Exchange rate movements and export prices an empirical analysis

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Abstract

This paper uses an empirical approach based on Knetter [1989, 1993]'s to study the effect of currency changes on international trade prices. Exchange rate pass-through elasticities are estimated for more than 2000 industries from six OECD exporting countries and compared at different levels of aggregation. The analysis reveals, in various industries, a sensitivity of export prices to exchange rate movements, in a way that is compatible with strategies of local price stabilization in response to macroeconomic perturbations. This phenomenon is especially pronounced in Italian data but the high disparity of results at the sector-based level suggests a pre-eminent role for structural factors, rather than macroeconomic ones, to explain it.

Keywords: exchange rate pass-through, macroeconomic environment, price strategies, panel data
J.E.L. Classification: F14, F41

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1 Introduction

The sensitivity of prices to exchange rate movements is a recent but fruitful subject in Open Macroeconomics debates. Indeed, since Betts and Devereux [1996]'s seminal paper, the hypothesis of a full pass-through of currency changes into import prices, at the root of the standard Purchasing Power Parity relation, has been questioned many times. Empirically, the size and persistence of the deviations to the Law of One Price, even for traded good prices, are well documented (see e.g. Engel [1999]). This imperfect transmission of exchange rate movements into import prices led to the emergence of new models integrating an "Incomplete Pass-Through" phenomenon. The supposed degree of pass-through proved to be an important determinant of the international monetary transmission, the exchange rate dynamics, etc. Those models however do not agree on the explanation of the nominal deviations : whereas Betts and Devereux [1996] introduce them using an ad-hoc hypothesis of Local Currency Pricing combined with price rigidities[1], Corsetti and Dedola [2003] explain this phenomenon by local distribution costs influencing the exporter's behaviour, Bergin and Feenstra [2000] by the interaction between staggered contracts and a specific input-output structure and Taylor [2000] by a decline in the pricing power of firms in a low inflation environment.

Such theoretical differences appeal for new empirical facts. The present paper uses a supply-side approach and a fine industry-based level to study the influence of currency changes on export prices, the degree of "exchange rate pass-through" (ERPT hereafter). The main underlying assumption is that the high disparity of pass-through elasticities documented in many empirical papers (see e.g. Campa and Goldberg [2002]) is a consequence of different pricing strategies at the microeconomic level. Admitting such an hypothesis, a remaining question will concern the kind of factors able to influence those pass-through strategies and, in particular, if they are mainly structural, as suggested in the Pricing-to-Market literature (see Krugman [1986]), or if there is a scope for a macroeconomic influence too (as in Taylor [2000] for instance). To answer, I use exchange rate pass-through elasticities estimated

[1] By Local Currency Pricing, one thinks of a pricing strategy in which exporters set their price directly in the buyer's currency, leading, in the short term, to a perfect rigidity of import prices to exchange rate movements

from export data[2] on a large set of industries located in six exporting countries, thus allowing a multidimensional comparison. The main benefit of such an industry-based method is the high degree of disaggregation that weakens the risk of endogeneity and composition bias and increases the accuracy of estimated pass-through elasticities[3]. Moreover, by contrast with the comparable industrial economic literature (see Mann [1986], Gagnon and Knetter [1991], Knetter [1989, 1992, 1993], etc.), the covered array of industries is large enough to provide lessons on the macroeconomic implications of the estimated price sensitivities. Indeed, the averaged estimated elasticity measures the reaction of the export price index to exchange rate movements, for a representative basket of goods sold by six large exporting countries. One can then hope to derive from it insights on the incomplete pass-through phenomenon already observed on import prices. At this aggregated level, only Italian exporters seem to have a pronounced propensity to smooth exchange rate movements by mark-up adjustments, a tendency that can be explained by several national specificities. Pass-through estimates are however various at the sector-based level, implying a high behavioral heterogeneity from an industry to another. Even in the United States (where competitive pricing strategies of full pass-through appeared to dominate in previous papers), mark-up adjustments to exchange rate changes seem to be strong in some given sectors. This heterogeneity of estimated strategies suggests that the explanation of the incomplete pass-through phenomenon is mainly structural, calling for a microfounded introduction of it in macroeconomic models.

The model, the empirical method and the data are presented in section 2. In the third section, results are studied first at the sector-based level allowing a partial evaluation of those behaviours' determinants, next in the aggregate to explore the macroeconomic consequences of the measured pass-through strategies. Last, section 4 concludes.

[2] On that point, my approach differs from almost all the related empirical literature (see Devereux and Yetman [2002], Anderton [2003], Herzberg, Kapetanios and Price [2003] for recent contributions) that focuses on the macroeconomic consequences of the incomplete pass-through phenomenon using aggregated import prices, expressed in the consumer's currency. In those papers, the pass-through is said to be complete when the elasticity of prices with respect to exchange rate changes is unitary. The main difference with export prices will be lexical : the Exchange Rate Pass-Through is said complete when the estimated elasticity is zero, implying a perfect repercussion of currency changes on the consumer price of the considered traded good.

