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Selin Özyurt Has the exchange rate
pass through recently declined
in the euro area?

Abstract

This study investigates the degree and speed of the exchange rate pass through (ERPT) into extra-euro area import prices for the euro area aggregate and the five largest countries. Based on quarterly frequency data, the analysis covers the period 1996Q1-2015Q2. Two alternative measures of the nominal exchange rate are used: the NEER of the euro against 38 partners and the EUR/USD bilateral exchange rate.

The results show that the pass through is only "partial" in the euro area, most probably reflecting slow nominal price adjustments and the pricing-to-market behaviour of firms. We find clear evidence that the degree of pass through has been declining over the past two decades. Interestingly, the period of strong fall of pass through coincides with the increasing share of the emerging countries in world trade and the accession of China to the WTO.

Looking at the largest euro area countries, we find striking heterogeneities in the degree but also in the speed of the ERPT. The lowest degree of pass through of a change in NEER is found for Germany while it is the highest for Italy. In addition, unlike the other large euro area countries, we do not find evidence for Italy of a decline in the degree of pass through over time. In a monetary union, such differences may signal large heterogeneities in domestic markets structures.

Non-Technical Summary

Understanding the impact of the exchange rate movements on prices has been of key interest to scholars and policy makers. Having reliable estimates of exchange rate pass through (ERPT) as well as a good understanding of its transmission channels is crucial for the conduct of monetary policy.

This paper studies the impact of the nominal exchange rate movements of the euro on extra-euro area import prices based on quarterly frequency data over the period 1996Q1-2015Q2. Compared to earlier studies, the use of extra-euro area import deflators, instead of unit values or total import prices provides a significant contribution compared to previous studies of ERPT in the euro area. We use two alternative measures of the nominal exchange rate: the Nominal Effective Exchange Rate (NEER) of the euro against 38 partners and the EUR/USD bilateral exchange rate. We investigate both the size and the speed of the pass through. Importantly, we also capture the path and the timing of the variation in pass through by running rolling-window regressions. In addition to the euro area aggregate, the pass through is estimated for the five largest euro area countries.

Our findings concur with the literature suggesting that in the euro area, the ERPT is partial and has been steadily declining over the past few decades. In particular, we find a strong fall in pass through in the 2000s. This period of decline in pass through coincides with the increasing share of the emerging countries in world trade and the accession of China to the WTO. The rising share of the BRICs in euro area imports is likely to enhance the fall in pass-through via active pricing-to-market strategies of exporters to defend their market shares. Furthermore, increasing settlement and invoicing of imports in euro over the past decade is another possible factor weakening the elasticity of prices to exchange rate movements. Interestingly, we find that controlling for foreign marginal cost yields weaker pass through, in particular in the period preceding the Great Recession.

Looking at the largest euro area countries, we find striking heterogeneities in the degree but also in the speed of the ERPT, most probably as a result of the heterogeneities in domestic markets structures. The lowest degree of pass through of a change in NEER is found for Germany, most likely reflecting the large size of the country and the strong presence of extra-euro area importers in the domestic market. In addition, the high share of local currency pricing could be another factor explaining the low pass through in Germany. For the Netherlands, low pass through relative to the size of the country may suggest a non-systematic relation between the market size and pass through. Italy appears to have the highest degree of pass through of a change in NEER, compared to the euro area and the other four largest countries. The dominance of the Italian industrial sector by a large number of small and medium sized firms could explain, to a certain extent, the high degree pass through in Italy. Another striking finding is the stability of the degree of pass through in Italy, where we find no evidence of decline in pass through over the past two decades.

While the present research draws conclusions on the speed and size of the ERPT based on aggregate-level information, it has been extensively documented that pass-through elasticities may vary dramatically across sectors. Moreover, the pass through relation could depend on the nature of shocks underlying the exchange rate movements. Thus, our evidence on the variability of pass through could be complemented with further analysis taking into account the nature of shocks driving the economic developments.

1. Introduction

The exchange rate of the euro has shown strong fluctuations since its inception on 1 January 1999. Understanding the impact of the exchange rate movements on import prices has been of key challenge for scholars and policy makers. The concept of the "Exchange-rate pass though" (ERPT) refers to the degree to which exchange rate movements are transmitted into import prices and then to consumer prices in an economy, other things equal. Having reliable estimates of ERPT as well as a good understanding of the underlying transmission channels is crucial for the conduct of monetary policy. Accurate estimates of the ERPT enable central banks and policy makers to closely monitor inflationary pressures arising from exchange rate fluctuations. Both the size and speed of the pass through matter for the transmission of exchange rate movements into prices and then to real economy. Furthermore, the ERPT gives insight on market characteristics by revealing to what extent exchange rate movements are passed on traded goods prices or absorbed in exporter profit margins or markups. "Complete" pass through arises from a one-to-one response of prices to exchange rate changes. A large body of both empirical and theoretical literature put forward that the ERPT is 'incomplete', even in the long run, as a result of slow nominal price adjustments or the pricing-to-market behaviour of firms (De Bandt et al. 2007, Corsetti et al. 2008). Moreover, recent studies suggest that the ERPT has been steadily declining over the past few decades. Potential sources of this decline have been extensively identified and discussed in the literature. To name only a few, Taylor (2000) attributes the fall in pass through to the persistent low inflation achieved by many central banks in recent decades.[1] Fierce competition in large and attractive markets could also encourage the pricing-to-market behaviour of exporters. Exporters may choose to not fully pass on exchange rate changes on prices, in view to maintain their competitive advantage. Furthermore, increasing invoicing of imports in local currency is another factor weakening the elasticity of prices to exchange rate movements.

This paper studies the impact of the nominal exchange rate movements of the euro on extra-euro area import prices. Compared to earlier studies, the use of the extra-euro area import deflator[2], instead of unit values[3] or total import prices is a significant contribution of the study. Both the path and the timing of the variation in pass through are investigated by running rolling-window regressions. In addition to the euro area aggregate, we also estimate the pass through for the five largest euro area countries to identify possible country level divergences in pass through.

Our findings point out that in the euro area, the ERPT is partial and it shows a significant decline in the 2000s, probably as a result of the emerging countries' increasing share in world trade and the accession of China into the WTO. Looking at the largest euro area countries, we find striking heterogeneities in the degree but also in the speed of the ERPT, most probably reflecting

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[1] Taylor (2000) argues that in a model of monopolistic competition and staggered price setting, when inflation is low and not very persistent, agents perceive shocks to the price level as transitory and have less incentive to change their prices, leading to lower ERPT.

[2] The extra euro area import deflator is calculated by the ECB staff using trade weights.

