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Abstract

We estimate a three-region (DE-REA-RoW) structural macroeconomic model, and we provide a counterfactual on how nominal exchange rate flexibility would have affected the German trade balance (TB) by simulating the shocks of the estimated model under a counterfactual flexible exchange rate regime. The actual and counterfactual TB trajectories are similar overall. Results suggest an around 2 pp lower trade surplus during 2012-15 together with a stronger real effective exchange rate in the counterfactual. The latter shows a similar upward trend in the TB, however, and the 2012-15 gap between actual and counterfactual closes at the end of the sample.

JEL-Codes: E440, E520, E530, F410.

Keywords: Germany, euro, exchange rate, trade balance.

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1. Introduction

Causes and consequences of Germany's persistent trade surplus have been a recurrent topic in international and European macroeconomics in recent history. Kollmann et al. (2015) review competing hypotheses about the drivers of the surplus and assess their quantitative importance in an estimated structural macroeconomic model.

While attention had centred on the implications of Germany's surplus for imbalances inside the euro area (EA) for many years, the policy focus has shifted to spillover to non-EA economies and global implications more recently. Peter Navarro, e.g., argued that German net exports benefit from an undervalued euro (Financial Times, 01/31/2017). Linking the trade surplus to euro membership, the view suggests that German net exports might have been lower without the euro in recent years.

The "undervaluation" claim has triggered lively debates among economists, with different views on what the (conjectured) euro weakness meant for German net exports, the euro area, and the rest of the world compared to a hypothetical D-Mark survival. Münchau (2017), e.g., argues that the critics have a point and that Germany has manipulated its real exchange rate by low wage growth and support for policies that have led to a weaker euro. Fuest (2017) objects that euro membership should not matter much for the net trade of non-EA economies, even when one abstracts from structural, long-term factors behind the German surplus. In particular, he argues that euro undervaluation for Germany comes with overvaluation for other EA countries, which implies countervailing effects on EA aggregate exports to and imports from non-EA economies. Zettelmeyer (2017) makes the complementary point that Germany's trade surplus is not a structural feature of EMU membership. Real exchange rate adjustment in response to shocks and crisis takes longer than in a system of freely floating nominal exchange rates, but it remains possible also with EMU membership. The latter applies at least to real effective appreciation, whereas depreciation may be complicated by downward nominal wage rigidity in a low-inflation environment as argued, e.g., by Krugman (2017).

This paper contributes to the discussion by presenting a simple (and imperfect) counterfactual. Counterfactual analysis is a major strength of DSGE models, as discussed, e.g., in Coenen et al. (2017). In particular, we estimate a version of the Global Multi-Country model (GM) with Germany (DE), the rest of the EA (REA), and the rest of the world (RoW) over the period 1999q1-2016q2. GM is a structural dynamic macroeconomic (DSGE) model and described in detail in Albonico et al. (2017). The model builds on Kollmann et al. (2016) and is similar to the one in Kollmann et al. (2015).

Estimation of the DSGE model provides parameter values and shock processes, and a decomposition of the German trade balance into its main drivers. In the counterfactual, we then rerun the model with the estimated shocks and an alternative monetary policy setting. In particular, we assume a flexible exchange rate between Germany and the REA block and

add a monetary policy rule by which the short-term interest rate in Germany responds to domestic output and inflation only, whereas the short-term interest rate in the REA block responds exclusively to output and inflation in the REA, i.e. excluding Germany. The idea of the counterfactual is similar to Christiano et al. (2008) and Sahuc and Smets (2008) that compare the EA and US economies and assess the role of differences in shocks and structure for macroeconomic outcomes and the stance of monetary policy.

The counterfactual in this paper is a thought experiment to discuss the role of nominal exchange rate flexibility in a narrow sense for short- and medium-term adjustment. In particular, we ask whether Germany's (effective) exchange rate would have been stronger, and the trade surplus smaller, in recent years in a model with independent monetary policy (separate Taylor rule) and nominal exchange rate flexibility, all else remaining equal. We discuss the transmission of main shocks with a common currency and with nominal exchange rate flexibility, respectively, and present the implications for the counterfactual trade balance.

According to our results, the impact of nominal exchange rate flexibility on Germany's trade balance has been modest. The finding is plausible in light of the long-term upward trend in the German trade balance and the observation that nominal exchange rate flexibility should play a limited role over longer horizons in a model that features relative price adjustment and monetary neutrality in the long run.

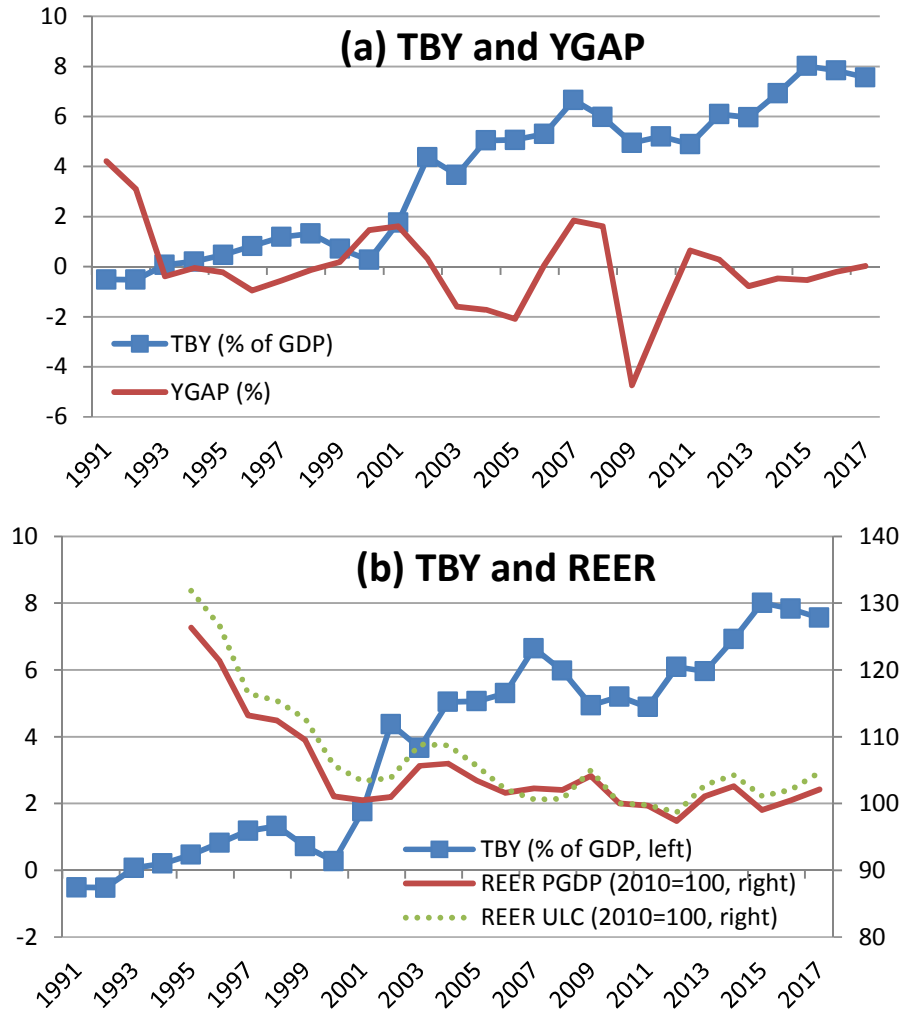
The scope or value of our counterfactual is certainly limited. We present a simple thought experiment about the role of exchange rate adjustment in a given economic context, rather than an estimate of how the German trade balance might have evolved in the absence of monetary union. The central caveat is the analysis' assumption that all else would have been equal. The *ceteris paribus* assumption neglects institutional features and specificities of EMU that go beyond the sharing of a nominal exchange rate and monetary policy. In particular, shock processes (e.g., intra-EA portfolio preferences, captured by risk premia shocks, and the pressure to implement structural reforms) as well as parameter values (e.g., parameters governing the behaviour of fiscal policy, wage and price adjustment, and capital market integration) may capture omitted characteristics of EMU. Hence, it seems plausible that at least some shock processes and "structural" parameter values would have looked differently without a common currency. Barrell et al. (1996), e.g., construct a counterfactual to German economic and monetary union in which unification is proxied mainly by fiscal and labour market shocks.