[3] Indeed, Campa and Goldberg [2002] underscore the presence of composition bias in pass-through estimates based on price indexes. The endogeneity question is also brought up in several papers.

2 Estimation of Pass-Through coefficients

2.1 The Model

As justified before, estimations are made systematically using disaggregated data on a large sample of industries. To be applicable for any exporting sector, the estimated equation is derived from a simple non structural model, that only requires a constant returns assumption. Considering the representative exporting firm of a given industry located in a given country and selling its goods in N separated national markets ($j = 1...N$), the pricing decisions can be summarized by a system of N maximizing problems of the following form :

$$Max \quad \Pi_t^j = Max \quad (P_t^j - Cm_t^j)D_t^j$$

where :

- P_t^j is the optimal price chosen by the representative firm, specifically for its sales in the country j and supposed to be denominated in its own money,
- Cm_t^j is the marginal cost of producing the good,
- D_t^j is the demand addressed by country j to the considered producer.

First-order conditions lead to a set of N optimal prices ($j = 1...N$) :

$$P_t^j = \mu_t^j Cm_t^j \tag{1}$$

with μ_t^j the optimal mark-up that depends on the perceived elasticity of demand η_t^j :

$$\begin{aligned} \mu_t^j &= \frac{\eta_t^j}{\eta_t^j - 1} \\ \eta_t^j &= -\frac{\partial D_t^j / D_t^j}{\partial (P_t^j S_t^j)/(P_t^j S_t^j)} \quad = \quad \eta^j(P_t^j S_t^j, Z_t^j) \end{aligned}$$

The optimal prices thus depend on the production costs (Cm_t^j) and the elasticity of demand with respect to the price expressed in the consumer's currency. To keep things as general as possible, this elasticity is written as a function of the consumer price ($P_t^j S_t^j$ with S_t^j the number of j's monetary units equivalent to one unit of the exporting country's currency) and of a set of demand attributes (Z_t^j)[4]. Totally differentiating (1) leads to a theoretical relation that links the export price to the marginal cost, the features of

[4]This program doesn't take into account the potential transport costs from the exporting country (i) to the destination (j). One can however incorporate it quite simply by

demand and the exchange rate :

$$d \ln P_t^j = (1 + \beta^j) d \ln Cm_t^j + \frac{\varepsilon_Z^\eta}{\varepsilon_{PS}^\eta} \beta^j d \ln Z_t^j + \beta^j d \ln S_t^j \tag{2}$$

with :

$$\beta^j = -\frac{\varepsilon_{PS}^\eta}{\eta^j - 1 + \varepsilon_{PS}^\eta}, \quad \varepsilon_{PS}^\eta = \frac{\partial \ln \eta_t^j}{\partial \ln(P_t^j S_t^j)}, \quad \varepsilon_Z^\eta = \frac{\partial \ln \eta_t^j}{\partial \ln(Z_t^j)}$$

In (2), β^j measures the sensitivity of the export price to exchange rate movements, the "pass-through coefficient" specific to each destination country. As already demonstrated in the Pricing-to-Market literature (see Krugman [1986]), this elasticity depends on the convexity of the perceived demand schedule (summarized by ε_{PS}^η) : it is null when the elasticity of demand with respect to the consumer's price is constant ($\varepsilon_{PS}^\eta = 0$), in what case the optimal pass-through is complete, negative for a less convex demand schedule, when the perceived elasticity of demand is an increasing function of the local currency price ($\varepsilon_{PS}^\eta > 0$)[5] and positive in the opposite situation.

2.2 Empirical specification

The estimation equation used to identify the pass-through coefficients β^j is directly obtained from (2) :

$$\Delta \ln P_t^j = \alpha^j \Delta \ln Cm_t^j + \gamma^j \Delta \ln Z_t^j + \beta^j \Delta \ln S_t^j + \varepsilon_t^j \tag{3}$$

with Δ the first order difference operator. In this equation, the parameter of interest is β^j, the elasticity of prices to exchange rate movements. The two other parameters are difficult to estimate with accuracy because of measurement problems, linked to the unobservable nature of marginal costs and the undetermination of variables included in Z_t^j without an exact definition of the functional form of demand (D_t^j). Moreover, beyond those measurement

assuming, as standard in the trade literature, a constant iceberg cost and a mill pricing strategy. In that case, the optimal export price would be multiplied by the iceberg cost: $P_t^j = \tau^{ij} TM_t^j Cm_t^j$ with τ^{ij} the quantity of goods that is "lost" during the transport between i and j. This constant term would however vanish from the estimated equation after the transformations described hereafter.

