



## Exchange Rate Pass-Through to Domestic Prices

Paul Reddan & Jonathan Rice<sup>1</sup>

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### Abstract

Even by euro area standards, Irish goods inflation remained very weak throughout 2016. This Letter provides empirical evidence that Irish consumer goods price inflation is particularly exposed to movements in the euro-sterling exchange rate - notwithstanding factors such as global prices, interest rates and domestic consumption. This exposure of Irish consumer prices to sterling currency movements is shown to closely explain price dynamics throughout 2016, in particular for the period following the British vote to leave the EU.

## 1 Introduction

Weak inflation has been prevalent in Ireland and the broader euro area (EA) in recent years. However, having been unchanged in 2015, inflation for the EA began to increase through 2016, as rising energy prices passed through to consumers. In contrast, consumer prices remained subdued in Ireland, with HICP inflation *decreasing* by 0.2 per cent in the year. Exchange rate movements may explain part of this weakness. Exchange rates influence the price of traded goods, which pass through to both producer and consumer prices. The exchange rate channel is particularly important

for Ireland, a small open economy with a large share of trade outside the EA. The UK and the USA account for approximately 70 per cent of this trade, and over 40 percent of Ireland's overall trade, and hence fluctuations in the US dollar and sterling are of particular importance.

Understanding pass-through from exchange rate fluctuations to domestic inflation is important given current instability in the global macroeconomic environment. Developments surrounding the British exit from the EU had substantial effects on the value of sterling, and these effects are likely to persist as

<sup>1</sup>E-mail: [paul.reddan@centralbank.ie](mailto:paul.reddan@centralbank.ie) and [jonathan.rice@centralbank.ie](mailto:jonathan.rice@centralbank.ie). The views expressed in this Letter are those of the authors only and do not necessarily reflect the views of the Central Bank of Ireland. We thank Thomas Conefrey, John Flynn, Reamonn Lydon, Michael O'Grady, Gerard O'Reilly and Graeme Walsh for very useful comments.

the UK engages in deeper negotiations that are perceived as having direct consequences on the economies of both the UK and the European Union. Exchange rate pass-through has important effects on the real economy. For instance, low consumer price inflation in 2016, largely due to weakness in the value of sterling, stimulated personal consumption expenditure through an increase in the real disposable incomes of Irish consumers.<sup>2</sup>

Fluctuations in exchange rates affect consumers through two distinct price channels, (i) the prices of imported final goods sold directly to domestic consumers, and (ii) the prices of imported inputs feeding through domestic production of intermediate and final goods. The importance of this latter, more indirect channel, is likely to depend in part on the intensity of competition in domestic markets - while an exchange rate appreciation lowers the price of imported inputs, a firm with limited competitive pressure may avail of greater profit margins rather than reduce prices in an effort to maintain market share. In addition to these direct and indirect channels, a weak (strong) currency, may temporarily operate via these price dynamics to stimulate (dampen) economic activity and consumer incomes.

Since the mid-1970s policymakers have generally accepted that Irish consumer prices are ultimately determined by external inflationary pressures and changes in the exchange rate (Fitzgerald *et al.*, 2000). Previous research by Fitzgerald *et al.* has suggested that within the euro area, Ireland remains an outlier due to the extent of UK-based retail firms in the Irish market. Since these affiliate companies are often price takers, in the sense that their prices are often set by parent companies in the UK, it follows that Irish consumer prices may have a close tie to UK consumer prices. There is historical evidence through the 1970s of a strong tie between UK and Irish consumer

prices (Bradley, 1977; and Geary, 1976). The empirical link between sterling and the Irish pound was less clear however following the introduction of the EMS after 1979, yet work by Fitzgerald and Shortall (1998) recovered evidence of a link in consumer prices up until 1999, finding that changes in UK prices passed through rapidly and changes in the exchange rate passed through more slowly to Irish prices. The authors' analysis highlighted that at the inception of EMU, this link appeared to break down.