2. Stylised facts

Germany's trade balance has displayed a persistent and persistently increasing surplus since the late 1990s. It has increased from close to balance in the late 1990s to circa 8% of GDP currently. Kollmann et al. (2015) give an overview of the development of main macroeconomic time series for Germany (DE) since unification and show that the widening of the external surplus is associated with both a decline in the investment rate and an increase in the

savings rate in the private sector. The decline in the investment ratio and the increase in the savings rate are both very persistent, suggesting no predominant role for cyclical factors. Similarly, Figure 1 points to an upward trend in Germany's trade balance to GDP (TBY) that is largely unrelated to cyclical fluctuations as measured by the output gap (YGAP).

Figure 1: DE trade balance, output gap, and REER



Note: REER is calculated based on the GDP deflator (PGDP) and unit labour costs (UCL) respectively against a group of 37 industrial countries; a decline indicates REER depreciation. Data source: AMECO

Panel (a) of Figure 1 plots DE TBY and the output gap (YGAP) as calculated by the European Commission. While TBY has responded to cyclical conditions to some extent (see, e.g., the reduction in the surplus during the global recession of 2008-9), the series suggest disconnect between the upward trend in TBY and business cycle fluctuations.

In addition, Panel (b) of Figure 1 shows that the upward trend in TBY does not coincide with a period of continued depreciation of the real effective exchange rate (REER) that would indicate continued price or cost competitiveness gains. Pronounced REER depreciation until the year 2000 (around 25% depreciation between 1995 and 2000) has not been associated

with a sizable TBY increase during this period, compared to the TBY increase since 2000 that has occurred in a context of less pronounced changes (fluctuations within a band of +/-5%) in the REER during 2000-17.

Taken together, the persistent upward trend in TBY, i.e. the non-cyclical nature of the surplus increase, and the lack of a strong empirical link between the REER and the trade balance in Figure 1 suggest that the loss of nominal exchange rate flexibility and monetary policy independence as such may have played a very limited role for Germany's TBY dynamics. It follows that the availability of country-level monetary policy and exchange rate flexibility as short-term shock absorber and stabilisation tools might not have led to a very different pattern of TBY. The pattern for Germany differs from the experience of other EMU countries. In particular, the TBY has displayed a strong cyclical component in Greece, Portugal, and Spain (not displayed here). The TBY has deteriorated in these countries in the context of raising output gaps and REER appreciation, which points to the dominant role of booming domestic demand for imbalances in these countries prior to the EA crisis.

3. Estimated model

The analysis uses the European Commission's Global Multi-Country (GM) DSGE model in a three-region set-up with Germany (DE), the rest of the EA (REA), and the rest of the world (RoW). Kollmann et al. (2016) describes the general structure of the GM model. Albonico et al. (2017) adapts the framework to configurations with individual EA member countries, the REA, and the RoW and provides a detailed inventory of the model equations. The individual-country block of the model, i.e. DE in our case, has a detailed structure, whereas the REA and RoW blocks are more stylized.

The DE block comprises two (representative) households, firms in one production sector, and a government. The households provide labour services to domestic firms. A share of households ("Ricardian") has access to financial markets, owns the domestic firms, and smooths consumption over time. The rest of households ("liquidity-constrained") is without access to financial markets and without financial or physical capital, and simply consumes the disposable wage and transfer income in each period ("hand to mouth"). Household preferences for both types include consumption and leisure.

Perfectly competitive firms that combine domestic and imported intermediate inputs generate final output. Monopolistically competitive firms, using local labour and capital, produce intermediate inputs. The firms maximize the present value of their dividends, at a discount factor that is strictly larger than the risk-free rate ("equity premium") and varies over time, and subject to investment and labour adjustment costs and variable capacity utilization. Monopolistic trade unions set the wages in the country block. Price and wage setters face quadratic adjustment costs, giving rise to price and wage stickiness. The government buys parts of the final good, makes transfers to local households, levies labour and consumption taxes, and issues debt.

The REA and RoW blocks are simplified structures, each consisting of a budget constraint for the representative household, demand functions for domestic output and imports derived from the CES consumption good aggregator, a production technology that uses labour as the sole (variable) factor input, and a New Keynesian Phillips curve.

Monetary policy in the EA follows a Taylor-type rule in which the short-term policy rate reacts (gradually) to area-wide CPI inflation and the area-wide output gap plus an idiosyncratic policy shock. The uncovered interest parity (UIP) condition that follows from the first-order conditions for the allocation of financial wealth determines the nominal exchange rate of the EA, i.e. of Germany and the REA, vis-à-vis the RoW. The UIP condition includes a risk premium on foreign over domestic assets that depends on the region's net foreign asset (NFA) position plus an exogenous component ('shock').

DE and REA as parts of the model share the same Taylor rule and have the same nominal exchange rate vis-à-vis the RoW in the benchmark. The counterfactual of nominal exchange rate flexibility modifies this setting. In the counterfactual, DE and REA have one Taylor rule each, reacting to CPI inflation and the output gap in DE and REA respectively, and individual nominal exchange rates (UIP conditions) towards the RoW, which means that the nominal exchange rate between DE and REA is flexible in the counterfactual.

We compute an approximate model solution by linearizing the model around its deterministic steady state. Following the standard practice in the DSGE literature, we calibrate a subset of parameters to match long-run data properties, notably average historical ratios and trade linkages for the DE economy, and estimate the remaining parameter. The estimation uses quarterly data for the time period 1999q1-2016q3. The estimated model includes 38 exogenous shocks for Germany, because many shocks are required to capture the key dynamic properties of the macroeconomic and financial data (e.g., Kollmann et al. 2015). The large number of observables (37) in our estimation also requires a large number of shocks to avoid stochastic singularity of the model.

Table 1 reports the posterior estimates of key model parameters for DE. The model properties that are discussed in sections 4-6 are evaluated at the posterior mode of the model parameters. Estimated habit persistence in consumption is high, indicating a sluggish adjustment of consumption to income shocks. The risk aversion coefficient, which is the inverse of the intertemporal elasticity of substitution, is 1.38. The estimated labour supply elasticity for Germany is 0.36. The estimated share of Ricardian households is high, i.e. around 79 per cent, implying a small share (21 per cent) of liquidity-constrained consumers. The estimates suggest substantial price and wage rigidities, particularly high real wage stickiness, and moderate employment adjustment costs. The fiscal feedback rule operates on lump-sum taxes and exhibits endogenous persistence and a positive response to deficit and debt levels. The Taylor-rule parameters for EA monetary policy are taken from the estimated EA aggregate block in Kollmann et al. (2016) and imposed in the estimation process.