[5] Indeed, with such a perceived elasticity (that corresponds, for instance, to that of a linear demand), the exporter's optimal response to exchange rate movements is to adjust its mark-up. Following a depreciation of j's currency (an increase in S_t^j), he will cut its margin in order to maintain the local price, a mark-up decrease that is compensated during periods of appreciation.

problems, a more serious risk arises due to the potential correlation between those explanatory variables and the exchange rate. For instance, when part of the inputs incorporated in the production are imported from abroad, the marginal cost is influenced by exchange rate movements. In this case, an exact estimation of (3) would require to split the marginal cost using clear assumptions about the cost structure (see Athukorala and Menon [1994] for a joint estimation of export prices and marginal costs). To keep things more general however, one has to turn to a statistic version of (3), inspired from Knetter [1989], that uses both the time and individual variabilities of export price data in a multi-destination sample relative to a given exporting sector (in which importing countries are assimilated to individuals). Indeed, if the exporter's cost changes ($\Delta \ln Cm_t^j$ in (3)) are mainly common to all the importers j, driving price adjustments whatever the destination, a complete set of time dummies incorporated in (3) instead of a (probably mismeasured) marginal cost variable should catch them rather good. In the same way, one can hope to capture part of the country-specific features leading to price adjustments towards a specific market ($\Delta \ln Z_t^j$) with a complete set of individual effects. The present paper then proposes to estimate pass-through elasticities using separated samples relative to industries exporting their products in several countries during a given period, in a model with time and individual fixed effects :

$$\Delta \ln P_t^j = \alpha_t + \gamma^j + \beta^j \Delta \ln S_t^j + \varepsilon_t^j \tag{4}$$

with ε_t^j a residual term catching price adjustments that are neither linked to exchange rate movements, neither due to constant country-specific features, neither limited to a specific date but common to all the importers.

2.3 Data

(4) is estimated separately on samples relative to six exporting countries (Germany, the United States, France, Italy, Japan and the United Kingdom) and around 2000 industries at the 5-digit SITC commodity level (with no *ex ante* selection to cover a large range of those countries' exports). Importers (j) are restricted to OECD countries, in order to have long enough series, sufficient traded volumes and some heterogeneity between individuals. Data are annual and cover a period from 1988 to 1998 (1989-1998 for the USA). The choice of such a low periodicity is motivated by the volatility of volumes due to consumption transfers and the probable presence of nominal rigidities that could influence the estimated pass-through in a shorter horizon[6].

[6]The presence of such a bias is not however ruled out by annual data, in particular for industries in which menu costs are so large, that price adjustments spread over more than

As a proxy for export prices, the dependent variable is computed as first differences of the logarithm of F.O.B.[7] export unit-values (i.e. quotients of the value and quantity of shipments) obtained from the OECD's *International Trade by Commodities Statistics* database. Measurement errors in the dependent variable will then be a source of disturbance in the regression (see e.g., Kravis and Lipsey [1974]), leading to an upward bias if correlated with exchange rate movements. Those measurement errors are however more salient in aggregated data, because of the inherent heterogeneity of firms[8], thus again justifying our disaggregated approach. Exchange rate series are first differences of the bilateral exchange rate between the exporting country and each of its partner[9], deflated by the importer's CPI. The aim of this correction is to control for the potential influence of the global inflation on the exchange rate determination, that leads to price adjustments, independent from strategic considerations. Such a correction should then weaken the risk of endogeneity.

With time and individual effects that are probably correlated with the exchange rate, the chosen specification is a fixed effect model, estimated in its *within* form[10] to save degrees of freedom. For the estimation to be feasible, the errors ε_t^j are supposed to be *iid* but a White correction of the variance-covariance matrix leads to robust estimated standard errors, even in the case of heteroscedastic or autocorrelated errors. Last, only the coefficients estimated with a degree of freedom higher than 30 have been kept in order to delete part of the aberrant values.

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one year.

[7]The F.O.B.(*Franco On Board*) data do not include transportation, tariff wedges and local costs. The use of such data is then consistent with our initial omission of transport costs in the pricing equation. This question will still be problematic however if transport costs influence pricing strategies and are correlated with exchange rate movements.

[8]With heterogeneous industries, quality differences can justify price differences that are not caught by the model.

[9]Normalized to one dollar in 1995.

