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HOW DO MACROECONOMIC IMBALANCES INTERACT? EVIDENCE FROM A PANEL VAR ANALYSIS

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This paper investigates the interactions between three key macroeconomic imbalances, namely current-account discrepancies (external imbalances), output gaps (internal imbalances), and exchange-rate misalignments. We estimate a panel VAR model for a sample of 22 industrialized countries over the period 1980–2011. Our findings show that macroeconomic imbalances strongly interact through a causal relationship. If current-account disequilibria threaten the stability of the global economy, their origin can be found in internal imbalances and exchange-rate misalignments: positive output-gap shocks as well as currency overvaluation deepen current-account deficits. In addition, although variations in external imbalances mainly result from exchange-rate misalignments in the euro area, they are mostly explained by output gaps for non-eurozone members.

Keywords: Global Imbalances, Current Account, Output Gap, Exchange-Rate Misalignments, Panel VAR

1. INTRODUCTION

The 2000 decade was marked by various key economic phenomena, among which were the huge current-account deficits in the United States and some European countries, the public debt crisis and economic recession in the euro zone, and the persistence of exchange-rate misalignments leading to massive trade deficits in some developed countries and surpluses in several emerging Asia economies. Focusing specifically on current accounts, Figure 1 evidences that the 2008 financial and economic crisis was preceded by a dramatic increase in global imbalances,[1] whose level remains high in 2012 despite the adjustments that have been made since 2009.

Within this context of widespread imbalances, the recent literature in international macroeconomics has focused on external disequilibria by addressing on

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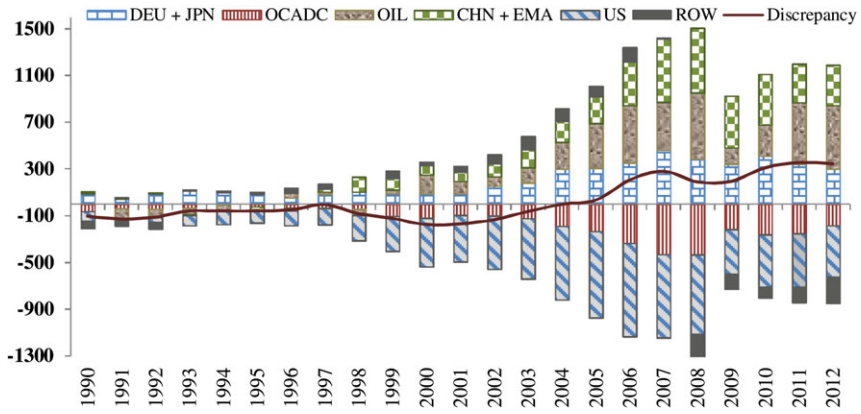

FIGURE 1. Global imbalances (current account, billions of U.S. dollars). DEU+JPN: Germany and Japan; CHN+EMA: China and emerging Asia (Hong Kong SAR, Indonesia, Korea, Malaysia, Philippines, Singapore, Taiwan province of China, and Thailand); OCADC (other current account deficit countries): Bulgaria, Croatia, Czech Republic, Estonia, Greece, Hungary, Ireland, Latvia, Lithuania, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Turkey, and United Kingdom; OIL: oil exporters; ROW: rest of the world; US: United States. *Source: World Economic Outlook*, October 2013.

one hand the issue of current-account sustainability [Edwards (2005); Aizenman and Sun (2010); Christopoulos and León-Ledesma (2010); Chen (2011); Schoder et al. (2013)][2] and on the other hand the question of current-account adjustment or reversal [Freund (2005); Clarida et al. (2007); Debelle and Galati (2007); Freund and Warnock (2007); Algieri and Bracke (2011); Lane and Milesi-Ferretti (2012); Gnimassoun and Mignon (2015)].[3]

This growing interest in the literature on current-account imbalances naturally stems from the threat they pose to the stability of the global economy, but also from the substantial economic costs often associated with their reversal.[4] Indeed, as shown by Freund (2005) and Obstfeld and Rogoff (2007), among others, reversal of the current-account deficit implies loss of economic growth and significant exchange-rate depreciation. In other words, there would be a potential causal relationship running from the adjustment of current-account deficits to economic growth and exchange rates. Specifically, considering a dataset including 25 adjustment episodes from 1980 to 1997, Freund (2005) shows that the current-account reversals usually start when the deficit reaches 5% of GDP, leading to a significant decline in output growth and a real depreciation of the currency, around 10 to 20%. Studying the particular case of U.S. deficit, Obstfeld and Rogoff (2007) find evidence that a reversal of the U.S. current account would result in significant depreciation of the real effective exchange rate, leading to damaging consequences for economic growth.

However, several other studies argue that currency misalignments are partly the cause of current-account imbalances. Specifically, according to Jeong et al. (2010),

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world current-account imbalances reflect, to some extent, exchange-rate misalignments. Gnimassoun and Mignon (2015) show that currency misalignments play an important role in the current-account adjustment and evidence that overvaluations tend to increase persistence of current-account imbalances, especially in the euro area. In addition, some authors claim that the current-account deficits recently observed in some countries are partly the result of intense economic activity or overly optimistic prospects in terms of economic growth. Indeed, independent of the convergence process and its potentially negative impact on current account, highlighted by Blanchard and Giavazzi (2002), Lane and Pels (2012) show that optimistic growth expectations can also generate current-account deficits, suggesting a causal relationship from exchange rates or economic growth to current accounts. Finally, investigating the exchange rate–growth nexus, Razin and Collins (1997), Rodrik (2008), and Béreau et al. (2012), among others, evidence a causal relationship from currency misalignments to economic growth without addressing the issue of reverse causality.[5]