Table 1: Prior and posterior distributions of key estimated German model parameters

Description	Prior Distribution		Posterior Distribution
	Dist.	Mean (std.)	Mode (std.)
Preferences			
Consumption habit persistence	B	0.5 (0.20)	0.86 (0.03)
Risk aversion	G	1.5 (0.20)	1.38 (0.14)
Inverse Frisch elasticity of labour supply	G	2.5 (0.50)	2.81 (0.53)
Total import price elasticity	G	2 (0.4)	1.30 (0.15)
Bilateral import price elasticity	G	2 (1)	5.67 (1.12)
Steady-state share of Ricardian HH	B	0.65 (0.10)	0.79 (0.04)
Nominal and real frictions			
Price adjustment cost	G	60 (40)	20.58 (6.31)
Nominal wage adj. cost	G	5 (2)	3.75 (1.00)
Real wage rigidity	B	0.5 (0.20)	0.96 (0.01)
Employment adjustment costs	G	60(40)	0.47 (0.35)
Fiscal policy			
Lump sum taxes persistence	B	0.5 (0.20)	0.78 (0.07)
Lump sum taxes response to deficit	B	0.03 (0.008)	0.03 (0.008)
Lump sum taxes response to debt	B	0.02 (0.01)	0.006 (0.004)
EA monetary policy			
Interest rate persistence	B	0.7 (0.12)	0.84 (0.03)
Response to EA inflation	B	2 (0.4)	1.55 (0.29)
Response to EA GDP	B	0.5 (0.2)	0.08 (0.03)

Notes: Column (1) lists model parameters; columns (2)-(3) indicates the prior distribution function (B: Beta distribution; G: Gamma distribution); column (4) shows the mode and the standard deviation (std) of the posterior distributions. The posterior estimates for the Taylor-rule parameters are based on an estimated three-region version (EA-US-RoW) of the GM model.

The dynamics of the model's endogenous variables can be decomposed into driving shocks, which include the shocks to the behavioural equations, such as shocks to consumption, investment and import demand, shocks to monetary and fiscal policy, and shocks to the economy's technology and resource constraints. The importance of the various domestic and foreign demand and supply shocks for explaining the macroeconomic dynamics depends on the shocks' ability to fit the observed variables and their co-movement.

Re-estimating the model with a clearly counterfactual monetary and exchange rate setting is not meaningful. Instead, we export the estimated shocks from the EMU structure, where DE and REA share the same monetary policy and nominal exchange rate, to the counterfactual exercise, in which DE and REA pursue independent monetary policies under a flexible exchange rate regime. Despite the observation that different central banks might have followed different policy rules, we impose an identical specification of the Taylor rule for DE

and REA in the counterfactual exercise to narrow attention to the consequences of nominal exchange rate flexibility and adjustment compared to a "one-size-fits-all" approach.

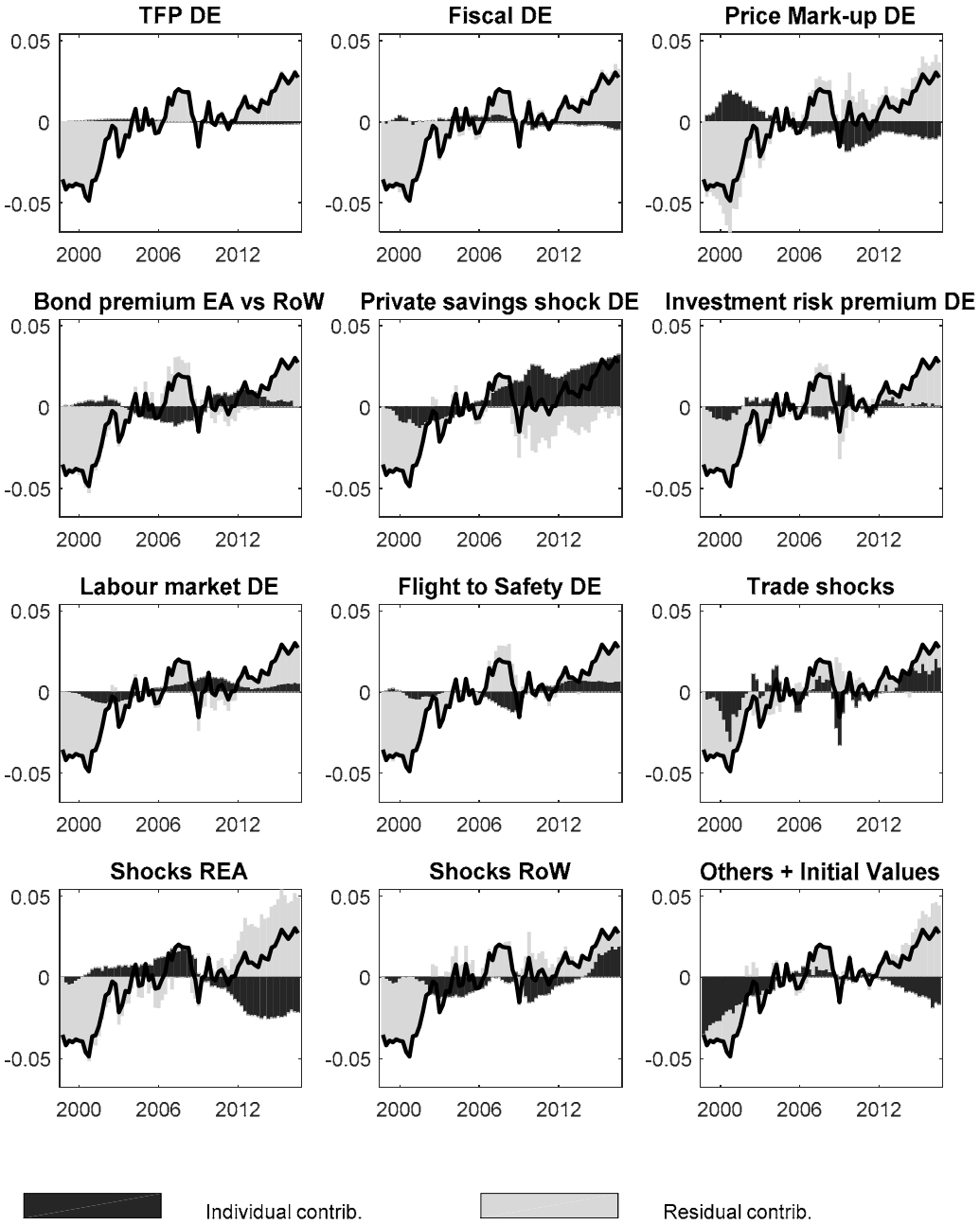
4. Historical decomposition of the German trade balance

The role that the estimated model assigns to different shocks as drivers of the German trade balance relative to GDP (DE TBY) can be illustrated graphically by a shock decomposition, which is provided in Figure 2. Individual shocks are summarised into main groups, which are displayed in distinct panels. The black lines in Figure 2 show the historical data, from which the steady-state value (sample mean) has been subtracted. The vertical black bars in each panel quantify the contribution of the respective group of shocks, while the light bars show the contribution of all the remaining shocks. Bars above the horizontal axis represent positive contributions to the trade balance compared to its sample mean, whereas bars below the horizontal axis represent negative contributions. Given the use of a linearized model, the black and the light bars *within* each panel as well as the black bars *across* panels add up to the historical data.