[3] The use of unit value indices as proxies for import prices has severe limitations. Aggregate import unit value indices are calculated by dividing the total value of imports by total quantities (generally in kilograms) without controlling for quality differences within the sector/import bundle. For a more extended discussion on the caveats of import unit values please refer to Anderton (2003, p.10) and de Bandt (2008 p.8)

heterogeneities in domestic markets structures. The lowest degree of pass through of a change in NEER is found for Germany while it is the highest for Italy. In addition, unlike the other large euro area countries, we do not find evidence for Italy of a decline in the degree of pass through over time.

The reminder of the paper is organised as follows. Section 2 presents the methodology and data. Section 3 shows and discusses the results for the euro area and the results for the five largest euro area countries are presented in Section 4. The last section concludes.

2. Methodology and Data

Since its inception in 1999, the nominal effective exchange rate (NEER) of the euro as well as its bilateral nominal exchange rate vis-à-vis the USD have shown strong variations (Figure 1). After having depreciated in the first two years of its existence, until the Great Recession, the euro has gradually appreciated both in nominal effective terms and vis-à-vis the USD. Following strong fluctuations during the years of Great Recession and the euro area sovereign debt crisis, the exchange rate has shown a declining path since mid-2014. Turning to the extra-euro area import deflator, it mirrored the nominal exchange rate movements of the euro until 2003 and showed a diverging pattern afterwards, in particular in the run up to the Great Recession. Over the period 2003-2008, the nominal exchange rate of the euro has gradually appreciated together with increasing extra-euro area import prices. This increase in import prices despite the currency appreciation is somewhat puzzling and can only be partly explained by the sustained rise in oil prices in the same period. Therefore, we cannot rule out the hypothesis that the degree of the relationship between the exchange rate and import prices may have weakened owing to some structural changes in domestic and/or global factors.

Figure 1: Nominal Exchange Rate of the euro and the import deflator

NEER 38, 1999Q1=100. Extra-euro area import deflator
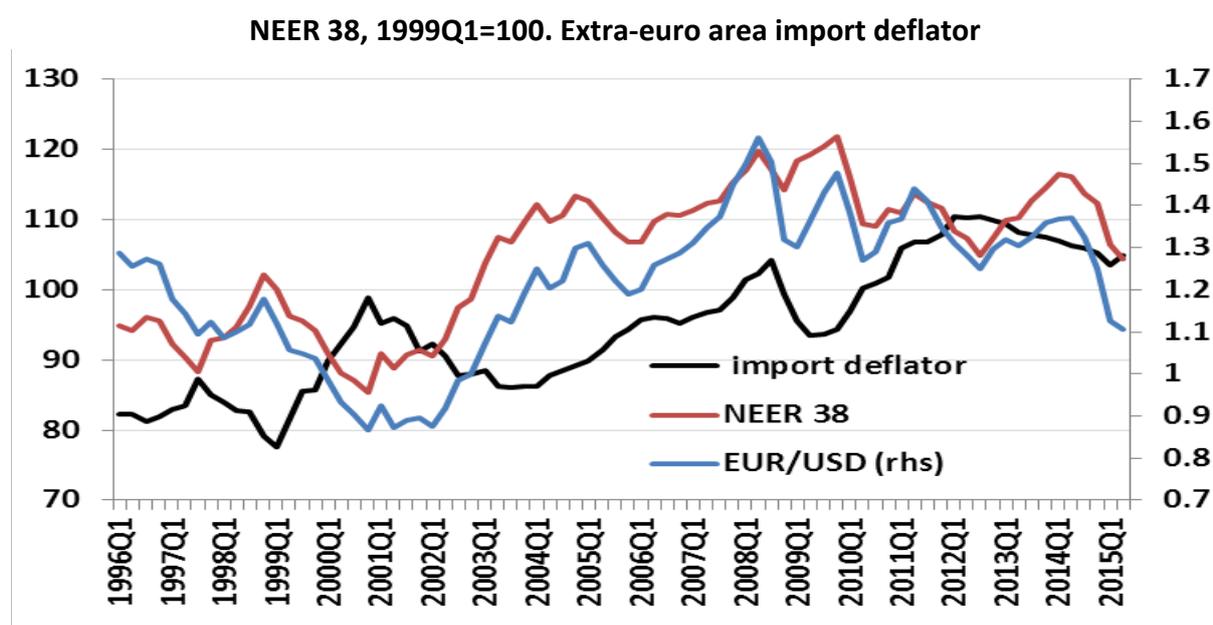
Sources: ECB and IMF

This study investigates the degree of the ERPT in the euro area and its five largest countries based on quarterly frequency data over the period 1996Q1-2015Q2. We use two alternative measures of the nominal exchange rate: the NEER of the euro against 38 partners and the EUR/USD bilateral exchange rate. The empirical specification below is quite standard and follows the literature on the pass-through where the quarter-on-quarter change in import prices is regressed on the quarter-on-quarter change in exchange rates, the lagged dependent variable and some domestic and international control variables. In Equation 1, *mxd* is the extra-euro area import prices in euro, *e* is the nominal exchange rate, *oil* is the global oil prices in euro and *Other* refers to demand- and supply-related control variables. The underlying series are available from the ECB Statistical Data Warehouse and the ECB Macroeconomic Projection Exercise Database.

$$\Delta mxd_t = \alpha_0 + \alpha_1 \Delta e_t + \alpha_2 \Delta mxd_{t-1} + \alpha_3 \Delta oil_t + \alpha_4 \Delta other + \varepsilon_t \qquad (1)$$

The coefficient α_1 associated with the exchange rate variable captures the degree of the short run ERPT while the estimate of the medium term ERPT parameter will be $\alpha_1/(1- \alpha_2)$. As the oil price variable is included into the specification as an explanatory variable, the associated coefficient with ERPT excludes the pass through coming from oil price variations. As evidenced in the next section, the pass though impact of oil prices is found to remain constant over the past decades. Therefore, filtering out the oil component appears more suitable for analysis focussing on the time variation of the pass though.

The lagged dependent variable is included into the model to account for price stickiness. Corsetti, Dedola and Leduc (2008), CDL hereafter, put forward that differences between short-term and long-term pass through mainly arise from nominal rigidities in the economy. The recursive structure of Equation 1 implies that a shock to the exchange rate would impact the import deflator also through its lagged value.

