Expansionary appreciation

SUMMARY

We identify exogenous effects of shifts in effective exchange rates for euro area (EA) countries between 1999 and 2016. The identification strategy is based on an external instrument built on the assumption that movements in the euro nominal effective exchange rate are largely exogenous for individual EA countries once we control for EA aggregates. We find that a real appreciation creates a trade-off between expenditure switching (contractionary) and terms of trade (expansionary) effects, with the latter prevailing in most countries. We also find some heterogeneity in the way movements in the euro exchange rate are transmitted within the EA, in particular between 'core' and 'peripheral' countries, although differences are mostly not statistically significant.

JEL codes: F31, F32, F41, F45

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Can appreciation be expansionary? Evidence from the euro area

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1. INTRODUCTION

The economics literature is riddled with puzzles concerning exchange rates. First, real exchange rates are more volatile and more persistent than implied by most models, especially in floating regimes (Mussa, 1986). Second, the Backus–Smith puzzle postulates

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that real exchange rates are less positively correlated with consumption than predicted by most structural models, with the consequence that they also do not appear to play a role in international risk sharing (Backus and Smith, 1993). Finally, there is also a literature on exchange rate disconnect, whereby exchange rates and fundamentals appear to be largely independent of each other (Obstfeld and Rogoff, 2000).

Exchange rates are highly endogenous and forward-looking variables, which constitutes a formidable challenge for empirical analysis. In general, it is difficult to learn much from reduced form evidence without making restrictive assumptions on the shocks driving the variables. In this paper, we exploit the unique situation of countries in a monetary union to achieve a clean identification and hence make progress in the understanding of the effects of movements in exchange rates on fundamentals (we do not deal with the opposite direction of causation, i.e., from fundamentals to exchange rates).

The intuition behind our identification strategy is that individual euro area (EA) countries, especially the smaller ones, do not exert an independent influence on the European Central Bank's monetary policy or on other determinants of the euro exchange rate, especially after controlling for EA aggregate variables. A rise in, say, Austrian inflation should not affect, say, the euro dollar exchange rate as long as it does not lead to a rise in EA inflation. At the same time, movements in the euro-dollar exchange rate affect the Austrian real effective exchange rate (REER), to an extent that depends on Austria's composition of trade, notably the share of intra- versus extra-EA trade. We build on differences in the exposure to intra- versus extra-EA trade of member countries to build an external instrument that is able to capture largely exogenous effects of movements in the external value of the euro on the real exchange rate.

Armed with this identification strategy, we regress a number of country-level variables on real exchange rate movements, using annual data for EA countries between 1999 and 2016. To evaluate the effect of real appreciation and depreciation, we apply the local projections approach of Jord (2005), which is a flexible method that also allows for a smooth implementation of instrumental variables (IVs) estimation. In most specifications, the instrument turns out to be strong.

We consider not only standard macroeconomic variables, but also variables aimed at capturing the distributional effects of exchange rate movements ('who gains, who loses' from exchange rate swings), which may also be important to understand the welfare implications of exchange rates. As argued by Frieden (2009, 2014), movements in exchange rates imply redistribution within societies and are therefore highly political. We ask ourselves whether it is true, for example, that real appreciation harms exporters but benefits consumers. We also take a look at sectoral variables, with the aim of identifying the effects of exchange rate movements on the composition of value added and production between manufacturing and services, and between tradables and non-tradables. Partly, this question relates to the 'Dutch Disease' question, namely whether appreciation harms the more efficient tradables sector to the benefit of the more sheltered, less productive non-tradables sector (Rodrik, 2008; Benigno and Fornaro, 2014).

Our work is related to previous literature in several ways. First, there is a literature on the role of exchange rates as shock absorbers versus sources of shocks, which includes among others Edwards and Levy Yeyati (2005), Artis and Ehrmann (2006) and Farrant and Peersman (2006). Bergin *et al.* (2014) show, for example, that a flexible exchange rate regime increases the persistence of the real exchange rate and possibly the duration of its misalignments. Second, since we look at the effect of appreciation on prices and wages, our work is also relevant for the literature on exchange rate pass-through, see for example Campa and Goldberg (2005) and Gopinath (2015). Third, there is a small literature on the distributional effects of exchange rates. On the theoretical side, Tille (2006) proposes a model with differentiated sectors and incomplete asset markets where depreciation is harmful for the country as a whole, but a minority of households benefit. Cravino and Levchenko (2015) is an empirical analysis of the Mexican devaluation in the mid-1990 s, showing that devaluation hurts low-income households more than high-income ones, because they consume more tradables.[1] Gourinchas (1999) looks at the effects of exchange rates on employment flows. Fourth, the heterogeneous impact of shifts in the external value of the euro on individual member countries has also been studied by Honohan and Lane (2003) (which focuses on the implications for divergent inflation rates across the EA) and Chen *et al.* (2013) (which focuses on the impact on trade and imbalances). Fifth, there is also an earlier literature on the contractionary effects of devaluation, which recognizes that terms of trade losses can dominate the expansionary mechanisms typically associated with devaluation (Diaz-Alejandro, 1963, Cooper, 1971, Krugman and Taylor, 1978). Finally, the recent literature on the valuation impact of currency movements on external and sectoral balance sheets recognizes that a country which runs a net short position in foreign currency may suffer from devaluation events (see, among many others, Lane and Shambaugh, 2010).

Apart from the identification strategy, we depart from previous literature in other significant ways. First, we look at advanced countries, since EA countries are almost the only advanced countries in a fixed exchange rate arrangement (note that we include Denmark in the sample because it had a peg to the euro for the entire period, as well as Estonia, which only joined the EA in 2011). Second, we look at 'normal' fluctuations in exchange rates and not only at large devaluations, as previous literature has mostly done (see, among others, Burstein and Gopinath, 2014).

Our paper reaches two main findings. Overall, we find that real appreciation has two countervailing effects. On the one hand, appreciation leads to demand switching away from exports and towards imports; hence our results confirm that real appreciation is detrimental for competitiveness. We also find that appreciation has an allocative effect, shifting resources away from manufacturing and tradables towards services and non-tradables. Predictably, it also results in a deterioration of the current account. At the

1 An older important reference is Romer (1993), who showed that the harmful effects of real depreciation after inflation are larger in more open economies.

same time, the competitiveness channel is more than compensated by the improvement in the terms of trade. We find that as countries get richer by improving their terms of trade, imports become cheaper and real disposable income, real wages and consumption rise. Moreover, while the CPI and the import deflator fall in the short term from the mechanical effect of appreciation, they eventually rise in the medium term on account of the expansion of economic activity. Finally, we subject our main results to a battery of robustness checks to which they survive at least qualitatively. One notable result, however, is that the expansionary effect on activity and wages appear to be quicker in the so-called peripheral countries of the EA, which also leads to a sharper deterioration of the current account in these countries compared with the so-called core ones. Overall, appreciation makes countries richer and their citizens better off, while at the same time hurting the exports sector and competitiveness more generally, including a fall in the employment share of manufacturing (although not in tradables more broadly).

One important question that our analysis also needs to address is the impact of exchange rates on welfare. Previous work (in particular Di Tella *et al.*, 2003) has established that measures of subjective well-being are correlated with real GDP growth, the unemployment rate and inflation (with respectively positive, negative and negative signs).[2] By looking at the effect of exchange rate movements on these variables, we can indirectly estimate the effect on household welfare. A detailed calculation of the welfare effects of exchange rate movements, however, is outside the scope of this paper.

It is also useful to compare our results with previous work on the effect of terms of trade shocks in emerging markets. In general, our results are broadly consistent with findings in the literature on the effects of commodity price shocks on commodity exporters. For example, Kamber *et al.* (2016) find that consumption and investment rise after higher commodity prices that imply real appreciation. Bjornland and Thorsrud (2016) find that for two commodity exporters (Norway and Australia) the Dutch disease only applies in certain circumstances, in particular if the improvement in the terms of trade is not driven by a rise in global demand for commodities. More recently, Schmitt-Grohé and Uribe (2018) show that terms of trade shocks have a limited quantitative impact on macroeconomic variables (once variables are properly deflated) in both a standard model and in the data for emerging markets. Our results for EA countries appear to suggest larger effects, and we acknowledge that this quantitative discrepancy calls for further research.[3]

There are some important caveats that have to be kept in mind in interpreting our results. First, our results are conditional on the type of shock that we look at through our

2 See Stracca (2014) for similar results for EU countries.

3 Observe that consumption responds positively to a terms of trade shock in their theoretical model, and the median consumption response is also positive for years 1–6 in their empirical work, albeit negative on impact.

identification strategy. The way the model is set up leads one to consider movements in real exchange rates that are caused by non-fundamental exchange rate shocks, imposing a kind of pecuniary externality on the economies of EA countries. However, we check if results change significantly when shifts in the euro exchange rate are caused by monetary policy shocks, and we find this not to be the case. Second, our time horizon is constrained by the length of the sample, which is limited to the period since the introduction of the euro. Therefore, we have little to say on the longer-term consequences of appreciation, which may also imply unsustainable booms in external borrowing and credit growth, as well as the need for a costly internal devaluation down the road.

The paper is organised as follows. Section 2 contains a theoretical background, explaining what the transmission channels of appreciation could be for EA countries. Section 3 presents the data. Section 4 provides a description of the empirical model. The results are presented in Section 5. Section 6 concludes.

2. THEORY: WHAT SHOULD WE EXPECT?

Before turning to the empirical analysis, which is the main novel contribution of our work, it is useful to pause to consider the possible transmission channels whereby real appreciation influences consumption and output.[4] Generally speaking, the effect of appreciation on the economy clearly depends on the shock driving the appreciation. The way we see real appreciation in the context of a typical small open economy (SOE), that is also a EA member, is very similar to that of a SOE facing an exogenous improvement in its terms of trade due to a global shock in the market of the good that it exports. To a large extent, this can be seen as a positive wealth shock that may boost aggregate demand, especially so if the shock is expected to be persistent. The logic of the two-country model of Bodenstein *et al.* (2011) for oil shocks carries through to a large extent here: real appreciation leads to a wealth transfer towards the home country, at least in the absence of complete markets and full international risk sharing.

With this main idea in mind, we illustrate a real (flexible price) redux version of the Lombardo and Ravenna (2014) SOE model. The model (henceforth 'Lombardo and Ravenna redux') features households who consume a non-tradable and a tradable good, where the tradable good can be produced at home or in the foreign country. The share of domestically produced tradables depends on the real exchange rate, which is subject to exogenous shocks.[5] Moreover, domestic production of tradables requires the use of

4 An early analysis of the possible channels whereby devaluation can be contractionary, rather than expansionary, is Lizondo and Montiel (1989).

5 Think of those shocks as shocks to the foreign price level that, due to nominal rigidities in the foreign economy, are not immediately compensated by movements in the nominal exchange rate; or to an import subsidy that is paid for by a foreign government.

an imported (intermediate) good, the cost of which declines after real appreciation.[6] Note that by focusing on a real model we do not consider a host of issues related to nominal rigidities and exchange rate pass-through, which have been emphasized in recent research; see for example Casas *et al.* (2016). Although understanding pass-through is important, our focus here is on the medium-term implications of real appreciation, and we just assume that nominal appreciation leads to real appreciation.

Armed with this simple model, we study the effect of an exogenous appreciation of the SOE real exchange rate on the SOE variables (output, consumption, etc.) depending on the model parameters. Intuitively, there are three channels to consider: (1) real appreciation tilts production of tradables towards foreign producers (expenditure switching), curtailing exports; (2) domestic production of tradables is made less expensive by lower expenditure on imported inputs, and (3) appreciation relaxes the budget constraint of the household due to the lower cost of the consumption basket due to cheaper foreign goods; hence households can find it optimal to borrow from abroad and consume more, with expansionary effects.[7] Whether real appreciation is expansionary or contractionary depends on whether the second and third effects dominate on the first one, and whether we measure the effect on consumption or on output.