The decomposition in Figure 2 echoes the results in Kollmann et al. (2015). In particular, positive shocks to private savings, which lead to lower domestic and import demand, account for the largest part of the continuous DE TBY increase in recent years. The estimated model does not provide an explanation of the savings shocks as change in preferences or constraints. Kollmann et al. (2015) argue that changing expectations of population ageing may partly account for the increase in private sector savings. Foreign factors, notably foreign demand shocks, have also played an important role. Strong REA (demand) growth prior to the financial crisis strengthened Germany's net exports, whereas the EA slump has reduced DE TBY. Similarly, the global recession is associated with falling net exports, followed by a positive impact of the global recovery. In addition to the contraction of foreign demand, further contraction of international trade ("trade shocks") has affected the trade balance negatively during the global recession. Labour market factors, including the labour market reforms and wage moderation in general, have been associated with competitiveness gains and a strengthening of the trade balance in recent years, whereas shocks to fiscal policy have not contributed to the growing trade surplus according to Figure 2.

Interesting in our context is also the quantitatively important role of non-fundamental exchange rate dynamics, which the model captures through the EA-RoW bond premium ("non-fundamental" here simply refers to exchange rate dynamics that is not part of the economy's adjustment to other shocks and instead originates in the foreign exchange market itself). An increase (decline) in the premium implies a capital outflow from (inflow into) the EA, leading to euro depreciation (appreciation). The panel for the bond-premium shock indicates a positive impact of the depreciation of the euro in the early 2000s and during the EA crisis and a negative impact of the mid-2000s appreciation on DE TBY.

Figure 2: Shock decomposition of the German trade balance to GDP



Note: Units on the x-axis are years, units on the y-axis measure DE TBY relative to its sample mean, where 0.01 corresponds to 1% of GDP.

5. The role of monetary policy and nominal exchange rate adjustment

This section compares results from the benchmark model to a counterfactual in which DE and REA have separate nominal exchange rates and monetary policy rules. In a first step, we illustrate differences in the transmission by comparing impulse responses for identical shocks under both settings, followed by a counterfactual in which we simulate the model

under separate DE and REA nominal exchange rates and monetary policy rules with the estimated shocks from the original model of section 4.

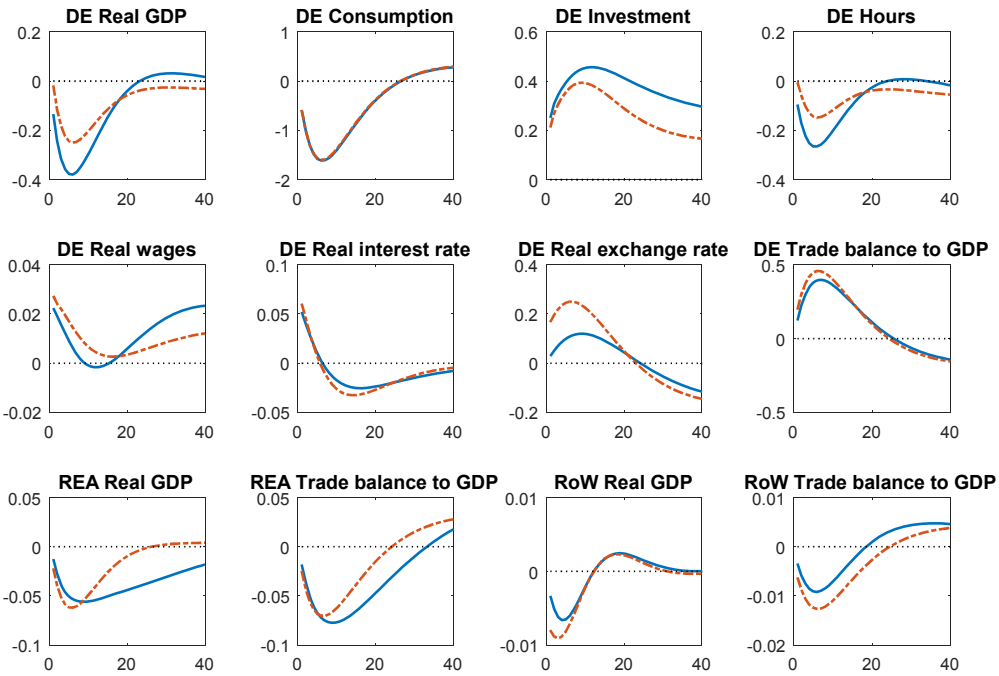
5.1 Impulse responses

Comparing impulse response functions (IRFs) is helpful to understand better the role of monetary policy and the exchange rate regime for the transmission of shocks in the model. This sub-section presents IRFs for the main drivers of the rising German trade surplus as identified in Figure 2 and contrasts the effects with IRFs for the counterfactual set-up of flexible nominal exchange rates and separate monetary policies in DE and REA.

Figure 3 shows the response to a positive DE private saving shock (savings increase), which is modelled as a persistent fall in the subjective rate of time preference of DE households. The shock triggers a persistent reduction in aggregate consumption, and it hence raises the DE saving rate. The size of the shock is illustrative and set to generate an initial fall in private consumption by 1% of GDP. Domestic GDP and employment decline, given sluggish price and wage adjustment. The shock triggers a reduction in the policy and real interest rate in the medium term, leading to an increase in DE investment. DE TBY rises on impact due to a combination of lower import (domestic demand contraction) and stronger export demand (real exchange rate depreciation). Both REA and RoW net trade decline in response. Note that real GDP declines in REA and RoW due to negative spillover from the aggregate demand contraction in DE. Expansionary monetary policy mitigates the negative spillover to some extent, but does not fully offset it in light of the estimated degree of inertia in the monetary response.

Under the counterfactual setting with independent monetary policy and flexible nominal exchange rate, the decline in domestic demand and inflation leads to a more pronounced reduction in the short-term policy rate on impact and, by consequence, nominal exchange rate depreciation and a stronger depreciation of the real effective exchange rate. The monetary policy response stabilises domestic activity. Differences between the monetary union case and the counterfactual in the trade balance response are minor, however, which also reflects counterweighing effects of the monetary policy response on net exports. The real effective depreciation that follows a reduction in short-term interest rates strengthens net exports, whereas the stabilisation of domestic demand achieved by the monetary expansion also supports the demand for imports. The similar size of negative GDP spillover under monetary independence versus monetary union membership concurs with the observation by McCallum (2003) of the two-sided effect of monetary stabilisation. The interest rate reduction and exchange rate depreciation in response to a negative domestic demand shock strengthen exports via real depreciation and imports via the stabilisation of domestic demand as long as the price elasticity of trade is limited, i.e. as long as the income effect of stabilisation remains important relative to the competitiveness effect.