We tested alternative specifications including up to four lags of the nominal exchange rate and the dependent variables. However, only the coefficients associated with the contemporaneous nominal exchange rate and the one-year lagged dependent variable appeared significantly different from zero. Lag selection based on Akaike information criterion also suggests the use of the specifications with one lag. We chose to exclude the individually non-significant lags from the pass through specifications. Our approach contrasts with Campa and Goldberg (2005) and few other studies where the number of lags to include is chosen without considering the significance of the coefficients on the individual lags (which are also likely to be multi-collinear). These studies calculate the long-run pass through by summing up the lagged coefficients (generally up to four lags) although these coefficients may not be different from zero. Consequently, the degree of the long-run pass through estimates of these studies may diverge strongly from the actual long run effect of exchange rate changes.

CDL show that ERPT estimations are sensitive to the inclusion of controls for cost and demand conditions. They find that local costs play a key role in dampening the propagation of exchange rate changes to the HICP. Drawing on CDL, we include in Equation 1 a foreign marginal cost variable approximated by the log change in the weighted Unit Labour Cost (ULC) of the main 19 trade

partners.[4] In most studies, foreign costs are proxied by foreign Producer's Price Index (PPI). However, this is rather an incomplete measure of cost as PPI includes both costs and mark-ups.[5] To control for demand factors, quarterly GDP growth is also included into the baseline specification. We also tested alternative proxies for domestic demand conditions, such as output gap and industrial production index. Nevertheless, those variables did not appear significant in explaining the pass through. In order to allow for the monetary policy to influence the pass through, we ran alternative regressions including a set of interest rate variables. However, unlike the VAR-based empirical evidence in the literature (e.g. Hahn 2003), we did not find a significant impact of the monetary policy and money market conditions on exchange rate pass through.

Equation 1 is estimated using ordinary least squares on variables in log differences. The Philipps-Perron and (Augmented-)Dickey-Fuller unit root tests both reject the existence of the unit root (at the 1 per cent confidence level) in first difference equations, confirming the stationarity of both the dependent and the explanatory variables in first differences. In addition, the inclusion of the lagged dependent variable appears to correct for serial correlation in the residuals. Durbin-Watson statistics as well as the Breusch-Goldfrey LM tests confirm the absence of serial correlation in the residuals in first difference equations. On the other hand, it is possible that the linear combination of import prices, exchange rates and foreign prices is a stationary process. We, therefore, test for a cointegration relation and explore the possibility of specifying a vector error correction model accounting for a long-run cointegration relationship between import prices, exchange rates and foreign prices. We performed the Johansen cointegration test on the series in levels to check for the number of possible cointegration vectors. Yet, different specifications of the Johansen tests failed to reject the no co-integration vector hypothesis for the combination of these three variables.[6]

3. Results for the Euro Area

Table 1 summarises the results of dynamic regressions for the euro area over the full sample (1996Q2-2015Q2). In the baseline model, the quarterly change in extra-euro area import prices is specified as a function of change in nominal exchange rate (NEER and EUR/USD), one-quarter lagged extra-euro area import prices, oil prices as well as one-quarter lagged GDP growth.

Estimations with nominal effective exchange rate vis-à -vis the 38 largest trade partners are reported on the left hand side of the table. The coefficient associated with the NEER appears significantly different from zero and is closer to -0.35. Accordingly, a 1 percent appreciation in the NEER of the euro would translate into a decline of the extra-euro area import prices of around 0.35 per cent in the same quarter. This outcome concurs with the literature finding compelling evidence of partial ERPT for the euro area. More importantly, the magnitude of the suggested ERPT is below the range

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[4] For the euro area, these partners are AU, CA, DK, HK, JP, NO, SG, KR, SE, CH, GB, US, BG, CZ, HU, PL, RO, HR and CN. The marginal cost variable is built as in Otani et al (2005).

[5] We also ran different regressions including PPI as an alternative foreign cost measure. However, the associated coefficients did not appear significantly different from zero.

[6] More precisely, the associated p-values of the Trace statistic for no-co-integration hypothesis are 0.12, 0.72 and 0.54, under the assumption of specification with intercept and no trend, with intercept and trend (linear), and with intercept and trend (quadratic), respectively.

of the findings from existing studies for the euro area covering an earlier period.[7] In addition, we find evidence of price stickiness given that the lagged import prices appear significant in all specifications. The pass through of oil prices is also found significant with a coefficient close to 0.09, in line with the share of oil in total euro area imports. Domestic demand conditions captured with the lagged growth rates also appear to explain significantly the variation in import prices.

A visual observation of the regression residuals suggests a possible regime shift after the year 2000. In addition, the Chow test signals the instability of the coefficient associated with the exchange rate variable before and after 1999 (at the 5 per cent confidence level) and points to a structural change in this parameter.[8] We therefore augment the baseline specification with an indicator variable for 1999Q4 as well as an interaction variable between the nominal exchange rate and a binary variable which takes the value of zero until 1999Q4 and the value of one afterwards. Both the dummy variable and the regime shift variable appear significantly different from zero - with a positive sign - signalling that degree of the ERPT to import prices may have declined in the euro area over the recent period. A possible reason for this structural change as of 2000 could be the rising share of the emerging economies in global trade and the accession of China to the WTO.

Table 1: Euro area full sample estimations - baseline specification

Dependent Variable: extra euro area import deflator (mxd)	NEER (38 partners)				USD			
	1996Q2-2015Q2				1996Q2-2015Q2			
NEER	-0.35 ***	-0.34 ***	-0.35 ***	-0.54 ***				
USD					-0.18 ***	-0.17 ***	-0.17 ***	-0.29 ***
mxd(t-1)	0.23 ***	0.15 ***	0.19 ***	0.16 ***	0.23 ***	0.15 ***	0.19 ***	0.17 ***
OIL	0.09 ***	0.08 ***	0.08 ***	0.08 ***	0.10 ***	0.10 ***	0.10 ***	0.09 ***
growth (-1)		0.63 ***	0.66 ***	0.64 ***		0.56 **	0.58 ***	0.50 **
D1999Q4			-0.03 ***				-0.03 ***	
1999Q4*NEER				0.25 **				
1999Q4*USD								0.14
adj R^2	0.67	0.71	0.74	0.72	0.63	0.66	0.69	0.64
Durbin-Watson	2.24	2.24	2.17	2.25	2.19	2.15	2.11	2.17
Observations	77	77	77	77	77	77	77	77

Note: All variables are in growth rates and expressed in natural logarithms. The symbols ***,. **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Regressions including the EUR/USD bilateral exchange rate are reported on the right hand side of Table 1. First, it appears that the pass through on import prices from a movement of the bilateral USD/EUR exchange rate is almost half as big as the NEER pass through. At the same time, the

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[7] Based on a VAR specification, Hahn (2003) finds that the ERPT to non-oil import prices is 50% at the end of three quarters. Using both time series and panel estimation techniques, Anderton (2003) finds that in imports of manufactures the pass through of the effective exchange rate of euro is around 50%-70 %.