In our 'redux' version, domestic consumers maximize a per-period utility function defined as:

$$\log(c_t) - \frac{h_t^{1+\eta}}{1+\eta}, \tag{1}$$

where c is real private consumption, and h is hours such that $h = h_N + h_D$ where N is the non-tradable sector and D the domestic production of tradables. The balance sheet for the domestic household is:

$$c_t + \frac{m_t}{S_t} + b_t + \frac{\delta}{2} b_t^2 = w_{tD} h_{tD} + w_{tN} h_{tN} + b_{t-1} R_t, \tag{2}$$

where b is the real value of a foreign bond (denominated in domestic currency), w is the real wage, R is the ex post (world) real interest rate, S the real exchange rate, m

6 This is related to the literature on global value chains and their implications for the role of the real exchange rate for exports and competitiveness. For example, Amiti *et al.* (2014) observe that the 30% yen depreciation in 2011 failed to increase exports. They show from Belgian firm-level data that large exporters are also large importers, which has a material effect on the pass-through from exchange rate changes on export prices. In particular, they show that pass-through is especially low for exporters with large import shares.

7 Although it is not part of the simple model that we illustrate, one could also think that appreciation relaxes an open-economy borrowing constraint, further boosting aggregate demand, as shown in previous work (see Mendoza, 2002).

represents (the real value of) imported intermediate goods purchased at the real price S_t.[8] The term $\frac{\delta}{2}b_t^2$ is included to ensure determinacy of the level of the net foreign asset position and to close the SOE model. Note that as in Bodenstein *et al.* (2011) we assume incomplete markets and that only a risk-free bond is traded internationally. Therefore, there is no international risk sharing.

Agents maximize a discounted infinite sum of per-period utility functions, using a discount factor β. Consumption c is a composite index of tradables T and non-tradables N:

$$c_t = c_{Nt}^{\gamma_n} c_{Tt}^{1-\gamma_n}. \tag{3}$$

In turn, the tradable basket can be domestically or foreign produced:

$$c_{Tt} = c_{Dt}^{\gamma_D} c_{Ft}^{1-\gamma_D}. \tag{4}$$

Production in the non-tradable sector is driven by:

$$Y_{Nt} = h_{Nt}, \tag{5}$$

whereas for non-tradables is:

$$Y_{Dt} = h_{Dt}^{\gamma_v} m_t^{1-\gamma_v}. \tag{6}$$

Observe that we do not focus on valuation effects in this model because balance sheet exposure to currency movements is not important in EA countries, most of which tend to have mild positive net foreign asset positions; see Figure 1 and Benetrix *et al.* (2015). Therefore, valuation effects are unlikely to play a material role in the transmission of exchange rate shocks in EA countries.

The resource constraint is:

$$Y_t = h_{Nt} + h_{Dt}^{\gamma_v} m_t^{1-\gamma_v} \tag{7}$$

and for the tradable sector (because there is no investment in the model):

$$Y_{Dt} = c_{Dt} + c_{Dt}^{*}, \tag{8}$$

where c_{Dt}^{*} is foreign consumption of imported goods, namely the SOE's exports. Note that these are a function of foreign consumption, which is assumed to be exogenous.

8 Note that this is a real version of the model, so everything is re-based in terms of relative prices versus the price of the overall consumption basket including tradables and non-tradables.

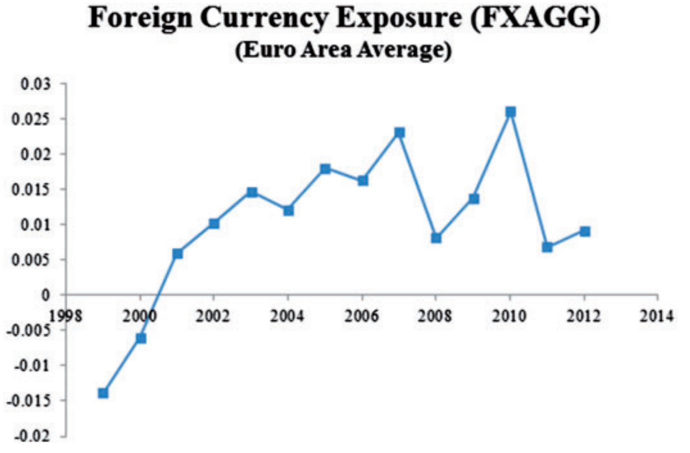

Figure 1. Foreign currency exposure: EU Countries excluding Cyprus, Luxembourg and Malta

Notes: By construction, the FXAGG index lies in the range (−1; 1), where a value of −1 corresponds to a country that has zero foreign currency foreign assets and only foreign currency foreign liabilities (a caricature of the traditional profile of a non-advanced economy), whereas +1 corresponds to a country that has only foreign currency foreign assets and only domestic currency foreign liabilities (a caricature of the traditional profile of an advanced economy with a reserve status currency).

Source: Benetrix *et al.* (2014).

The labour market is perfectly competitive, which ensures the same equal wage across sectors:

$$w_{Nt} = w_{Dt}. \tag{9}$$

Appendix A reports the first-order conditions of the redux model, which we use to run the following exercise. We assume an exogenous appreciation (rise in S) stemming from a global factor. The baseline calibration is taken from Lombardo and Ravenna (2014) and posits $\beta = 0.995$, $\gamma_n = 0.5$, $\gamma_v = 0.54$, $\gamma_D = 0.74$, $\eta = 0.5$. In Figure 2, we report the impulse responses for the baseline calibration (solid lines), a calibration with higher home bias in consumption ($\gamma_n = 0.75$, lines with asterisks) and with higher home bias in production ($\gamma_v = 0.75$, lines with triangles). We show that, consistent with Bodenstein *et al.* (2011), the effect of real appreciation is mostly expansionary. The positive wealth effect stemming from appreciation is visible from the fact that the foreign asset position increases despite a contraction in the trade balance. Apart from a fall in exports and in the trade balance, all other variables increase, in particular imports of both foreign-produced consumption goods and imported inputs. With higher home bias in consumption, the effects are generally similar but attenuated. With higher home bias in production, instead, the beneficial effects are reduced and output actually falls after appreciation, because in this case the beneficial effects of cheaper intermediate goods are reduced in importance, and the expenditure switching channel has a higher relative weight.

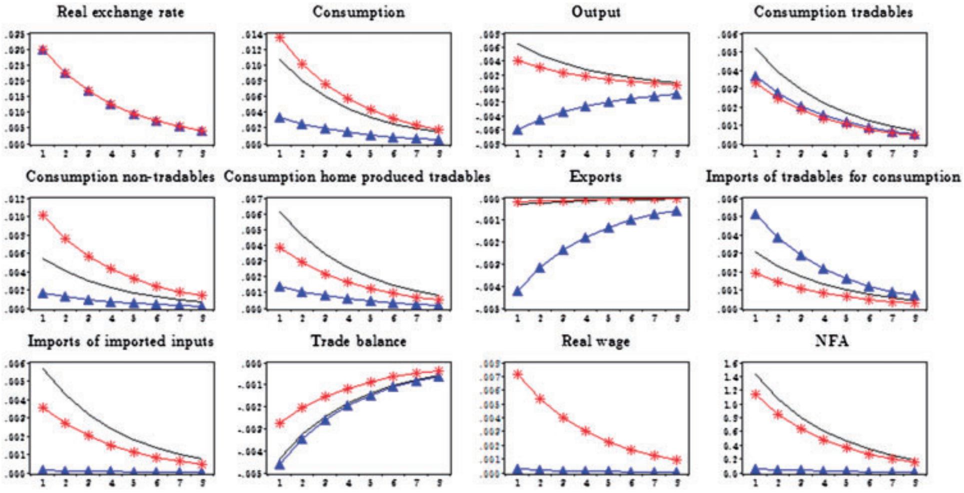

Figure 2. Simulated impulse responses from 'Lombardo and Ravenna redux'

Notes: The solid lines refer to the baseline calibration, the lines with asterisks to higher home bias in consumption ($\gamma_n = 0.75$), the lines with triangles to higher home bias in production ($\gamma_v = 0.75$).

Table 1. Country sample

Extended list	Restricted list
Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain	Austria, Belgium, Denmark, Estonia, Finland, Greece, Ireland, Netherlands, Portugal

3. DATA

We focus on EA countries or countries that are pegged to the euro. The country list is provided in Table 1. Note that we exclude Luxembourg from the sample due to its small size and include Denmark, because it has been in a fixed exchange rate arrangement with the euro continuously since 1999. On the right-hand side of Table 1, we drop the largest EA countries (Germany, France, Italy and Spain) and hence include only the smaller EA countries, with the idea that our identification is even stronger for them. It is less likely that idiosyncratic developments in the smaller individual EA countries affect the euro exchange rate than it is for the larger countries.

The data are annual and cover the time span 1999–2016. Table A in the Online Appendix reports a detailed description of the variables and of the data sources, in most cases international institutions such as the European Commission, the OECD and the IMF. The REER is based on the relative CPI. We also look at sectoral data, in particular manufacturing, services, tradables and non-tradables using the definitions of the European Commission.

There is a very high correlation between the country-specific REER and the euro nominal effective exchange rate (NEER), at 0.88. The correlation is even higher for

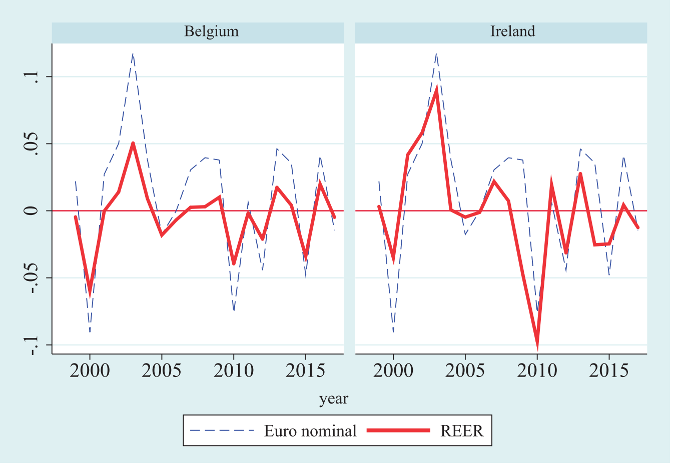

Figure 3. Aggregate euro NEER and domestic REER movements

Notes: The average extra-EA trade share in 1999–2016 is 76% in Ireland and 32% in Belgium.

countries with a higher than average trade exposure to non-EA countries (0.91). A bilateral panel regression of the annual growth in country-specific REERs on the annual growth of the euro NEER (as well as time and country fixed effects) leads to an R^2 of 0.77. In short, variation in the euro exchange rate is the major source of variation in country-level REERs at the annual frequency. This is visible in Figure 3, where we report the euro nominal appreciation and real appreciation in two EA countries, Belgium and Ireland (with respectively high and low exposure to extra EA trade). It shows the high correlation between euro nominal appreciation and country-level real appreciation, as well as the fact that the link is much closer for Ireland (example of high exposure to extra area trade) than for Belgium (example of low exposure).

4. EMPIRICAL APPROACH

4.1. Measuring the impact of real exchange rate movements

To measure the effects of real exchange rate movements, we estimate local projections similar to Jorda (2005) combined with IVs. The model has a panel specification and can be described as follows:

$$x_{i,t+h} = \alpha_i + \beta_h \Delta\mathrm{REER}_{it} + \gamma z_t^{\mathrm{EA}} + \delta z_t^{\mathrm{EA}} \mathrm{extrade}_{i,t-1} + \rho x_{i,t-1} + \eta \Delta\mathrm{REER}_{i,t-1} + \epsilon_{it+h}, \tag{10}$$

where x is the variable of interest in (EMU) country i, α_i are country fixed effects, $\Delta REER_{it}$ is the appreciation of the real exchange rate and z_t^{EA} is a set of EA controls that includes the EA short-term rate, EA term spread, EA real GDP growth (actual and forecast for next year) and EA HICP inflation; $extrade_{i,\, t-1}$ is the share of the country exports that are sent to countries other than the EA. Note that we include interaction terms between the EA controls and the lagged extra-EA trade share to control for the possibility that EA countries respond differently to aggregate EA shocks depending on their trade structure and on how connected they are with the rest of the EA. We consider $h = 0, \ldots, 4$, measuring the effects up to 4 years ahead. Standard errors are robust to serial correlation and heteroscedasticity.