Much of the literature on exchange rate pass-through has focused on pass-through to a single price variable (such as import, producer or consumer prices) and on differences between countries or industries. Campa and Goldberg (2005) use a single equation approach to estimate pass-through to import prices for a sample of OECD countries, finding pass-through of 79 per cent in the short run and 100 per cent in the long run for Ireland. Honohan and Lane (2003) use single-equation panel regressions to consider pass-through to consumer price inflation following the introduction of the euro and show that exchange rates played a significant role in driving consumer price differences between Ireland and other euro area countries.

In contrast to the aforementioned approaches, the estimation strategy adopted in this Letter is a Vector Autoregressive (VAR) model, which confers a number of distinct advantages over single-equation methods. Inclusion of import, producer and consumer prices in a single system allows estimation of *relative* pass-through rather than absolute pass-through to a single price variable. We can also consider lagged interactions between prices - allowing fluctuations in import prices to pass-through to producer prices, and fluctuations in producer prices to pass-through to consumer prices. We simulate an exogenous shock to

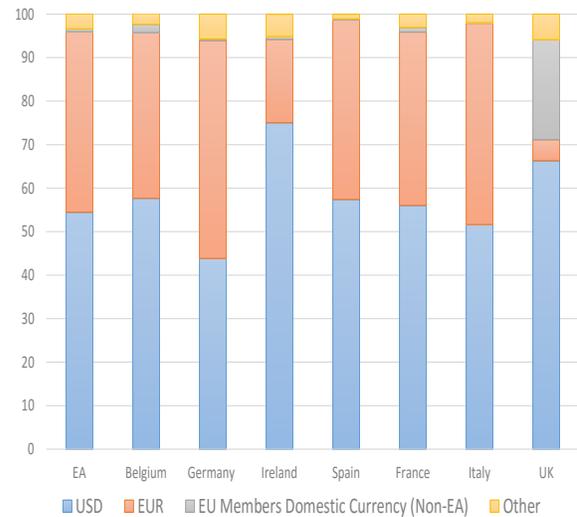
<sup>2</sup>See Irish Central Bank Quarterly Bulletin 2017 Q2, Box C.

the exchange rate, which could be interpreted as an *uncertainty* shock (such as that of the Brexit vote), or alternatively as a shock driven by exogenous asset market disturbances. Similar approaches using VAR methods include McCarthy (2000), Hahn (2003) and Faruqee (2006).

A regular finding in the literature is that pass-through differs between countries and across sectors. When a country, such as Ireland, has a large traded (relative to non-traded) sector, exchange rate pass-through to consumer prices tends to be large. Another widely recognised reason for differences across countries relates to the pricing strategies of exporting firms. For instance, when a firm based in the UK operates under producer currency pricing (PCP), it prices its exported goods in sterling. Following an appreciation in sterling Irish firms may substitute to purchase of domestic goods such that UK firms pricing in sterling may risk losing market share.<sup>3</sup> On the other hand, where a firm chooses to price in the currency of export destination, that firm is practicing local currency pricing (LCP).<sup>4</sup> In Ireland, approximately 71 per cent of imported non-petroleum related goods from outside the EU are priced in US dollars (see Figure 1) - the largest share of any other EU country. A further 24 per cent are priced in euros, signifying countries from outside the EU pricing to the euro area market. While no comparable data on currency pricing is available for Irish trade with the UK, we know that the UK share of Irish trade has declined in recent decades and there is evidence that during the initial years of the EMU, UK exporters were increasingly choosing to price their goods in euros.<sup>5</sup> For these reasons, we might expect large pass-

through from movements in the US dollar to Irish import prices.

**Figure 1:** Extra-EU imports of non-petroleum goods by member state, shares by invoicing currency



Source: Eurostat

To further demonstrate the importance of invoice currency choice for pass-through to imported goods prices, Figures 2 and 3 plot year-on-year growth rates in the price of imported non-petroleum goods from the USA against EUR:USD and year-on-year growth rates in the price of imported non-petroleum goods from the UK against EUR:GBP, for the euro area.