[8] We perform CUSUM and CUSUM squares tests to investigate the issue of parameter instability over the full estimation period. We cannot reject the null of no structural break over the period considered, using the 5% critical lines).

magnitude of the associated coefficient with the USD variable is still higher than the share of the US in total euro area total imports (at around 9 per cent), most probably signalling the disconnect between the trade partners and invoicing in dollar. A reason behind this could be the large share of the emerging market exporters, who either invoice in USD or peg their currencies to the USD. Otherwise, the associated coefficients and their degree of significance are fairly similar to those reported for the NEER specifications.

To test the relevance of the marginal cost variable in explaining the pass through, we include the weighted foreign ULC as an additional explanatory variable. Results in Table 2 start only in 1999Q2 because of limited data availability for exporters' marginal cost. First, we observe that the pass-through coefficient changes only marginally with the inclusion of the marginal cost variable. Moreover, the associated coefficient with the marginal cost variable appears significantly different from zero (at the 10 per cent level) only in the specification with the NEER and excluding the lagged growth. This finding is somewhat disappointing; on the other hand, estimations over the full sample could mask some underlying sub-period dynamics.

Table 2: Euro area full sample estimations - including the marginal cost variable

Dependent Variable: extra euro area import deflator (mxd)	NEER (38 partners) 1999Q2-2015Q2				USD 1999Q2-2015Q2			
NEER	-0.31 ***	-0.30 ***	-0.29 ***	-0.29 ***				
USD					-0.16 ***	-0.15 ***	-0.15 ***	-0.15 ***
mxd(t-1)	0.25 ***	0.14 **	0.13 **	0.21 ***	0.25 ***	0.15 **	0.14 **	0.22 ***
OIL	0.09 ***	0.08 ***	0.08 ***	0.09 ***	0.10 ***	0.10 ***	0.10 ***	0.10 ***
growth (-1)		0.65 ***	0.58 ***			0.64 ***	0.58 ***	
relative ulc			-0.21	-0.37 *			-0.17	-0.34
adj R^2	0.70	0.74	0.74	0.72	0.68	0.72	0.71	0.69
Durbin-Watson	2.27	2.24	2.17	2.25	2.24	2.30	2.28	2.22
Observations	65	65	65	65	65	65	65	65

Note: All variables are in growth rates and expressed in natural logarithms. The symbols ***,. **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

In the following, we estimate the pass-through over two sub-periods by introducing a break point in the middle of the sample (2005q3).[9] Table 3 points to a clear decline in ERPT between the two sub-samples. In the second sub-period, the exchange rate coefficients (both in NEER and EUR/USD terms) appear be reduced by half. Interestingly, the foreign marginal cost variable appears significant (at the 5 per cent level) with a fairly high coefficient in the period 1996Q2-2005Q3 both for NEER and EUR/USD. This finding may suggest the importance of the cost factors in determining import prices during the period where the emerging economies (in particular China) were gaining ground as global exporters.

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[9] The choice of the break date is arbitrary but allows for sufficient data to perform the estimation. The use of 1999Q4 - as included through a dummy variable above - would have left the first sub-period too short to estimate the equation. Time-varying estimations below remove this element of arbitrariness.

Table 3: Euro area estimations- 2 sub-periods

| Dependent Variable: extra euro area import deflator (mxd)	NEER						USD					
	First Period			Second Period			First Period			Second Period		
	1996Q2-2005Q3		1999Q2-2005Q3	2005Q4-2015Q2			1996Q2-2005Q3		1999Q2-2005Q3	2005Q4-2015Q2		
NEER	-0.45 ***	-0.46 ***	-0.37 ***	-0.20 ***	-0.22 ***	-0.22 ***						
USD							-0.25	-0.25 ***	-0.21 ***	-0.11 ***	-0.13 ***	-0.13 ***
mxd(t-1)	0.17 ***	0.15	0.14	0.41 ***	0.22 **	0.23 ***	0.15 ***	0.14	0.13	0.43 ***	0.23 ***	0.24 ***
OIL	0.07 ***	0.07 ***	0.07 ***	0.08 ***	0.08 ***	0.08 ***	0.09	0.09 ***	0.08 ***	0.10 ***	0.10 **	0.10 ***
Growth (-1)		0.52			0.66 ***	0.66 **		0.12			0.71 ***	0.71 ***
ULC			-0.97 **			0.05			-0.87 *			0.05
adj R^2	0.68	0.69	0.75	0.73	0.77	0.77	0.64	0.63	0.72	0.71	0.77	0.76
Durbin-Watson	2.21	2.25	2.11	2.43	2.46	2.45	2.19	2.17	2.09	2.36	2.48	2.48
Observations	38	38	26	39	39	39	38	38	26	39	39	39

Note: All variables are in growth rates and expressed in natural logarithms. The symbols ***,. **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

After having identified that the ERPT has declined between the two sub-samples, in what follows, we explore the time-variability of the ERPT coefficient. We run rolling regressions to identify the speed and the time of the decline in pass through. More specifically, we estimate the pass-through over 40 quarter rolling sub-samples, by moving up one quarter at a time. Figure 2 plots the estimates of the basic model (as specified in Table 1) starting from 1996Q2 as well as the estimates of the model including foreign unit labour cost as of 1999Q2. The dates on the horizontal axis below refer to the last observation of each rolling window.

The short-term pass through estimates in both panels display a clear declining pattern for the estimation period up to end 2012. In the more recent period, the magnitude of the pass through estimates seems to stabilise at low levels. A dramatic fall in the degree of ERPT can be clearly observed over the estimation period ending at 2012, most probably reflecting the disconnect between the nominal exchange rate and import prices plotted in Figure 1. Interestingly, the model including marginal cost yield weaker NEER pass through than the baseline model, in particular over the sample up to 2010. By contrast, in the last three rolling window estimates the baseline model generates somewhat higher pass through. Turning to the EUR/USD nominal exchange rate, the second panel displays that the baseline model generates significantly higher degrees of pass through than the model with foreign marginal cost for the entire period studied. Importantly, the pass through estimates of both models start to converge at the end of the sample.

We also report the coefficients associated with the change in oil prices where the relation between the change in oil prices and overall extra-euro area import prices appears stable. In both panels, specifications including foreign marginal cost are found to generate slightly higher coefficients for oil price elasticities.

