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Does nominal rigidity mislead our perception of the exchange rate pass-through?*

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Abstract

Relying on a novel dataset of detailed micro-data on import prices, this paper explores the close link that exists between nominal import price rigidity and the extent of exchange rate pass-through (ERPT). We show that previous evidence in favor of incomplete and low value of ERPT in the empirical literature may be explained by two factors: the relative importance of small variations in the exchange rate and, mainly, nominal rigidity. Once nominal rigidity is taken into account, we find for French manufacturers that ERPT may be incomplete in the short run, but with relatively high value, and complete in the long run. In addition, assessing non-linearity and asymmetry issues, we provide evidence that the shape of the import price reaction function is distorted by the presence of nominal rigidity. Indeed, the linearity assumption is verified once nominal rigidity is taken into account. However, in the case where it is rejected, the import price reaction function is concave rather than convex, indicating that firms aim at protecting market shares. As a consequence, the common belief that "prices rise faster than they fall" is the results of nominal import price rigidity as far as ERPT is concerned.

Keywords: Exchange rate pass-through, nominal rigidity, import price
JEL: F31, E31, C23

1 Introduction

The phenomenon of exchange rate pass-through, henceforth ERPT, is an issue of a particular relevance for policy makers and has received a great deal of attention in both the theoretical and empirical literature. As shown by Obstfeld and Rogoff (2000), Betts and Devereux (2000) and Engel (2003), the traditional Keynesian effects of exchange rate movements such as expenditure switching effect, consumption risk sharing, terms of trade effect, international competitiveness, welfare analysis and the law of one price assumption are altered by the extent of the ERPT. In addition, the ERPT plays an important role for monetary policy analysis as evidenced by Gagnon and Ihrig (2001) and Monacelli (2005). Thus, there is no doubt concerning the impact of the ERPT on macro-economic environment and its important role for policy decision making. However, no clear consensus has been reached so far concerning its extent. From a positive perspective, the extent of the ERPT is low and incomplete as a result of an increasing degree of pricing-to-market behavior of firms or of a change in the import consumption basket towards products characterized by a high degree of pricing-to-market.[1] From a normative perspective, the pass-through is incomplete in the short run due to price stickiness but complete in the long run.[2]

The aim of this paper is not to reconcile these two different points of view. However, it highlights the important role of nominal rigidity in explaining the commonly observed phenomenon of incomplete ERPT on the basis of a unique dataset of import prices recorded at company level. As argued by Burstein and Gopinath (2013), the latter phenomenon might be explained by two factors: nominal rigidity and pricing-behavior of firms through a mark-up adjustment. This paper focuses on the normative approach by studying the close link that exists between price stickiness and ERPT. The reason why nominal rigidity should be the main polar star in this study when trying to rationalize incomplete ERPT is twofolds. First, the use of micro-data at company level offers the possibility of controlling for nominal rigidity by conditioning import prices on adjustment, i.e. to take into account that import prices adjustments take place at discrete points in time while exchange rates move continuously. It is worth noting that data availability for Euro-area import prices prevented so far previous studies from using thoses indices for ERPT analysis.[3] Second, given that the literature that

[1] We can refer to the seminal work of Betts and Devereux (2000) for theoretical approach of this literature. One can cite, however, among the large number of empirical studies in this field, the work of Marazzi and Sheets (2007), Bouakez and Rebei (2008), Gust et al. (2010), and more recently Auer and Schoenle (2013).

[2] This strand of the literature is composed in a large part by the New-Keynesian general equilibrium model such as Obstfeld and Rogoff (2000), Smets and Wouters (2002) and Monacelli (2005). To cite a few empirical studies that support this approach, we can refer to the work of Campa and Goldberg (2002), Campa et al. (2005) and Campa and Minguez (2006).

[3] The import price index was officially introduced by the Regulation (EC) No. 1158/2005 of the European Parliament and of the Council of 6 July 2005 amending Council Regulation (EC) No. 1165/98 concerning short-term statistics, and was published in the Official Journal of 22 July 2005. Among the scarce recent studies that use firm-product-level imports prices data for the Euro-area, one can cite Amiti et al. (2012) who study the role of maket share and/or import intensity of Belgian exporting firms in explaining the phenomenon of incomplete ERPT.

supports the positive approach generally shares the same common point of using data that exhibit some degree of nominal rigidity, it is legitimate to ask whether these findings are distorted by the presence of price stickiness. Therefore, isolating the role of nominal rigidity in explaining the phenomenon of incomplete ERPT will help us disentangle about the two alternative explanations advanced in the literature.

To tackle this issue, we use unpublished micro-data of French import prices at the monthly frequency for the period 2005M8 to 2011M5 made available to us by the French National Statistical Agency (INSEE). First, relying on statistical analysis commonly used in the consumer and producer prices micro-data studies, we advance some new import prices stylized facts in order to get some insight of the close link that exists between nominal rigidity and ERPT. Namely, we show that import prices are more prone to frequent changes and that the amplitude of these price changes is relatively small. Second, we find that evidence in favor of incomplete and low values of ERPT is the result of nominal import price rigidity and small exchange rate changes that occur more frequently. Once price stickiness is taken into account, the pass-through is high, if not complete in the short run, and complete in the long run. Third, we provide evidence that price stickiness distorts the shape of the import price reaction function to exchange rate changes. That is, as far as ERPT is concerned, the common belief that "prices rise faster than they fall" (Pelzman (2000)), which is formally characterized by a convex import price reaction function, is the result of nominal import price rigidity. Once nominal rigidity is taken into account, the linearity assumption is verified. But in some cases where the latter is rejected, import price reaction function is concave, indicating that firms aim at protecting market share.

In light on these findings, we contribute to the literature by proposing some new stylized facts on import prices and by contributing to shed light on the blurred but important issue of the extent of ERPT. Our results mainly show that nominal rigidity plays an important role in explaining the phenomenon of incomplete ERPT and that its presence in the import prices misleads our perception of the observed ERPT, especially when using aggregate prices.

The rest of the paper is organized as follows: section 2 describes the data; section 3 proposes some import price related facts; section 4 assesses the extent of ERPT; Section 5 concludes.

2 Data description

Data used in this study are based on the unpublished monthly import price index issued by the French National Statistical Agency (INSEE).[4] The monthly import prices provided by the INSEE are "at the dock" company-level transaction prices of French importing firms for the month considered. This is the finest possible degree of import prices that can be recorded for France. It corresponds to the 6-digit level which we denote as the entry level items,

[4] We are thankful to the INSEE for making these data available to us under confidentiality restriction following the agreement of the Secrecy Committee (Comité du Secret Statistique).

henceforth ELI. This amounts to a set of around 4150 individual prices each month. Notice that, in contrast with some countries such as the United States and the United Kingdom where prices are collected on a particular day at the beginning of the month, firms give their transaction price for the month. This methodology could lead to collect what is called a "mean price" but in turn would avoid collecting a "list price" (without rebate and discount) which may have a different evolution than the actual transaction price. Therefore, given the methodology adopted by the INSEE, the exchange rate used in this study is the monthly averaged one. Gopinath and Rigobon (2008) used the end of the month exchange rate but lagged one period due to the price collection procedure.

Our dataset covers the 2005M8 to 2011M5 period. In order to present and compare our results to other studies, we rely on some product classifications - or sector/product break downs - generally used in this type of literature. We refer to the classification used by Rauch (1999), Vermeulen et al. (2012) and the 2-digit European Statistical Classification of Economic Activities, henceforth NACE2.[5] Rauch (1999) classified goods into differentiated products (DP), homogeneous products (HG) that are traded on an exchange and reference priced (RP) products whose prices are listed in a trade publication. Vermeulen et al. (2012) classified goods into six categories that are consumer food products (CFP), consumer non-food non-durables (CNFND), consumer durables (CD), intermediate goods (IG), energy (ENER) and capital goods (CG). Moreover, we choose to use the NACE2 classification, because it is the level at which import prices begin to be published by INSEE and Eurostat.