Figure 3: IRFs for German private savings shock (negative consumption demand shock)



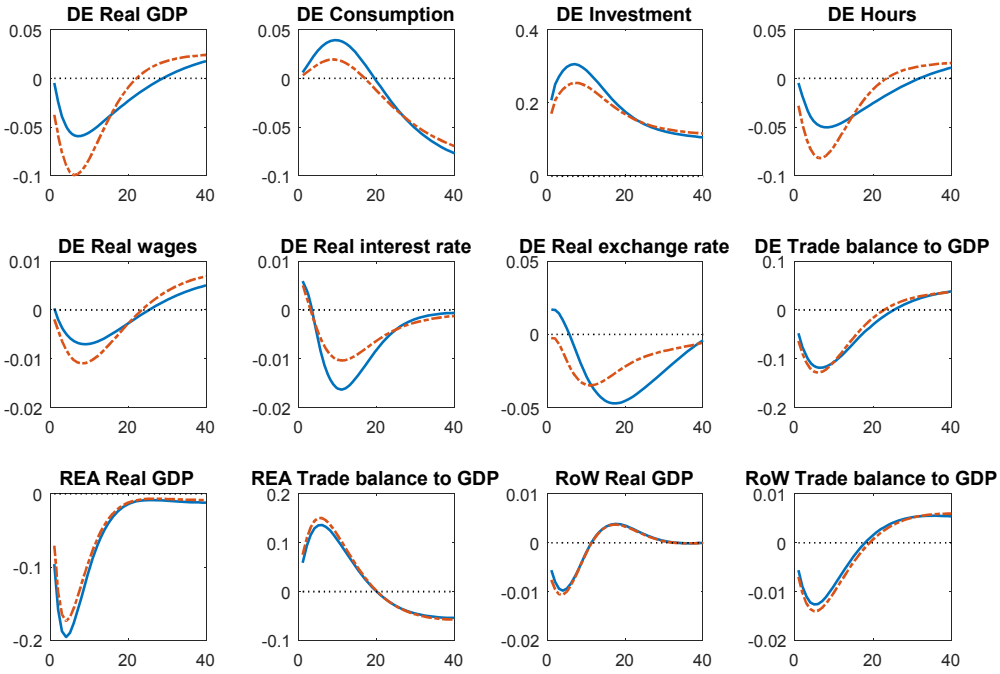
Note: Solid blue lines refer to the benchmark model (EMU), dotted red lines to the counterfactual. An increase in the real exchange rate corresponds to real effective depreciation. Units on the x-axis are quarters, units on the y-axis are percentage-point deviations from baseline (real interest rate, trade balance) and per-cent deviations from baseline (all other variables) respectively.

Figure 4 presents dynamic responses to a foreign demand shock, namely a positive shock to savings (negative shock to private demand) in the REA. This type of shock drives the negative contribution of REA shocks to the German trade balance during the EA crisis in Figure 2. Analogously to the German savings shock in Figure 3, the positive REA savings shock is modelled by a rise in the subjective discount rate in the REA and its illustrative size chosen to generate 1% of REA GDP consumption decline on impact. The shock lowers REA demand and activity in combination with real effective depreciation in REA, which both goes into the direction of reducing German and RoW net exports. The reduction in EA policy rates in response to lower output and inflation strengthens consumption and investment demand in Germany, without, however, fully offsetting the negative spillover on GDP and employment. The fall in the German savings rate (consumption increase) and the increase in the investment rate mirror the decline in the external balance. IRFs for the impact of a RoW savings shock on the German economy, a second important foreign factor in the trade balance decomposition, are very similar in qualitative terms.

The counterfactual with independent monetary policy and flexible nominal exchange rate generates less policy rate reduction in Germany given that activity and inflation in Germany decline less than for the EA average. Consequently, there is less increase in German con-

sumption and investment and a stronger negative spillover to German economic activity in the counterfactual in the short and medium term, which dampens the demand for imports. The stronger real exchange rate appreciation in the short term also dampens exports further, however. In sum, the response of DE net exports in the counterfactual remains very similar to the response in the EMU setting.

Figure 4: IRFs for REA private savings shock (negative foreign demand shock)

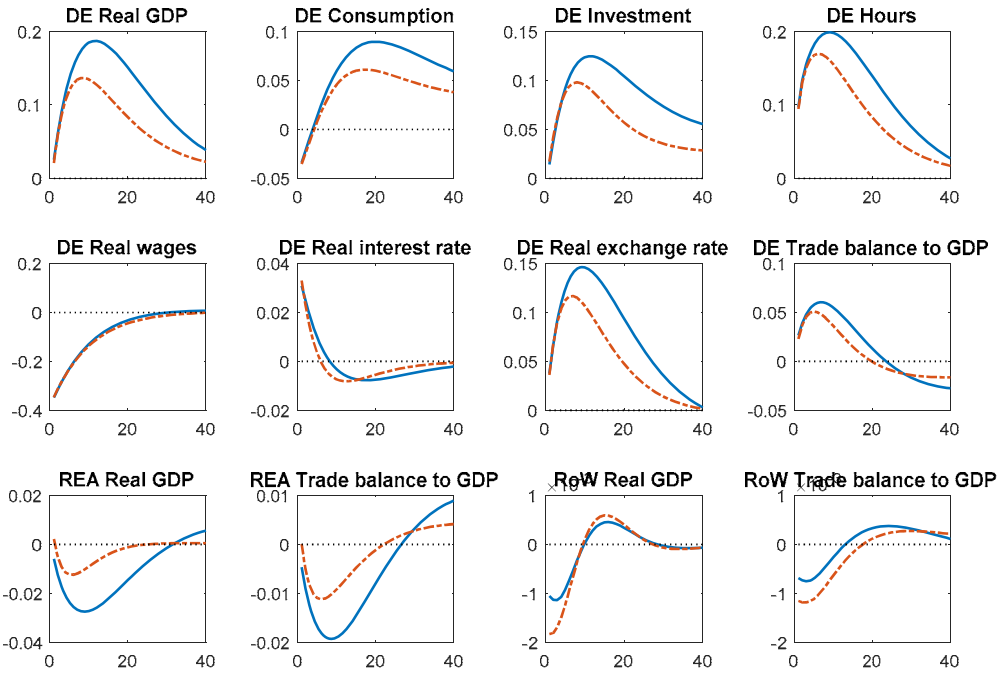


Note: Solid blue lines refer to the benchmark model (EMU), dotted red lines to the counterfactual. An increase in the real ex-change rate corresponds to real effective depreciation. Units on the x-axis are quarters, units on the y-axis are percentage-point deviations from baseline (real interest rate, trade balance) and per-cent deviations from baseline (all other variables) respectively.

Figure 5 reports dynamic responses to a persistent positive labour supply shock in Germany, which is modelled as a decline in the wage mark-up (wage moderation). The shock causes a fall in the real wage and an increase in employment. Consumption declines initially due to a temporary decline in household disposable income, but it increases relative to baseline as the wage sum recovers in the medium term. Investment strengthens in response to higher marginal returns to capital and lower real interest rates in the medium term. On impact, the real rate increases, due to downward wage and price adjustment in conjunction with the very contained response of monetary policy to the positive supply shock in the benchmark EA model. DE net exports rise moderately in response to the competitiveness gain (real effective depreciation) and despite stronger (medium-term) domestic demand. Spillover to REA and RoW is small, but negative in the short and medium term. REA real GDP declines slightly on impact, because of a decline in REA net exports that the positive effect of mone-

tary easing on domestic demand does not offset. Output in the RoW also declines temporarily due to the decline in competitiveness and the associated trade balance deterioration.