Although it is undeniable that the current account, exchange rate, and economic growth are *theoretically* linked,[6] there is no clear *empirical* evidence regarding the existence of a causal relationship between these key macroeconomic variables. However, because of their interdependence, it is quite plausible that imbalances linked to one of these variables lead to imbalances related to the other variables. Such interdependence may first be simply apprehended through the definition of equilibrium exchange rates, from which currency misalignments are derived. Various concepts of equilibrium exchange rates have been developed in the literature, depending on the time horizon considered. The two extreme cases are the (very) short-run market view and the purchasing power parity (PPP) approach supposed to hold in the very long run (Rogoff, 1996). In between, the two main popular approaches are probably the medium-run, fundamental equilibrium exchange-rate approach (FEER) of Williamson (1983)—according to which the real equilibrium exchange rate is the one that allows the simultaneous realization of both internal and external equilibrium—and the behavioral equilibrium exchange-rate approach (BEER) introduced by Faruqee (1995), MacDonald (1997), and Clark and MacDonald (1998)—which consists in estimating a long-run, cointegrating relationship between the real exchange rate and its determinants. Dealing here with medium-/long-run issues, we consider this strand of the literature and rely on the usual definition of the equilibrium exchange rate as the level of the real effective exchange rate consistent with internal and external balances. It follows that misalignments arise from internal and external imbalances. Second, currency misalignments can also originate from economic policy choices—such as joining a monetary union in which the members cannot use the nominal exchange rate to adjust their price-competitiveness level. This could result in overvaluations' persistence and a widening of external imbalances (deficits), which are themselves sources of economic recessions. Conversely, current-account surpluses may reflect a deliberate strategy, with the aim of gaining a competitive advantage through an undervalued currency even if there are good economic reasons that justify

appreciation.[7] In a context where external imbalances have significantly increased, it is a key issue to determine if their origin comes from internal disequilibria and/or exchange-rate misalignments. More generally, it is highly relevant to analyze the interactions between these three imbalances that we henceforth designate by macroeconomic imbalances.[8] To the best of our knowledge, there is no empirical study that examines the transmission mechanisms between these key macroeconomic imbalances.

This paper aims at filling this gap by studying the interactions between external imbalances, internal disequilibria, and exchange-rate misalignments. To this end, we rely on the estimation of a panel vector autoregression (PVAR) model on a sample of 22 industrialized countries over the period 1980–2011. We pay particular attention to the persistence of shocks, as well as the potential influence of monetary union or exchange-rate regime, by distinguishing between euro area member countries and nonmember economies. To shed light on the direction of the relationship between disequilibria, we also perform a panel causality analysis.

Our paper contributes to the literature on global imbalances in several ways. It provides an in-depth analysis of the impact of exchange rates and economic activity on current accounts. Beyond simple variations that may result from the evolution of exchange rates and economic activity, our study assesses the impact of overvaluation and economic overheating shocks on current-account imbalances. The advantage of the PVAR approach is that it imposes no a priori constraint on the relationships between the macroeconomic imbalances, and is thus particularly suitable for our purpose given the likely endogenous interactions across those disequilibria. In addition, our causality analysis allows us to go further than previous studies by identifying the direction of the link between the three considered macroeconomic imbalances. On the whole, our paper sheds light regarding the interactions between macroeconomic disequilibria, which are a key issue in the current context where one of the major concerns is the inversion of global imbalances.

The rest of the paper is organized as follows. Section 2 details our empirical methodology. Data and estimation results are presented in Section 3, together with a robustness analysis. Section 4 concludes the paper.

2. METHODOLOGY

To provide a full description of the interactions between macroeconomic imbalances, we rely on two complementary approaches. We first estimate a panel VAR model to analyze the transmission mechanisms between disequilibria. The VAR specification not being sufficient to perform an economic policy analysis because it does not provide enough information about the causal impact of shocks [Moneta et al. (2013)], we then implement a causality analysis.

2.1. Panel VAR Approach

Combining the traditional VAR approach [Sims (1980)] with panel data econometrics, the PVAR model is particularly suitable to address a number of recent

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issues, including the analysis of global imbalances and their interactions.[9] Indeed, impulse-response functions (IRFs) and variance decompositions (VDCs) deduced from the PVAR estimation are very useful in analyzing how macroeconomic imbalances interact.

The reduced form of a PVAR model is defined as follows:

$$Y_{i,t} = \alpha_i + \Gamma(L)\, Y_{i,t} + \varepsilon_{i,t}, \tag{1}$$

where i ($i = 1, \ldots, N$) denotes the country and t ($t = 1, \ldots, T$) the time. $Y_{i,t}$ is the vector of endogenous stationary variables, $\Gamma(L)$ represents the matrix polynomial in the lag operator L, α_i denotes the vector of country fixed effects, and $\varepsilon_{i,t}$ is a vector of errors. The vector $Y_{i,t}$ is composed of our three macroeconomic imbalances, namely the output gap measured relative to the rest of the world (rogap), current-account gap (CA_gap), and exchange-rate misalignment (mis):

$$Y_{i,t} = \left(\text{rogap}_{i,t}, \text{CA\_gap}_{i,t}, \text{mis}_{i,t}\right)'. \tag{2}$$

From a methodological viewpoint, implementing the VAR procedure on panel data requires imposing the same underlying structure for each cross-sectional unit (country), a constraint that may be violated in practice [(see Love and Zicchino (2006)]. The country fixed effects introduced in (1) are a way to overcome the restriction on the parameters to the extent that they capture individual heterogeneity.[10] It is, however, well known that the fixed-effects estimator in autoregressive panel data models is inconsistent, fixed effects being correlated with the regressors due to lags of the dependent variable [Nickell (1981)]. To overcome this issue, we consider the generalized method of moments (GMM). More precisely, to remove the fixed effects, we use the forward mean-differencing procedure—also known as the Helmert procedure—following Love and Zicchino (2006), among others. In this approach, all variables are transformed into deviations from forward means, and each observation is weighted to standardize the variance. This transformation preserves orthogonality between the transformed variables and lagged regressors, allowing us to use the lagged regressors as instruments and estimate the coefficients by the GMM procedure.