Some definitions are necessary for the rest of the paper. They are standard definitions in the literature on price persistence. *Quote-line* (also refered to as *price quote* in the literature) indicates the time, defined in terms of number of months in our study, that elapses between the entry of a given ELI in the sample and its exit. Table 1 in the appendix D depicts quote-lines for the different classifications listed above. In general, the weighted (respectively, the non-weighted) mean of quote-lines amounts to 38.23 months (respectively, 39.70). That is, import prices at the entry level last in general three years in the sample. However, quote-lines are heterogeneous across products. Some categories of products rotate more frequently, such as the manufacture of leather and related products (LEATH) that rotate in average every two years, while some products last longer such as the manufacture of beverages that rotates in average every five years.

Price spell refers to the time that elapses between the current observed price change and the last one. There may be several price spells, possibly with different durations which henceforth are denoted as s, within a given quote-line. Moreover, price spells are heterogeneous across products. There are products that have frequent price changes, and thus a low price spell, as well as products that do not have any price change during their entire life in the sample. Therefore, some assumptions are sometimes needed regarding price change concerning the entry and exit of products. We consider that a price introduction also corresponds to a price change. That is, we do not take left censoring into account. Indeed, the value

[5] Classifications and tables of correspondence are presented in a supplement available upon request.

of the import price prior to the introduction of the ELI in the sample is unknown. In turn, several specifications are possible concerning exit. It will be indicated throughout the analysis whether or not we consider right censoring, which we will refer to as censoring for short.[6]

Finally, the weight used throughout this study is calculated from individual import turnovers that were also provided to us alongside the import prices. However, those weights, denoted w_i, are only available until the 4-digit classification. Hence, we use the turnover to compute the weighted mean of the variables of interest until 4-digit and from there on, compute an arithmetic mean until a given classification provided above.

3 Some stylized facts on import prices

In order to guide us for the estimation of the ERPT, it is useful to contemplate a few summary statistics of our database and derive a few stylised facts. The use of micro-data in the literature of the ERPT has received a great deal of interest since the seminal work of Gopinath and Rigobon (2008), henceforth G.R. For instance, Gopinath, Itskhoki and Rigobon (2010) estimate the extent of ERPT depending on the currency (Dollar or non-Dollar) in which import prices are denominated. In turn, Gopinath and Itskhoki (2010) focus on the relationship between the frequency of price changes and the extent of ERPT. For the Euro-area, while there are many studies conducted by the Inflation Persistence Network team at the European Central Bank that use micro-data, they focus only on consumer and producer price indexes. Álvarez et al. (2005) provide a comprehensive review of this literature. To the best of our best knowledge, our study is the first to provide detailed statistics on import prices at the micro-level and their use for the ERPT analysis for the Euro-area and mainly for France. This lack in the literature may be explained by data availability constraints, given that the import price index exists officially for the Euro-area since 2005. It is thus of interest to present some important import price statistical facts in order to complement the literature and to better understand some features of the observed ERPT.

3.1 Hazard rate

Following the seminal paper of Monacelli (2005), a significant part of the literature relates the extent of ERPT to the degree of nominal price rigidity. The latter is defined as the probability that import prices remain unchanged for a given period.[7] For micro-data based studies such

[6] Nakamura and Steinsson (2012) and Gagnon et al. (2012) go in depth into this problem of missing price change before entry and after exit, which they call "product replacement bias". The first authors argue that this generates a large downward bias in the estimation of the ERPT using aggregate import price index and find an estimate of the long run pass-through that amounts to 0.60 after correcting the bias, whereas the second authors argue that this downward bias is mitigated and find in turn an estimate of 0.28 after the bias correction. This issue is, however, beyond the scope of this study.

[7] It is common to measure this rigidity by the means of Calvo parameter in the open macro-economic models, namely for the dynamic stochastic general equilibrium model used extensively for policy analysis as in Adolfson et al. (2007) and Christoffel et al. (2008). Moreover, it is generally assumed that the degree of nominal rigidity

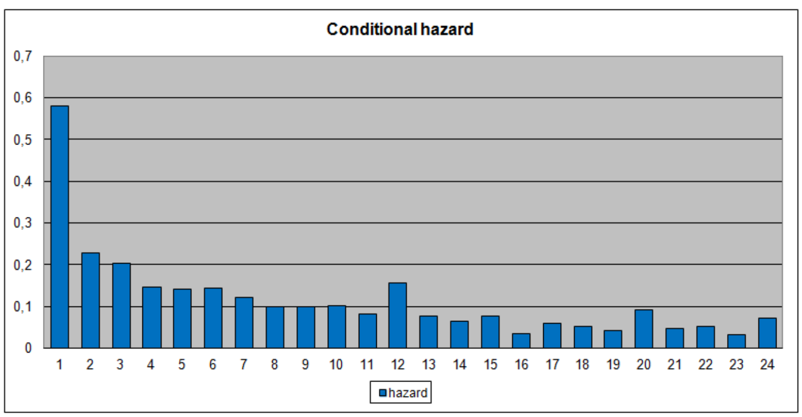
as G.R, it is common to measure nominal rigidity by the means of the hazard rate. This is the instantaneous probability of a price change (of leaving a state) conditional on no price change (on survival) until the considered period. In the following, we assess hazard rate conditional on price duration or price spell.

Let us define p_{it}^{m} the import price index of a given quote-line i for the period t, I_t^i is a price change indicator that takes the value of 1 if $p_{it}^{m} \neq p_{it-1}^{m}$ and 0 otherwise, and $\mathcal{I}_t^{i,\{s=\tau\}}$ a price spell indicator that takes the value of 1 if the price spell s lasts τ months and 0 otherwise. Rather than specifying a given functional form, as the exponential function that gives a constant hazard rate,[8] we use the specification adopted in Klenow and Kryvtsov (2008), henceforth K.K, and compute the hazard rate λ conditional on price spell. That is,[9]

$$\lambda |\{s=\tau\} = \sum_i w_i \lambda_i |\{s=\tau\} = \sum_i w_i \left[\frac{\sum_t I_t^i . \mathcal{I}_t^{i,\{s=\tau\}}}{\sum_t \mathcal{I}_t^{i,\{s=\tau\}}} \right] \tag{1}$$

Recall that w_i is the weight of the individual product i. This yields the following Figure 1 of the hazard rate by spell, that is, the probability of price change conditional on the length of the period (in months) represented in the horizontal axis during which prices remain fixed.

Figure 1: Hazard rate conditional on price spell (from 1 to 24 months)



As shown in Figure 1, the hazard rate of the first spell, namely the probability of a price change every month, is slightly less than 0.6. It is three times greater than the hazard rate of the second and third spells which indicate that when prices have not changed for 2 or 3

is constant and does not depend on the number of periods elapsed since the last price change.

[8] See for example G.R and Klenow and Kryvtsov (2008). The use of the exponential function assume ex-ante that the hazard rate is constant. We opt for non-parametric specification and assess this hypothesis.

[9] Detailed and intuitive derivation of the following conditional hazard rate can be found in the Appendix A.1.

months, the probability of a price change is around 0.2. This finding is mainly explained by the volatility of the exchange rate that contributes to frequent changes (lower degree of stickiness) of the import prices compared to the producer and consumer prices. It is worth noting that 57.6% of the observations fall in the first three spells. Moreover, there is clearly a decline in the hazard rate as the length of the spell increases. That is, the stickier the prices, the lower the probability of price changes.

However, as is common in duration analysis, this situation may occur as a result of an aggregation of heterogeneous individuals. That is, the hazard rate may effectively be constant within a category of goods but may differ across different categories even if they are driven by the same covariates due to unobserved heterogeneity.[10] Aggregating across heterogenous categories of goods which have constant but different hazard rates, in other words ignoring unobserved heterogeneity, will lead to a decreasing shape of the hazard rate. Therefore, before drawing any conclusion, it is necessary to correct the conditional hazard rate above for a possible unobserved heterogeneity by normalizing hazard rates within different categories of goods before aggregation. To this end, let υ^i be the unconditional hazard rate, which is the frequency of price changes, of a given import price i. In order to obtain normalization coefficients which we refer to as fixed effects, let us sort import prices into decile based on the value of υ^i and compute the mean of the unconditional hazard υ^d for each decile.