4.2. Instrumentation strategy

In principle, real exchange rates are highly endogenous variables, and an OLS estimation of Equation (10) would generally lead to inconsistent estimates. Therefore, we instrument the potentially endogenous variable, ΔREER_{it}, using an external instrument $\mathcal{Z}_{it}$ defined as follows,

$$\mathcal{Z}_{it} = \Delta\text{EuroNEER}_t * \text{extrade}_{i,t-1}, \tag{11}$$

where $\Delta\text{EuroNEER}_t$ is the appreciation of the euro in nominal effective terms and $\text{extrade}_{i,\,t-1}$ is the (lagged) share of extra EA trade for country i.

The intuition behind our identification strategy relies on the different trade structure of EA countries. Consider two countries, one with a substantial share of extra-EA trade (say, Ireland) and one with a low share (say, Belgium); see Figure 3. We assume that the euro can appreciate for reasons that are independent of country fundamentals in Belgium or Ireland, *controlling for* EA *aggregates* (growth, growth forecasts, inflation, short-term rate, term spread). If this is the case, and considering the different trade composition (essentially given in the short term), movements in the euro NEER will influence the REER of Ireland more than that of Belgium. We can therefore look at the different impact on countries like Ireland versus countries like Belgium to identify the effects of exogenous movements in the exchange rate. In this way, we achieve a clean identification of the effects of exogenous changes in exchange rates. Appendix B sketches a simple model underpinning the identification strategy and makes more transparent the conditions under which the proposed identification is valid.[9]

4.2.1. Caveats and qualifications on the identification strategy. It is also useful to describe the conditions under which our identification strategy might fail, as no identification scheme is ever bulletproof. The biggest risk with our identification strategy

9 Exploiting shifts in exchange rates among major economies as a source of exogenous variation in trade-weighted effective exchange rates has also been employed by Kappler *et al.* (2012) in studying large real exchange rate appreciations. Bussiere *et al.* (2015) also study large appreciation episodes. However, restricting attention to large episodes limits data availability, and neither study focuses on the special characteristics of the members of the EA, which share a common external nominal exchange rate.

is with the exclusion restriction: in particular if the EA exchange rate is driven by EA or international shocks that we do not properly control for, and also impact macroeconomic developments in EA countries. The question therefore is whether there are plausible shocks that are not reflected in the list of controls that we include. For example, a positive demand shock in the United States can boost EA exports while at the same time lead to a depreciation of the euro, and this effect may not be fully neutralized by the EA controls. In the Online Appendix, therefore, we include one robustness exercise where we run OLS regressions with time dummies on the instrument itself, which we can do if we assume (as we do) that the instrument is exogenous for individual countries, and by including time dummies to cater for all aggregate effects. This exercise shows that, while time dummies lead to larger standard errors, the main results are at least qualitatively the same as in the baseline exercise.

Finally, note that when presenting the results we assume a 3% real appreciation, which corresponds to the standard deviation of the real exchange rate in the data. This should facilitate the interpretation of the results in terms of economic significance for the fluctuations of the real exchange rate that we typically observe over a year.

4.3. First-stage regression

Table 2 reports the results of the first-stage regression. We first include the baseline regression, then two regressions using estimated monetary policy shocks and FX shocks for building the instrument (see later in Section 5), and finally we consider appreciations and depreciations separately. For those, we consider changes in the country-level real exchange rate that are associated with a positive (appreciations) or negative (depreciations) value for the instrument Z_{it}, i.e. the 'predicted' sign of the exchange rate movement. Overall, the estimates shown in the table confirm that our instrument is strong and the sign of the coefficient is consistent with our identification story: a nominal effective appreciation of the euro contributes to real appreciation in EA countries, more so in countries that trade a lot outside the EA. The key message is that a nominal appreciation of the euro in effective terms translates into a real appreciation of about the same size in countries with a higher share of extra-EA trade.

5. RESULTS

We now turn to the results of the empirical analysis. Before describing the results in detail, it is useful to first give an overview of the main findings. Overall, we find that real appreciation has two countervailing effects. On the one hand, appreciation leads to demand switching away from exports and towards imports; hence our results confirm that real appreciation is detrimental to competitiveness. We also find that appreciation has an allocative effect, shifting resources away from manufacturing and tradables towards services and non-tradables. Predictably, it also results in a deterioration of the

Table 2. First-stage regressions

	(1) Baseline	(2) Instrument based on estimated monetary policy shocks	(3) Instrument based on estimated FX shocks	(4) Appreciations	(5) Depreciations
External instrument: Euro NEER appreciation * Extra EA trade share ($t-1$)	0.850***			0.315***	0.534***
	(0.051)			(0.049)	(0.037)
EA foreign demand growth	0.186	−0.116	0.353	0.228**	−0.042
	(0.123)	(0.171)	(0.227)	(0.076)	(0.118)
EA real GDP growth	−1.449**	−1.575**	−1.781**	−1.301***	−0.148
	(0.495)	(0.537)	(0.623)	(0.408)	(0.215)
EA real GDP growth forecast for the following year	0.020***	0.046***	0.010	0.013*	0.008*
	(0.006)	(0.009)	(0.008)	(0.007)	(0.004)
EA inflation	0.288	2.570**	−0.714	−0.231	0.519
	(0.684)	(0.923)	(1.248)	(0.403)	(0.510)
EA short-term rate	−0.006**	−0.017***	−0.005	−0.004**	−0.002
	(0.002)	(0.005)	(0.006)	(0.002)	(0.003)
EA term spread	−0.009*	−0.008	−0.016**	−0.008**	−0.001
	(0.005)	(0.007)	(0.006)	(0.003)	(0.003)
EA foreign demand growth * Extra-euro trade share ($t-1$)	−0.530*	−0.432	−0.698	−0.225*	−0.305
	(0.244)	(0.337)	(0.430)	(0.124)	(0.203)
EA real GDP growth * Extra-euro trade share ($t-1$)	2.553**	1.968*	2.921**	1.075	1.478***
	(0.990)	(1.039)	(1.157)	(0.827)	(0.415)

(*continued*)

Table 2. Continued

	(1) Baseline	(2) Instrument based on estimated monetary policy shocks	(3) Instrument based on estimated FX shocks	(4) Appreciations	(5) Depreciations
EA real GDP growth forecast for the following year * Extra-euro trade share ($t-1$)	−0.022*	−0.030	−0.015	0.003	−0.026***
	(0.010)	(0.018)	(0.018)	(0.010)	(0.008)
EA inflation * Extra-euro trade share ($t-1$)	0.036	1.050	1.167	0.033	0.003
	(1.354)	(2.280)	(2.605)	(0.832)	(0.800)
EA short term rate * Extra-euro trade share ($t-1$)	0.009*	0.011	0.009	0.009***	−0.000
	(0.004)	(0.011)	(0.012)	(0.002)	(0.004)
EA term spread * Extra-euro trade share ($t-1$)	0.017	0.010	0.011	0.015**	0.002
	(0.010)	(0.013)	(0.012)	(0.007)	(0.005)
External instrument: EA monetary policy shock * Extra EA trade share ($t-1$)		−0.099***			
		(0.007)			
External instrument: EA FX shock * Extra EA trade share ($t-1$)			−0.092***		
			(0.008)		
Observations	247	234	234	247	247
R^2	0.764	0.425	0.392	0.420	0.724
Number of countries	13	13	13	13	13

Notes: Dependent variable: Log REER. Pooled OLS regression with country fixed effects. Robust standard errors in parentheses; ***, **, * denotes significance at 1%, 5%, 10% confidence level. Sample period: annual data from 1999 to 2016. See Section 3 on the definition of the instrument; for columns (2) and (3) the instrument is based on EA monetary policy and FX shocks respectively (see Section 5 for more details).

current account. At the same time, the competitiveness channel is more than compensated by the improvement in the terms of trade. We find that as countries get richer out of improving terms of trade, imports become cheaper and real disposable income, real wages and consumption rise. Moreover, while the CPI and the import deflator fall in the short term due to the mechanical effect of appreciation, they eventually rise in the medium term on account of the expansion of economic activity. Finally, we subject our main results to a battery of robustness checks to which they survive, at least qualitatively, although statistical significance sometimes worsens compared with the baseline case. One notable result, however, is that the expansionary effect on activity and wages appears to be quicker in the so-called peripheral countries of the EA, which also leads to a sharper deterioration of the current account in these countries compared with the so-called core ones, although the differences are, again, often not statistically significant.

5.1. Baseline results

Figure 4 reports the results of the baseline model in (1) for all countries of the left-hand side of Table 1, for 30 variables. The impulse responses are derived from the β_h coefficients in Equation (10) (for example, the impulse response reported in period 1 is the coefficient β_0).

One main result from the impulse responses is that appreciation leads to a demand switching away from exports and towards imports, as can be expected. In particular, net exports decline by almost 2% after a 3% appreciation, while the unit labour cost increases by about 1%. Overall, this confirms the view that real appreciation is detrimental to competitiveness. This is also confirmed by the contraction of the manufacturing sector, as measured by the employment share, and the parallel expansion of services (non-tradables). The relative real wage goes down in both manufacturing and tradables, suggesting that appreciation boosts wages more in the sectors that are less exposed to international competition.[10] Real exchange rates, therefore, have a powerful allocative effect.

At the same time, the competitiveness channel is more than compensated by the improvement in the terms of trade. As countries get richer with better terms of trade, not only do imports increase, but also real disposable income and consumption, by about 2% albeit with some delay. The rise in consumption is accompanied by a larger rise in gross capital formation (investment), by about 6%. It is also notable that both exports and imports (in values in USD) increase, the latter by up to 10%. Real wages also increase.

Turning to the effect on prices, we find that appreciation reduces both the import and the export deflators, and leads to a fall in the CPI by about 0.5%, which is however temporary. The import and export deflators eventually *rise* after an initial contraction.

10 Note that the definition of the tradable sector follows the NACE classification and it is defined broadly, including agriculture, mining, manufacturing, electricity and gas, water supply, wholesale and retail trade, transportation, accommodation and food services, and information and communication.