[10]The within estimation is based on series in distances towards individual means :

$$\Delta \ln P_t^j - \Delta \ln \bar{P}^j = (\alpha_t - \bar{\alpha}) + \beta^j(\Delta \ln S_t^j - \Delta \ln \bar{S}^j) + (\varepsilon_t^j - \bar{\varepsilon}^j) \tag{5}$$

with :

$$\begin{aligned} \Delta \ln \bar{P}^j &= \frac{1}{T^j}\sum_t \Delta \ln P_t^j, \quad \bar{\alpha} = \frac{1}{T^j}\sum_t \alpha_t \\ \Delta \ln \bar{S}^j &= \frac{1}{T^j}\sum_t \Delta \ln S_t^j, \quad \bar{\varepsilon}^j = \frac{1}{T^j}\sum_t \varepsilon_t^j \end{aligned}$$

and T^j the number of dates for which information on j's imports is available in the considered sub-sample.

3 Results

3.1 Unconstrained sectorial results

Previous empirical papers studying the size and macroeconomic consequences of the incomplete pass-through phenomenon have underscored large differences in the sensitivity of different national import price indexes to exchange rate movements. The first question that comes immediately in mind when reaching the microeconomic aspects of the incomplete pass-through phenomenon thus concerns the way a given exporting firm behaves towards its different markets : is the disparity observed at the aggregated level attributable to an adaptation of each exporter's pass-through strategy to the macroeconomic and competitive environment of the importing country or to a basic composition effect due to the interaction of different degrees of pass-through between industries with different baskets of imported goods between countries? A simple way to explore this question is to estimate importer-specific pass-through coefficients and then to test the null hypothesis of those estimates' equality ($H_0 \ : \ \beta^j = \beta \ \forall j$). Mean results of the corresponding F-test, applied at the sector-based level, are presented in table 1.

As in Knetter [1993], those tests lead to accept the null of an homogeneous pass-through behaviour towards all the destinations in a large majority of industries, however less crushing than in Knetter's more restricted sample (in which the null is rejected for only 8 of the 52 source-industry pairs) : between 70 and 85% of the total exported volume of each country are produced in industries for which the hypothesis of an uniform pass-through strategy towards the different markets can not be rejected. Moreover, when computing importer-specific mean pass-through coefficients[11], no clear path rises up to indicate a more pronounced pricing-to-market behaviour towards a specific market. In particular, exporters do not seem to adopt a differentiated strategy in response to the dollar's fluctuations. These results can not be assimilated to a formal proof of the homogeneity of pass-through strategies towards all the markets, since importers in this work are restricted to OECD ones. However, they seem to suggest that, if any, factors leading an exporter to differentiate its strategy are industry-specific, explaining the absence of pronounced effects at the global level.

Based on these results, and to limit the mass of coefficients to be analyzed, (5) is estimated again at the same sector-based level but imposing a constraint on the pass-through coefficients ($\Delta \ln P_t^j - \Delta \ln \bar{P}^j = (\alpha_t - \bar{\alpha}) +$

[11] Results available upon request.

$\beta(\Delta \ln S_t^j - \Delta \ln \bar{S}^j) + (\varepsilon_t^j - \bar{\varepsilon}^j))$. As argued by Knetter [1992], such a constrained specification will, at least, capture the mean degree of pass-through across destinations.

3.2 Constrained sectorial results

Table 2 gives the mean constrained estimates, at the 2-digit level[12] with figures in bold corresponding to the larger exporting classes (making up more than 2% of the total exported volume of the considered country)[13]. In some cases, the specification appears clearly too basic to catch the subtleties of the price dynamics : for instance, the improbable estimated elasticity of 2.076 concerning the US exports of live animals is attributable to a complex price dynamic in the sector 00151 ("Horses") that only a structural analysis is liable to explain. In almost all the considered industries however, results are in the scope of the theory, even if the number of positive mean values (125 on 352 source-industry pairs) is surprising, since corresponding in theory to non standard forms of demand (in which the perceived elasticity is a decreasing function of the local currency price). As in the previous literature, those positive pass-through elasticities are more frequent in estimations on US data, at least for the main exporting classes. As argued by Rangan and Lawrence [1993], this phenomenon could be explained by the important weight of intra-firm trade in US firms' sales, leading to transfer pricing strategies that can influence the degree of pass-through caught by our basic equation. Unfortunately, the lack of data on intra-firm trade prevents us to test this hypothesis formally and one can not rule out the alternative possibility of omitted variables explaining those results.

Except for Germany, one or several of the main industry-specific coefficients of each exporting country are significantly negative, i.e. compatible with a strategy of consumer price stabilization in response to exchange rate movements. The most pronounced Pricing-to-Market behaviours can be observed in the class 78 ("Road vehicles") for the USA, 67 ("Iron and Steel") for the UK, 54 ("Medicinal and pharmaceutical products") for France, 75 ("Office and data processing machines") for Italy and 51 ("Organic chemicals") for Japan. Some connections with the previous literature can be noticed, such as the important share of negative coefficients relative to manufactured

[12] Those averages are computed using a weighting scheme based on export volumes to take into account the representativeness of each sector in the considered 2-digit class.