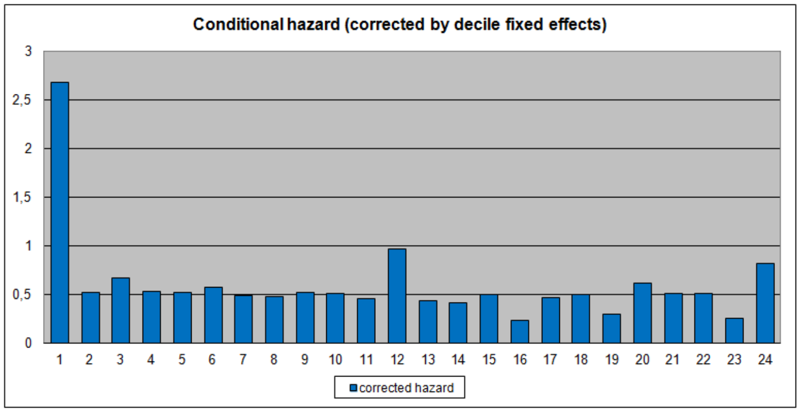
Therefore, the corrected hazard rate (before aggregation) is obtained by dividing the conditional hazard rate $\lambda_i | \{s = \tau\}$ of the ELI i defined in (1) by the corresponding average frequency of price changes υ^d of the decile category to which the individual import price belongs, which we denote υ_i^d for the sake of clarity. Therefore, the aggregate corrected hazard rate with decile fixed effects is given by:

$$\tilde{\lambda} | \{s = \tau\} = \sum_i w_i \left(\frac{\lambda_i | \{s = \tau\}}{\upsilon_i^d} \right) \tag{2}$$

This yields the corrected hazard rate by spell dispayed in Figure 2.

[10] As far as exchange rate pass-through is concerned, heterogeneity may stem from micro and macro-factors. Devereux and al. (2004) and Goldberg and Tille (2008) study the explicit role of industry-specific features in contrast to macro-economic variability. They argue that the macro-economic environment plays an important role in the extent of pass-through for differentiated products. In contrast, producers of homogeneous goods characterized by high elasticity of demand, the so-called Walrasian goods, are much more influenced by micro-determinants.

Figure 2: Corrected hazard rate conditional on price spell (from 1 to 24 months)



Clearly, the decreasing shape of the hazard rate disappears once we take into account the unobserved heterogeneity, but the fact that prices in the first spell have a higher hazard rate remains.[11] Thus, the probability of import price changes is higher within the first spell relative to other spells. In contrast to findings of K.K that concerns PPI and CPI, this result indicates that import prices are more prone to frequent changes due to exchange rate volatility. Finally, apart from some spikes every twelve months, the hazard rate is essentially flat. Recall that the number of prices that last one and two years is small, more precisely 1.4% and 0.5% of the total observations, so the higher value of the hazard rate for those spells does not really matter.

3.2 Import prices change more frequently

As shown in Table 1, the average duration of the import price stickiness[12] amounts to 6.67 months. That is, changes in the import price index occur in average twice a year. This duration is short as compared to a change of once a year for the Euro-area CPI (13.0 months) and PPI (10.8 months) in Álvarez et al. (2006) and the import price duration of 10.6 months for the United States in G.R.[13]

[11] Taking into account only complete spell, that is, not considering the introduction of a given quote-line in the sample as a price change, does not alter the conclusion.

[12] As is standard in the literature of Calvo price setting, duration is calculated as the inverse of the unconditional probability (frequency) of price changes. It is given by $1/(1-\theta)$ where θ denotes the (Calvo) probability that firms keep price unchanged for a given period that is independent of the time elapsed since firms last reset price.

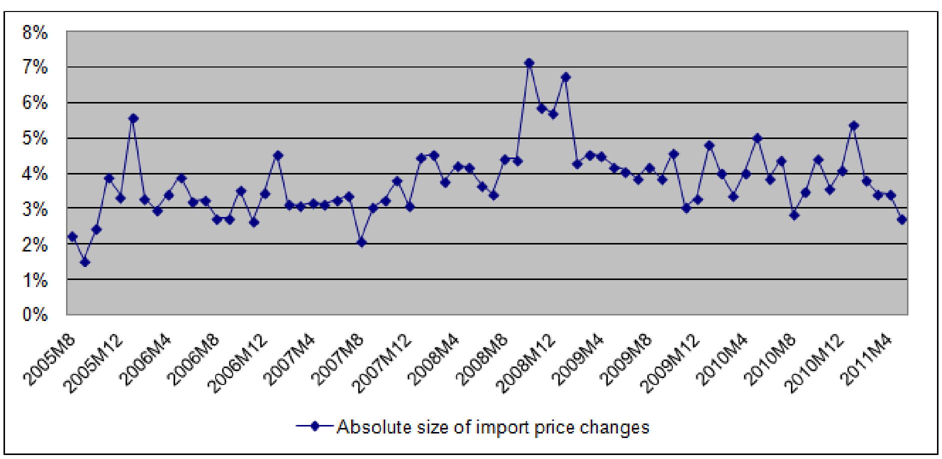
[13] Compared to the results of G.R., difference in the value of import price duration may stems from various factors such as the difference in import basket composition, the data collection procedure and the difference in the degree of entry level items, namely, G.R. used United States data at 10-digit level compared to the French data at 6-digit we use in this study. This difference was also pointed out by Berman et al. (2012).

However, price rigidity is heterogeneous across products. As one may expect, homogeneous goods (HOMO) have a shorter price duration which is only equal to 1.65 month. Indeed, this category of goods, which is traded essentially on an exchange, is characterized by a high price elasticity of demand. It is more sensitive to international price fluctuations within raw materials market. For instance, the manufacture of electricity, gas, stream and air conditioning supply (EGSA) has its price changed each month, that of petroleum products (PETRO) and mining and quarrying (MINQUA) have their prices changed every 2 months (respectively, 2.29 and 1.66 months). On the contrary, differentiated products (DP) are characterized by a low price elasticity of demand, at least in the short run. Hence, they are characterized by a higher price stickiness which amounts to 7.44 months. For instance, the manufacture of furniture (FURN) has the highest price duration, reaching 15 months.

3.3 The amplitude of import price changes is small

In our sample, the weighted (respectively, the non-weighted) mean of the absolute size of the import price changes amounts to 4.26% (respectively, 4.32%). This is relalively small compared to the value of 8.2% found by G.R for the United States. However, this should be related to our earlier findings that prices change relatively more often than in other countries. When splitting into price increases and decreases, the weighted average size amounts respectively to 5.9% and 3.4%. These are small compared to the value of 8.2% and 10% found by Álvarez et al. (2006) for the consumer price index of the Euro-area. Note that the inter-quartile interval of the size of import price changes ranges from 0.56% to 1.26%. A value that is relatively small.

Figure 3: Evolution of the absolute size of price changes in percentage



Plots of the evolution of the absolute size of price changes in Figure 3 show that apart from a sharp increase in the last quarter of 2008 during the world trade collapse and which was associated to an appreciation of the US Dollar, it remains small and fluctuates around 3% before 2008 and around 4% thereafter.

4 Exchange rate pass-through

On the basis of these stylized facts which show that import prices are more volatile than in the US, but exhibit a significant degree of rigidity, we now estimate the degree of the ERPT. First, to serve as a benchmark and in order to compare our results to those of previous studies, we proceed to panel estimation of the ERPT without any transformation of the data. Second, we take into account the presence of nominal rigidity in the estimation of the ERPT. For that purpose, we condition our data on price adjustments and price changes.[14] Intuitively, conditioning data on price adjustment permits to measure, for **each complete spell**, the extent of price adjustment that is explained by the cumulative sum of exchange rate changes during the spell. While conditioning data on price change considers, for **each period**, only products that have a price change. This distinction is important in order to assess if firms take into account either the cumulative sum over the entire price spell or the current, and possibly lags, of exchange rate changes whenever they adjust their prices. Third, we assess non-linearity and asymmetry issues using the threshold model under the panel and conditional on price adjustment specifications. It permits to assess how common results of the ERPT are altered by the presence of nominal rigidity as far as non-linearity and asymmetry issues are concerned.