It appears that, for the euro area, pass-through from the US dollar is more substantial than pass-through from sterling.<sup>6</sup> These figures suggest that the dominant strategy for US firms exporting to the euro area is producer currency pricing - pricing in US dollars - and that a greater proportion of UK exporting firms may be engaging in local currency pricing, or pricing to a destination market.

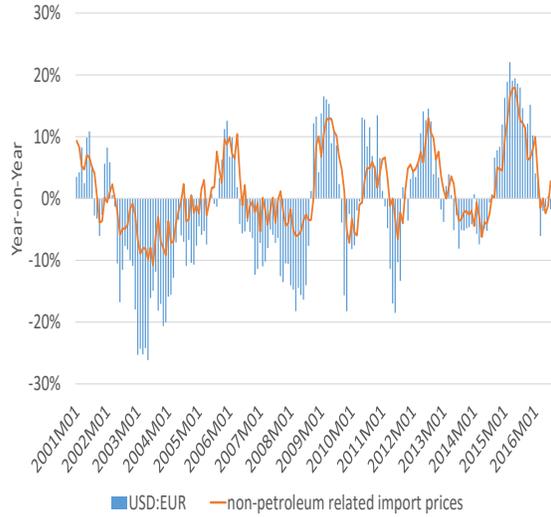
<sup>3</sup>An appreciation in the value of sterling decreases the purchasing power of foreign goods for an Irish firm importing goods from that UK firm.

<sup>4</sup>Firms may strategically price in local currencies in order to maintain stability in their prices by shielding against exchange rate movements.

<sup>5</sup>See for example, McArdle (2000) and Fitzgerald, Duffy and Smyth (2000).

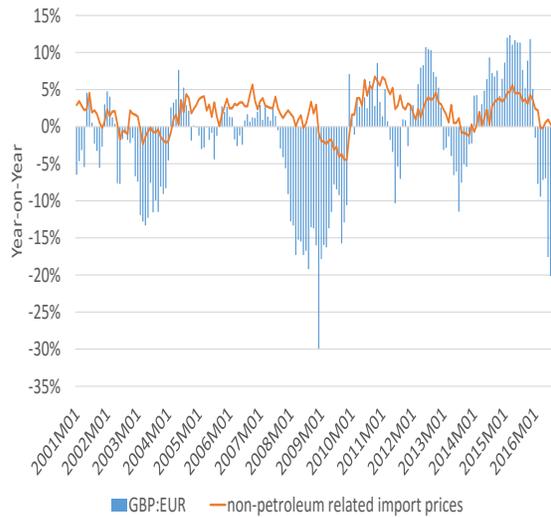
<sup>6</sup>The correlation coefficient for the USD and imports prices from the US is 0.89, against a coefficient of 0.59 for sterling and import prices from the UK.

**Figure 2:** USD:EUR and euro area non-petroleum goods import prices from the United States



Source: Eurostat

**Figure 3:** GBP:EUR and euro area non-petroleum goods import prices from the UK

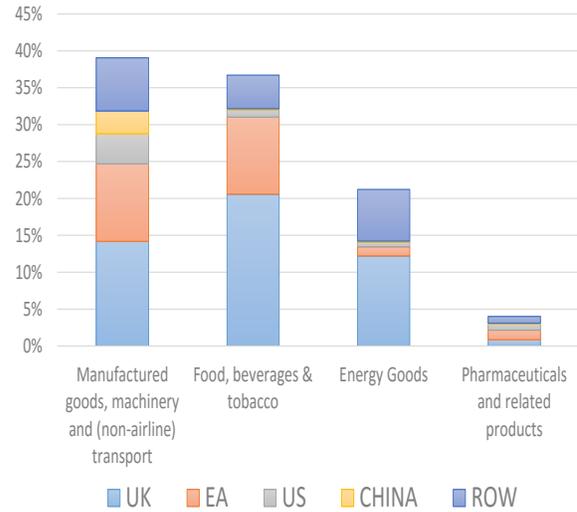


Source: Eurostat

Despite the importance of movements in the US dollar to import prices, pass-through to wholesale and consumer prices from the US dollar does not necessarily follow. Where imported goods do not trickle down through domestic production chains, or get sold to Irish consumers, pass-through to wholesale and consumer prices may be negligible. Figure 4 shows Ireland's share of imports by trade