Once the coefficients have been estimated, we compute the IRFs and VDCs using the Cholesky decomposition. Neither economic theory nor empirical studies allow us to choose the order to retain for the variables in the Cholesky decomposition unambiguously. As an illustration, the real effective exchange rate can be viewed as the most endogenous variable, given that it is determined by internal fundamentals associated with economic growth (productivity) and external fundamentals associated with the current-account position (net foreign assets). On the other hand, the real effective exchange rate is also frequently considered as an explanatory variable in the growth literature or in current-account models [Salai-i-Martin (1997), Arghyrou and Chortareas (2008), among others]. We thus retain the order of the variables as presented in (2) and test the robustness of our results to changes in this ordering.

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2.2. Causality Analysis

To specify the causal direction of the transmission mechanism between imbalances, we rely on the panel noncausality test developed by Dumitrescu and Hurlin (2012). This is a simple extension of the Granger (1969) test to heterogeneous panel data models. By preserving the heterogeneity of cross-sectional units, it allows us to test the direction of the relationship between macroeconomic imbalances without imposing the same dynamic model for all the countries of the sample. The starting point is the following heterogeneous autoregressive model:[11]

$$y_{i,t} = \theta_i + \sum_{k=1}^{K} \gamma_i^{(k)} y_{i,t-k} + \sum_{k=1}^{K} \delta_i^{(k)} x_{i,t-k} + \varepsilon_{i,t}, \tag{3}$$

where x and y are two stationary variables observed in T periods for N countries. The individual effects are assumed to be fixed and the lag-order K is supposed to be common.[12] $\gamma_i^{(k)}$ denote the autoregressive parameters, and $\delta_i^{(k)}$ are the regression coefficients' slopes; both parameters differ across countries. By definition, x causes y if and only if the past values of the variable x observed on the ith country improve the forecasts of the variable y for country i only. The test is based on the null hypothesis of homogeneous noncausality (HNC), i.e., that there is no causal relationship from x to y for all the countries of the panel ($\delta_i = (\delta_i^{(1)}, \ldots, \delta_i^{(k)})' = 0, \forall i = 1, \ldots, N$). Under the alternative hypothesis, there exists a causal relationship from x to y for at least one country of the sample. The test statistic is given by the cross-sectional average of the individual Wald statistics defined for the Granger noncausality hypothesis for each country (W_{HNC}) and converges to a chi-squared distribution with K degrees of freedom. Two standardized statistics have been defined by the authors: the first is based on the exact asymptotic moments of the individual Wald statistics (Z_{HNC}), and the second on approximated moments for finite T samples ($\tilde{Z}_{\text{HNC}}$).[13]

3. DATA AND EMPIRICAL RESULTS

3.1. Data and Preliminary Tests

We rely on a panel of 22 OECD countries, half of which belonging to the euro area.[14] Data are annual and cover the period from 1980 to 2011.[15] Internal imbalances are proxied by the output gaps calculated by the IMF and expressed relative to the rest of the world. External, current-account imbalances are measured by the current-account gap ($\text{CA\_gap}_{i,t}$), defined as the difference between the observed current account ($\text{CA}_{i,t}$) and its estimated equilibrium value ($\text{CA}_{i,t}^{\text{eq}}$):

$$\text{CA\_gap}_{i,t} = \text{CA}_{i,t} - \text{CA}_{i,t}^{\text{eq}}. \tag{4}$$

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The equilibrium current account (or current-account norm) is given by estimation of the following specification:

$$\mathrm{CA}_{i,t} = a_i + \sum_{j=1}^{n} b_j Z_{i,t} + \mu_{i,t}, \tag{5}$$

with n denoting the number of explanatory variables $Z_{i,t}$, $\mu_{i,t}$ being an i.i.d. error term, and a_i standing for country fixed effects. Falling into the strand of the literature on current-account medium-term determinants [Lane and Milesi-Ferretti (2012); Cheung et al. (2013); IMF (2013); Schubert (2014)], we consider the following explanatory variables: the relative fiscal balance (rdef), the lagged net foreign asset position (nfa), the relative level of PPP-adjusted GDP per capita (prod), the relative GDP growth rate (rgrw), the aging rate (raging), the old-age dependency ratio (rold), the population growth rate (popg), the M2 to GDP ratio, the degree of openness (open), terms of trade (tot), and the oil balance (oilb).[16] The estimation results (see Table A.2 in the Appendix)[17] are in line with the findings of the existing literature [Chinn and Prasad (2003); Lane and Milesi-Ferretti (2012)], showing that fiscal policy, the net foreign asset position, demographic factors such as population growth and aging rate, trade openness, and oil balance are significant in explaining the current-account dynamics in our advanced countries.

Similarly, exchange-rate misalignments are defined as the difference between the observed real effective exchange rate and its estimated equilibrium level. The latter is derived from the estimation of a cointegrating relationship between the real effective exchange rate and its two usual determinants, namely the net foreign asset position and a proxy for relative productivity.[18] As expected, a rise in the net foreign asset position, as well as in relative productivity, leads to a real exchange rate appreciation (see Table A.3 in the Appendix).[19]

We perform panel unit root tests to ensure that our variables have suitable properties. Results presented in Table A.4 in the Appendix show that the three variables measuring macroeconomic imbalances are stationary. Those findings are not surprising, because they indicate that imbalances are stabilizing, although strong persistence can sometimes be observed, requiring painful corrective policies.