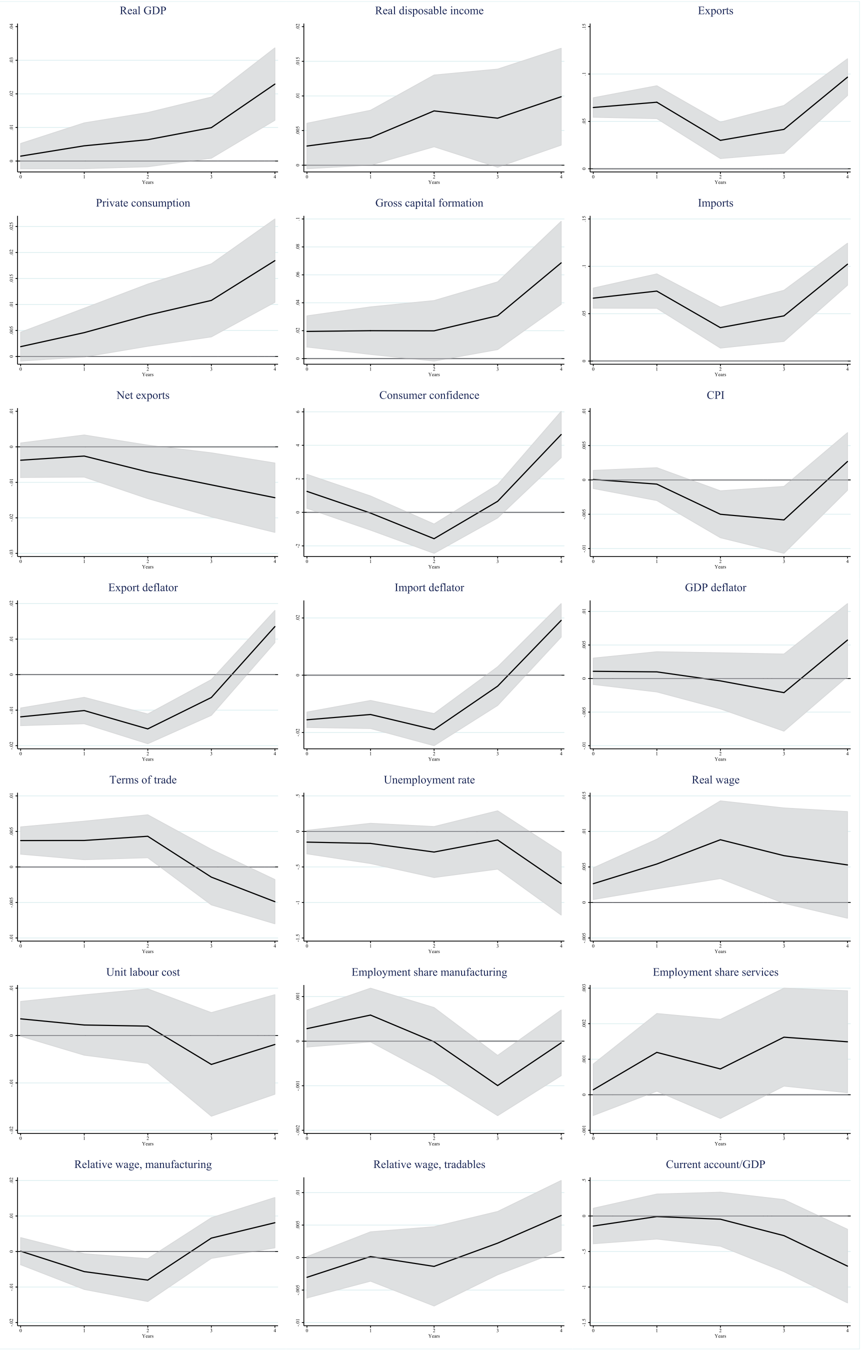

Figure 4. Baseline results: Local projections with instrumental variables

Notes: Impulse responses are to a 3% real appreciation. Each impulse response is derived from the local projections estimation (panel with country and time fixed effects) combined with IVs, for each horizon $h = 0, 4$. The external instrument is the growth rate of the NEER of the euro, multiplied by each countrys share of extra-EA trade in year $t - 1$. Each regression also includes, for each variable at $t + h$: the dependent variable at $t - 1$; a set of EA controls at time t including the EA short-term rate, EA term spread, EA real GDP growth (actual and forecast for next year) and EA HICP inflation; interaction terms between the EA controls and the lagged extra-EA trade share. The error bands are based on standard errors that are robust for heteroscedasticity and serial correlation, and we report a 90% confidence interval. Sample period: 1999–2016, annual data.

The GDP deflator does not change significantly in the short term, but then *rises* significantly at the end of the horizon.

Finally, in terms of external adjustment, we find that the current account deteriorates over time after a real appreciation, by between 0.5% and 1% of GDP at the peak after 4 years.

5.2. Comparing IV and OLS estimates

After describing the main results, we now present a battery of robustness checks. We begin by comparing, in Figure 5, the results obtained using OLS and IV. Is the correction for the endogeneity of the real exchange rate of material importance for the results? The solid lines refer to the IV baseline, and the dashed lines to the estimates of Equation (10) using OLS. The differences between solid and dashed lines should reflect the extent of the endogeneity bias of OLS, or, in other words, the reverse causality running from country-specific variables to the REER. If, as argued above, the country-specific REERs are largely driven by the euro NEER, we would expect these differences to be small. This is indeed the case.

Figure 5 shows that differences are mostly small and not statistically significant. One exception is clearly the CPI, which is not at all surprising since it is mechanically a component of the REER (hence reverse causality is there by construction). The difference is also large and statistically significant for other price and cost indicators, notably the unit labour cost and the GDP deflator.

5.3. Conditional evidence: does it matter which shock drives the Euro NEER?

In this section, we consider whether results differ depending on the reason underlying the appreciation or depreciation of the euro, which then has cascading effects on real exchange rates in individual EA countries.

5.3.1. Identifying structural shocks using a monthly VAR. We decompose movements in the NEER of the euro into four structural shocks, namely demand, supply, monetary policy and foreign exchange shocks, similar to previous contributions such as Farrant and Peersman (2006) and Forbes *et al.* (2015). We then save estimates of these underlying shocks and use the shocks (rather than the euro NEER appreciation) to build our instrument. We estimate a monthly VAR model, from 1999: 1 to 2016: 12, including EA industrial production, the EA HICP, the euro NEER and the 3-month Euribor rate. The VAR is estimated in a frequentist way, and sign restrictions are imposed by multiplying the covariance matrix by random orthogonal matrixes, in the same way as in Rubio-Ramirez *et al.* (2010). Table 3 reports the sign restrictions that we impose, which are relatively standard in the literature and consistent with many different open economy models. Note, however, that unlike in other papers we do not impose any restriction on the reaction of industrial production to FX shocks, because we want to remain agnostic on

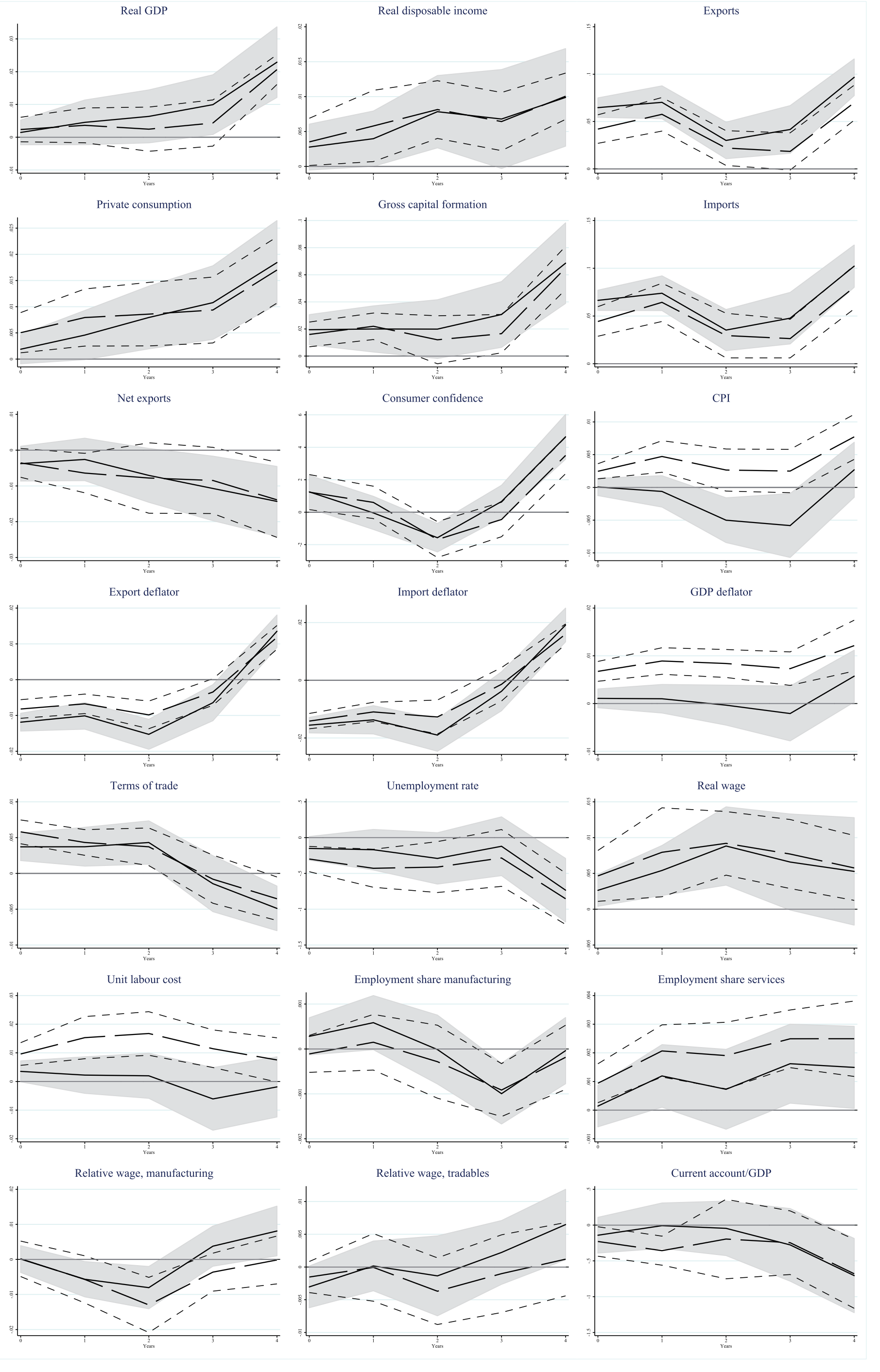

Figure 5. OLS vs. IV estimates

Notes: Impulse responses are to a 3% real appreciation. See notes to Figure 4. The solid lines refer to the IV estimates, and the dashed lines to the OLS ones.

Table 3. Sign restrictions imposed on a monthly VAR of the EA, estimated on the sample 1998: 1 to 2016: 12

Shock	*Demand*	*Supply*	*Monetary policy*	*FX*
Industrial production	+	+	+	
HICP	+	−	+	+
NEER	+		−	−
3-month interest rate	+	0	−	+

Note: All restrictions are imposed contemporaneously, with the exception of the HICP, where the restriction is imposed at $t+12$.

whether these shocks are expansionary or contractionary, since this is the main question addressed in this paper. To ensure that the restrictions are mutually exclusive, we also impose that the interest rate reaction to supply shocks is not strictly positive or negative, which we believe to be very plausible especially at monthly frequency.

Figure 6 reports the impulse responses derived from this identification scheme. The impulse responses accord well with the conventional wisdom on the effect of the shocks we consider and are mostly statistically significant. In reaction to FX shocks leading to euro depreciation, we find that both industrial production and the HICP rise in a statistically significant way, whereas the reaction of the exchange rate to monetary policy shocks is not statistically significant.

Note that monthly changes in the euro NEER are mostly correlated with FX shocks and significantly less so with other shocks. Table 4 shows the correlations and the variance decomposition for a randomly picked set of structural shocks satisfying the sign restrictions. Predictably, we find that over half of the variance in the euro NEER is explained by FX shocks, in line with the literature on the exchange rate disconnect.