Figure 2: Euro Area Exchange rate pass through - Rolling Window Regressions
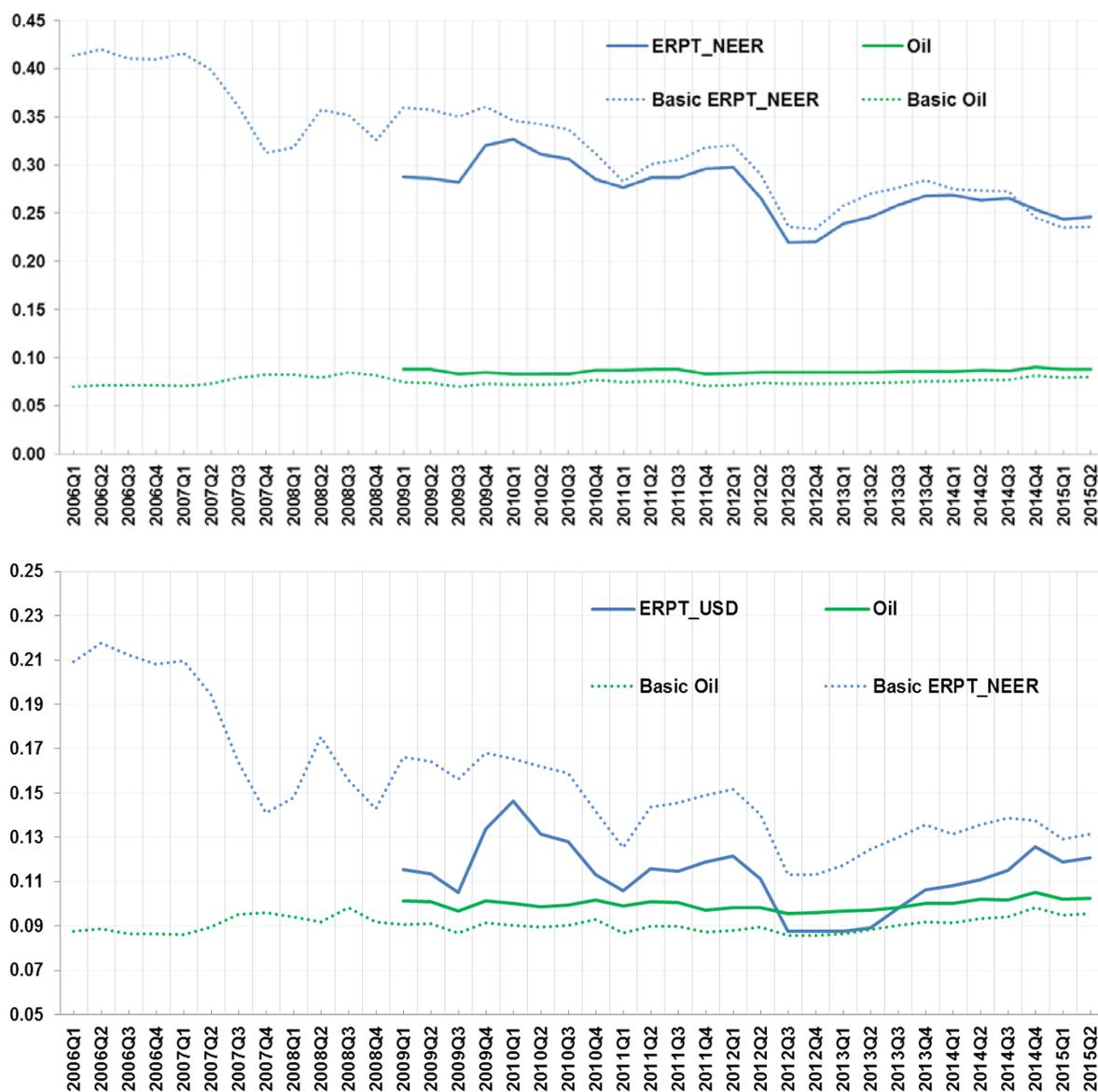
Note: Rolling regressions are conducted over the subsamples of 40 quarters, the ending quarters are reported on the horizontal axis. While the dotted lines show the result of the baseline specification (Table 1) the solid lines correspond to the specification including the foreign cost measure.

The empirical analysis presented above provides strong evidence that the pass through of the euro has declined over time. In what follows, we discuss the possible factors that may explain this decline together with some evidence from recent literature. First of all, the ERPT captures the pricing strategies of exporters which are, in turn, determined by the demand and costs conditions as well as the competition in the market. Exporters facing strong competition may be constrained to follow the market price by adjusting markups to absorb exchange rate shocks. In the same way, exporters

facing highly elastic demand curves or small exporters supplying a large market with strong local competitors would have limited scope for full pass through (Campa and Goldberg, 2005).[10]

The empirical findings in Figure 2 point out that the largest decline in ERPT occurred in the 2000s, until the Great Recession. This period also coincides with the increased globalisation of the European firms and the greater share of the Emerging Market Economies (EMEs) in euro area trade. To illustrate, the share of euro area trade with BRIC has more than doubled since 2000, largely on account of significant increases in import trade with China and Russia. In fact, the rising share of the BRIC in euro area imports is likely to enhance the decline in pass-through via active pricing-to-market strategies of exporters to defend their market shares (Di Mauro et al. 2008). Turning to the US, Marazzi and al. (2005) also identify the increasing presence of Chinese exporters in the US as a major source of decline in pass-through over the past decades. Furthermore, stronger integration of firms into the global value chain (GVC) and greater intra-firm trade is another potential weakening factor of the pass through (Ollivaud et al. 2015). Clearly, global firms are expected to pass less of a change in the exchange rate into intra-firm import prices.

Change in the aggregate pass through could also arise from the compositional change in import bundles over time, as the level of pass through changes dramatically across sectors (Devereux et al. 2015, de Bandt et al. 2007). For instance, the law of one price may hold for oil and commodities which generally have high, or even, full pass through. In the same way, import-intensive or/and low value-added sectors are likely to follow the exchange rate movements closely.

On the other hand, pricing-to-market behaviour is more prevalent in the manufacturing sector. Thus, shifts from commodity-based goods imports towards manufactured products may dampen the ERPT. Di Mauro et al. (2008)[11], Osbat and Wagner (2006) find that by the shift of the composition of euro area imports towards sectors with low ERPT (such as chemicals and food) is the main reason behind the decline in pass through.

Local currency pricing (LCP), which is a particular form of the pricing-to-market, is another factor of decline in pass through. LCP refers to the situations where exporting firms adapt their mark-ups depending on the destination market to offset completely or partially the exchange rate movements. The growing share of trade with the EMEs is known to enhance LCP. In large and attractive markets, competitive pressures from other low-cost countries may push producers to adjust their mark-ups and to move towards greater local currency pricing strategies in order to limit the negative volume effect of a currency appreciation. In an open economy general equilibrium framework, Bachetta and Van Wincoop (2005) show that firms facing strong competition in foreign markets are more likely to price in local currency.