3.2. Panel VAR Results

We focus on the impulse response functions (IRFs) derived from the estimation of (1),[20] and also briefly comment on the variance decomposition. Figure 2 displays the IRFs for the whole panel, together with the 5% standard-error bands generated through Monte Carlo simulations.

As shown, a positive shock to output gap leads to (i) a significant and negative response of current-account gap and (ii) a significantly positive response of exchange-rate misalignments. In other words, economic overheating generates a huge current-account deficit together with a currency overvaluation. This finding

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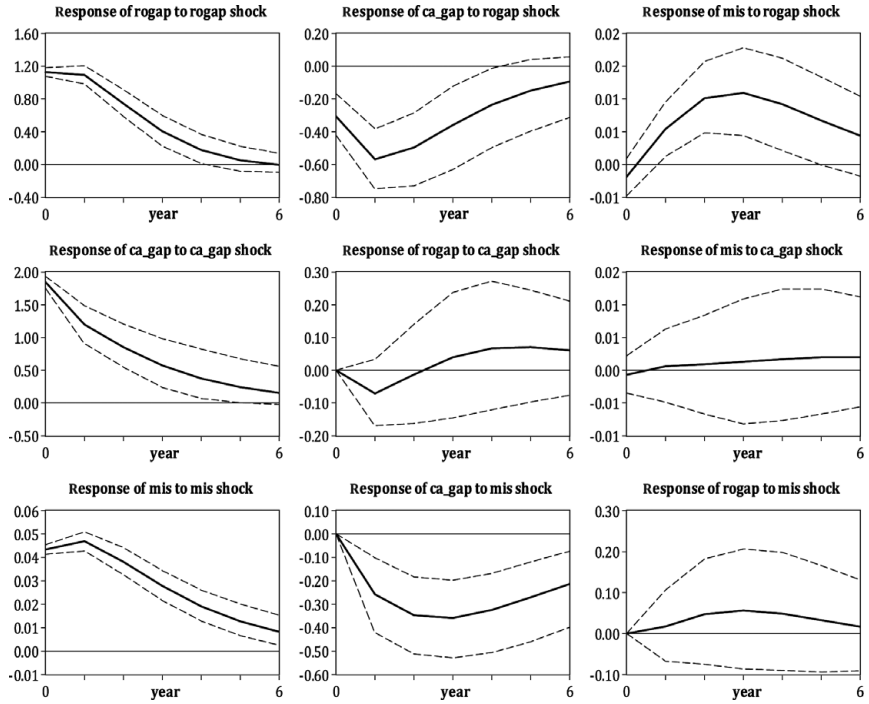

FIGURE 2. Impulse-response functions for the whole sample. Impulse responses are represented by solid lines. Standard-error bands (dashed lines) are generated through Monte Carlo simulations with 1,000 repetitions.

could be explained by a demand effect or price effect that implied a deterioration of the trade balance. Indeed, when the production factors are limited to meet domestic demand, excess demand is offset by an increase in imports. Strains on production factors result in inflationary pressures and exchange-rate overvaluation that negatively affect the trade balance. A 12% economic overheating shock results in an instantaneous current-account deficit of about 3%. This deficit is maximal after one year, reaching 5.5% before the beginning of adjustment toward equilibrium. This output-gap shock also generates a relatively low and gradual overvaluation, which is maximal around 1% after three years, before the start of adjustment toward equilibrium. Regarding the current account, a shock to the current-account gap significantly affects neither exchange-rate misalignments nor the output gap. Finally, turning to the last imbalance, our findings show that misalignment shocks significantly impact current-account disequilibria, with overvaluation gradually accentuating the current-account deficit before the reversion toward equilibrium begins. Exchange-rate overvaluation has, however, no significant effect on output gap. These findings are consistent with the idea that overvalued currencies are associated with unsustainably large current-account deficits, balance of

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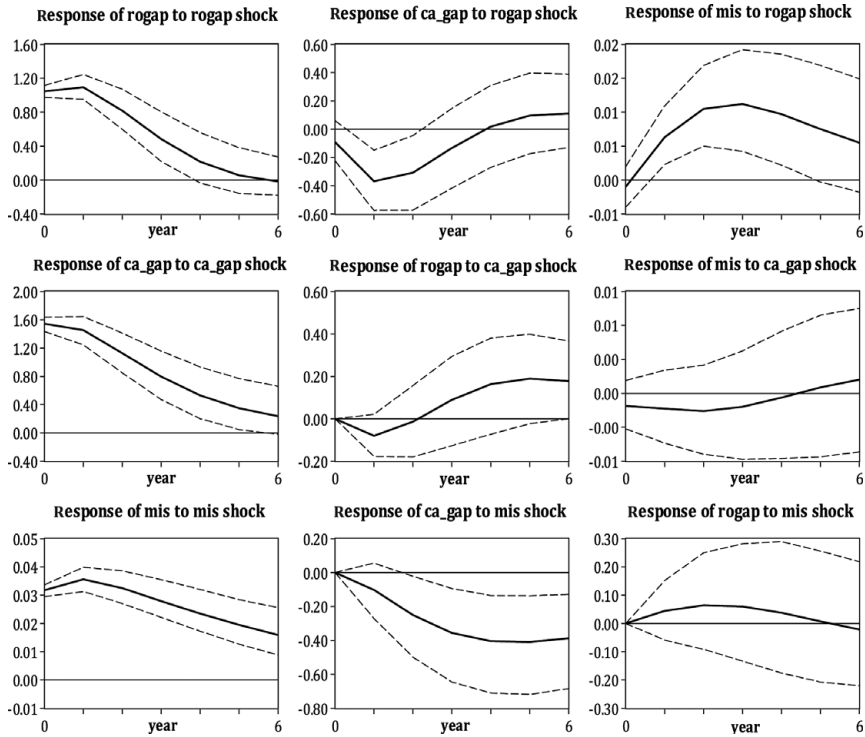