[13] In the following, I will focus mainly on those sectors because of their bigger influence on global results. Moreover, those mean estimates are obtained from data covering a larger quantity of trade and thus the biases due to punctual shocks affecting a specific export price in a given year are more likely to be smoothed.

goods, already observed by Campa and Goldberg [2002] on import prices and explained by a higher degree of product differentiation in those sectors (providing their producers a pricing power that can be used to smooth exchange rate changes). However, the high heterogeneity of results, even inside a given 5-digit industry, casts doubt on the validity of such an explanation based on produced good characteristics (traded vs non traded, differentiated vs homogeneous, etc.). Indeed, if the degree of pass-through was actually determined by goods' intrinsic skills, exporters of the same industry localized in different countries should have the same pass-through strategy, since those features do not depend on the production place. On the contrary here, the estimated pass-through coefficients can vary largely, even in a given industry (as in the class 72 for instance).

In fact, the heterogeneity of results is already embarrassing when aggregating results at the 2-level digit, as done previously to summarize data. Indeed, when estimating sector-specific pass-through coefficients on samples grouping data on this higher level of aggregation, the null hypothesis of an equality of the 5-digit industry-specific estimates is rejected almost all the time, as shown in table 3. In general then, the optimal degrees of pass-through chosen by each representative firm of two different 5-digit industries, even in the same 2-digit class, will not be equal. This heterogeneity confirms the appropriateness of a sector-based study : any aggregation of the data will indeed lead to an averaged pass-through coefficient, potentially biased by composition effects.

Such a high disparity of results can be seen as a sign in favor of a structural origin of the incomplete pass-through phenomenon. Indeed, only industry- or firm-specific elements, as market structures for instance, can explain large strategic differences between exporters from different countries and/or different 5-digit industries. Even with a structural source of the incomplete pass-through however, one can not remove the possibility of a macroeconomic influence but its intensity should differ between industries, leading to a smoothed impact at the global level. Unfortunately, the choice of our purely statistic empirical method precludes any further analysis indispensable to corroborate this view. Indeed, the determination of specific structural features explaining the pass-through would required a more structural model, fitting each industry's specificities. Without entering in such a structural analysis however, results can still be instructive, in particular to evaluate the influence of those heterogeneous strategies at the global level.

3.3 Global consequences

To evaluate the global consequences of the previously observed various strategies, industry-specific statistics are averaged with a weighting scheme based on total exported volumes. The obtained figures (summarized in table 4 and illustrated in figure 1) can thus be interpreted as the mean pass-through behaviour of each exporting country, potentially explaining a part of its partners' import price sensitivity to exchange rate movements. Focusing on the estimates' significance (the second line in table 4) leads to a picture that is perfectly in line with the comparable sector-based literature : the share of significant coefficients is much higher in German estimations than when the considered exporters are US, English or Japanese, as in Knetter [1989, 1993], but also French or Italian (two countries that were not included in previous empirical papers). This high significance is often interpreted as as sign of the propensity of German exporters to "price-to-market" but one has to be cautious with such an assertion. Indeed, German estimations appear to be much more precise than the five others, leading to smaller estimated standard errors that explain the high probability of rejecting the null hypothesis in t-tests. Refuting the previous assertion, the German distribution is much more centered around zero than the five others with 46 % of its exports produced in sectors for which the estimated pass-through is between -0.01 and 0.01, a level assimilated to a complete pass-through coefficient. By opposition, the asymmetry of their distributions towards negative values suggest a higher propensity to smooth exchange rate movements from Japanese, French and, above all, Italian exporters. In fact, the original feature of the Italian behaviour seems to be strong, leading to a pass-through estimate that is almost all the time beside the mean (-0.18 point on average).

In fact, the Italy, as a whole, is the only country that appears to have a strong tendency to smooth exchange rate movements with, on average, 22% of currency changes absorbed into mark-ups. Several reasons can be advanced to explain this specificity. First, this result can be linked to the lira's high volatility during the 90's, especially after the EMS's crisis in 1992. Indeed, those monetary disturbances appear in the data (although smoothly on the full period) : the weighted mean of the lira's annual depreciation towards its trading partners is bigger than 5%, whereas between 1.5 and 3.4% for the 5 other countries. As suggested by Anderton and al. [2003], a high monetary volatility can increase the exporter's incentive to price-to-market, in order to maintain its sales when the demand becomes highly volatile, or to take advantage of an increased cost of arbitrage. One can however suspect another explanation for the low pass-through of the lira's fluctuations into export prices, linked to the small size of Italy as an exporter.

