, refined petroleum products and nuclear fuel</td>
<td>0.60</td>
</tr>
<tr>
<td>Chemicals and chemical products</td>
<td>0.65</td>
</tr>
<tr>
<td>Rubber and plastics products</td>
<td>0.71</td>
</tr>
<tr>
<td>Other non-metallic mineral products</td>
<td>0.72</td>
</tr>
<tr>
<td>Basic metals</td>
<td>0.60</td>
</tr>
<tr>
<td>Fabricated metal products, except machinery and equipment</td>
<td>0.63</td>
</tr>
<tr>
<td>Machinery and equipment n.e.c.</td>
<td>0.54</td>
</tr>
<tr>
<td>Office, accounting and computing machinery</td>
<td>0.67</td>
</tr>
<tr>
<td>Electrical machinery and apparatus n.e.c.</td>
<td>0.59</td>
</tr>
<tr>
<td>Radio, television and communication equipment and apparatus</td>
<td>0.55</td>
</tr>
<tr>
<td>Medical, precision and optical instruments, watches and clocks</td>
<td>0.56</td>
</tr>
<tr>
<td>Motor vehicles, trailers and semi-trailers</td>
<td>0.83</td>
</tr>
<tr>
<td>Other transport equipment</td>
<td>0.64</td>
</tr>
<tr>
<td>Furniture; manufacturing n.e.c.</td>
<td>0.75</td>
</tr>
<tr>
<td></td>
<td>0.67</td>
</tr>
</tbody>
</table>

Figure 1: **Pass-through elasticities of French import prices:** $1 + \xi_{P_{k,t}}$
4 Estimated exposures
References


Krugman, P. R. (1986). Pricing to market when the exchange rate changes.


Appendix 1: Exchange-rate elasticity of French manufacturing firms’ profits

Exchange-rate elasticity of Export Profit:

\[
\frac{\partial \Pi_{i,l}}{\partial E_i} = -P_{i,l}^e \frac{Q_{i,l}^e}{E_i} + \frac{\partial Q_{i,l}^e}{\partial E_i} P_{i,l}^e - \frac{\partial Q_{i,l}^e}{\partial E_i} U_i - Q_{i,l}^e \frac{\partial U_i}{\partial E_i}
\]

\[
\frac{\partial \Pi_{i,l}}{\partial E_i} \frac{E_i}{\Pi_{i,l}^E} = -P_{i,l}^e \frac{Q_{i,l}^e}{E_i} + \frac{\partial Q_{i,l}^e}{\partial E_i} P_{i,l}^e - \frac{\partial Q_{i,l}^e}{\partial E_i} U_i - Q_{i,l}^e \frac{\partial U_i}{\partial E_i}
\]

\[
\frac{\partial \Pi_{i,l}}{\partial E_i} \frac{E_i}{\Pi_{i,l}^E} \left[ \frac{\partial P_{i,l}^e}{\partial E_i} E_i - 1 \right] + \frac{\partial Q_{i,l}^e}{\partial E_i} E_i \left[ P_{i,l}^e E_i - U_i \right] - Q_{i,l}^e \frac{\partial U_i}{\partial E_i}
\]

\[
\frac{\partial \Pi_{i,l}}{\partial E_i} \frac{E_i}{\Pi_{i,l}^E} \left[ \frac{\partial P_{i,l}^e}{\partial E_i} E_i - 1 \right] + \frac{\partial Q_{i,l}^e}{\partial E_i} E_i \left[ P_{i,l}^e E_i - U_i \right] - Q_{i,l}^e \frac{\partial U_i}{\partial E_i}
\]

\[
\frac{\partial \Pi_{i,l}^E}{\partial E_i} = P_{i,l}^e Q_{i,l}^e \left[ \frac{\partial P_{i,l}^e}{\partial E_i} E_i - 1 \right] + \frac{\partial Q_{i,l}^e}{\partial E_i} E_i \left[ P_{i,l}^e E_i - U_i \right] - Q_{i,l}^e \frac{\partial U_i}{\partial E_i}
\]