FIGURE 3. Impulse-response functions for euro area members. Impulse responses are represented by solid lines. Standard-error bands (dashed lines) are generated through Monte Carlo simulations with 1,000 repetitions.

payments crises, and stop-and-go macroeconomic cycles [see Rodrik (2008)] All these results are robust to changes in the variables' order retained in the Cholesky decomposition.[21]

Given that our panel of countries includes eurozone members as well as other countries, we now investigate whether belonging to a monetary union has an influence on our previous findings. To this end, we split our panel into two subsamples: a panel including 11 euro area members, and a panel encompassing the other 11 countries. As evidenced by Figure 3, which reports IRFs for eurozone members, interactions between macroeconomic imbalances within the euro area are similar to those obtained for the whole panel. Indeed, economic overheating leads to currency overvaluation and a large current-account deficit, and a currency-overvaluation shock tends to deepen the current-account deficit. However, imbalances' magnitude and persistence in the euro area differ from those for the whole panel. Indeed, for an equivalent output-gap shock, the response of the current-account gap is smaller in the euro area, whereas overvaluation is much larger. As for the whole panel, adjustment toward equilibrium begins after one year

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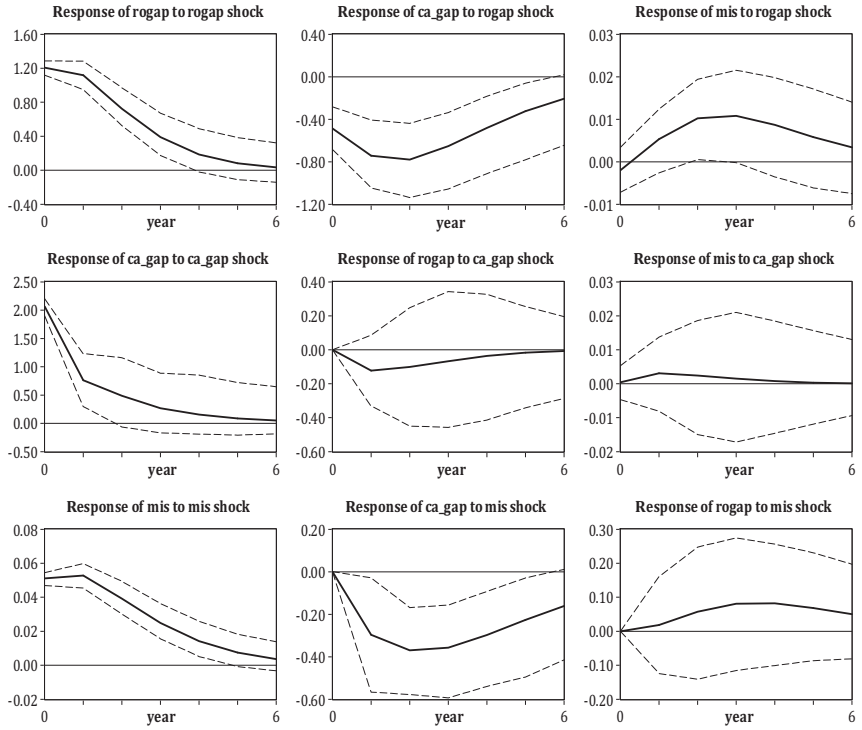

FIGURE 4. Impulse-response functions for non-eurozone countries. Impulse responses are represented by solid lines. Standard-error bands (dashed lines) are generated through Monte Carlo simulations with 1,000 repetitions.

for the current-account gap and after three years for misalignments. Finally, for a relatively lower overvaluation shock, current-account imbalances are larger and more persistent within the eurozone. Indeed, an overvaluation shock of about 3.2% results in a massive and persistent current-account deficit, stabilizing at around 40%.

Turning to non-eurozone members (Figure 4), macroeconomic imbalances interact in the same way as in the two previous cases, with the exception of the output-gap shock, which does not lead to significant currency overvaluation. However, for a similar output-gap shock, current-account imbalances are larger than in the eurozone. By contrast, for a similar misalignment shock, current-account deficits are smaller than in the euro area. Persistence of current-account imbalances is also weaker, and adjustment toward equilibrium occurs more rapidly, the reversion beginning after two years.

To sum up, our IRF analysis shows that macroeconomic imbalances interact with each other. More specifically, an economic overheating shock (positive output-gap shock) deepens current-account deficits for both eurozone members

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TABLE 1. Variance-decomposition results

	rogap	CA_gap	mis
		All sample	
rogap	98.96	0.74	0.29
CA_gap	11.65	80.56	7.79
mis	5.60	0.32	94.09
		Eurozone members	
rogap	94.66	4.37	0.96
CA_gap	3.50	83.01	13.49
mis	7.92	0.58	91.50
		Non-eurozone members	
rogap	98.35	0.91	0.74
CA_gap	28.01	65.24	6.75
mis	4.58	0.23	95.20

Note: This table reports the percentage of variation in the variable in a row explained by the variable in a column. The figures reported are averages of 10, 20, and 30 years.

and nonmembers, with a greater impact for the latter. However, the currency overvaluation that results from this shock is significant only for the euro area. Finally, an overvaluation shock contributes to feed current-account imbalances for both eurozone members and nonmembers, with a more persistent impact for the former.