A large number of empirical studies find a negative relationship between LCP and the degree of ERPT (Devereux et al. 2015, Otani et al. 2003). Keeping this in mind, the wider use of euro for extra-euro

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[10] Devereux et al. (2015) find a U-shape relationship between the exporter's market share and the degree of pass through. Holding the exporter's market share constant, they find that a rise of the importer's market share would also decrease the pass through because of greater bargaining power. Contrasting evidence is found for Japan, where Otani et al. (2003) argue that the decline in the pass through reflected the decline in ERPT elasticities of the product categories rather than a sectoral shift in import composition.

[11] Di Mauro et al. (2008) find that in the euro area the change in import composition between 1988 and 2005 mechanically resulted in a decline of overall ERPT from 0.83 to 0.74.

area trade invoicing may also underlie the decline in ERPT. In the recent years, in about 50% of the settlement or invoicing of the imported goods was in euro. More precisely, in 2013, 51.7% of extra-euro area imports of goods and 61.5% of imports of services were settled in euros, up from 48.8% and 53.8% in 2006, respectively (ECB 2015). ECB (2015) finds a causal relationship between invoicing currency choice and the ERPT showing that that an increase of 10 percentage points in the share of the euro as an invoicing currency for extra-euro area imports lowers the ERPT to import prices by close to 7 percentage points. Importantly, the analysis points to strong cross-country variation in ERPT across euro area countries.

4. Results: Medium term pass through and country-level analysis

This section presents the medium term ERPT estimates for the euro area and its five largest economies. As discussed in Section 2, the recursive structure of Equation 1 implies that exchange rate changes can also impact import prices via the lagged dependent variable. Therefore, the degree of the short- and medium-term estimates of the ERPT could differ, reflecting nominal rigidities in the economy.

Table 4 summarises the dynamic response of import prices to a one-period change in exchange rates. More specifically, the exchange rate change is defined as a 10 per cent appreciation and the cumulative response of the extra-euro area import deflator is reported over an eight-quarter-horizon. The euro area coefficients are taken from Table 1, while the country-specific pass through estimates are run on a similar baseline specification to the euro area's.[12]

Starting with the euro area, as a response to a temporary exchange rate shock, we find rather strong pass through in the first year while the impact of the exchange rate appreciation fades away at the end of the second year. More precisely, a 10 per cent appreciation of the nominal effective exchange rate appears to decrease the extra-euro area import prices by 4.5 per cent at the end of the fourth quarter. Importantly, in the euro area, exchange rate movements seem to be passed fairly rapidly into import prices. Pass through occurs mainly in the first three quarters and its marginal impact becomes rather meagre afterwards. As for the EUR/USD exchange change, the degree of pass though is half as big as the NEER's while the path of diffusion is highly similar for both exchange rate measures.

These findings for the euro area may obscure some country-level differences given strong structural heterogeneities. Osbat and Wagner (2006) puts forward that ERPT depends tightly on country-specific factors such as the substitutability between foreign and domestic goods, competitive structure of the industry, barriers to trade, import penetration and relative market size. Overall, the outcome of our country-level analysis suggests that the euro area aggregate estimations may mask strong heterogeneity in the pass-through elasticities.

Following a change in NEER, Germany appears to have the lowest pass through compared to the other four largest euro area countries. The pass through is essentially observed in the first six quarters and its marginal impact on import prices becomes negligible afterwards. Among other

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[12] To save space, we do not report all country estimate coefficients, but the regression outputs are available from the author. Figure 3 plots the findings of Table 4 to ensure better readability of the results.

factors, low pass through in Germany may relate to the large size of the country. As evidenced in Dees et al. (2013) a large destination market implies lower ERPT because of pricing-to-market behaviour of foreign exporters seeking to maintain or gain market shares in a particular market. Figure 3 shows that after the Netherlands, Germany has the largest share of the extra-euro area countries in total imports, confirming the large presence of extra-euro area exporters in the domestic market. In particular, Russia and China are among the largest exporters to Germany and to the Netherlands. As discussed in the previous section, higher international competition in these markets could push exporters to follow active pricing-to-market strategies by absorbing exchange rate shocks in their markups. In addition, increased LCP could be another factor explaining the low ERPT in Germany. As evidenced in Figure 5, in 2014, Germany had the highest rate of invoicing in euro for the extra-EU exports, most probably, reflecting the strong pricing-to-market behaviour of firms. The most recent data available for the extra-euro area imports also confirm that Germany had the highest share of invoicing in euro in 2012 (ECB 2014).

Interestingly, the largest pass through for the EUR/USD exchange rate shock is found for Germany compared to the euro area and the four largest euro area countries. The high sensitivity of German import prices to the EUR/USD bilateral exchange rate may result from the dominant share of the US in German imports. Furthermore, the pass through of the USD is likely to be amplified by intensive German trade with the EMEs which tend to peg their currencies to the USD or use the as a settlement/reference currency for imports.

Table 4 : Cumulative impact of a 10% nominal exchange rate appreciation on extra-euro area import prices

CUMULATED - deviation of the level from the baseline	Year 1	Year 2	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
NEER appreciation										
EA	**-4.16**	**-4.50**	**-3.46**	**-4.26**	**-4.44**	**-4.49**	**-4.49**	**-4.50**	**-4.51**	**-4.51**
DE	-4.44	-5.32	-3.18	-4.45	-4.96	-5.16	-5.24	-5.33	-5.36	-5.37
FR	-6.07	-6.88	-4.69	-6.17	-6.64	-6.79	-6.83	-6.88	-6.90	-6.90
IT	-11.61	-15.17	-7.59	-11.37	-13.26	-14.20	-14.67	-15.14	-15.37	-15.49
ES	-7.49	-8.14	-6.18	-7.66	-8.01	-8.10	-8.12	-8.14	-8.15	-8.15
NL	-5.48	-5.54	-5.33	-5.53	-5.54	-5.54	-5.54	-5.54	-5.54	-5.54
EUR/USD appreciation										
EA	**-2.11**	**-2.28**	**-1.76**	**-2.16**	**-2.25**	**-2.27**	**-2.28**	**-2.28**	**-2.28**	**-2.28**
DE	-3.08	-3.67	-2.20	-3.09	-3.44	-3.59	-3.65	-3.67	-3.68	-3.68
FR	-0.81	-0.86	-0.69	-0.82	-0.85	-0.86	-0.86	-0.86	-0.86	-0.86
IT	-2.80	-3.20	-2.13	-2.84	-3.08	-3.16	-3.19	-3.20	-3.20	-3.20
ES	-1.41	-1.55	-1.14	-1.44	-1.52	-1.54	-1.55	-1.55	-1.55	-1.55
NL	-2.27	-2.29	-2.20	-2.28	-2.29	-2.29	-2.29	-2.29	-2.29	-2.29