Exchange-rate elasticity of Domestic Profit:

\[
\frac{\partial \Pi_{i,l}^d}{\partial E_i} = \frac{\partial P_{i,l}^d}{\partial E_i} Q_{i,l}^d + \frac{\partial Q_{i,l}^d}{\partial E_i} P_{i,l}^d - \frac{\partial Q_{i,l}^d}{\partial E_i} U_i - Q_{i,l}^d \frac{\partial U_i}{\partial E_i}
\]

\[
\frac{\partial \Pi_{i,l}^d}{\partial E_i} \frac{E_i}{\Pi_{i,l}^E} = \frac{\partial P_{i,l}^d}{\partial E_i} Q_{i,l}^d + \frac{\partial Q_{i,l}^d}{\partial E_i} P_{i,l}^d - \frac{\partial Q_{i,l}^d}{\partial E_i} U_i - Q_{i,l}^d \frac{\partial U_i}{\partial E_i}
\]

\[
\frac{\partial \Pi_{i,l}^d}{\partial E_i} \frac{E_i}{\Pi_{i,l}^E} \frac{E_i}{\Pi_{i,l}^E} \left[ \frac{\partial P_{i,l}^d}{\partial E_i} E_i - 1 \right] + \frac{\partial Q_{i,l}^d}{\partial E_i} E_i \left[ P_{i,l}^d E_i - U_i \right] - Q_{i,l}^d \frac{\partial U_i}{\partial E_i}
\]

\[
\frac{\partial \Pi_{i,l}^d}{\partial E_i} \frac{E_i}{\Pi_{i,l}^E} \frac{E_i}{\Pi_{i,l}^E} \left[ \frac{\partial P_{i,l}^d}{\partial E_i} E_i - 1 \right] + \frac{\partial Q_{i,l}^d}{\partial E_i} E_i \left[ P_{i,l}^d E_i - U_i \right] - Q_{i,l}^d \frac{\partial U_i}{\partial E_i}
\]

\[
\frac{\partial \Pi_{i,l}^d}{\partial E_i} \frac{E_i}{\Pi_{i,l}^E} \left[ \frac{\partial P_{i,l}^d}{\partial E_i} E_i - 1 \right] + \frac{\partial Q_{i,l}^d}{\partial E_i} E_i \left[ P_{i,l}^d E_i - U_i \right] - Q_{i,l}^d \frac{\partial U_i}{\partial E_i}
\]
\[ \Pi^d_f = \text{French manufacturing firm } f's \text{ gross nominal profits from sales to the import-competing domestic market } k, \text{ in euro terms} \]
\[ \Pi^x_{f,l} = \text{French manufacturing firm } f's \text{ gross nominal profits from sales to the foreign market } k \text{ in country } l, \text{ in euro terms} \]
\[ Q^x_{f,l} = \text{export volume to country } l \]
\[ Q^d_f = \text{output volume sold domestically} \]
\[ U_i = \text{the unit variable cost of French manufactured output} \]
\[ E_l = \text{the nominal exchange rate, defined as } E \text{ units of foreign currency } l \text{ per unit of euro} \]
\[ P^x_{i,l} = \text{the (foreign currency } l) \text{ unit price of French firm’s exports to } l \]
\[ P^d_i = \text{the (euro) unit price of French firm’s output sold domestically} \]
\[ P^m_k = \text{the (euro) average unit price of French imports in market } k \]
\[ P^*_{k,l} = \text{the foreign country } l's \text{ price level on the market } k \]
\[ Y = \text{the French domestic revenue, in euros} \]
\[ Y^*_l = \text{the foreign country } l's \text{ revenue, in foreign currency} \]
\[ \xi^x_{l} = \text{Pass-through elasticity of French firms’ export prices with respect to } E_l \]
\[ \xi^d_l = \text{Pass-through elasticity of French firms’ domestic prices with respect to } E_l \]
\[ \xi^m_{l,k} = \text{Pass-through elasticity of French firms’ import prices with respect to } E_l \]
\[ \xi^u_{i} = \text{Pass-through elasticity of French firms’ marginal costs of production with respect to } E_l \]
\[ \lambda^d_l = \text{The firm-specific price elasticity of domestic demand} \]
\[ \lambda^x_{f,l} = \text{The firm-specific price elasticity of foreign demand in country } l \]
\[ \gamma^x_l = \text{Elasticity of foreign demand to foreign revenue in country } l \]
\[ \gamma^d = \text{Elasticity of domestic demand to French revenue} \]
Figure A: Frequency Distribution for Estimates of $\sigma_j$ in France
Source: Broda et al. (2006)