To complete our findings, we perform a variance-decomposition analysis to assess the percentage of variation in a variable explained by another variable more precisely. Results presented in Table 1 indicate that a change in the output gap is mainly explained by itself. This explains why the output gap does not significantly react to both current-account gap and misalignment shocks. Indeed, current-account imbalances explain only 4.4% of the variation in output gap for eurozone members and 0.9% for nonmembers. Turning to external imbalances, output gap and misalignments respectively contribute 3.5% and 13.5% to explaining current-account disequilibria in the eurozone, whereas these percentages amount to 28% and 6.8% for nonmembers. Our findings thus show that variations in current-account imbalances mainly result from exchange-rate misalignments in the euro area and from the output gap for non-eurozone members. Changes in currency misalignments mostly come from themselves, about 7.9% being explained by the output gap for the eurozone, however.

Our results are consistent with previous studies evidencing that excessive current-account deficits can partly be explained by overly optimistic prospects of economic growth [Blanchard and Giavazzi (2002); Blanchard and Milesi-Ferretti (2009); Lane and Pels (2012)]. The importance of exchange-rate misalignments in explaining global imbalances, especially in the euro area, is also consistent

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with the findings of Gnimassoun and Mignon (2015). The latter indeed show that low overvaluations can lead to strong persistence in current-account imbalances in the euro area, whereas this is not the case for non-eurozone members. This is partly explained by the fact that the increase in current-account deficit due to a loss of price competitiveness cannot be corrected by any nominal exchange rate adjustment in a monetary union except by resorting to devaluation, which may be costly economically. Thus, improving competitiveness must be carried through other channels, such as a decline in wages or a rise in working hours that are unpopular and instability-generating measures.

More generally, although in contrast to previous studies on the cyclical adjustment of external imbalances our paper investigates not only how output affects the current account, but also how the current account impacts output, some common findings can be highlighted. Focusing on the cyclical component of the current account, IMF (2013) shows that an increase in output gap by 1 percentage point is associated with a decline of the current account by about 0.4 percent of GDP. In the same vein, Cheung et al. (2013) analyze the structural and cyclical factors behind the evolution of current accounts and find that part of the narrowing of the current-account balances since the financial crisis appears to be related to various cyclical factors including changes in output growth, oil prices, and exchange rates. The same cyclical relationship between the output gap and current-account imbalances has been stressed by Tressel and Wang (2014). As the IMF (2013), these authors find that an increase in the output gap by 1 percentage point deteriorates the current-account balance by about 0.40 to 0.46 percent of GDP. All these results are in line with the usual IMF research on the external balance assessment [see also Isard et al. (2001)].

3.3. Panel Causality Test Results

As previously mentioned, knowing the causal direction between macroeconomic imbalances is obviously useful for decision making in economic policy. We therefore perform causality tests, whose results are reported in Table 2.[22] These findings appear to be quite consistent with our previous conclusions. Indeed, whatever the test statistic and regardless of the number of lags retained in the model, the homogeneous noncausality (HNC) hypothesis from misalignments to current-account imbalances is strongly rejected at conventional levels. However, the HNC null hypothesis from current-account imbalances to misalignments cannot be rejected with the standardized statistic ($\tilde{Z}_{\text{HNC}}$) and for a number of lags equal to 1. The HNC hypothesis from output gap to current-account imbalances is strongly rejected, this result being robust to both the lag order and the statistic test. Regarding misalignments and the output gap, the HNC hypothesis from output gap to misalignments is generally rejected, whereas it is significantly rejected only for the Z_{HNC} statistic (and for $K = 1$ with $\tilde{Z}_{\text{HNC}}$)when the misalignment to output gap direction is considered.

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TABLE 2. Causality between output gap, misalignments, and current-account imbalances

	Statistical tests								
Lag order	W_{HNC}	Z_{HNC}	$\tilde{Z}_{HNC}$	W_{HNC}	Z_{HNC}	$\tilde{Z}_{HNC}$	W_{HNC}	Z_{HNC}	$\tilde{Z}_{HNC}$
	mis to CAgap			rogap to CAgap			rogap to mis		
$K = 1$	2.34	4.45a	3.67a	2.69	5.61a	4.69a	3.76	9.14a	7.78a
$K = 2$	3.29	6.04a	2.23	5.56	16.70a	6.76a	4.02	9.46a	3.69a
$K = 3$	5.16	12.41a	2.96a	6.14	18.02a	4.50a	7.41	25.35a	6.50a
	CAgap to mis			CAgap to rogap			mis to rogap		
$K = 1$	1.522	1.73	1.29	1.83	2.76a	2.19	2.29	4.28a	3.53a
$K = 2$	2.603	2.83a	0.87	3.29	6.04a	2.23	3.31	6.13a	2.27
$K = 3$	4.202	6.91a	1.46	6.63	9.38a	2.14	4.45	8.34a	1.85

Notes: "X to Y" means that we test the null hypothesis of homogenous noncausality (HNC) from X to Y. The letter "a" indicates rejection of the null hypothesis at the 1% significance level.

On the whole, our findings emphasize the existence of a causal relationship between macroeconomic imbalances. In particular, there is a strong and robust causal link from exchange-rate misalignments to current-account imbalances, at least for some countries in the sample. Furthermore, a causal relationship from the output gap to current-account imbalances seems to be clearly established, as well as from the output gap to misalignments. The latter result is very appealing regarding the literature that tends to focus on a causal link from exchange-rate misalignments to economic activity, often showing a negative impact of currency overvaluation on GDP growth [Razin and Collins (1997), Rodrik (2008), and Berg and Miao (2010), among others)]. Whereas these findings are not challenged by ours, we show that the reverse relationship is quite robust: economic overheating leads to exchange-rate overvaluation, especially in the euro area. Such results have not been strongly highlighted in previous studies, mainly because of the a priori choice of model specification, in which misalignments are often considered as an explanatory variable.

All these results confirm the IRF analysis, which notably revealed that current-account deficits are growing in response to economic overheating or overvaluation shocks. These findings are highly relevant to economic policy to the extent that they show that a reduction in misalignments and output gaps could play a key role in reducing global imbalances.