4.1 Panel estimation

An important puzzle in the empirical literature of the ERPT is the choice of partner's export prices. This includes both the relevant exchange rate and a proxy for domestic costs. Thus, we adopt the same approach as Nakamura and Steinsson (2012) and use the real effective exchange rate due to the lack of information on the country of origin and, hence, on the relevant nominal bilateral exchange rate to use. This also has the advantage of taking into account the change in the relative price (PPI) between home and foreign directly in the real exchange rate, rendering the equation of pass-through homogeneous across countries and

[14] Details of these data transformation can be found in the Appendix B.1.

products.[15] Fixed effect panel estimates of the ERPT are given by the following equation:

$$\Delta\left(p_t^m - p_t^{ppi}\right) = \sum_{j=0}^{6} \alpha_j \Delta q_{t-j} + d_w' \delta + \varepsilon_t \tag{3}$$

where p_t^m and p_t^{ppi} denote respectively the (log) stacked import and domestic producer prices, q_t is the logarithm of the effective real exchange rate,[16] and d_w is the vector of dummy variables corresponding to the 4-digit level of the NACE2 classification used to control individual heterogeneity. Results are presented in Table 2 of appendix D. It is worth noting that for the different specifications adopted in this paper, our results are robust to the number of lags chosen in the estimation as shown in appendix C. Pass-through is incomplete both in the short and long run with estimates that amount respectively to 0.214 and 0.475. G.R obtained similar estimates where the weighted average of the ERPT for market transaction amounts to 0.21 and is in general around 0.33 or lower across individual products. For the Rauch classification, pass-through into import prices of differentiated products is lower and incomplete both at the short and long run, respectively 0.196 and 0.399. Pass-through in turn is low in the short run, 0.186 and 0.281, but high in the long run, 0.722 and 0.700, respectively for homogeneous and reference priced products. These are common results in the pass-through empirical literature. Differentiated products that are characterized by high transformation have lower price-elasticity of demand. In turn, homogeneous and reference priced products are more sensitive to international price fluctuations within raw materials market and are characterized by high price-elasticity of demand. Therefore, ERPT is higher for these categories of products compared to that of differentiated products. At a more disaggregated level, there is complete pass-through, in both the short and long run, for the mining and quarrying (MINQUA), the manufacture of coke and refined petroleum (PETRO) and the manufacture of electrical equipment (ELEC) products.

4.2 Stickiness and pass-through

If we rely on the panel specification above, one could conclude, as is common in the literature, that pass-through is in general low and incomplete at the short run and it remains true for a large number of products at the long run, especially for differentiated products. From a

[15] Let us start from the following simple equation of the import price with full and immediate pass-through: $p_t^m = e_t + p_t^{x,*}$. Assuming that the foreign export price $p_t^{x,*}$ is proxied by exporter's producer price $p_t^{*,ppi}$ and subtracting importer's producer price p_t^{ppi} on both sides of the equation yield $p_t^m - p_t^{ppi} = e_t + p_t^{*,ppi} - p_t^{ppi}$. The right-hand side variable is nothing but the real effective exchange rate q_t. Taking first difference and adding a constant, an error term and lags to real effective exchange rate, yield the equation (3). See Barhoumi (2006) for a discussion. Baillu and Fujii (2004) in turn use unit labor cost based on real effective exchange rate in their study.

[16] The effective real exchange rate used in this study is defined as a geometric weighted average of the relative producer prices (expressed in the same currency) between the Euro-area and each of its 20 major trading partners.

positive perspective, this phenomenon is explained as an increase in the degree of pricing-to-market or a declining value of the pass-through. Initiated by the seminal work of Betts and Devereux (2000), this strand of the literature supports the hypothesis that an increasing fraction of firms practice the Local Currency Pricing - Pricing-to-Market (LCP-PTM) strategy relative to those that practice the Producer Currency Pricing (PCP) one. Thus, as the number of firms that practice LCP increases, the ERPT becomes low and incomplete both at the short and long run. From a normative perspective, initiated by the seminal paper of Monacceli (2005), short term ERPT might be incomplete as a result of nominal import price rigidity but long term ERPT instead is complete. The degree of price stickiness in turn is measured by the means of the Calvo import price rigidity.

Thus, as argued by Burstein and Gopinath (2013), the phenomenon of observed incomplete ERPT is the result of Pricing-to-Market behavior of firms through mark-up adjustment or/and nominal import price rigidity. One may therefore wonder what happens to the extent of ERPT once nominal price rigidity is taken into account. This is of particular importance in order to disentangle the two alternative explanations advanced in the literature. It will help us to better understand some features of the ERPT, such as the role of pricing-to-market, pass-through dynamics, currency invoicing, measurement errors, etc, without having results that are distorted by nominal rigidity.[17]

4.2.1 Conditioning on price adjustment

In order to take into account the presence of nominal price stickiness as in Gopinath, Itskhoki and Rigobon (2010), we condition the estimation of the extent of ERPT on import price adjustments. To this end, we run a regression were the dependent variable is defined as the difference between the (log) value of the current import price when adjustment is observed and that of the previous price change.[18] The elapsed time during price adjustments, the price spell, depends on the degree of price stickiness and is different across categories of products. By the same analogy, independent variables are defined as the (log) cumulative sum during the import price spell. Formally, estimates of the ERPT conditional on price adjustment result from the following regression:[19]

$$\bar{\Delta}_s \left(p_t^m - p_t^{ppi}\right) = \alpha_0^c \nabla_s q_t + \sum_{j=1}^{6} \alpha_j^c \Delta q_{s,t-s-j} + d_w' \delta + \varepsilon_t \tag{4}$$

[17] This part is not tackled in this paper. Our first objective is to estimate the extent of pass-through and to present facts that have to be taken into account to avoid misleading interpretation due to the presence of nominal price rigidity. This is however an important topic for future research.

[18] In the case of the first price change, it is the difference between the (log) value of the import price where the first price change is observed and the one that corresponds to the introduction of the product. For the last spell before the exit, if no price change is observed before the item leaves the sample, this price spell is discarded. That is, we do not consider censoring.

[19] See appendix B.2 for detailed explanation of the conditional on price adjustment specification.

where the subindex s refers to a complete spell of length s, $\bar{\Delta}_s$ is the difference operator over the spell of length or duration s, ∇_s is the cumulative sum operator over the price spell and $\Delta q_{s,t-s-j}$ denotes the (log) change in the real exchange rate j-month prior to the s-th spell. The short run ERPT conditional on price adjustment is measured by the coefficient α_0^c whereas that of the long run is given by the sum of the pass-through of the cumulative exchange rate changes during the spell (α_0^c) and the pass-through of the first 6 months past exchange rate changes prior to the spell ($\sum_{j=1}^{6} \alpha_j^c$), that is, $\sum_{j=0}^{6} \alpha_j^c$.

Results that are depicted between square brackets in Table 2 in the appendix show that ERPT is incomplete in the short run, whereas it is complete in the long run. In stark contrast with the estimated values found in the panel specification, the short run estimate is slightly higher and amounts to 0.32 whereas it amounts to 0.86 in the long run and is not statistically different from one (complete). The same conclusion can be drawn for the Rauch classification.