5.3.2. Annual aggregation of monthly shocks. In the second step, we aggregate the monthly shocks to an annual frequency using simple averages of monthly observations, and obtain annual demand, supply, monetary policy and FX shocks (note that these are not perfectly orthogonal due to the time aggregation). For each shock ϵ_t^j, $j = 1, .., 4$, we define new instruments as follows:

$$Z_{it}^j = \epsilon_t^j \text{extrade}_{i,t-1} \tag{12}$$

We then compare results using these alternative instruments to the baseline results with the instrument in (11). In particular, we will be looking at movements in the euro effective exchange rate driven by monetary policy and FX shocks, which have the most explanatory power, as suggested by the variance decomposition also shown in Table 4.[11]

11 Note that we pick the structural shocks randomly among the many estimated shocks that satisfy the sign restrictions. Generally speaking, structural shocks are generated regressors, which should be

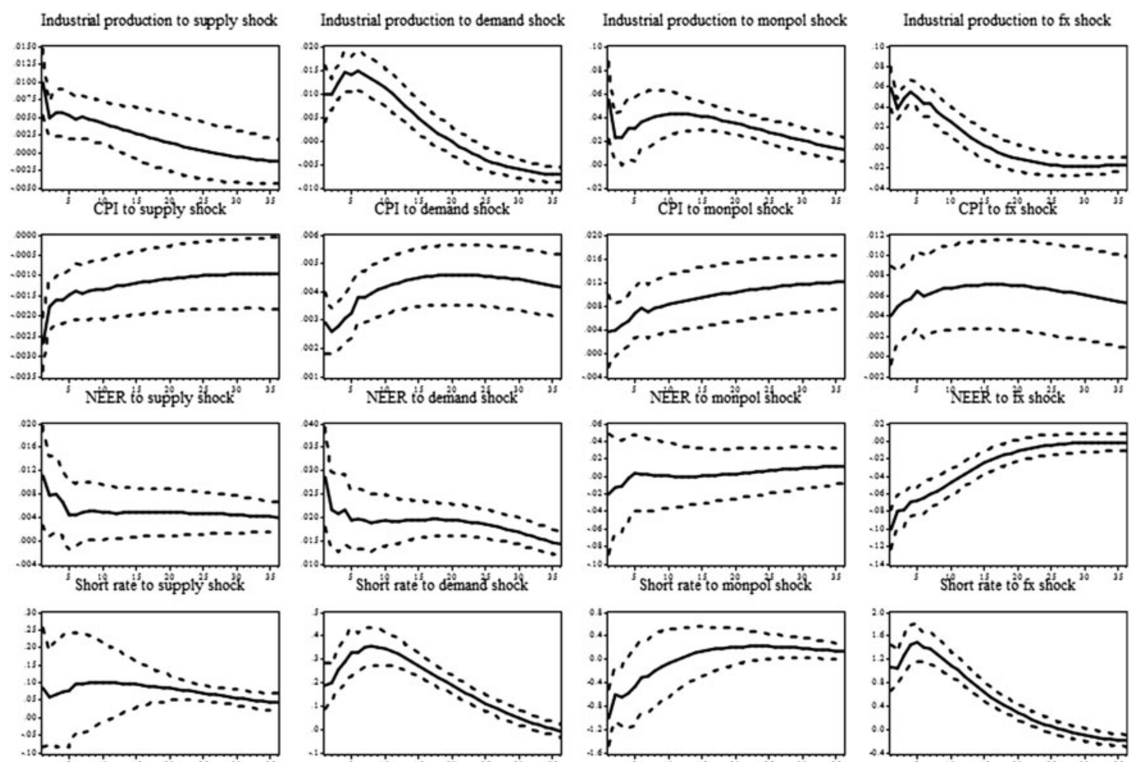

Figure 6. Impulse responses to structural shocks in a monthly VAR of the euro area

Notes: Impulse responses are derived from a monthly VAR including EA industrial production, the EA HICP, the euro NEER and the 3-month Euribor rate, 1999: 1 to 2016: 12. The sign restrictions are shown in Table 3.

Table 4. Sample period 1999: 1-2016: 12, monthly data

Shock	Correlation	Contributions to the variance of the euro NEER
Demand	0.13	0.27
Supply	0.22	0.11
Monetary policy	−0.39	0.10
FX	−0.48	0.52

Do the results differ depending on the source of the fluctuation in the euro NEER? In Figures 7 and 8 we instrument real exchange rates with alternative instruments based on, respectively, EA monetary policy and FX shocks. The information shown in the figures suggest that the effects of appreciation are largely independent of the source of the fluctuation in the euro NEER. This, in turn, reinforces the view that, for individual EA countries, movements in the real exchange rate, after controlling for EA aggregates, are similar to exogenous terms of trade shocks irrespective of the origin of the exchange rate movement. The effects estimated when using FX shocks to build the instrument, however, are larger for some of the variables.

Is this result surprising? In our view it is not, because the source of the fluctuation of the euro NEER should be largely be captured already by the EA controls that we include in the regression, and it may influence individual EA countries mainly or exclusively through the EA aggregate variables. The *additional* effect on individual countries is captured by the pure ‘pecuniary’ element of the FX movement, which remains after controlling for EA -level trends.

Does it matter which shock we pick? In the Online Appendix, we include a chart where we replicate the results for 50 shocks. The results appear to be reasonably consistent across different draws of the structural shocks.

5.4. Comparing appreciations and depreciations

We consider next whether the impact of appreciation and depreciation is different, namely if the real exchange rate has an asymmetric impact as argued, for example, by Demian and di Mauro (2015). One of the advantages of the local projections approach is its flexibility in allowing for interactions and non-linearities, and we build on this desirable property here. We now build two new variables, say $\Delta \text{REER}_{it}^{\text{appr}}$ and $\Delta \text{REER}_{it}^{\text{depr}}$, which takes the value of ΔREER_{it} if respectively the instrument $\mathcal{Z}_{it} > 0$ and $\mathcal{Z}_{it} < 0$. The logic of this distinction is to see if results differ if the exogenous component of the real exchange rate change is an appreciation or a depreciation. Figure 9 reports the results of this exercise, where solid lines refer to

taken into account for the standard errors. However, generated regressors are generally not a problem when used as instruments; see Pagan (1984). A relevant caveat here is that the annual shocks series are not perfectly orthogonal due to the time aggregation, although the correlations are very low in absolute value.

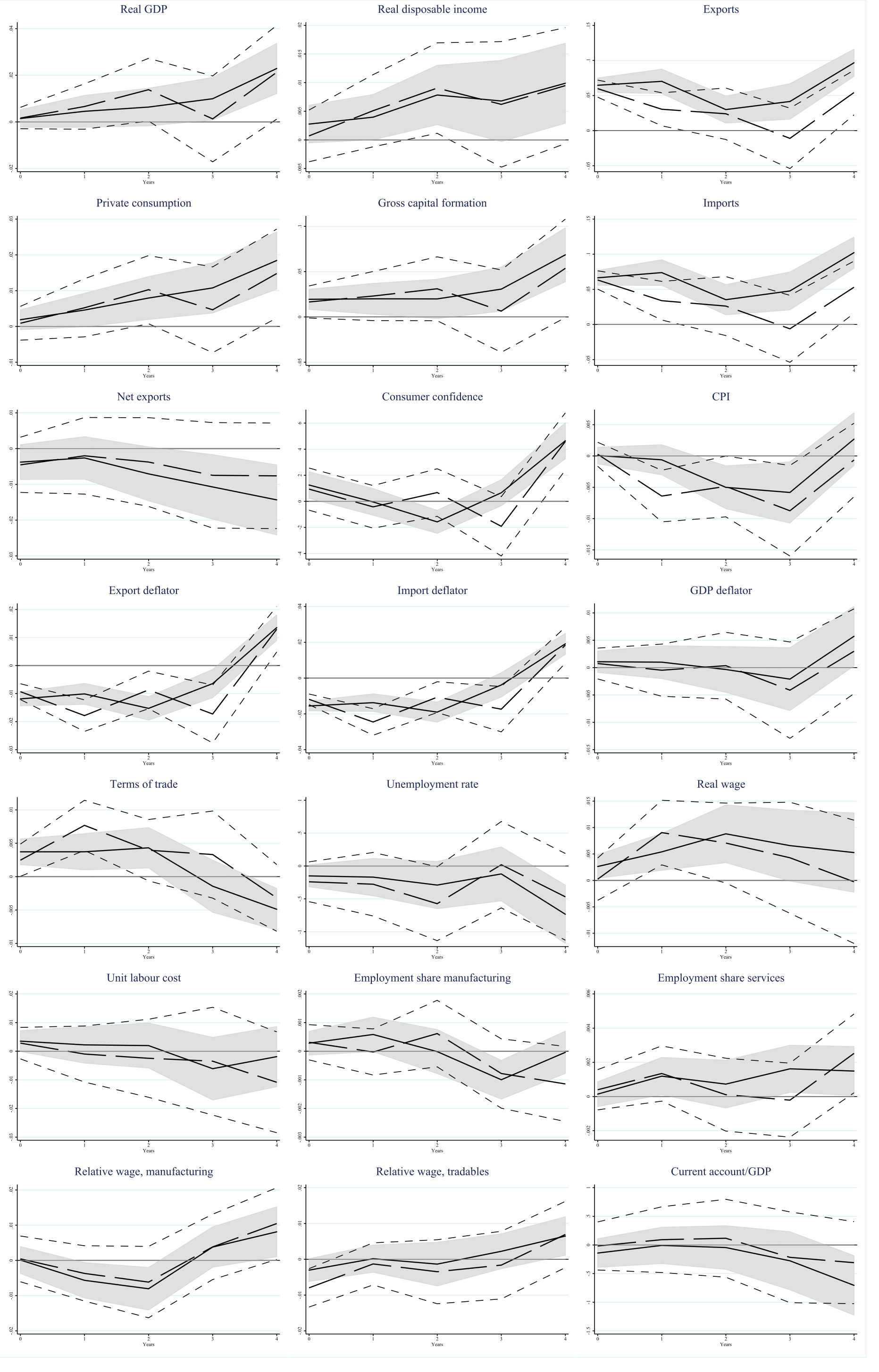

Figure 7. Results using monetary policy shocks to build the external instrument

Notes: Impulse responses are to a 3% real appreciation. See notes to Figure 4. Solid lines are the baseline impulse responses, dashed lines are derived using estimated monetary policy shocks (aggregated from the monthly VAR) rather than the euro NEER to build the instrument.

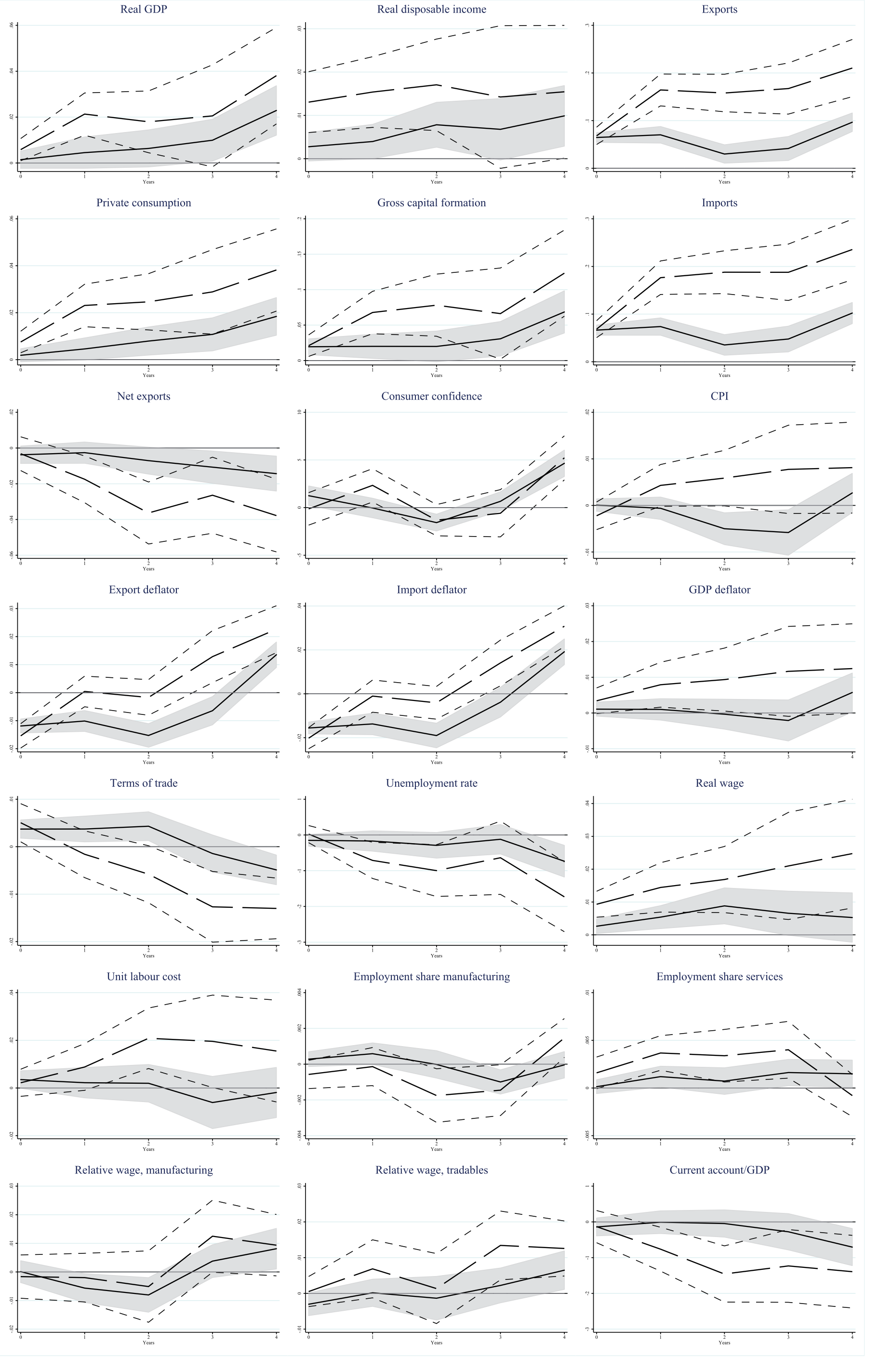

Figure 8. Results using monetary policy shocks to build the external instrument

Notes: Impulse responses are to a 3% real appreciation. See notes to Figure 4. Solid lines are the baseline impulse responses, dashed lines are derived using estimated FX shocks (aggregated from the monthly VAR) rather than the euro NEER to build the instrument.

appreciation, and dashed lines to depreciation. Overall, most of the results are qualitatively the same between appreciations and depreciations, although in some cases the standard errors are larger due to the decrease in the sample size. We generally find no statistically significant difference between impulse responses for appreciation and depreciation and the sign of the effects is the same, but for some variables effects are larger for appreciation than for depreciation.