Indeed, as shown by Feenstra and al. [1996], the share of an exporter in the total consumption of the destination market can influence the degree of pass-through in a non linear way : above a given market share, the exporter can be considered as a "price maker", a status that allows him to pass a larger share of exchange rate changes into consumer prices. As a consequence, a country like Italy that is quite big but probably less than the five others (as regards to its weight in the world exports) could have a higher incentive to smooth exchange rate movements. Both explanation could explain the low pass-through observed at the aggregated level. However, here again, any rigorous test will require more precise assumptions about the technology and the functional form of demand. For instance, the relation between the market share and the degree of pass-through studied by Feenstra and al. [1996] depends on the competitive environment, the elasticity of substitution between goods, etc. Tests on the influence of the market share would then require either a precise characterization of each industry (with the inherent risk of omitting an important industry-specific determinant) or the use of simplifying assumptions that would weaken the reach of results.

4 Conclusion

Using disaggregated data on a large array of industries and several exporting countries, the previous systematic estimations, even if very basic, give us a rich information about the effect of exchange rate fluctuations on international trade prices. Contrary to the standard hypothesis at the root of the Purchasing Power Parity relation, export prices appear sensitive to exchange rate movements, even after having controlled for the possible effect of supply shocks and importer-specific features. Since this relation is observed on export prices, it is interpreted as a consequence of a "pass-through strategy" from exporting firms. The estimated coefficients are however various from an industry to another (whatever the considered degree of aggregation) and/or between the different exporting countries. This high disparity suggests that structural features such as the market structures or the firm's competitive environment have a large influence on those decisions. On the contrary, the apparent homogeneity of pass-through elasticities towards an exporter's different markets suggests that the impact of the macroeconomic environment in which products are sold, if any, is small, at least when restricting our attention to OECD's importers. Last, the higher propensity of Italian exporters to smooth exchange rate movements, observed both at the sectorial and at the aggregated level, do not allow us to remove the possibility that the supplier's macroeconomic environment could influence pass-through strategies.

The present non structural approach is obviously limiting a further analysis, that would require a more structural method, in particular to evaluate jointly the micro and macroeconomic aspects of the incomplete pass-through phenomenon. Several insights already emerge from this basic study however. First, the systematic estimation, made without any selection on industries, has shown that the incomplete pass-through phenomenon is not confined in specific sectors, as one could believe when reading papers centered around a small number of industries. On the contrary, negative elasticities can be observed in a large range of industries, in a way that is sometimes quite severe, thus possibly explaining by cumulative effects the incomplete pass-through observed on aggregated prices. Second, the high heterogeneity of the observed pass-through strategies suggests a primarily role for structural features in the pass-through decision, a result that should be a guide for macroeconomists. Indeed, in line with the current project of the New Open Macroeconomy to build micro-founded models, such a "pass-through decision" (or any strategic decision affecting the elasticity of prices to exchange rate movements) should then be incorporated in general equilibrium models. Ideally, this could be done in multi-sector models, in order to reproduce the strategic heterogeneity observed in this paper.

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Table 1: Results of the test concerning the homogeneity of pass-through strategies towards different importers[a]

Exporting country	**Share of the exported volume produced in industries rejecting the null of behavioral homogeneity (%)**
USA	23.1
UK	14.8
Germany	26.2
France	17.8
Italy	30.3
Japan	24.9

(a) The test uses results of an unconstrained version of the estimated equation :

$$\Delta \ln P_t^j - \Delta \ln \bar{P}^j = (\alpha_t - \bar{\alpha}) + \beta^j (\Delta \ln S_t^j - \Delta \ln \bar{S}^j) + (\varepsilon_t^j - \bar{\varepsilon}^j)$$

A F-test is used, that compares the constrained and unconstrained estimations at the sector-based level. The null hypothesis of the test is then $H_0 \ : \ \beta^j = \beta \ \forall j$. The given figures represents the share of each producer's global exported volume produced in industries for which this assumption is rejected at the 5% level. For instance, the first number means that only 23% of the US exports are produced in industries in which pass-through strategies are differentiated across importers.

Table 2: Comparison of mean pass-through at the 2-digit level[a]

SITC 2-digit Industry	$\beta^{\bar{USA}}$	$\beta^{\bar{UK}}$	$\beta^{\bar{DEU}}$	$\beta^{\bar{FRA}}$	$\beta^{\bar{ITA}}$	$\beta^{\bar{JAP}}$
0. Food and live animals						
00.Live animals (other than div.03)	2.076	0.227	-0.387	-0.240	-0.204	.
01.Meat and meat preparations	**-0.311**[b]	-0.592	-0.297	-0.070	-0.177	.
02.Dairy products and birds' eggs	0.181	-0.179	-0.022	-0.142	-0.416	.
03.Fish, crustaceans, etc.	-0.121	-0.050	-0.129	-0.052	-0.218	-0.109
04.Cereals and cereal preparations	-0.007	-0.282	0.076	0.011	-0.477	0.097
05.Vegetables and fruit	**0.112**	-0.097	-0.059	-0.015	**-0.448**	-0.179
06.Sugars, sugar preparations and honey	0.022	0.012	-0.030	-0.051	-0.319	-0.067
07.Coffee, tea, cocoa, spices	0.191	-0.013	-0.001	-0.099	0.311	0.210
08.Feeding stuff for animals (excluding unmilled cereals)	0.049	0.045	0.081	-0.227	-0.271	0.844
09.Miscellaneous edible products	0.028	-0.054	-0.040	-0.071	-0.890	-0.440
1.Beverages and tobacco						
11.Beverages	0.060	**-0.014**	-0.026	**-0.017**	-0.216	-0.254
12.Tobacco and tobacco manufactures	0.777	0.574	-0.704	0.133	.	.