4.2.2 Conditioning on price change

In the next specification, we condition the estimation of the ERPT on price changes. That is, within each 4-digit category of goods and for each time period, we only consider goods that have a price change. Taking the mean of prices that have changed across individual goods for each time period yields a time series observations for each 4-digit good. Therefore, to estimate the extent of ERPT conditional on price changes, we run the following regression:[20]

$$\Delta\left(\bar{\mathfrak{p}}_t^m - \bar{\mathfrak{p}}_t^{ppi}\right) = \sum_{j=0}^{6} \alpha_j \Delta q_{t-j} + d_w' \delta + \varepsilon_t \tag{5}$$

where $\bar{\mathfrak{p}}_t^m$ denotes (stacked observation of) the mean of the import price changes across goods within the 4-digit bin at the period t. This specification differs from equation (4) - where changes were conditional on price adjustment - in the sense that it gives now a picture of the pass-through where the nominal rigidity is corrected for each time period rather than for each spell. The correct interpretation is now the following: if firms change their prices, to what extent the current (not the cumulative) exchange rate changes and its lags, six months in our specification, are passed-through changes in price? Here lags take into account possible delays in the response of import prices to previous exchange rate movements. Table 2 in the appendix reports between parenthesis the pass-through estimates resulting from the conditional on price change specification. The conclusion is relatively the same as that for the conditional on price adjustment specification except that, and this is of a great deal of importance, the short run ERPT is now high, if not complete, with the weighted mean that amounts to 0.60 for a large number of products. That is, the observed low estimates of the ERPT, as found in subsection 4.1, may be explained in large part by the presence of price stickiness. Once the latter is taken into account, pass-through estimates are in general high if not complete both at the short and long run. This finding, combined with the one obtained in the conditional on price

[20] See appendix B.3 for detailed explanation of the conditional on price change specification.

adjustment specification, is a support of the staggered price setting fashion à la Calvo or à la Taylor commonly used in the general equilibrium models of the ERPT. A similar conclusion is advanced by K.K.

4.3 Non-linearity and asymmetry

The phenomenon of asymmetry and non-linearity in the ERPT has received a great deal of attention recently. This strand of the literature[21] tries to answer the following question: Do an appreciation and a depreciation be passed-through into import prices in the same magnitude (the phenomenon of asymmetry), and does the size of the exchange rate changes influence the magnitude of the pass-through (the phenomenon of non-linearity)? In order to see how results are sensitive to price stickiness, we use two specifications which are (1) the pooled panel and (2) the conditional on price adjustment. The first specification, which we denote "panel" in Table 3, corresponds to the specification generally used, using micro or macro-data, in the literature of asymmetry and non-linearity and thus will permit to compare our results with those of other studies. The second specification in turn, which we denote "conditional on price adjustment", henceforth "cpa", permits to isolate the phenomenon of asymmetry and non-linearity, if they exist, from nominal price rigidity. Notice that the conditional on price change specification is not retained due to the finding of Buissière (2013). He argued that aggregation of the import prices leads to non-linearities that cancel each other given the sign of the convexity of the export reaction function that varies across different trading partners.

4.3.1 Nominal rigidity distorts the shape of the import price reaction function

We assess the asymmetry and non-linearity issues using the Threshold model that is described in the appendix B.4. Positive (respectively, negative) significant estimate of the Threshold parameters β in Table 3 indicates a more (respectively, less) than proportional effect of the exchange rate changes into import price changes. Note that for the sake of clarity, only significant estimates are reported and that non-significance of the parameters supports the linearity assumption. For the panel specification, a depreciation has a total impact of 0.33, while an appreciation has a corresponding impact of 0.09 on the import price changes in the short run. This is a support of the convex import price reaction function that relies on two disctinct micro-economic behavioral assumptions. The first one concerns the *price downward rigidity* at the export side during an appreciation of the exporter's currency. This will yield a higher ERPT at the import side during a depreciation of importer's currency and is characterized by a positive significant estimate of β. The second assumption concerns the *quantity upward rigidity* on the export side during a depreciation of exporter's currency. Competitiveness gain due to depreciation leads exporting firms to raise prices rather than quantities due to production capacity constraints or when it is more costly to raise production compared to the gain issued by the rise in demand. This will yield a lower ERPT at the

[21] Bussière (2013) provides a comprehensive review of this literature.

import side during an appreciation of importer's currency and is characterized by a negative significant estimate of β. For the cpa specification however, different but important results emerge. In the short run, the linearity assumption could not be rejected. In the long run in turn, a depreciation has a total impact of 0.65, while an appreciation has a corresponding impact of 1.27 on the import price changes. This is a support of the concave import price reaction function which indicates that firms are more concerned with demand conditions. In other words, once nominal rigidity is taken into account, linearity assumption prevails, and if it is not the case, as for the long run ERPT, import price reaction function curvature is no longer convex but rather concave.[22]

Therefore, and as long as ERPT is concerned, the common belief that "Prices rise faster than they fall" in response to exchange rate changes is the result of nominal import price rigidity. Firms are concerned with demand conditions once price stickiness is taken into account. It is worth noting that the convex shape of the import price reaction function remains even if unobserved heterogeneity across products has been taken into account by the means of fixed effects in the panel specification. That is, apart from unobserved heterogeneity which can be handle with various econometric specifications, price stickiness distorts the reaction of the import prices to exchange rate changes and, hence, has to be taken into account rather in the estimation or in the interpretation.

4.3.2 Small exchange rate changes

At a more thinner grid, if the linearity assumption is rejected, parameters β remain positive for depreciation except for the small exchange rate changes of magnitude $0 < \Delta q \leq 1\%$, and negative for appreciation.[23] That is, prices rise in response to a small depreciation, $\Delta q \leq 1\%$, but the impact is less than proportional. This result is in favor of incomplete ERPT both at the short and long run for the panel specification. It may be of a relevant importance, and could be advanced as an explanation of the results obtained in the empirical literature, given that this category represents 34.1% of the total observations and 59.7% of the observed depreciation episodes. For the cpa classification however, the linearity assumption is not rejected for small depreciation of magnitude $0 < \Delta q \leq 1\%$.

Therefore, one can argue that the observed low value and incomplete ERPT in the empirical literature may be explained by two factors: the relative importance of small exchange rate changes and, mainly, the nominal rigidity. Once nominal rigidity taken into account, this fact vanishes.

[22] As robustness check, we run the Quadratic model specified by Buissière (2013) that permits to formally test and identify the shape of the import price reaction function. We uncover that this finding is not solely an aggregate case and remains true at a disaggregated level (NACE2). Results are available upon request.

[23] Except for the long term estimate of β for large exchange rate changes of $-3\% > \Delta q \geq -4\%$ where it is only significant at 10% level.

5 Conclusion

To conclude, the extent of exchange rate pass-through and the shape of the import price reaction function to exchange rate changes are distorted by the presence of nominal rigidity. Namely, the linearity hypothesis is verified once nominal rigidity is taken into account. However, in the case where it is rejected, import price reaction function is concave rather than convex, indicating the objective of firms to maintain market shares. Consequently, and as long as ERPT is concerned, the common belief that "prices rise faster than they fall" is a result of nominal price rigidity. Therefore, care must be taken when interpreting ERPT results in the literature, especially when using aggregate prices. As shown through a number of specifications adopted in this paper, ERPT may be incomplete in the short run, but with relatively high value, and complete in the long run once nominal price rigidity is taken into account.

While we acknowledge that micro-data are rarely available when estimating or investigating ERPT, caution must be taken when interpreting pass-through estimates if nominal price rigidity is not accounted for. Our paper provides evidence in favor of the staggered price setting framework à la Calvo or à la Taylor commonly used in the general equilibrium model. In other words, firms gradually pass-through exchange rate changes whenever they are able to adjust prices but the commonly observed low and incomplete value of ERPT in the litterature is explained by the relative importance of small exchange rate changes and, mainly, the presence of nominal rigidity.

In terms of policy implications, given that (1) the size of import price changes is small, (2) the extent of ERPT is distorted by the nominal rigidity especially for small exchange rate changes where the impact on import prices is less than proportional, and (3) the home consumption bias is important, the role of the ERPT is considerably reduced in influencing inflation. From a normative point of view, it seems therefore important to understand the reasons behind import price rigidity for differentiated goods that are characterized by high degree of nominal price rigidity. However, for homogeneous products that are characterized by low degree of price stickiness and less home consumption bias, such as the manufacture of coke and refined petroleum (PETRO), pass-through of exchange rate changes will have an important impact on inflation.