We also exclude the sovereign debt crisis period (2010–2012) from the sample to exclude the possibility that events in smaller EA countries (e.g. Greece) may have had an own independent impact on the euro exchange rate in that period. The results, not reported for brevity, indicate that this makes little difference to the results, which are qualitatively the same as in the baseline analysis.

5.5. Excluding the largest countries

As mentioned before, our identification strategy is stronger for the smaller countries of the EA. In a figure reported in the Online Appendix, we compare results for the full sample (solid lines) with results for the smaller nine countries in the right-hand column of Table 1 (dashed lines). The results in this figure lend further support to our identification strategy, because the results are largely the same in the two country groups, and removing the large countries does not have an appreciable difference.

5.6. Core versus peripheral countries

Finally, in Figure 10 we report results separately for the so-called ‘core’ countries (Austria, Belgium, Denmark, Estonia, Finland, France, Germany, the Netherlands) and ‘peripheral’ ones (Greece, Ireland, Italy, Portugal and Spain). We consider this distinction because these two sets of countries have experienced significant economic divergence, especially in crisis times. Real appreciation, in particular, was widely considered to be a problem in the latter group of countries, leading to a costly internal depreciation that is partly still ongoing. Solid lines refer to peripheral countries, and dashed lines to core countries.

Our results suggest that effects of real appreciation are qualitatively the same between the two country groups but the effects appear larger for some variables (real GDP, investment and the current account in particular) in the peripheral countries. The differences, however, are often not statistically significant. We do not investigate formally what the reasons for this interesting discrepancy may be in this paper, but there are two plausible candidates that may be further explored in future research. First, households might be more liquidity constrained in the peripheral countries, and hence more responsive to the relaxation in the budget (and possibly balance sheet) constraint brought about by appreciation. Second, the wage setting behaviour might have amplified the upward impact on real wages stemming from real appreciation. We emphasize that, at this stage, these are just plausible conjectures that merit further work. Finally, although this

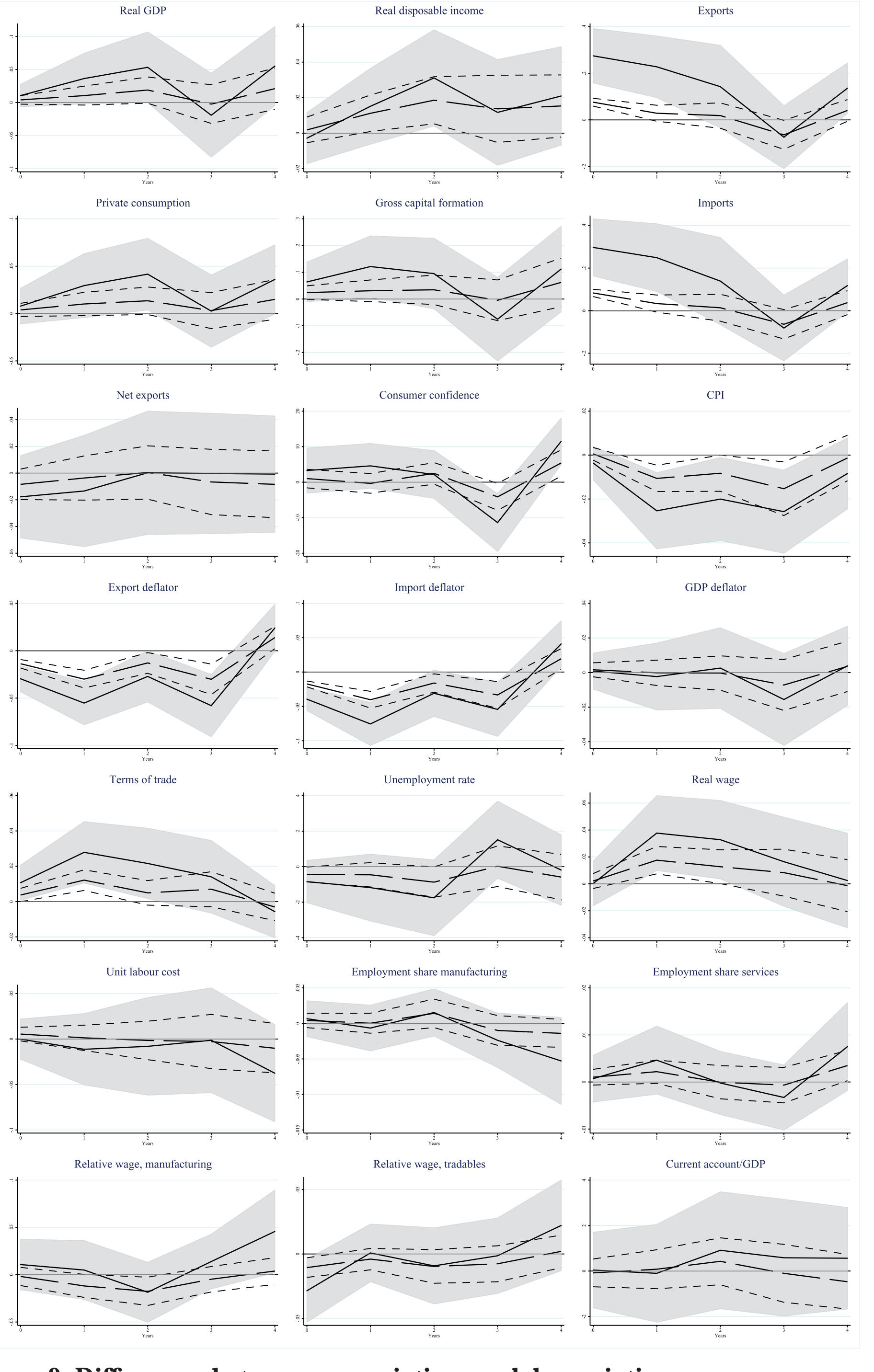

Figure 9. Differences between appreciations and depreciations

Notes: Impulse responses are to a 3% real appreciation. See notes to Figure 4. The solid lines refer to predicted appreciations, the dashed lines to predicted depreciations.

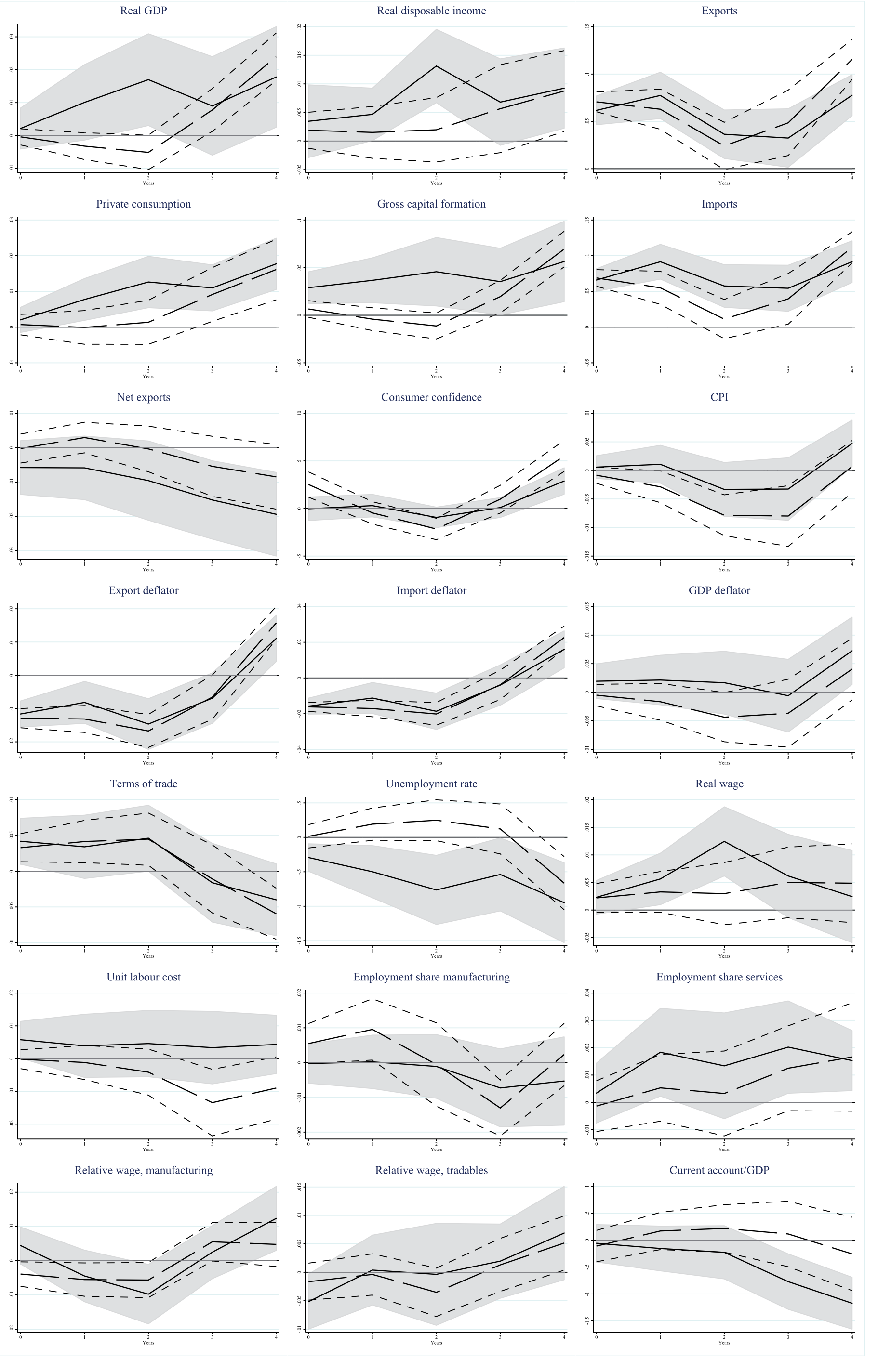

Figure 10. Differences between 'core' and 'peripheral' countries

Notes: Impulse responses are to a 3% real appreciation. See notes to Figure 4. Solid lines refer to 'peripheral' countries, dashed lines to 'core' countries.

is largely outside the scope of this paper, we note that one important implication of these findings is that movements in the euro exchange rate may contribute to imbalances *within* the EA itself (see also Honohan and Lane, 2003).

5.7. Results using quarterly data

Finally, we run the baseline exercise also on quarterly data, on the variables that are available at that frequency. This is reported in Figure 11, which shows the local projections up to 16 quarters after the initial appreciation. The results overall confirm those obtained on annual data and are in most cases stronger or more statistically significant; moreover, the effects on the price variables appear to be more consistently negative on the quarterly data. In comparing the results with the annual estimates, we need to be aware that the original shock has different persistence; the growth rate of the REERs is hardly autocorrelated in the annual data, but it is mildly positively autocorrelated in the quarterly data (the quarterly autocorrelation is 0.16).