Figure 5: IRF for German labour supply shock



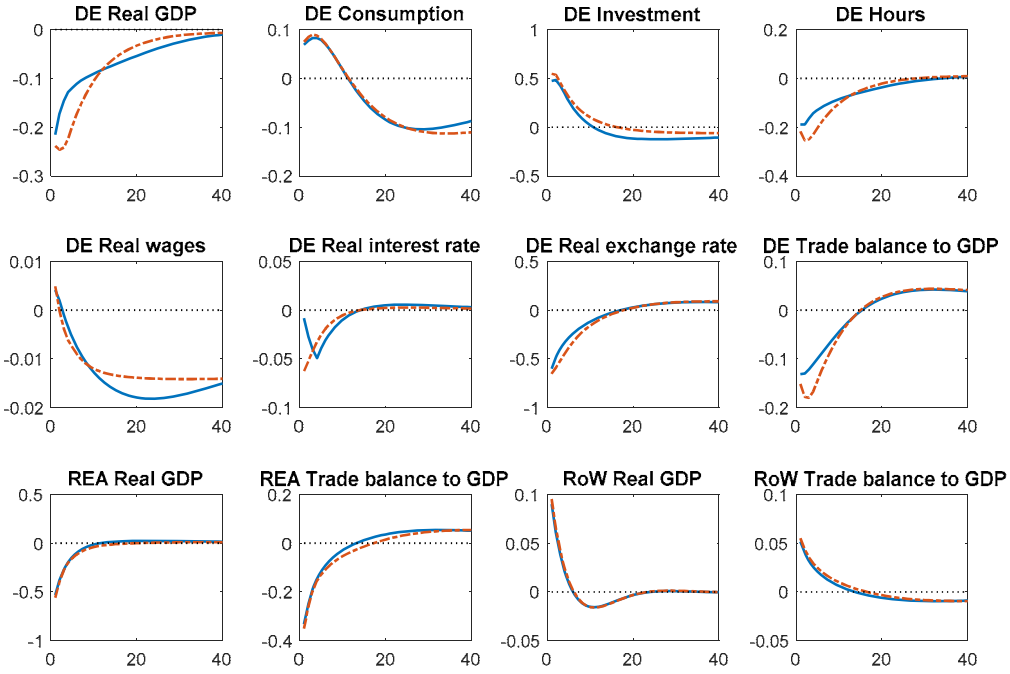
Note: Solid blue lines refer to the benchmark model (EMU), dotted red lines to the counterfactual. An increase in the real ex-change rate corresponds to real effective depreciation. Units on the x-axis are quarters, units on the y-axis are percentage-point deviations from baseline (real interest rate, trade balance) and per-cent deviations from baseline (all other variables) respectively.

In the counterfactual scenario in which DE monetary policy and the nominal exchange rate of DE are autonomous, the DE short-term nominal interest rate is lowered by more than in case of an EA policy rule reacting to EA-wide aggregates, because wage and price inflation in Germany decline more strongly than in the EA aggregate. The monetary policy response remains very gradual, however, so that the real interest rate increases temporarily due to the deflationary impact of the shock. At the same time, the nominal exchange rate of DE appreciates in the counterfactual in light of the capital inflow, driven by higher investment in response to an increase in the marginal return to capital. The appreciation pressure associated with capital inflow explains why the DE real effective exchange rate depreciates less in the counterfactual compared to the EMU benchmark. The nominal exchange rate appreciation associated with capital inflows dampens the competitiveness gain that follows from the supply side reform, which explains the less pronounced increase in DE TBY and the dampening of negative spillover to economic activity in REA in the counterfactual.

To conclude the comparison of impulse responses, Figure 6 shows the dynamic adjustment to an exchange rate shock, which is a temporary increase in the risk premium on RoW bonds

by annualised 1 pp. The shock leads to capital inflow into EA and an appreciation of the EA exchange rate in nominal and real terms. Net capital inflow is associated with a fall in TBY in DE and REA. Domestic demand increases in response to lower interest rates, contributing to stronger imports, whereas export demand declines in response to real exchange rate appreciation and the decline in RoW demand.

Figure 6: IRF for bond premium shock (1 pp annually)



Note: Solid blue lines refer to the benchmark model (EMU), dotted red lines to the counterfactual. An increase in the real ex-change rate corresponds to real effective depreciation. Units on the x-axis are quarters, units on the y-axis are percentage-point deviations from baseline (real interest rate, trade balance) and per-cent deviations from baseline (all other variables) respectively.

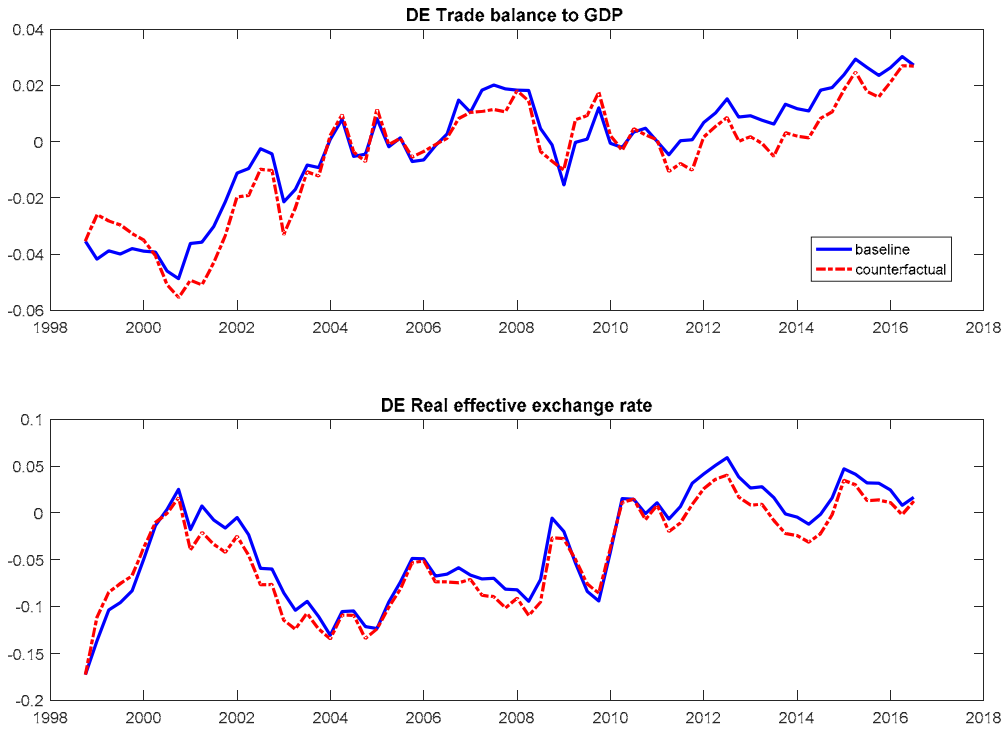
Impulse responses for the benchmark EMU configuration and the counterfactual with independent monetary policy and flexible exchange rate in DE are very similar, as the shock in Figure 6 is a shift in investor preferences away from RoW and towards both DE and REA. Given that DE is more exposed than REA to trade with the RoW, consumer price inflation in DE is more affected by exchange rate appreciation vis-à-vis the RoW than inflation in the EA aggregate, which leads to moderately stronger monetary easing in the counterfactual.