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A Import price statistics

A.1 Concepts and specifications

In order to better understand the different specifications adopted in the statistical analysis of the import prices in section 3, let us depict in the following table a simple picture of our database structure. That is,

	period	p_i^m	Δp_i^m	I^i	τ	s_{cs}	s_{rcs}	s	Q	$\mathcal{I}_t^{i,\{s=1\}}$	$\mathcal{I}_t^{i,\{s=2\}}$	$\mathcal{I}_t^{i,\{s=3\}}$
Entry	t	4.61	–	$1^{(*)}$	1	1	–	1		1	0	0
	$t+1$	4.64	0.03	1	1	1	–	1		1	0	0
	$t+2$	4.64	0.00	0	1	–	1	1		1	0	0
	$t+3$	4.64	0.00	0	2	–	2	2		0	1	0
	$t+4$	4.68	0.04	1	3	3	–	3		0	0	1
	$t+5$	4.68	0.00	0	1	–	1	1		1	0	0
	$t+6$	4.70	0.02	1	2	2	–	2		0	1	0
	$t+7$	4.70	0.00	0	1	–	1	1		1	0	0
Exit	$t+8$	4.70	0.00	0	2	–	2	2	8	0	1	0

- I^i is a price change indicator.
- $^{(*)}$ indicates that price introduction is a price change.
- τ is the number of months elapsed since the last price change.
- s_{cs} indicates the length of "Complete Spell". Notice that $s_{cs} = I^i.\tau$.
- s_{rcs} indicates the length of "Right Censored Spell".
- s indicates the length of complete and censored spell.
- Q is the quote-line
- $\mathcal{I}_t^{i,\{s=\tau\}}$ is the price spell, complete and censored, indicator

Denote p_{it}^m the (log) import price of an individual product i. I_t^i is a price change indicator that takes the value of 1 if $p_{it}^m \neq p_{it-1}^m$ and 0 otherwise. For the sake of illustration, we assume that the individual product i enters the sample at the period t and that price introduction is a price change. The latter assumption implies that $I_t^i = 1$ at the period t and simply means that we do not consider left censoring.

τ is the number of months elapsed since the last price change. The **complete spell** of length s_{cs} is defined to be the number of months elapsed between the current observed price change and the last one. It is given by the value of τ conditional on observed price change, that is, $\tau | \left\{I^i = 1\right\}$. In turn, the right **censored spell** of length s_{rcs} is defined to be the number of months elapsed since the last price change but where the current period does not correspond yet to the price change. It is therefore given by the value of τ where no price change is observed, that is, $\tau | \left\{I^i = 0\right\}$.

The quote-line Q, defined to be the number of months that elapsed between the entry of the individual product i in the sample (period t) and its exit (period $t+8$), is equal to 8 months in our simple example.

Finally, $\mathcal{I}_t^{i,\{s=\tau\}}$ is a price spell indicator that takes the value of 1 when the number of spell s, complete and censored, corresponds to a given value of τ, and 0 otherwise. It permits to classify observations by the number of spell.

A.2 Hazard rate

The expression of the conditional hazard rate in equation (1) in section 3.1 is obtained as follows. The term $\sum_t \mathcal{I}_t^{i,\{s=\tau\}}$ in the denominator computes the number of observations/occurrences for which the length of spell s of an individual price i last τ months. Namely, it corresponds to the total number of complete and censored spell of length τ months. In our example, it is given by $\sum_{T=t}^{t+8} \mathcal{I}_T^{i,1}$ and is equal to 5 for $s=1$. While the term $\sum_t I_t^i.\mathcal{I}_t^{i,\{s=\tau\}}$ in the numerator computes the number of observations/occurrences having a spell of length τ months with price changes. Namely, it corresponds to the total number of **complete** spell of length τ months. In our example, it is given by $\sum_{T=t}^{t+8} I_T^i.\mathcal{I}_T^{i,1}$ and is equal to 2 for $s=1$. Finally, taking the weighted mean across individual products i yields the expression of the hazard rate conditional on a given price spell.

B Pass-through and price stickiness

B.1 Specification

	p_1^m	p_2^m	p_3^m	p_4^m		q
t	x	x	x	x		q_t
$t+1$	o	o	x	x		q_{t+1}
$t+2$	o	o	o	x		q_{t+2}
$t+3$	x	o	x	o		q_{t+3}
$t+4$	x	x	o	o		q_{t+4}
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$		$\vdots$
- x indicates price change						
- o indicates no price change						

Denote p_i^m the (log) import price of an individual product i and q the (log) real exchange rate. Assume that all products enter the sample at period t for simplicity. Under the assumption that a price introduction is a price change, the row corresponding to period t contains "x" which indicates a price change. This assumption simply means that we do not consider left censoring.

B.2 Specification of ERPT equation conditional on price adjustment (cpa)

Concerning the "conditional on price adjustment" (cpa) specification, the variables used in the estimation are constructed as follows. Let us take the case of the import price of the first individual good p_1^m. For this good, we observe 2 complete price spells: from t to $t+3$ and $t+3$ to $t+4$. The first spell lasts 3 months and the second spell 1 month. Therefore, import price changes conditional on price adjustment is given by $\bar{\Delta}_3 p_1^m = p_{1t+3}^m - p_{1t}^m$ and $\bar{\Delta}_1 p_1^m = p_{1t+4}^m - p_{1t+3}^m$. Deflating with the PPI index yields the dependent variable $\bar{\Delta}_s \left(p^m - p^{ppi}\right)$ in equation (4). Independent variables in turn are obtained as the cumulative sum of real exchange rate changes during each complete spell. That is in the case of individual good 1, $\nabla_3 q = (q_{t+1} - q_t) + (q_{t+2} - q_{t+1}) + (q_{t+3} - q_{t+2}) = (q_{t+3} - q_t)$ and $\nabla_1 q = (q_{t+4} - q_{t+3})$. This yields the cumulative real exchange rate changes $\nabla_s q$ for complete spell of length s (or more precisely, of length s_{cs}) in equation (4).

B.3 Specification of ERPT equation conditional on price change (cpc)

In turn, "conditional on price change" (cpc) specification considers, for each period, only products that have a price change. That is, period t import price changes $\Delta \bar{\mathfrak{p}}_t^m$ in equation (5) is obtained by taking the mean of import prices that have changed at period t across individual products. In our example, if we denote $\Delta p_{it}^m = p_{it}^m - p_{it-1}^m$, conditional on price change dependent variable $\bar{\mathfrak{p}}_t^m$ is given by: $\Delta \bar{\mathfrak{p}}_{t+1}^m = mean(\Delta p_{3t+1}^m, \Delta p_{4t+1}^m)$, $\Delta \bar{\mathfrak{p}}_{t+2}^m = \Delta p_{4t+2}^m$, $\Delta \bar{\mathfrak{p}}_{t+3}^m = mean(\Delta p_{1t+3}^m, \Delta p_{3t+3}^m)$ and so on. Independent variables in turn correspond simply to one period change of the real exchange rate Δq_t and the last six lagged values.

B.4 The Threshold model

We assess non-linearity and asymmetry issues using the following Threshold model:

$$
\begin{aligned}
\text{(panel)} \quad : \quad & \Delta\left(p_t^m - p_t^{ppi}\right) = \sum_{j=0}^{6} \alpha_j \Delta q_{t-j} + \sum_{j=0}^{6} \beta_j D^x \Delta q_{t-j} + d_w' \delta + \varepsilon_t \\
\text{(cpa)} \quad : \quad & \bar{\Delta}_s\left(p_t^m - p_t^{ppi}\right) = \alpha_0^c \nabla_s q_t + \sum_{j=1}^{6} \alpha_j^c \Delta q_{s,t-s-j} + \beta_0^c D^x \nabla_s q_t + \\
& \sum_{j=1}^{6} \beta_j^c D^x \Delta q_{s,t-s-j} + d_w' \delta + \varepsilon_t
\end{aligned}
\tag{6}
$$