6. CONCLUSIONS

In this paper, we have built on the unique situation of EA countries to address one of the most intractable questions in international economics, namely the effects of exogenous real appreciation (i.e. exchange rate movements that are not related to country fundamentals). We note that appreciation has effects that can benefit or hurt different sectors of the economy: on the one hand, it lowers import prices, boosting the terms of trade, purchasing power and thereby making domestic residents richer. On the other hand, it makes exports less competitive, which may be a drag for growth, in particular in manufacturing. Which of the two effects dominates, from a welfare standpoint, is largely an empirical matter. There is little evidence available so far in the literature because it is not easy to identify exchange rate movements that can be characterized as truly exogenous shifts unrelated to domestic fundamentals. Hence, our paper is among the very first to provide evidence on this important question.

We note that fluctuations in real exchange rates in individual EA countries are largely driven by a common component, the variation in the euro exchange rate versus other major currencies, and country-specific sensitivity to it, which is practically unchanged over time (i.e. the share of extra- EA trade). We assume that shifts in the euro exchange rate are unrelated to country-specific fundamentals, after controlling for EA and global aggregates. Building on this assumption, we build a strong external instrument by interacting movements in the euro NEER and countries' exposure to extra area trade. We then run local projections with IVs on a large number of country-specific variables on real appreciation, up to 4 years after an appreciation episode.

The main findings of our work are two. First, we find that the expansionary effects of appreciation due to the terms of trade tend to prevail over the expenditure switching

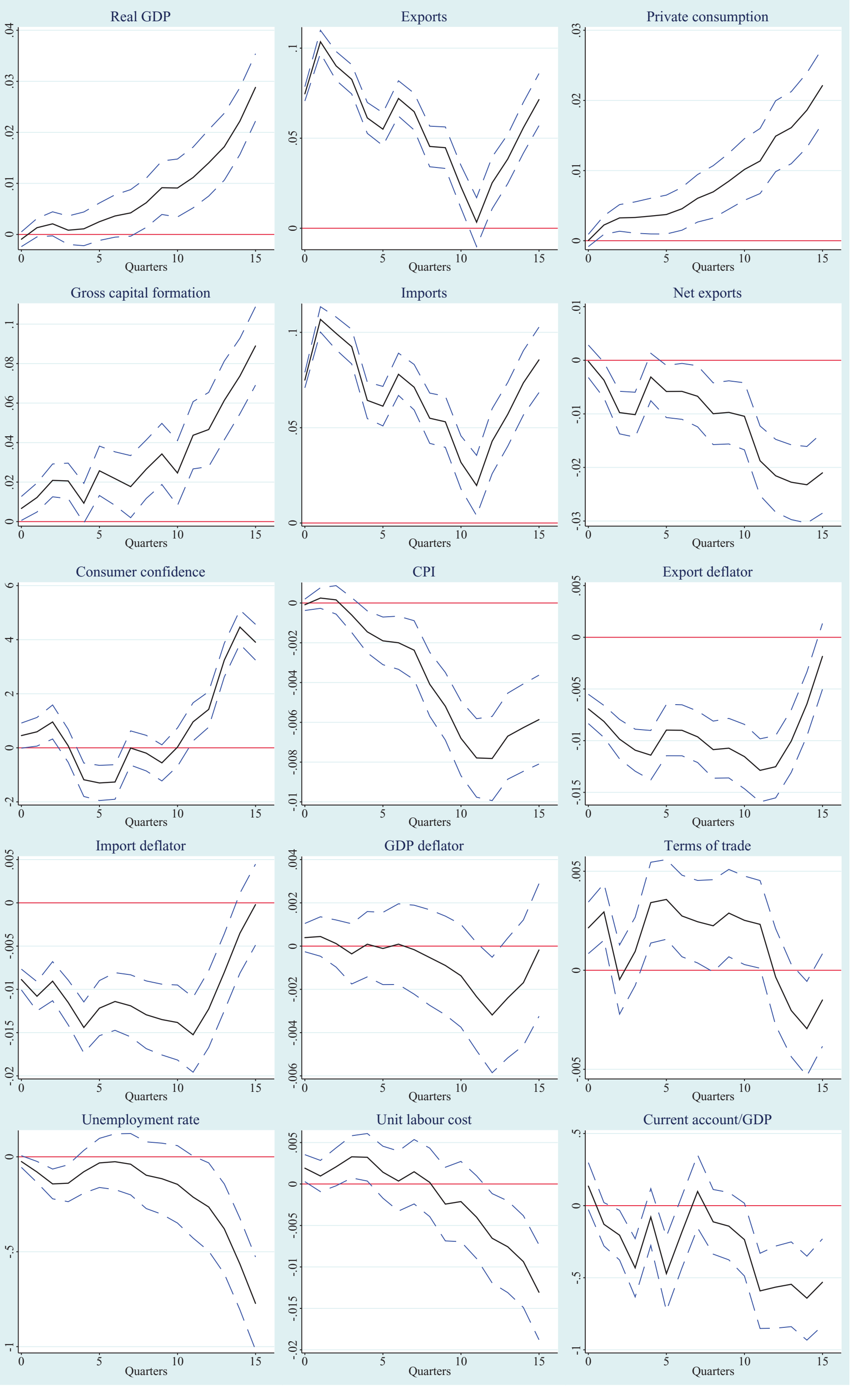

Figure 11. Results on quarterly data

Notes: Impulse responses are to a 3% real appreciation. See notes to Figure 4. Unlike Figure 4, which is based on annual data, the results are based on quarterly data, 1999: 1 to 2016: 4.

effect, by raising real disposable income and consumption. In terms of distributional effects within societies, this suggests that consumers stand to benefit from appreciation, and lose from depreciation. In other words, appreciation makes countries richer and citizens potentially better off, but it does hurt the exports sector and competitiveness more generally. Second, while the main results are generally robust to different assumptions and samples, the effects of appreciation are to some extent different within the EA, in particular between the so-called 'core' and 'peripheral' countries. In particular, we find that effects are larger and quicker in peripheral countries, at least for some variables. In turn, in line with Chen *et al.* (2013), this implies that movements in the euro exchange rate also foster an internal reallocation within the EA, with appreciation leading to more growth, but also more imbalances (for example, a current account deficit) in the peripheral countries. Symmetrically, this evidence indicates that euro depreciation narrows intra-area imbalances.

Our study is subject to a number of limitations. First, the time horizon is limited to 4 years, while real appreciation may have long lasting effects on economies, in particular needing a correction of current account imbalances (and often of excessive credit and asset price growth) down the road. Second, the experience in EA countries may not necessarily extend to other advanced countries, and even less so to emerging countries.[12] Finally, it should be clear that in this paper we are looking at the pecuniary effect of exchange rate movements, namely at shifts that are essentially exogenous for the individual EA countries. It is a different matter to analyse the role of exchange rates in a larger economy for which movements in exchange rates are endogenous, and for which the nature of the shock driving the change in the exchange rate may be crucial. In spite of all these limitations, however, we believe that this paper makes significant progress towards understanding the effects of exchange rate shocks.

Discussion

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This is an interesting and provocative paper tackling an important question from both an academic and policy perspective. The identification strategy is also innovative, but results are surprising. Thus, the authors bear a heavier than usual burden of convincing the reader of the validity of their empirical approach and of supporting their empirical results with theory and additional independent evidence.

12 In fact, one of us has shown in another paper that depreciation is beneficial for growth in emerging countries (Habib *et al.*, 2017).

What does this paper do and find?

This paper studies empirically the effects of an appreciation of the real exchange rate. While conventional wisdom suggests that a real appreciation has contractionary effects, this paper emphasizes that a real appreciation works via competing channels and finds that that expansionary effects prevail in EA countries.

By using the institutional framework of the EA, the authors identify exogenous shifts in the REER of EA countries. The country-specific REER is instrumented with the NEER interacted with country-specific extra-EA trade shares. Using the Local Projection Method provided by Jorda (2005), the authors construct impulse response functions to REER shocks of a large number of macroeconomic indicators.

The key finding is that a REER appreciation is expansionary in EA countries. In particular, the authors find that while net exports decline and unit labour costs rise, real disposable income and consumption rise. Prices eventually rise after an initial contraction, consistently with an expansionary effect.

The authors interpret their empirical findings through the lenses of the SOE model in Lombardo and Ravenna (2014). They make clear that REER appreciations impact the economy via two channels with contrasting effects. On one hand, an appreciation of the REER leads to a conventional contractionary expenditure-switching effect: consumption of tradables shifts from domestic to foreign goods. On the other hand, it also leads to a less conventional expansionary terms-of-trade effect: terms of trade become more favourable, relaxing households' budget constraints by lowering the cost of the consumption basket. It turns out that the expansionary effect prevails over the contractionary one in the EA.

How does this paper do it?

The authors estimate the following panel regression:

$$x_{i,t+h} = \alpha_i + \beta_h \Delta \mathrm{REER}_{i,t} + \gamma z_t^{\mathrm{EA}} + \delta z_t^{\mathrm{EA}} \cdot \mathrm{extrade}_{i,t-1} + \\ + \rho x_{i,t-1} + \eta \Delta \mathrm{REER}_{i,t-1} + \epsilon_{i,t+h}, \tag{13}$$

where i denotes the country, $h \in \{0, 1, 2, 4\}$ denotes some horizon, $x_{i,t}$ is the variable of interest, $\mathrm{extrade}_{i,t-1}$ is the share of extra-EA trade of country i relative to its total international trade, z_t^{EA} is a set of EA aggregate control variables and α_i is a country-specific fixed effect. The set of variables $x_{i,t}$ include in particular real GDP, real disposable income, consumption, gross exports, gross imports, net exports, CPI and the unemployment rate. The regression is estimated for each horizon h. The data are at annual frequency and ranges from 1999 to 2015. Countries include those using the euro or those whose currency is pegged to the euro from 1999: Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal and Spain.

As the REER is a highly endogenous variable, the authors propose to instrument its change with the change in the EA NEER interacted with the country-specific extra-EA trade share:

$$\mathcal{Z}_{i,t} \equiv \Delta \text{NEER}_t \cdot \text{extrade}_{i,t-1}. \tag{14}$$

Identification is achieved by controlling for EA aggregates such as GDP growth, inflation and, importantly, short-term interest rates.

The identification strategy is key. The authors observe that running a simple OLS regression of $\text{REER}_{i,t}$ on $x_{i,t}$ is likely affected by endogeneity bias. The goal is to capture variation in $\text{REER}_{i,t}$ that is exogenous to the variables $x_{i,t}$ of interest, and this is achieved by instrumenting the change in $\text{REER}_{i,t}$ with $\mathcal{Z}_{i,t}$. Although the instrument is country-specific, its strength is attributed to the EA-wide component NEER_t. The exclusion restriction assumption states that $\mathcal{Z}_{i,t}$ should affect $x_{i,t}$ only through $\text{REER}_{i,t}$, and the authors argue that this is true once they control for EA aggregate variables. Controlling for EA aggregates, however, may render the instrument itself endogenous, as country-specific developments may impact the EA macro state, in turn determining the NEER. Country-specific developments may also directly impact the NEER. The key identification assumption is then that the macro state of the individual EA countries has a negligible impact on the EA aggregate state. Of course, this assumption is most likely to hold for small EA countries. In an earlier version of their paper, the authors were strengthening their argument by additionally controlling for EA foreign demand, as shocks in the rest of the world, in particular foreign demand shocks, may drive both the NEER and the EA countries' macro state.

The authors also conduct a large battery of robustness checks. They first show evidence that OLS estimates of Equation (13) yield substantially the same results as the baseline IV regression, concluding that the endogeneity bias is not quantitatively important. The authors then try to disentangle the source of variation in the instrument $\mathcal{Z}_{i,t}$ using a monthly VAR specification, so as to identify potential drivers for the results: they find that the source of variation that drives the EA NEER, namely demand, supply, monetary policy or foreign exchange shocks, is not important. Another exercise consists of investigating whether appreciations and depreciations have non-symmetric effects on the variables $x_{i,t}$, and the answer is negative. Excluding the largest countries from the sample does not make an appreciable difference either. Finally, the main result goes through when the authors use quarterly data as opposed to yearly data.