5.2 Counterfactual outcomes with the estimated shocks

The previous sub-section has compared IRFs for the benchmark EMU set-up and the counterfactual with separate monetary policy rules and a flexible exchange rate between DE and REA to illustrate differences in the transmission of identical shocks. In Figure 7, we display a

counterfactual trade balance-to-GDP series obtained from simulating the counterfactual set-up with the estimated (smoothed) shocks from the estimated EMU set-up ("baseline").

Figure 7: Data and counterfactual TBY and REER for Germany



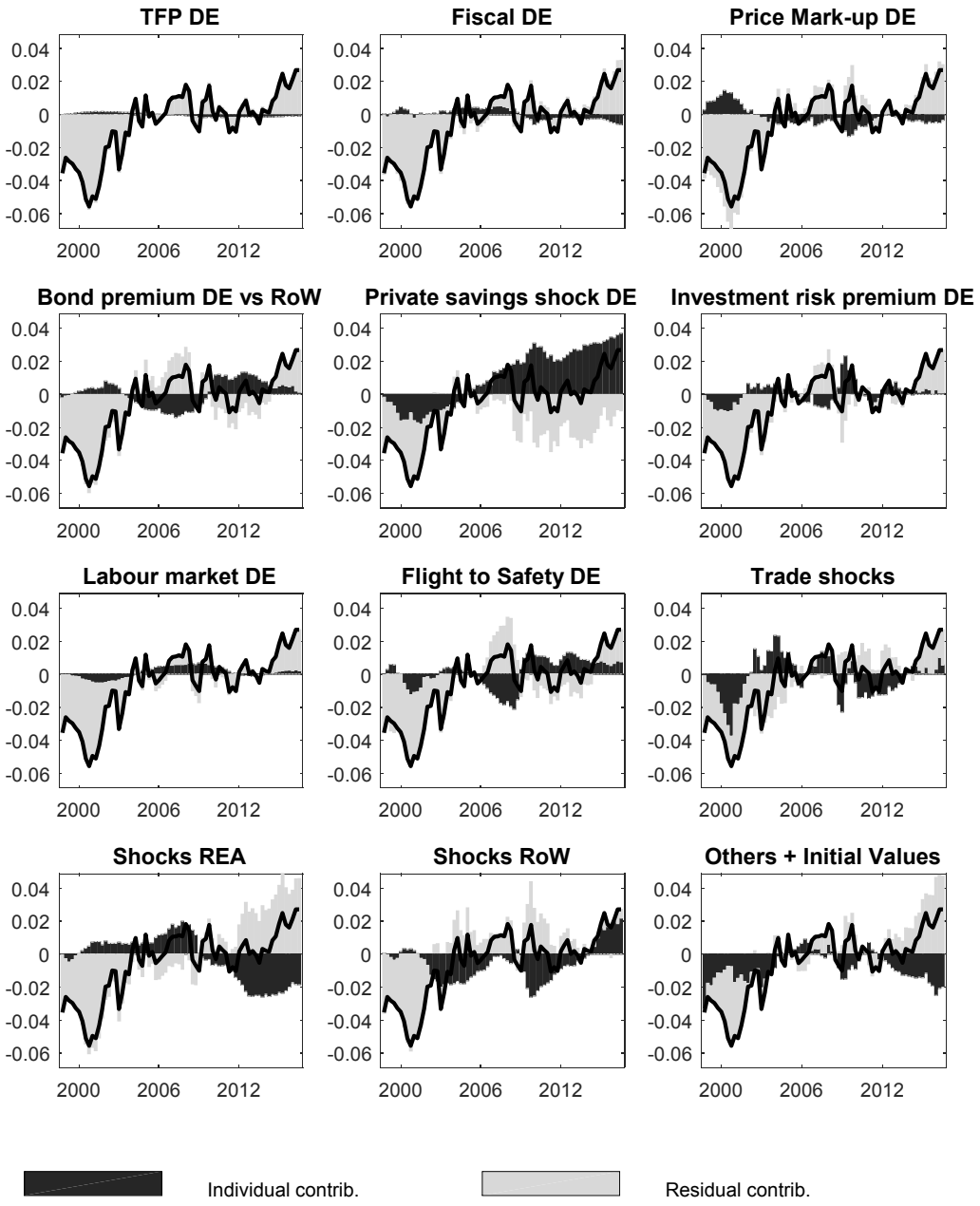
Note: Data and counterfactual simulations have been initialised at the same initial state in 1999q1. The label 'baseline' refers to the data and 'counterfactual' to the simulations with the counterfactual model set-up; 0.01 corresponds to 1% of GDP (TBY) and 1% (REER) respectively. An increase in the value of the real effective exchange rate corresponds to real effective depreciation. The real effective exchange rate here is based on the price level and nominal exchange rate series used in model estimation for DE, REA and RoW, i.e. it is not identical to the REER series plotted in Figure 1b.

The simulations with the benchmark EMU model and the counterfactual setting are initialised at the same initial state in 1999q1. The initialisation with pre-sample information allows for the possibility that DE entered EMU at an overvalued conversion rate compared to its equilibrium REER, which, in combination with sluggish price and wage adjustment, would have contributed to an overcooling of the German economy in the early-2000s (Deroose et al. 2004). Alberola et al. (1999) and Hansen and Roeger (2000) suggest real effective overvaluation of around 5% for Germany in 1998.

Both actual and counterfactual series show a persistent upward trend in TBY. The largest difference occurs during the EA crisis. The counterfactual TBY is lower than the data and the counterfactual REER appreciates compared to the data during this period. The gap between the data and the counterfactual TBY is largest for 2012-15, for which the counterfactual TBY

is 1-2 pp lower than the actual one. The gap closes towards the end of the sample, however, with almost zero difference in 2016.

Figure 8: Decomposition of German counterfactual TBY



Note: Units on the x-axis are years, units on the y-axis measure DE TBY relative to its sample mean, where 0.01 corresponds to 1% of GDP.

Figure 8 displays the shock decomposition of the counterfactual DE trade balance, where the "data" now corresponds to the dotted line in Figure 7. DE TBY still increases persistently, and the relative contribution of the different groups of shocks remains similar. In particular, the shock to private savings in DE remains the most important driver of the persistent TBY

increase with a very similar profile and quantitative contribution. The shocks to REA (demand) remain important, but the more countercyclical policy stance in REA and the exchange rate adjustment in DE cushion their impact on DE TBY slightly. The post-crisis recovery in RoW, furthermore, still raises DE TBY, and the exchange rate regime between the DE and REA blocks has limited impact on the transmission of RoW shocks to DE.

6. Limitations

The previous comparison comes with a number of limitations or caveats that underline the nature of the exercise as thought experiment about monetary policy and exchange rate adjustment. The strongest restriction is our assumption that, except for different equations for monetary policy and nominal exchange rate determination, all other elements of the benchmark EMU model remain the same in the counterfactual set-up.