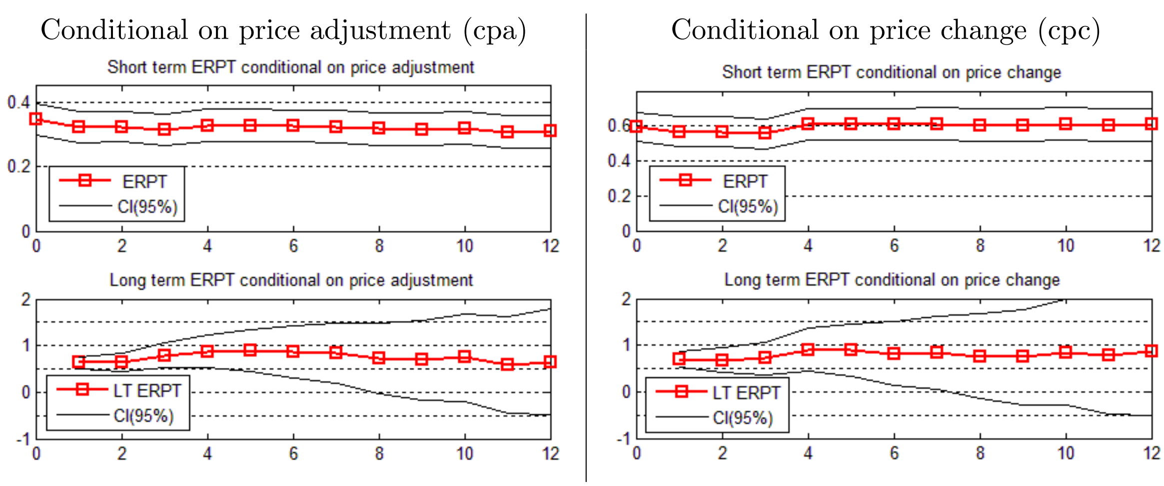
where D^x is a dummy variable that takes the value of 1 if x is true and 0 otherwise. We consider different hypothesis for x, namely positive vs negative exchange rate changes, and various amplitudes for exchange rate changes. Thus, for the panel and cpa specification, we make a general distinction between appreciation and depreciation in order to assess asymmetry issue, and add a thinner grid of exchange rate changes in order to assess non-linearity issue.

The interest lies in estimating and testing the sign of the threshold parameters β_0 or β_0^c for short term and $\sum_{j=0}^{6} \beta_j$ or $\sum_{j=0}^{6} \beta_j^c$ for long term. We denote henceforth β this set of Threshold parameters. Positive **significant** estimate of the Threshold parameters β in Table 3 indicates a more than proportional effect $(\alpha + \beta)$ of the exchange rate changes into import price changes. In turn, negative estimate of the Threshold parameters indicates a less than proportional effect $(\alpha - \beta)$.

For the panel specification, a positive significant estimate of $\beta = 0.24$ indicates that a depreciation $(\Delta q > 0)$ has a more than proportional effect of 0.33 $(\alpha + \beta = 0.09 + 0.24 = 0.33)$ on import price in the short run. In turn, a negative significant estimate of $\beta = -0.24$ indicates that an appreciation $(\Delta q < 0)$ has a less than proportional effect of 0.09 $(\alpha - \beta = 0.33 - 0.24 = 0.09)$ on import price in the short run. For the conditional on price adjustment specification, a depreciation has a less than proportional effect with a total impact of 0.65 $(1.27 - 0.62 = 0.65)$ in the long run. In turn, an appreciation has a more than proportional effect with a corresponding impact of 1. 27 $(0.65 + 0.62 = 1.\,27)$ in the long run.

C Lag-evolution of the ERPT

Figure 4: Lag-evolution of pass-through estimates



Plots of pass-through estimates for different number of lags below confirm the choice of 6 lags included in the estimation. As shown in figure 4, the estimated values of ERPT show a rather stable evolution for both cpa and cpc specifications. Moreover, long term pass-through rises gradually and reaches its maximum value within the first 6 months after exchange rate changes. This finding is line with Obstfeld and Rogoff (2000) who argued that in general, import price adjustments take place within 90 days or less.

D Tables

Table 1: Import price summary statistics

General			**NACE2**		
Group	**Quotes**	**Rigidity**	**Group**	**Quotes**	**Rigidity**
–	38.23 [39.70]	6.67 [6.67]	MINQUA	35.49 [35.43]	1.66 [1.97]
			FOOD	35.52 [35.24]	4.38 [5.79]
Rauch			BEVE	64.68 [59.42]	4.51 [4.98]
Group	**Quotes**	**Rigidity**	TOBA	39.00 [39.00]	5.34 [5.15]
DP	40.33 [38.48]	7.44 [7.14]	TEXT	40.09 [39.10]	5.17 [4.74]
HG	37.47 [42.29]	1.65 [2.50]	WEAP	41.12 [44.39]	8.19 [12.38]
RP	38.28 [36.55]	5.95 [6.31]	LEATH	22.17 [16.18]	4.60 [2.83]
NC	38.93 [38.41]	4.56 [5.60]	WOOD	43.11 [42.83]	8.71 [7.34]
			PAPE	46.20 [44.07]	5.65 [5.86]
Vermeulen			PETRO	33.28 [29.63]	2.29 [4.46]
Group	**Quotes**	**Rigidity**	CHEM	39.79 [36.05]	4.46 [4.59]
CFP	39.22 [39.32]	4.29 [6.00]	PHAR	51.18 [50.92]	9.58 [10.71]
CNFND	34.55 [31.49]	6.06 [6.65]	RUBB	40.65 [35.32]	10.17 [9.54]
CD	46.93 [45.64]	9.19 [9.47]	NMMP	30.01 [24.45]	8.89 [7.99]
IG	37.12 [34.60]	6.18 [5.71]	METAL	35.72 [38.34]	7.32 [6.50]
ENER	44.76 [44.89]	1.91 [3.04]	FMET	43.02 [42.56]	8.48 [6.34]
CG	36.97 [35.71]	8.60 [8.15]	COMP	36.36 [40.67]	9.21 [8.38]
NC	45.95 [45.99]	8.01 [7.59]	ELEC	48.97 [49.09]	5.00 [4.97]
			MACH	43.85 [42.03]	8.72 [8.76]
			VEHI	45.03 [43.71]	2.51 [3.75]
			OTRA	29.10 [26.25]	6.72 [7.78]
			FURN	48.10 [48.46]	15.02 [14.70]
			OMAN	43.53 [38.65]	7.44 [6.38]
			EGSA	37.00 [37.00]	1.00 [1.00]

- The Table provides summary statistics on import prices based on 3 different product classifications which are Rauch (1999), Vermeulen et al. (2012) and NACE rév 2.
- Quote-lines indicate the number of months elapsed between the entry of a given ELI in the sample and its exit.
- Price rigidities indicate the average number of months where prices remain unchanged and are calculated as the inverse of the probability of price changes (frequency).
- Values between square brackets are the Non-weighted mean of quote-lines or price rigidities.

Table 2: ERPT estimates

General		
Group	**ST-ERPT**	**LT-ERPT**
–	$0.21, [0.32], (0.60)$	$0.47, [0.86^{\ddagger}], (0.81^{\ddagger})$
	Rauch	
Group	**ST-ERPT**	**LT-ERPT**
DP	$0.19, [0.33], (0.60)$	$0.39, [0.84^{\ddagger}], (0.81^{\ddagger})$
HG	$0.18, [0.30], (0.32^{\flat})$	$0.72, [0.65^{\ddagger}], (0.06^{\flat})$
RP	$0.28, [0.32], (0.83^{\ddagger})$	$0.70, [1.07^{\ddagger}], (1.14^{\ddagger})$
NC	$0.29, [0.28], (0.42)$	$0.68, [0.82^{\ddagger}], (0.54^{\ddagger})$
	Vermeulen	
Group	**ST-ERPT**	**LT-ERPT**
CFP	$0.30, [0.36], (0.59)$	$0.87^{\ddagger}, [1.35], (1.28^{\ddagger})$
CNFND	$0.17, [0.39], (0.86^{\ddagger})$	$0.38, [0.85^{\ddagger}], (1.25^{\ddagger})$
CD	$0.27, [0.50], (0.46)$	$0.85^{\ddagger}, [2.17], (1.59^{\ddagger})$
IG	$0.19, [0.26], (0.56)$	$0.42, [0.52], (0.50)$
ENER	$0.54, [0.48^{\flat}], (0.46)$	$-1.2, [-2.2], (-1.5^{\flat})$
CG	$0.22, [0.20], (0.70)$	$0.46, [1.10^{\ddagger}], (1.17^{\ddagger})$
NC	$0.23, [0.22], (0.55)$	$0.46, [0.95^{\ddagger}], (0.74^{\ddagger})$