3.4. Robustness Analysis

Alternative measures of macroeconomic imbalances. To check the robustness of our results, we perform the IRF analysis again using alternative measures of macroeconomic imbalances. Specifically, instead of being based on fundamentals as before, we measure exchange-rate misalignments as the deviation of the actual real exchange rate from its Hodrick-Prescott detrended value as in Goldfajn

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and Valdes (1999) and Béreau et al. (2012), among others. The output gap is constructed in the same way, as the deviation of the actual real GDP from its Hodrick–Prescott filtered value [see, e.g., De Masi (1997); Isard and Faruqee (1998)]. Similarly, external imbalances are also calculated using the Hodrick–Prescott filtering method. If these alternative measures of macroeconomic imbalances have the disadvantage of having no economic foundations, they present the interest as homogeneous.[23] The IRFs derived from using these new proxies are reported in Figures A.1 to A.3 in the Appendix.

These results show that our previous findings are globally robust to the choice of the measure retained for macroeconomic imbalances. Indeed, as before, current-account deficits are growing massively in response to a positive output-gap shock for the whole panel as well as for the two subpanels. This shock also leads to an exchange-rate overvaluation, which is more pronounced in the euro area. Moreover, current-account deficits are amplified in response to a positive currency misalignment shock, the impact being more persistent in the euro zone as previously.

Interactions between the observed macroeconomic variables. Whatever the approach followed—based on economic fundamentals or statistical methods—macroeconomic imbalances are determined after an "equilibrium level" is estimated for the different variables. To account for potential estimation bias and as a robustness check, we complement our analysis by investigating interactions between changes in the *observed* macroeconomic variables (namely current account, economic growth, and real effective exchange rate) for the same samples. Because these changes concern the variables themselves and not the corresponding imbalances, we do not expect to obtain exactly the same results as before. However, given that disequilibria result from the difference between the observed variables and their equilibrium level, we may expect that imbalances and observed variables globally react in the same way without considering the magnitude of shocks and the respective responses to shocks. As an example, if the current-account gap reacts negatively to an overvaluation shock, one may hypothesize that a real exchange-rate appreciation should have a negative effect on the observed current account. The IRFs resulting from the interactions between current account, economic growth, and real effective exchange rates are displayed in Figures A.4 to A.6 in the Appendix.

These results support our previous findings. Indeed, a positive shock to the real effective exchange rate (a real appreciation) leads to a current-account deficit for all the considered panels. Similarly, a positive shock to economic growth negatively affects the current account regardless of the sample, and leads to an exchange-rate appreciation in the euro area. Moreover, economic growth responds positively to a positive shock to the current account for all samples. Finally, it is worth noting that responses to shocks are generally more persistent for imbalances than for the macroeconomic variables themselves. The impact of macroeconomic imbalances would thus be more painful, because it is more difficult to absorb than the effect

TABLE 3. Variance-decomposition results (robustness checks)

	rogap	CA_gap	mis
	Without Norway		
rogap	99.22	0.56	0.22
CA_gap	10.56	82.02	7.43
mis	5.80	0.41	93.79
	Without Norway or Iceland		
rogap	98.29	1.40	0.31
CA_gap	8.47	82.69	8.84
mis	7.07	0.44	92.50
	Without Greece or Portugal		
rogap	98.92	0.88	0.20
CA_gap	19.85	75.69	4.46
mis	6.48	0.07	93.45
Without Greece, Iceland, Norway, Portugal, or Switzerland			
rogap	96.19	3.27	0.54
CA_gap	16.16	79.09	4.75
mis	8.38	0.24	91.39

Note: See note to Table 1.

of simple changes in macroeconomic variables, which is a relevant and expected result.

Finally and for the sake of completeness, note that we have conducted an analysis mixing observed variables and corresponding imbalances.[24] Our results show that (i) a shock to economic growth or to the exchange rate produces current-account imbalances, and (ii) economic overheating leads to an exchange-rate appreciation and a deterioration of the current-account balance, in line with our previous results.

Heterogeneity across countries. Our panel of countries includes economies that obviously have different macroeconomic characteristics. Regarding the current-account position, some countries display a huge deficit—such as Iceland, Greece, Portugal, and Spain—whereas others exhibit surpluses—such as Norway or Switzerland—over the period under study. To account for this heterogeneity, we estimate several other PVAR specifications by varying the countries included in the sample. We report in Table 3 the variance-decomposition results corresponding to four different specifications: (i) without Norway, which displays a huge surplus because of its oil exports, (ii) without Norway and Iceland, which are the countries that exhibit the highest surplus and deficit, respectively, (iii) without Greece and Portugal, which are the most deficient countries of the euro area, and (iv) without Greece, Iceland, Norway, Portugal, and Switzerland, which are the economies displaying the greatest imbalances.[25]

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As shown, results in Table 3 corroborate our findings reported in Table 1 for the whole sample. Output-gap changes are mainly explained by themselves, and the contribution of exchange-rate misalignments in explaining variations in current-account imbalances for eurozone members is also evidenced, as notably highlighted by the third specification (i.e., without Greece and Portugal).

4. CONCLUSION

The explosion of global imbalances that preceded the 2008 global crisis and the issue of their adjustment have remarkably mobilized the attention of the international macroeconomic literature in recent years. This extensive literature was mainly devoted to the analysis of external imbalances in developed countries, given the challenge that they represent for global economy stability. In this context, the aim of this paper is to investigate the interactions between the three key macroeconomic imbalances (external imbalances, internal imbalances, and exchange-rate imbalances). To this end, we estimate a panel VAR model on a sample of 22 industrialized countries over the period from 1980 to 2011.