Source: Own calculations

Figure 3: Quarterly cumulative impact of a 10% nominal exchange rate appreciation on extra-euro area import prices
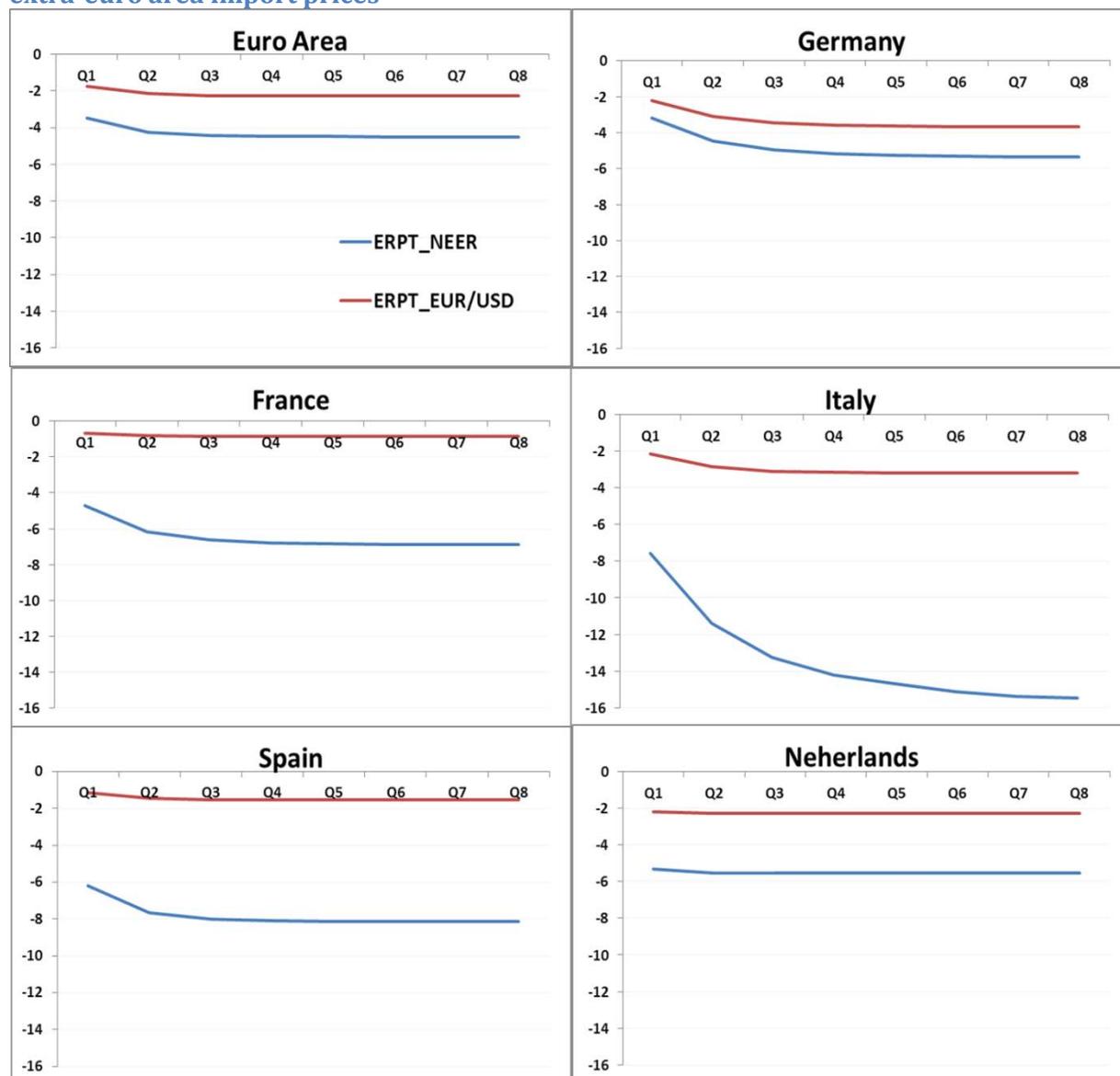
Note: y- axis refers to the percentage cumulative change in extra-euro area import prices while x-axis refers to the quarterly horizon.

In France, we find slightly higher pass through of a NEER appreciation compared to the euro area and Germany. In contrast to Germany, the pass through of a nominal EUR/USD exchange rate appreciation is the smallest in France, probably as a result the country's import basket composition in terms of products and destination countries. For instance, the US Foreign Trade Statistics report that in 2014, France's imports of goods from the US amounted only to half of German imports from the US.[13]

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[13] Data are available from https://www.census.gov/foreign-trade/balance/c4280.html#2014 .

Turning to other large euro area countries, Italy appears to have the highest pass through of a NEER appreciation compared to the euro area and four reference countries. In addition to the size of the importer country, the size of the importer firm is also found determinant for the degree of pass through (CDL). Small firms are likely to have weak price bargaining power with foreign exporters, therefore, generally have less scope for LCP. The dominance of the Italian industrial sector by a large number of small and medium sized firms could explain, to a certain extent, high degree pass through. Our results concur with the findings of Dées et al. (2013) where strong pass through for Italy (60%) and much lower pass through (40 %) for Germany are found. The diverging pass though probably results from the significant differences in market size and import composition between these two countries. Another striking finding for Italy is the stability of the degree of the ERPT over the past two decades. Unlike the euro area aggregate and the other four largest countries, our split-sample estimates signal no evidence of decline of pass through in Italy.[14]

In Spain, we find rather strong pass-through of the NEER shock, probably reflecting -among other factors- the country's size. The pass through in Spain mainly occurs in the first three quarters and fades away after the sixth quarter. This path contrasts with the strong and persistent pass through in Italy where the pass through fades away only after ten quarters.