partner expressed as a share of total HICP goods weights. These weights indicate the importance of each category in determining total Irish consumer goods price inflation (left axis). The figure therefore provides a rudimentary measure of the relative importance of Irish imports by location to Irish consumer goods inflation.

**Figure 4:** Irish non-energy goods imports by HICP weighting



Source: Eurostat, Authors' calculations

The UK clearly dominates extra-EA goods imports in the categories contributing most to Irish consumer goods inflation. Importantly, a large portion of the *energy goods* category (which includes petroleum products and has a close link to global oil prices), are likely to be priced in US dollars, regardless of trade partner. However, these goods are excluded from our analysis. A consideration of the goods bundle of Irish imports from the US is informative. For instance, a significant portion (approximately 29 per cent) of imports from the US are in pharmaceuticals and related products and, rather than being sold to Irish consumers, a large majority of these imports are later exported from Ireland (in the past two years, pharmaceuticals and chemical goods have made up approximately 50 per cent of total Irish goods exports). In addition,

Ireland imports a large quantity of aircraft and aircraft related equipment from the US. Over the past five years, aircraft and related products made up over 40 per cent of total goods imports from the US. Aircraft and related products are not sold to Irish consumers and therefore have a negligible contribution to domestic consumer goods inflation. On the other hand, 50 per cent of total *manufacturing goods* and 78 per cent of *Food, Beverages and Tobacco* imported from outside the EA come from the UK, and these imports are far more likely to feed through to the Irish consumer.

## 2 Data

A tabular description of data sources is included in the Appendix. Variables are seasonally adjusted where necessary and enter the VAR in logged first differences.<sup>7</sup> The data are monthly and the sample period ranges from 2000(1) to 2016(12). Lag order selection based on the Akaike Information Criterion (AIC) informed the choice of 4 lags for the VAR.

We use the Nominal Effective Exchange Rate (NEER) provided by the Bank for International Settlements. The NEER is an index of weighted average bilateral exchange rates based on import and double export weights.<sup>8</sup> We use the CSO merchandise trade price index for import prices. This series is based on unit values for imports and is provided at a monthly frequency. The wholesale price series used is the Irish *home* sector wholesale manufacturing price index. This index includes firms selling goods within the domestic market only, where the goods they sell may be constructed using both imported or domestically sourced inputs.

<sup>7</sup>The exception to this is the interest rate which is not logged, yet following unit roots tests is treated as an I(1) variable, and is therefore first differenced.

<sup>8</sup>See Bank for International Settlements for greater detail.

<sup>9</sup>We also estimated a simple PPP equation using data from our sample period and were unable to find evidence of a PPP relationship with the UK.

Importantly, we are interested in capturing exchange rate pass-through in the import channel, and therefore excluding exported goods in our measure of wholesale prices prevents pass-through to *export* prices from directly influencing our results. We use the Harmonised Index of Consumer Prices for our indicator of consumer prices. Our measure excludes energy goods and unprocessed foods in line with previous literature.