(a) Mean pass-through elasticities computed by averaging the coefficients obtained from the estimations at the 5-digit level for the sectors of the considered 2-digit class. A weighting scheme based on the sectorial composition of the class (on the share of each sector in the total exported volume) is used to catch the representativeness of each industry.

(b) Figures in bold correspond to pass-through estimates for classes that produce more than 2% of the total exported volume of the considered country.

21.Hides, skins and furskins, raw	-0.007	0.579	-0.332	-0.372	0.447	.
22.Oil-seeds and oleaginous fruits	0.228	0.624	-0.248	-0.340	-0.265	.
23.Crude rubber	-0.017	0.306	0.005	-0.062	-0.004	-0.126
24.Cork and wood	-0.122	0.172	-0.480	-0.707	-1.066	.
25.Pulp and waste paper	.	0.300	0.049	0.254	-0.059	.
26.Textile fibres and their wastes	-0.122	-0.152	0.030	-0.044	0.081	-0.088
27.Crude fertilizers and minerals	-0.303	-0.030	0.098	-0.093	-0.309	0.144
28.Metalliferous ores and metal scrap	-0.219	0.125	-0.258	0.186	-0.361	.
29.Crude animal and vegetable materials	0.222	0.014	-0.045	-0.220	-0.239	0.154
3.Mineral fuels, lubricants and related materials						
32.Coal, coke and briquettes	.	-0.205	-0.047	0.053	-0.024	.
33.Petroleum and related materials	0.155	-0.139	-0.005	0.118	-0.403	0.148
4.Animal and vegetable oil, fats and waxes						
41.Animal oils and fats	-0.029	-0.458	0.114	-0.249	-0.208	0.108
42.Fixed vegetable fats and oils	0.029	0.153	-0.080	-0.084	-0.844	0.811
43.Animal or vegetable fats and oils	-0.002	0.076	0.013	-0.245	-0.532	-0.514

5.Chemicals and related products, n.e.s.						
51.Organic chemicals	**-0.056**	**-0.008**	**-0.007**	**-0.113**	**-0.257**	**-0.216**
52.Inorganic chemicals	0.154	-0.204	0.054	-0.444	-0.218	-0.052
53.Dyeing, tanning and colouring materials	-0.173	-0.029	-0.020	-0.020	-0.290	-0.132
54.Medicinal and pharmaceutical products	-0.419	**0.158**	**0.036**	**-0.224**	**-0.008**	-0.062
55.Essential oils and perfume materials	-0.087	0.002	0.023	-0.087	-0.311	-0.005
56.Fertilizers (other than those of group 272)	.	-2.153	-0.198	-0.226	-0.273	-0.417
57.Plastics in primary forms	**-0.166**	-0.236	**-0.027**	**0.004**	**-0.201**	-0.160
58.Plastics in non-primary forms	0.318	-0.152	0.025	-0.170	-0.237	-0.008
59.Chemical materials and products, n.e.s.	**-0.043**	-0.049	**0.066**	-0.122	-0.121	0.093
6.Manufactured goods classified chiefly by material						
61.Leather (crude and manufactures), furskins	-0.169	0.129	0.038	-0.077	-0.085	0.625
62.Rubber manufactures, n.e.s.	0.144	-0.147	-0.105	-0.210	-0.277	-0.015
63.Cork and wood manufactures	-0.186	0.121	0.055	-0.299	-0.157	0.272
64.Paper, paperboard	**0.011**	**-0.134**	**-0.049**	**-0.209**	**-0.235**	0.065
65.Textile yarn	-0.036	**0.004**	**-0.004**	**-0.113**	**-0.284**	-0.176
66.Non-metallic mineral manufactures, n.e.s.	-0.247	0.065	**-0.004**	**-0.105**	**-0.213**	-0.259
67.Iron and steel	0.115	**-0.314**	**-0.035**	**-0.106**	**-0.223**	**-0.127**
68.Non-ferrous metals	**-0.296**	**-0.081**	**0.066**	**-0.125**	**-0.106**	0.170
69.Manufactures of metals, n.e.s.	**-0.057**	**0.038**	**0.049**	**0.021**	**-0.194**	**-0.070**