Comments

The paper points at novel empirical evidence. The authors find that an appreciation can be expansionary. This result is unexpected. At the same time, the robustness checks point at evidence that seems difficult to interpret, as results go through regardless. In what follows I outline some more specific comments.

Endogeneity bias

A standard OLS estimation of Equation (13) is among the robustness checks. Differences between OLS and IV estimates are mostly small and not statistically significant, except in a few cases (e.g. CPI as dependent variable). The authors conclude that the extent of the endogeneity bias in the OLS estimates is not so large after EA aggregates have been controlled for. That is, there is no omitted variable bias once EA controls are included and no reverse causality to REERs under the key identification assumption, implying in turn that REERs are mostly determined by the Euro NEER.

However, the result would have deserved further investigation. First, the IV estimator may not identify the average effect in the population of interest. In this paper, the IV estimator identifies the causal effect of variation in $\Delta \text{REER}_{i,t}$ on $x_{i,t+h}$ only for those countries whose $\Delta \text{REER}_{i,t}$ moves in the same direction of $Z_{i,t}$. Such subgroup is typically referred to as the 'compliers' by microeconometricians. While it is obvious that increases in ΔNEER_{t} translate into increases in $\Delta \text{REER}_{i,t}$, other things equal, it would have been beneficial to provide evidence that $Z_{i,t}$ indeed moves with $\Delta REER_{i,t}$ for all countries considered.

Second, one could think that there are multiple competing channels through which the dependent variable $x_{i,t}$ reverse-causes $\Delta REER_{i,t}$ and whose effects tend to cancel out on average, potentially explaining why OLS and IV estimates are essentially the same.

Finally, the authors highlight that their key identification assumption is more likely to hold for smaller countries. Accordingly, one can expect the OLS and IV estimates not to differ much for smaller countries, while they could potentially differ for larger countries. Therefore, it would have been interesting to see whether considering only the largest (not the smallest) countries weakens identification and matters for the results.

More generally, if the endogeneity bias was absent, then the OLS estimation should have been promoted to the main working regression, leaving the IV one as a robustness check.

Quarterly data and selection of EA controls

The authors estimate Equation (13) with annual data from 1999 to 2015 for 13 countries. The authors include a small section at the end of the paper where they briefly discuss results obtained from their baseline regression estimated with quarterly data. The authors find that empirical findings are preserved with higher frequency data, which provides support to the paper's main result. At the same time, however, the authors could have used this robustness check to shed some light on the timing of the effects. Are the medium-term effects of a real appreciation, captured by the regression estimated with annual data, different in any dimension from the short-term effects? Does the terms-of-trade versus expenditure-switching effect operate mostly in the short versus the medium term? More generally, the quarterly regressions could have been emphasized more in the paper, for reasons of both statistical power and economics intuition.

The authors highlight the importance of the EA aggregate controls for identification and interpretation of the results. The selection of these controls would have then warranted a more accurate discussion. The controls that are included are the short-term interest rate, aggregate GDP growth (both actual and forecast for the following year), inflation and the term spread. These choices, however, are not discussed. For example, the aggregate GDP growth forecast is included only at $t + 1$ for each horizon h. At the same time, the forecast for aggregate GDP growth represents the only forward-looking variable among the controls. Exploring which control variables and at which time and their matter for the results seems key to understand how much the headline result of the paper hinges on them, particularly in light of the identification assumptions.

Digging deeper into the mechanism and policy implications

The authors read their findings through the lenses of a version of the Lombardo and Ravenna (2014) model. This model incorporates the channels that the authors emphasize to explain their result. However, it seems inappropriate to assume that certain countries in the European Monetary Union behave like SOEs. Moreover, SOEs still retain monetary authority, while the key identification assumption in this paper (along with the novelty of the approach) relies on each country not controlling the nominal exchange rate. It would be interesting to know if the mechanism that the authors propose works unchanged when the model considers a SOE within a monetary union.

Provision of independent evidence or anecdotal evidence on the relative importance of terms-of-trade versus expenditure-switching effects would also be beneficial.

While this paper's findings are highly relevant to the European policymakers, there is no discussion in the paper of the policy implications. Such discussion could develop along several directions. One is the interplay between the EU central monetary authority and each country's government, where the former has to strike a balance between monetary stability and real growth. Perhaps more importantly, the results are relevant for the discussion around core and periphery countries.

Conclusions

This paper proposes an innovative empirical strategy to answer a question that has been difficult to tackle in the literature and finds an unexpected answer. It will certainly spur further theoretical and empirical research, especially considering how relevant the policy implications can be.

PANEL DISCUSSION

Ugo Panizza questioned how generalizable the results might be, and asked what would happen if they could do a similar experiment for the United States instead of the euro area. Moritz Schularick recommended that the authors use lags of the treatment in the estimations. Otherwise, one is measuring the cumulative effect of a long series of appreciation which may, in turn, explain such large effects. Tommaso Monacelli reinforced the latter point and argued that more needs to be said about what is driving the effects shown in the paper.

Andrea Ichino suggested that the IV estimates should be interpreted as the effect to the countries that react to the instrument instead of the average treatment effect. He also recommended the authors explain the circumstances in which the IV strategy can potentially fail. Finally, Andrea Ichino asked whether this framework could also be applied to regions within countries or even firms. George de Menil said he was intrigued by the results since terms of trade increase only in the first two years, but real GDP does not increase until the 3rd and 4th years. In addition, when the real GDP is increasing, the unemployment rate also increases.

Answering to comments and questions, Livio Stracca first explained that the interactions are used to have country-specific instruments and mentioned they should think carefully whether it is feasible to have instruments that only vary over time. He also clarified that GDP forecasts are included in the estimations. Finally, he acknowledged that examining only large countries can be an interesting exercise.

APPENDIX A: FIRST-ORDER CONDITIONS FOR LOMBARDO AND RAVENNA REDUX

The Euler equation (which is also the UIP condition) reads:

$$\lambda_t + \delta b_t = \beta E_t R_{t+1} \lambda_{t+1}, \tag{13}$$

where λ is the Lagrange multiplier for the budget constraint and $\lambda_t = 1/c_t$. The first-order conditions derived from the optimization of consumption and leisure are as follows:

$$h^{\eta}_{Ht} = \lambda_t w_{Ht} \tag{14}$$

$$h^{\eta}_{Nt} = \lambda_t w_{Nt} \tag{15}$$

Note that domestic production costs are given by the real wage, which is the same in the tradables and non-tradables sector. Moreover, the model assumes perfect competition, therefore the relative price of foreign-produced tradables is S, and the relative price for all tradables depends on the parameter γ_D, in particular it is $1 - \gamma_D/S$. Therefore:

$$c_{Ht} = (1 - \gamma_n)\gamma_n \frac{c_t}{S_t^{1-\gamma_D}} \tag{16}$$

$$c_{Ft} = (1 - \gamma_n)(1 - \gamma_D)\frac{c_t}{S_t} \tag{17}$$

and from these it is immediate to derive c_T and c_N. Note that exports for domestic producers, c^*_{tH}, can be derived in the same way (assuming the same structural parameters), taking total foreign consumption as exogenous and swapping signs:[13]

$$c^*_{Ht} = (1 - \gamma_n)(1 - \gamma_D)\frac{c^*_t}{S_t}. \tag{18}$$

From the optimization of the production side we derive

$$\frac{w_H h_D}{Y_h} = \gamma_v \tag{19}$$

$$\frac{m}{SY_h} = 1 - \gamma_v \tag{20}$$

Finally, the real exchange rate S follows an autoregressive exogenous process,

$$S_t = k + \rho_S S_{t-1} + \epsilon_t, \tag{21}$$

where the constant term k is scaled so that the steady state value of S is 1.

APPENDIX B: A SIMPLE MODEL UNDERPINNING THE IDENTIFICATION SCHEME

In this Appendix, we present a very simple model which helps making the assumptions behind our empirical identification scheme clearer and more transparent.[14] We assume that there are two economies, the EA and a SOE that is a (small) member of it. The law of motion for EA is as follows:

$$X_{\text{EA}} = -\beta R_{\text{EA}} - \gamma_{\text{EA}} S_{\text{EA}} + \epsilon^X_{\text{EA}} \tag{22}$$

$$R_{\text{EA}} = \rho X_{\text{EA}} + \epsilon^R_{\text{EA}} \tag{23}$$

$$S_{\text{EA}} = \delta X_{\text{EA}} - \eta R_{\text{EA}} + \epsilon^S_{\text{EA}}, \tag{24}$$

where X_{EA} represents the 'state of macro' (think of a combination of output and inflation), R_{EA} is the EA monetary policy rate, S is the euro NEER. The first equation describes the law of motion for the macro variable, which depends negatively on the interest rate and the exchange rate; the second is a EA monetary policy rule, whereby

13 Note that we keep the same calibration for the large foreign economy. If the foreign economy is interpreted to be the rest of the world, one would expect c^*_t to be much larger than c_t, but this is compensated by the fact that the weight of foreign-produced tradables (i.e. domestic from the standpoint of the foreign economy), γ_D, should also be much higher.

14 We thank Cedric Tille for suggesting the idea of this simple model to us.

the interest rate is an increasing function of the macro variable; and finally the third equation describes the law of motion for the exchange rate, which is driven by the macro state, the interest rate and is also hit by exogenous FX shocks.

Turning to the SOE, the law of motion is simpler than for the EA,

$$X_{\mathrm{SOE}} = \phi X_{\mathrm{EA}} - \beta R_{\mathrm{EA}} - \gamma^{\mathrm{SOE}} \mathrm{RER}_{\mathrm{SOE}} + \epsilon^{X}_{\mathrm{SOE}} \tag{25}$$

$$\mathrm{RER}_{\mathrm{SOE}} = \rho_{\mathrm{SOE}} X_{\mathrm{SOE}} + \omega S_{\mathrm{EA}} + \epsilon^{\mathrm{RER}}_{\mathrm{SOE}}, \tag{26}$$

where RER is the REER, which reflects both the country-specific fundamentals X_{SOE} and is also a function of the EA exchange rate and hit by exogenous shocks $\epsilon^{\mathrm{RER}}_{\mathrm{SOE}}$. The SOE is very correlated, in terms of macro, with the EA, i.e. we assume that φ is positive and close to one.

Suppose the parameter we want to estimate is γ^{SOE}. Regressing X_{SOE} on $\mathrm{RER}_{\mathrm{SOE}}$ will generally lead to inconsistent estimates, because the RER is an endogenous variable and in particular is itself a function of the macro state. Specifically, $\mathrm{RER}_{\mathrm{SOE}}$ and $\epsilon^{X}_{\mathrm{SOE}}$ will be correlated, leading to inconsistent estimates. However, S_{EA} is a valid instrument because it is uncorrelated with $\epsilon^{X}_{\mathrm{SOE}}$ (this shock does not appear anywhere in the determination of S_{EA}) but clearly correlated with $\mathrm{RER}_{\mathrm{SOE}}$, via Equation (25). A simple numerical example, available from the authors upon request, shows that this is indeed the case, and that instrumenting $\mathrm{RER}_{\mathrm{SOE}}$ with $\mathrm{S}_{\mathrm{SOE}}$ leads to a consistent estimate of γ^{SOE}.[15] Clearly, the key assumption, as highlighted in the main text, is that SOE-specific shocks do not exert an independent influence on S_{EA}, once controlling for EA variables.

SUPPLEMENTARY DATA

Supplementary data are available at *Economic Policy* online.

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15 In the numerical example we assume $\beta = 0.5$, $\gamma_{EA} = 0.2$, $\rho = 1$, $\delta = 0.4$, $\eta = 1$, $\phi = 0.9$, $\gamma_{\mathrm{SOE}} = \gamma_{\mathrm{EA}}$, $\omega = 1$.

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