## 3 Model Setup and Results

This section describes the reduced-form VARX model used for our analysis. As a small open economy and member of the euro area, Ireland is a price taker and monetary policy is set by the ECB based on euro area conditions. To account for this, our model includes an *exogenous* vector  $X_t$ , such that these *exogenous global* variables may affect, yet are not affected by, domestic variables in the model. We include the NEER as exogenous since Ireland is a relatively minor contributor to euro currency movements. For robustness, we also modelled specifications including foreign consumer prices as an exogenous variable (we tested with UK consumer prices, and a weighted average of US and UK consumer prices), yet the inclusion of these variables does not materially affect our results and therefore these were dropped due to concerns of endogeneity with the exchange rate in the VAR.<sup>9</sup> The VAR is described by equation 1 below:

$$AY_t = \sum_{i=1}^4 A^*_i Y_{t-i} + \sum_{j=0}^4 B^*_j X_{t-j} + \varepsilon_t, \quad (1)$$

where  $X_t$  is a 5x1 vector including a constant and our exogenous variables:

$$X_t = \begin{pmatrix} \text{constant} \\ \Delta \ln \text{ oil prices}_t \\ \Delta \ln \text{ industrial input prices}_t \\ \Delta \text{Euribor}_t \\ \Delta \text{NEER}_t \end{pmatrix}$$

and  $Y_t$  is a 4x1 vector of endogenous variables, as follows:

$$Y_t = \begin{pmatrix} \Delta \ln \text{ retail sales}_t \\ \Delta \ln \text{ import prices}_t \\ \Delta \ln \text{ wholesale prices}_t \\ \Delta \ln \text{ HICP}_t \end{pmatrix}$$

In the VAR system in equation 1,  $A$  is a 4x4 matrix of coefficients representing the instantaneous relations between the endogenous variables. The  $A_i^*$ 's and  $B_i^*$ 's are 4x4 and 4x5 coefficient matrices, respectively.  $\varepsilon_t$  is an error vector.

To analyse the effects of a change in an exogenous variable on the endogenous variables, we calculate *dynamic multipliers*. Dynamic multipliers can be obtained from the *final form*, which is shown in equation 2 (with lag operator notation).<sup>10</sup>

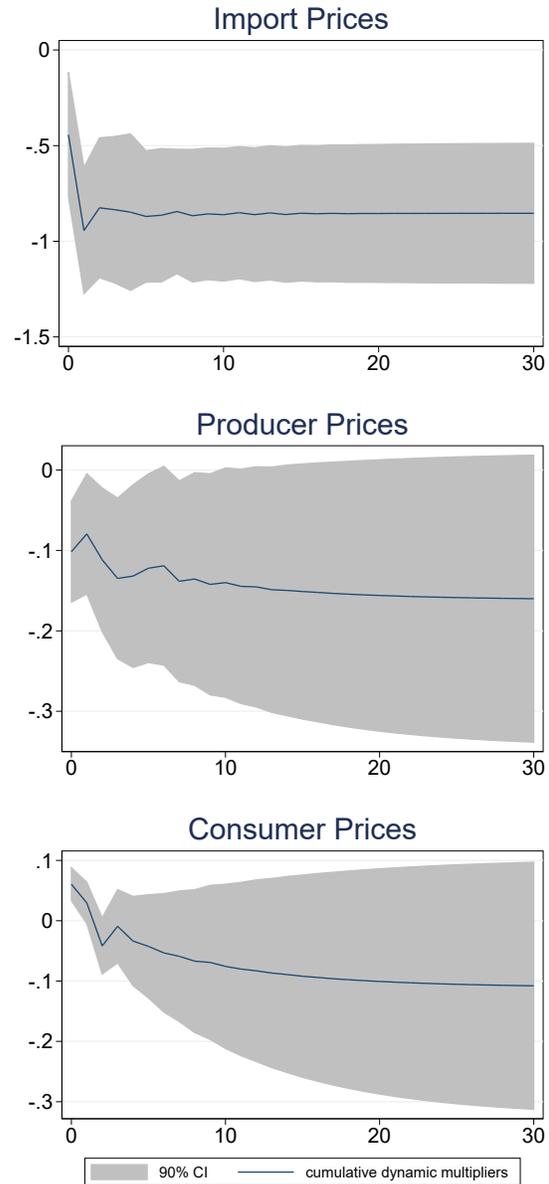
$$Y_t = D(L)X_t + A(L)^{-1}\mu_t, \quad (2)$$

The  $D$  matrices contain the dynamic multipliers. We will use these elements to estimate the effect of an increase in the exogenous exchange rate on our key domestic price variables.