**Figure 4: The ratio of the extra-euro area imports to total imports**
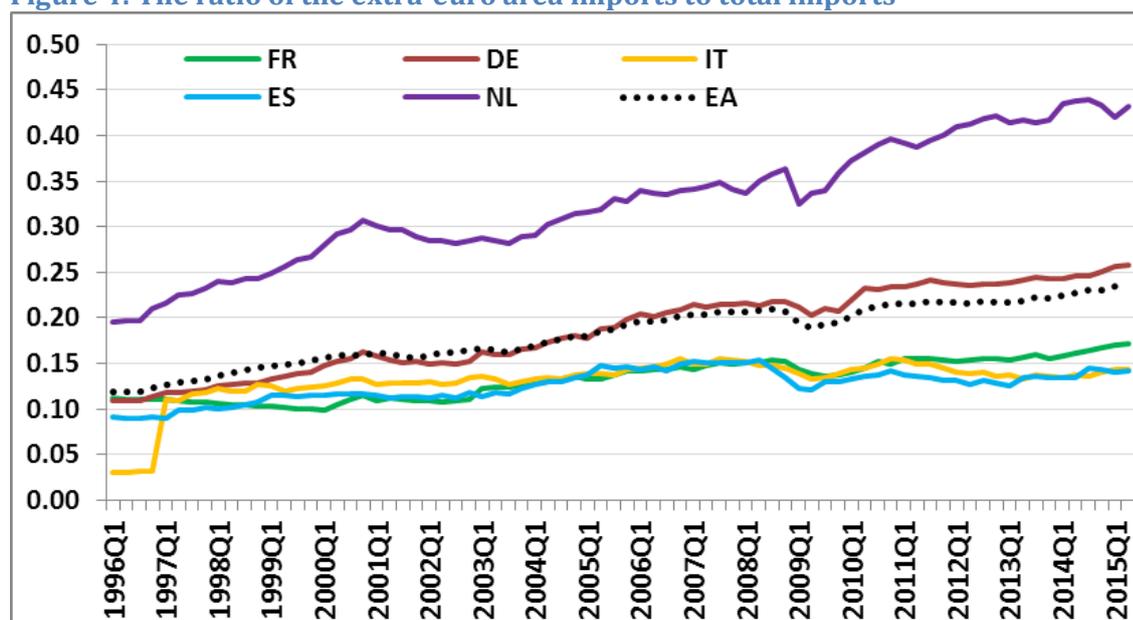
Source: ECB

Another interesting finding is the relatively low degree of ERPT in the Netherlands, in particular given the country's size. In addition, the pass through appears to operate only in the first three quarters to become almost null afterwards. The Netherlands represents, indeed, a specific case illustrating that the relation between the market size and pass through is not systematic. Having the largest port in Europe, the Netherlands is perfectly positioned as a gateway for imported goods into the EU. Importantly, an overwhelming share of imports into the Netherlands is not consumed

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[14] To save space, country-level regression results are not included in the paper but are available from the author upon request.

domestically; they are re-exported to other intra euro area countries. Thus, prices of most import goods entering the country could be negotiated between the producer and a third country importer. In other words, the weak relationship between the exchange rate movements and import prices, could be explained by the market characteristics of the final destination country. In addition, the Netherlands has the largest share of the extra-euro area imports in total imports (Figure 3). Similar to the German case, the strong presence of the other extra-euro area exporters in the Dutch market may constrain these exporters to follow aggressive pricing-to-market strategies.

Figure 5: The invoicing share of euro in extra EU trade
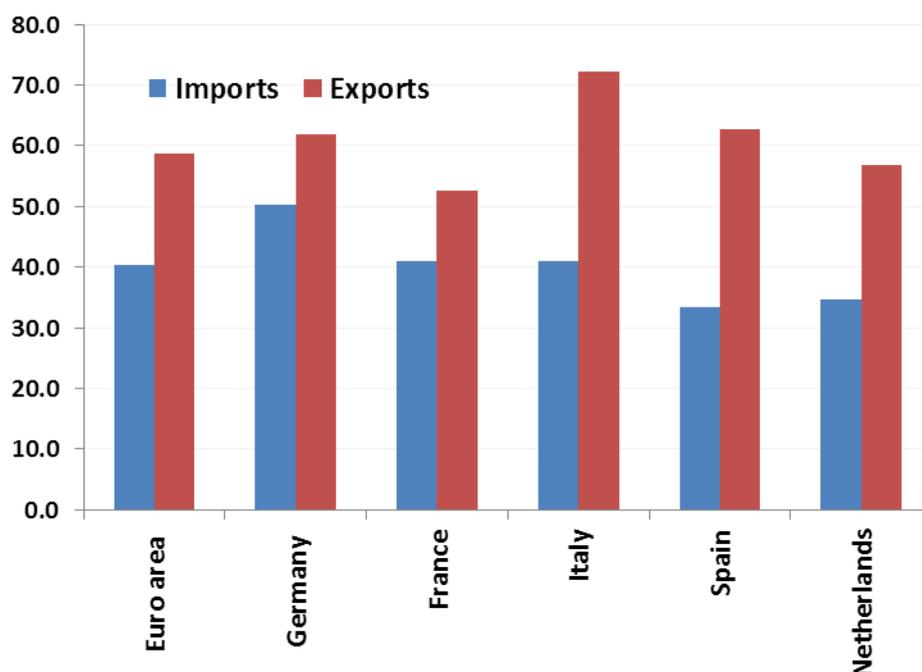
Source: Eurostat

All in all, we find strong heterogeneity in pass through dynamics across the largest euro area countries. In a monetary union, the variation of the pass through elasticities across countries may signal strong differences in domestic market conditions (e.g. size, competition environment, import penetration, geographic orientation and composition of imports, choice of the invoicing currency).

Conclusion

This study investigates the degree and the speed of the ERPT into extra-euro area import prices in the euro area and its five largest countries over the period 1996Q1-2015Q2. In line with the literature, we find incomplete pass through for the euro area aggregate and the five largest countries. Controlling for foreign marginal costs appears to reduce the pass through, in particular, in the beginning of the sample. We also find clear evidence that the pass through has declined over the past two decades. The period of strong fall in pass through coincides with the increasing share of the emerging market economies in the world trade and the accession of China to the WTO.

Our evidence on the variability of pass through could be complemented with analysis taking into account the nature of shocks driving the economy. As argued in Dées et al. (2013) and Corsetti et al. (2008), the nature of shocks underlying the exchange movements could determine the pass through relationship. In the same way, Forbes et al. (2015) emphasise that shocks causing the exchange rate movements should be explicitly taken into account. They argue that the impact on final prices of exchange rate movements would be different whether the exchange rate movements are driven by demand or productivity shocks.

Another interesting finding is that the degree and the speed of the pass through vary significantly across the five largest euro area countries, probably as a result of domestic market heterogeneities. The lowest pass through of a change in NEER is found for Germany while it is the highest for Italy. In addition, unlike the other large euro area countries, we do not find evidence for Italy of a decline in pass through over time. In a monetary union, such differences may signal large heterogeneities in domestic markets structures.

While, the present research draws conclusions on the speed and size of the ERPT based on aggregate-level information, it has been extensively documented that pass-through elasticities may vary dramatically across sectors. With better availability of granular import price data, further research could investigate whether our outcomes hold at the sectoral level.

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