NACE2		
Group	**ST-ERPT**	**LT-ERPT**
MINQUA	$0.56^{\ddagger}, [0.46^{\flat}], (0.59^{\ddagger})$	$-2.3, [-3.1], (-2.0^{\flat})$
FOOD	$0.24, [0.27], (0.51)$	$0.79, [1.21^{\ddagger}], (1.21^{\ddagger})$
BEVE	$0.23, [0.75^{\ddagger}], (0.57^{\ddagger})$	$0.60, [2.09^{\ddagger}], (0.54)$
TOBA	$0.22, [0.13^{\flat}], (2.34)$	$0.55, [0.12^{\flat}], (-3.3)$
TEXT	$-0.0^{\flat}, [0.18^{\flat}], (0.03^{\flat})$	$0.43, [1.01^{\ddagger}], (0.82^{\ddagger})$
WEAP	$0.10, [0.34], (0.59)$	$0.29, [0.63^{\ddagger}], (1.15^{\ddagger})$
LEATH	$0.66, [0.57], (0.91^{\ddagger})$	$0.77^{\ddagger}, [1.14^{\ddagger}], (0.47)$
WOOD	$0.17, [0.30], (0.77^{\ddagger})$	$0.13^{\flat}, [0.85^{\ddagger}], (1.22^{\ddagger})$
PAPE	$0.35, [0.41], (0.65^{\ddagger})$	$0.24^{\flat}, [0.10^{\flat}], (0.50^{\ddagger})$
PETRO	$0.62^{\ddagger}, [0.45^{\flat}], (0.98^{\ddagger})$	$1.71^{\ddagger}, [0.55^{\ddagger}], (1.18^{\ddagger})$
CHEM	$0.25, [0.48], (0.75^{\ddagger})$	$0.97^{\ddagger}, [1.05^{\ddagger}], (1.08^{\ddagger})$
PHAR	$0.14, [0.28^{\flat}], (1.33^{\ddagger})$	$0.50, [2.31^{\ddagger}], (2.14)$
RUBB	$0.11, [0.13^{\flat}], (0.36)$	$0.07^{\flat}, [0.72^{\ddagger}], (0.15^{\flat})$
NMMP	$0.33, [0.32], (1.00^{\ddagger})$	$0.35, [0.71^{\ddagger}], (0.72)$
METAL	$0.37, [0.55], (0.35^{\flat})$	$0.29^{\flat}, [-0.0^{\flat}], (-1.2^{\flat})$
FMET	$0.19, [-0.0^{\flat}], (0.83^{\ddagger})$	$0.36, [0.79^{\ddagger}], (1.17^{\ddagger})$
COMP	$0.20, [0.32], (0.71^{\ddagger})$	$0.28, [0.77^{\ddagger}], (0.71^{\ddagger})$
ELEC	$0.29, [0.71], (0.46)$	$1.12^{\ddagger}, [3.04], (1.58^{\ddagger})$
MACH	$0.13, [0.14], (0.48)$	$0.35, [0.96^{\ddagger}], (0.88^{\ddagger})$
VEHI	$0.05^{\flat}, [-0.0^{\flat}], (0.05^{\flat})$	$0.14^{\flat}, [0.23^{\flat}], (0.21^{\flat})$
OTRA	$0.04^{\flat}, [0.03^{\flat}], (0.05^{\flat})$	$0.07^{\flat}, [1.16^{\ddagger}], (0.49)$
FURN	$0.16, [0.51], (-0.01)$	$0.93^{\ddagger}, [1.55^{\ddagger}], (2.18^{\ddagger})$
OMAN	$0.45, [0.33], (1.29^{\ddagger})$	$0.53, [0.95^{\ddagger}], (1.61)$
EGSA	$-0.3^{\flat}, [-0.3^{\flat}], (-0.3^{\flat})$	$-2.0, [-2.0], (-2.0)$

- The table provides results from fixed effects panel estimation of ERPT equation. Three different specifications are considered:
  1- the benchmark panel specification (equation (3)) where results are depicted in the first value of the table,
  2- the conditional on price adjustment (equation (4)) where results are depicted between square brackets,
  3- the conditional on price change (equation (5)) where results are depicted between parenthesis.
- $(\flat)$ ERPT is not statistically different from 0 at 95% level (zero ERPT).
- $(\ddagger)$ ERPT is not statistically different from 1 at 95% level (complete ERPT).

Table 3: Threshold model

I- Panel specification					
Exchange rate changes	**Threshold**		**Percentage relative to:**		
Sign	Short term	long term	positive	negative	total
$\Delta q > 0$	0.24^{*}	·	·	·	57.2%
$\Delta q < 0$	-0.24^{*}	·	·	·	42.8%
Sign and magnitude	Short term	long term	positive	negative	total
$3\% < \Delta q \leq 4\%$	0.10^{*}	0.97^{*}	6.2%	·	3.5%
$2\% < \Delta q \leq 3\%$	0.11^{*}	·	9.4%	·	5.3%
$1\% < \Delta q \leq 2\%$	·	·	24.8%	·	14.2%
$0\% < \Delta q \leq 1\%$	-0.20^{*}	-0.47^{**}	59.7%	·	34.1%
$-1\% \leq \Delta q < 0\%$	·	-0.35^{**}	·	55.3%	23.7%
$-2\% \leq \Delta q < -1\%$	·	·	·	33.3%	14.3%
$-3\% \leq \Delta q < -2\%$	·	·	·	3.4%	1.4%
$-4\% \leq \Delta q < -3\%$	·	0.23^{**}	·	4.3%	1.8%
$-5\% \leq \Delta q < -4\%$	-0.18^{*}	-0.23^{*}	·	3.6%	1.6%
II- Conditional on price adjustment					
Exchange rate changes	**Threshold**		**Percentage relative to:**		
Sign	Short term	long term	positive	negative	total
$\nabla_s q > 0$	·	-0.62^{*}	·	·	48.9%
$\nabla_s q < 0$	·	0.62^{*}	·	·	51.1%
Sign and magnitude	Short term	long term	positive	negative	total
$5\% < \nabla_s q$	-0.32^{*}	·	19.5%	·	9.5%
$4\% < \nabla_s q \leq 5\%$	-0.25^{*}	·	5.9%	·	2.9%
$3\% < \nabla_s q \leq 4\%$	0.40^{*}	·	10.2%	·	5.0%
$2\% < \nabla_s q \leq 3\%$	0.48^{*}	1.54^{*}	9.1%	·	4.4%
$1\% < \nabla_s q \leq 2\%$	0.34^{*}	·	14.9%	·	7.3%
$0\% < \nabla_s q \leq 1\%$	·	·	40.5%	·	19.8%
$-1\% \leq \nabla_s q < 0\%$	0.79^{*}	·	·	35.2%	18.0%
$-2\% \leq \nabla_s q < -1\%$	0.20^{*}	·	·	25.0%	12.8%
$-3\% \leq \nabla_s q < -2\%$	-0.30^{*}	-1.13^{*}	·	15.9%	8.1%
$-4\% \leq \nabla_s q < -3\%$	·	·	·	10.2%	5.2%
$-5\% \leq \nabla_s q < -4\%$	·	1.06^{*}	·	6.1%	3.1%
$\nabla_s q < -5\%$	·	·	·	7.6%	3.9%

- * $^{(**)}$ Parameter estimate is statistically significant at 5% (10%) level
- Δq is the one period exchange rate changes
- $\nabla_s q$ is the cumulative sum of exchange rate changes during the complete spell s
- Positive sign in the Threshold model indicates a more than proportional effect.
- Negative sign in the Threshold model indicates a less than proportional effect.