6.1 Monetary policy in the counterfactual

Regarding monetary policy in the counterfactual, we assume separate Taylor rules for DE and REA that respond to domestic inflation and output rather than the common policy rule reacting to EA-wide inflation and output in the monetary union benchmark. The policy rule in the counterfactual imposes the same parameter values for the interest rate response to domestic inflation and output, despite empirical evidence pointing to differences in the parameter values of pre-EMU and EMU policy rules (e.g., Enders et al. 2013). Alternatively, one could have chosen to approximate DE monetary policy in the counterfactual, e.g., by a pre-1999 reaction function of the Bundesbank.

We have re-run the counterfactual with a more active monetary policy rule for DE, i.e. a rule with less interest rate persistence and stronger immediate responses to inflation and output, to get a better sense for the importance of the parametrisation of the Taylor rule in our context. The more activist parametrisation tends to improve stabilisation of economic activity in the short term. The differences with respect to TBY are small, however, which also concurs with our result that short-term fluctuations cannot account for the persistent increase in the German trade surplus.

6.2 EMU and macroeconomic shocks

The counterfactual further assumes that the shock processes driving the model dynamics would have been (largely) the same as in EMU. It is plausible, however, that changing the monetary policy and exchange rate regime could also affect the realisation of exogenous drivers in the model, i.e. that some exogenous model variables are not strictly policy-invariant in this simplified picture of economic structure. An obvious example is the initial narrowing and subsequent widening of risk spreads between "core" and "periphery" in EMU. The decline in periphery risk premia in the early years of EMU has led to strong net capital inflow that has alimented booming domestic demand in the EA periphery. Arguably,

there would have been less initial risk premia convergence, capital inflow, and demand expansion in the EA periphery without monetary union.

The membership in monetary union may also have affected the implementation of structural reforms as discussed, e.g., in Belke et al. (2006) and Duval and Elmeskov (2005). EMU may have mattered, e.g., for labour market shocks, including the Hartz reforms, and wage moderation captured by a falling estimated wage mark-ups.

Table 2 highlights the relevance of individual (groups of) shocks for DE TBY in the counterfactual simulation. It suggests that removing the REA demand shocks from the estimated model would have lowered DE TBY by up to 1.8 pp in the late 2000s, but increased DE TBY by up to 2.5 pp during the EA crisis. Furthermore, DE TBY would be up to 0.7 pp lower without the positive labour supply shocks in DE in the counterfactual.

Table 2: Annual shock decomposition of the counterfactual TBY

Year	Data	Counter-factual	Contribution in counterfactual of				
			Private savings	Labour supply	Shocks REA	Bond premia	All others
1999	-4.0	-2.9	-0.7	-0.1	-0.3	0.0	-1.8
2000	-4.3	-4.6	-1.5	-0.3	0.3	0.3	-3.3
2001	-3.1	-4.4	-1.6	-0.5	0.7	0.4	-3.3
2002	-0.7	-1.5	-1.1	-0.4	0.7	0.7	-1.2
2003	-1.4	-2.0	-0.8	-0.3	0.6	0.0	-1.6
2004	0.0	0.0	-0.5	0.1	0.6	-0.5	0.4
2005	0.0	0.2	0.3	0.2	0.7	-0.9	-0.2
2006	0.2	0.1	0.6	0.5	1.3	-1.1	-1.2
2007	1.7	1.1	1.4	0.6	1.8	-1.3	-1.4
2008	1.0	0.5	1.8	0.6	1.5	-1.0	-2.5
2009	-0.1	0.6	2.3	0.7	-0.2	-0.4	-1.7
2010	0.1	0.1	2.9	0.4	-0.7	1.1	-3.6
2011	-0.1	-0.7	2.2	0.2	-1.0	1.0	-3.0
2012	1.0	0.4	2.3	0.0	-2.1	1.3	-1.1
2013	0.9	0.0	2.8	-0.1	-2.5	1.0	-1.2
2014	1.5	0.5	3.1	0.1	-2.5	0.5	-0.6
2015	2.6	1.9	3.3	0.2	-2.2	0.5	0.1
2016	2.8	2.4	3.5	0.2	-1.8	0.4	0.1

Note: Numerical values for the data and the counterfactual are expressed in percentage-point deviations from the sample mean of TBY for Germany. The five different groups of shocks (columns 3-7) add up to the counterfactual (column 2); a value of 1 corresponds to 1% of GDP.

Despite the plausibility of regime-dependent elements of shock processes, Enders et al. (2013) find little evidence for EMU-related changes in the European business cycle overall. In particular, the volatility of macroeconomic variables has remained largely unchanged. Exceptions are the strong decline in real exchange rate volatility, attributable to the disappearance of bilateral nominal exchange rate shocks between EMU countries, and an ob-

served increase in the co-movement of macroeconomic time series across countries, which is a more general phenomenon, however, i.e. not specific to EMU.

6.3 Parameter stability

Besides the potential regime dependence of shocks (e.g., intra-EA portfolio preferences captured by risk premia shocks, and the pressure to implement labour market reforms), parameter values may change with policy if they are not truly policy-independent ("fundamental") parameters and constraints (e.g., Fernández-Villaverde and Rubio-Ramírez 2008). In particular, one may suspect EMU to affect parameters of goods and labour market adjustment. Similarly, the changing environment may have affected the behaviour of national fiscal policy as expressed in the estimated parameter values of fiscal rules. At the same time, the finding by Enders et al. (2013) of little EMU-related changes in the European business cycle does not suggest fundamental changes associated with policy-dependent parameter values.

7. Conclusions

Based on an estimated three-region (DE-REA-RoW) structural macroeconomic model, this paper has analysed the role of nominal exchange rate (non-)adjustment for trade balance dynamics. In particular, we have presented a simple counterfactual in which we simulate the shocks of the estimated model in a model version in which the nominal exchange rate between DE and REA is flexible and DE and REA each follow their own monetary policies. This counterfactual suggests that, for the same shocks, the trade surplus of DE would have been up to 2 percentage points lower during 2010-14, in conjunction with a stronger real effective exchange rate, and somewhat lower also in the earlier years of EMU. Overall, the trade balance pattern remains rather similar, however. The counterfactual trade balance for the DE block shows a similar upward trend and closely matches the observations at the end of the sample period (2015-16). The limited role of nominal exchange rate adjustment appears plausible given the medium-term to long-term nature of main drivers of the surplus (upward trend in savings, foreign demand growth), which combines with a model featuring long-term monetary neutrality.

The counterfactual has several limitations. The latter include the assumption of identical model structure, except for the monetary and exchange rate setting, which includes the assumption that, e.g., the level of price and wage rigidity, or the conduct of fiscal policy are independent of EMU membership. Probably still more important is the assumption that shocks in the counterfactual are identical to those estimated for the EMU model. Shocks that have driven the boom-bust cycle in the EA periphery (credit extension and declining financing costs) would arguably not have occurred to this extent in the absence of monetary union. In addition, EMU membership may have influenced labour market reform and wage moderation in Germany. Against this background, the paper also provides a decomposition of the counterfactual trade balance series into contributions by different groups of shocks, which allows amending the counterfactual easily by removing some of the shocks.

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