Figure 5 presents dynamic multiplier analysis from a one unit positive shock (or appreciation) to the NEER at period  $t$ . Cumulative responses are displayed for the three domestic price levels with 90 per cent confidence intervals.

<sup>10</sup>See Lutkepohl (2005) for detail on how to derive this representation.

Figure 5: Impulse Response Functions



Source: Authors' calculations

As expected, pass-through to import prices exceeds that of producer and consumer prices. Pass-through to import prices is fast and settles at approx. 85 per cent in the long-term, and this result is statistically significant. Pass-through to producer prices is 10 per cent on impact, which is statistically significant, and

settles at 16 per cent in the long term. Pass-through to HICP reaches 10 per cent in the long term, yet comes with a lag, with cumulative pass-through only becoming negative in month  $t+2$ .

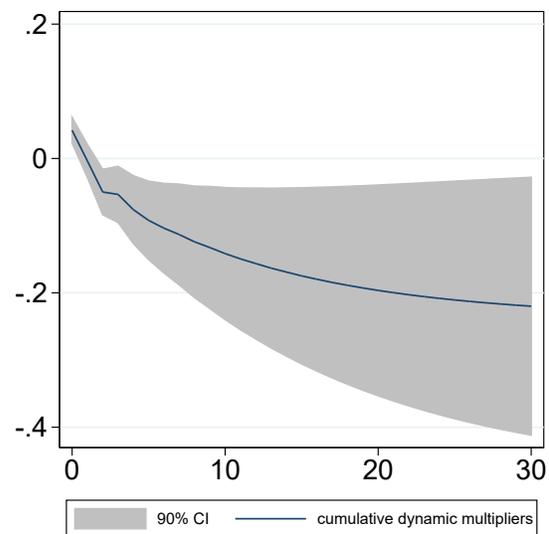
It is unsurprising that the negative response for consumer prices is not statistically significant, in particular given that the effect of a shock to the NEER is likely to be conditional on the currency driving that shock. As discussed above fluctuations in the US dollar for instance may have a different impact on consumer prices than fluctuations in sterling, or in other currencies. Furthermore, we model an exogenous shock to the NEER, yet fluctuations in the NEER are often caused by underlying factors, and attempting to fully control for these factors in a VAR setting is challenging - strong domestic consumption may drive an exchange rate appreciation yet simultaneously support prices and therefore mitigate against exchange rate pass-through. On the other hand, a monetary policy tightening may appreciate the exchange rate yet simultaneously contract demand and therefore reduce, or reverse, the associated inflationary pressure of a strong currency.<sup>11</sup>

We now consider whether sterling movements are of greater importance to consumer prices in Ireland by simulating an appreciation in the EUR:GBP exchange rate in the VAR. This requires some minor alterations to the model outlined above. We now include the EUR:GBP exchange rate instead of the NEER but we also include an (exogenous) measure of the NEER that excludes sterling, to control for other currency movements.<sup>12</sup>

Figure 6 shows the response of HICP to a

positive shock (appreciation) in the EUR:GBP exchange rate. Pass-through to HICP comes with a lag, similar to that observed following the NEER appreciation. However, pass-through is stronger and more rapid in comparison to pass-through from the NEER shock. Pass-through is over 15 per cent after 12 months, settling at approximately 21 per cent in the long term, double that implied by a shock to the NEER. This result demonstrates that sterling is more important for consumer goods in Ireland than the currencies of Ireland's other trading partners. Furthermore, the finding that pass-through to consumer goods prices from a positive shock to the exchange rate is negative, is statistically significant at the 10 per cent level in both the short and long-term.<sup>13</sup>