7.Machinery and transport equipment						
71.Power-generating machinery and equipment	**0.179**	**0.362**	**0.023**	**-0.079**	**-0.066**	**0.116**
72.Machinery specialized for particular industries	**0.123**	**0.221**	**0.060**	**0.017**	**-0.284**	**-0.146**
73.Metalworking machinery	0.204	-0.028	0.021	0.143	-0.481	**-0.054**
74.General industrial mach. and equip.	**0.063**	**-0.010**	**0.086**	**-0.041**	**-0.493**	**0.024**
75.Office and data-processing machines	0.038	**0.062**	-0.039	-0.023	**-0.536**	**-0.118**
76.Telecommunications, sound-recording and reproducing apparatus	**0.440**	**-0.052**	**-0.016**	**0.034**	**-0.142**	**-0.031**
77.Electrical machinery, apparatus and appliances	**-0.515**	**0.414**	**0.025**	**0.056**	**-0.251**	**-0.034**
78.Road vehicles (including air-cushion vehicles)	**-0.637**	**-0.078**	**0.034**	**-0.018**	**-0.025**	**-0.078**
79.Other transport equipment	**0.491**	0.026	0.341	0.355	**0.139**	1.546
8.Miscellaneous manufactured articles						
81.Prefabricated buildings	-0.136	0.522	-0.031	-0.107	-0.212	0.118
82.Furniture, and parts thereof	-0.063	0.107	-0.028	0.002	-0.107	-0.119
83.Travel goods, handbags, etc.	0.012	0.191	0.037	-0.093	-0.092	0.013
84.Articles of apparel and clothing accessories	0.092	0.019	-0.009	-0.053	-0.214	-0.242
85.Footwear	0.050	-0.109	-0.025	-0.018	-0.135	0.233
87.Professional and controlling instruments	**-0.089**	**-0.145**	**0.003**	-0.012	**-0.267**	**-0.037**
88.Photographic and optical equip; watches and clocks	0.165	0.458	0.136	0.080	-0.947	**-0.068**
89.Miscellaneous manufactured articles, n.e.s.	**0.335**	**0.038**	**-0.036**	**0.035**	**-0.098**	**-0.157**

Table 3: Results of the test concerning the equality of 5-digit sector-specific pass-through estimates in a given 2-digit class[(a)]

Exporting country	**Share of the exported volume produced in industries rejecting the null of behavioral homogeneity (%)**
USA	67.9
UK	71.7
Germany	97.0
France	79.3
Italy	70.6
Japan	90.6

(a) Here, (5) is estimated separately for each 2-digit class of products in a given exporting country, with the pass-through elasticities authorized to differ between 5-digit sectors (k) :

$$\Delta \ln P_t^{kj} - \Delta \ln \bar{P}^{kj} = (\alpha_t - \bar{\alpha}) + \beta^k (\Delta \ln S_t^j - \Delta \ln \bar{S}^j) + (\varepsilon_t^{kj} - \bar{\varepsilon}^{kj})$$

The null hypothesis, studied in a F-test, concerns the equality of those sector-specific estimates ($H_0 \; : \; \beta^k = \beta \; \forall k$). The table gives the share of the global exported volume, produced in classes for which this homogeneity assumption is rejected at the 5 % level.

Table 4: Averaged statistics on the sector-based estimates

	USA	**UK**	**DEU**	**FRA**	**ITA**	**JAP**
Nb of used pass-through coef.	1585	1905	2396	2178	2231	1354
Share of significant coefficients (%)$^{(a)}$	27.4	35.7	58.2	37.3	26.2	37.7
Share of negative coefficients (%)$^{(b)}$	47.8	43.8	47.1	57.8	63.3	64.6
Mean Pass-through coefficient (%)$^{(c)}$	-0.068	0.052	0.013	-0.056	-0.222	-0.053
Averaged distance from the mean estimated pass-through$^{(d)}$	-0.007	0.111	0.059	0.039	-0.179	0.023

(a) Share of the total exported volume produced in sectors for which the pass-through estimate is significant at the 5 % level.

(b) Share of the total exported volume produced in sectors for which the pass-through estimate is negative.

(c) Mean of estimated pass-through elasticities weighted by the share of each industry in the total exported volume.

(d) Weighted mean gap of i's estimated pass-through from the averaged sectorial elasticity ($gap^{ik} = \hat{\beta^{ik}} - \bar{\beta^{ik}}$ with $\bar{\beta^{ik}} = \sum_i \hat{\beta^{ik}} * Share^{ik}$ and $Share^{ik} = \frac{Vol^{ik}}{Voltot^{k}}$)

Figure 1: Weighted distributions of industry-based coefficients