Figure 6: Sterling Pass-through to Consumer Prices



Source: Authors' calculations

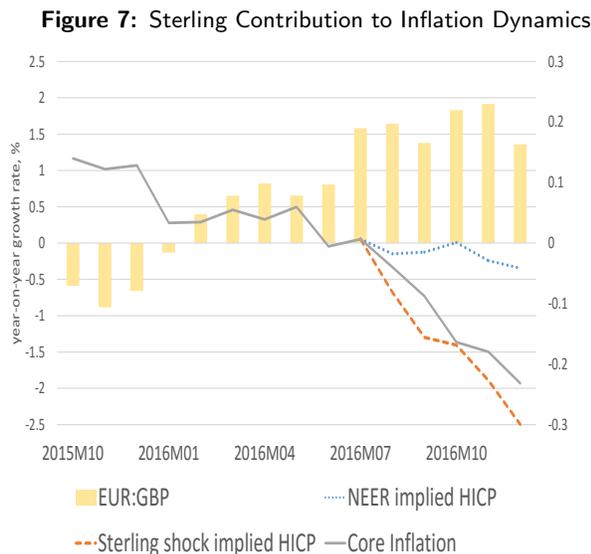
<sup>11</sup>For example see Forbes, Hjortsoe and Nenova (2015)

<sup>12</sup>The EUR:GBP exchange rate is in logs and first differences in similar fashion to the NEER and other variables.

<sup>13</sup>We also ran the model including UK consumer prices as exogenous, but results were very similar, we therefore removed UK prices from the final specification due to endogeneity concerns between UK prices and the NEER. In any case, we were unable to uncover a statistically significant link between UK and Irish consumer prices over the modeling sample.

## 4 The role of sterling in driving recent Irish inflation

Since 2011, weakness in sterling led monthly averages in the EUR:GBP exchange rate to exceed €1:£0.87 twice - in 2013, due to low growth in the UK and increased optimism in the euro area, and in 2016 following the British vote to exit the EU. Each of these episodes correspond to sharper declines in Irish consumer price inflation than predicted by movements in the NEER. Turning to recent dynamics, figure 7 plots year-on-year growth in the EUR:GBP exchange rate (right axis) against the VAR implied HICP with both the NEER shock and sterling shock separately, and Irish core inflation (left axis). The rapid appreciation in euro against sterling from June/July 2016 coincides with a rapid decrease in the price level of goods. Using the NEER as a measure of the exchange rate position appears to substantially understate the exposure of Irish inflation to EUR:GBP exchange rate movements.



Source: Eurostat & Authors' calculations

## Conclusion

The impact of exchange rate fluctuations for Ireland should necessitate the consideration of bilateral exchange rates, rather than composite series such as the NEER. Exchange rates directly impact the domestic price of foreign goods, where these goods are priced in foreign currencies. A large portion of extra-EU imports are denominated in US dollars and hence movements in the dollar have a significant impact on import prices for countries in the euro area. This is especially true of Ireland, where over 70 per cent of non-petroleum goods imported from outside the EU are priced in US dollars. On the other hand, since Irish non-energy goods imports from the UK largely consist of manufactured goods and food related products, while a large portion of US imports are later exported by Irish-based firms and therefore are not purchased by Irish consumers, sterling appears to have a disproportionate impact on Irish consumer goods price inflation. This finding aids our understanding of the significant impact that sterling weakness has had on recent Irish consumer goods inflation. It also explains why Irish inflation remained lower than all other euro area countries throughout 2016. Understanding the importance of sterling in driving consumer goods inflation is imperative, as forthcoming negotiations surrounding British exit from the EU are likely to have major consequences for the euro-sterling exchange rate.

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## A Data Table

<b>Data Series</b>	<b>Data Sources</b>
Crude Oil (petroleum) Price Index	IMF Primary Commodity Prices
Industrial Inputs Price Index	IMF Primary Commodity Prices
3 month Euribor	Bloomberg
Retail Sales - volume weighted	Central Statistics Office (CSO)
Nominal Effective Exchange Rate	Bank for International Settlements
Import Prices, unit values index	CSO
Wholesale Prices, manufacturing goods - home	CSO
Harmonised Index of Consumer Prices, non-energy goods	Eurostat (HICP data)