We find evidence that macroeconomic imbalances interact strongly through a causal relationship. Specifically, current-account imbalances respond positively and significantly to an output-gap shock. Such pressure on the economy also generates exchange-rate overvaluation in the euro area. Accordingly, although current-account deficits are often more pronounced for "small" countries because they tend to reduce savings and increase investment, developed economies are not immune to deep current-account deficits. Such deficits occur when these countries tend to produce beyond their level of potential output, in response, e.g., to strong demand. Moreover, a currency overvaluation shock deepens the current-account deficit, with more pronounced persistence for euro area members. Our findings are consistent with those of Friedman (1953) and the recent study by Ghosh et al. (2013) showing that external imbalances are harder to absorb for countries belonging to a monetary union or with a fixed exchange-rate regime. Turning in the direction of the relationship between disequilibria, we evidence that there is causality running from the output gap to current-account imbalances and exchange-rate misalignments, and also establish a causal link from currency misalignments to external disequilibria.

On the whole, contributing to the debate on global imbalances, our paper evidences that if external imbalances threaten the stability of the global economy, their origin can be found in internal imbalances and currency misalignments. Consequently, policies aiming at reducing global imbalances should focus on the correction of internal imbalances—output gaps—and exchange-rate misalignments.

NOTES

1. This term is generally used to designate the current-account imbalances of the major economies whose magnitude is such that it threatens the stability of the global economy. For instance, Bracke

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et al. (2010) define global imbalances as external positions of systemically important countries that reflect distortions or entail risks for the global economy.

2. For earlier literature on current-account sustainability, see for example Milesi-Ferretti and Razin (1996), Roubini and Wachtel (1998), and Mann (2002).

3. See also Corden (2007), Gruber and Kamin (2007), and Aizenman and Sun (2010) for other interesting aspects relating to the analysis of current-account imbalances.

4. Bracke et al. (2010) provide a quick overview of large current-account imbalances since 1970 and their consequences.

5. These studies generally show that overvaluations are harmful to growth, whereas undervaluations are growth-enhancing.

6. See, e.g., Obstfeld and Rogoff (1996).

7. Such policies can threaten the stability of the global economy because of worries about unfair competitive advantage they generate, and can therefore justify restrictions on undervaluation and current-account surpluses by the international community [see Blanchard and Milesi-Ferretti (2011)].

8. External imbalances or current-account imbalances are represented by the difference between the observed current account and the equilibrium level given by its fundamentals. Similarly, exchange-rate imbalances are known as exchange-rate misalignments and are defined as the deviation of the observed exchange rate to its equilibrium value. Internal imbalances refer to output gaps, generally measured as the difference between the observed GDP and its potential level. See Section 3.1 for more details.

9. See Canova and Ciccarelli (2013) for a survey of PVAR models and their interests.

10. The issue of heterogeneity is also addressed in Section 3.4 through a robustness analysis.

11. This test is briefly presented in this paper. For more details, the reader can refer to Dumitrescu and Hurlin (2012).

12. We consider several values for this parameter to test the robustness of our findings.

13. Despite its advantages, it should be noticed that this test does not take into account the possibility of a causal link between cross-sectional units. However, Dumitrescu and Hurlin (2012) show on the basis of Monte Carlo experiments that the standardized panel statistics have very good small sample properties, even in the presence of cross-sectional dependence.

14. Our sample includes (i) 11 eurozone members, namely Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, and Spain; and (ii) 11 noneurozone countries, namely Australia, Canada, Denmark, Iceland, Japan, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, and the United States.

15. All data used and their sources are given in Table A.1 in the Appendix.

16. Data sources for each series are presented in Gnimassoun and Mignon (2015).

17. We only report the significant estimated coefficients. Complete estimation results, together with various alternative specifications, are reported in Gnimassoun and Mignon (2015).

18. We rely here on a simple stock-flow model, following Alberola et al. (1999) and Bénassy-Quéré et al. (2009, 2010), among others.

19. As a robustness check and for the sake of completeness, we have also considered an alternative measure of real exchange-rate misalignments. Following Chinn (1999), we relied on a PPP-based measure such that the equilibrium exchange rate was associated with an international version of the law of one price and was obtained by regressing the real exchange rate on a constant plus a time trend (when significant). The correlation coefficients calculated between our measure and PPP-based misalignments are close to unity, varying between 0.830 for Ireland and 0.999 for Australia and being equal to 0.97 on the average for our whole panel of countries.

20. To save space, the detailed results of these estimates are not reported here, but are available upon request from the authors. Two lags have been retained for the estimation, as suggested by the usual information criteria.

21. Complete results are available upon request to the authors.

22. The three test statistics have been computed for various lags ranging from 1 to 3 to assess the sensitivity of our results to the choice of common lag order.

23. This robustness analysis is also relevant with regard to the determinants of the current-account norm which may be correlated with the output gap. One may indeed wonder whether the possible correlation between some of the determinants of the current-account norm—such as the fiscal balance—and the output gap could lead to underestimation of the effect of the output gap on the current account. However, our variables being expressed in relative terms, this is not an issue here. As an illustration, the correlation between the relative fiscal balance and the output gap is not significant, being equal to 0.08. Similar results are obtained for the other determinants with correlations that are lower than 0.10, with the exception of the relative growth variable. Consequently, the effect of the output gap on the current account is not understated, as is also corroborated by the present robustness analysis.

24. To save space, the corresponding IRFs are not reported here, but are available upon request to the authors.

25. Note that various other combinations have been considered, leading to similar results. We have also run country-by-country estimations. However, because of our limited number of observations, the robustness of such estimates is questionable, leading us to opt for various subsample specifications.

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APPENDIX

TABLE A.1. Sources of variables

Variable	Notation	Definition	Source
Exchange-rate misalignments	Mis	Difference between actual exchange rate and equilibrium exchange rate	Gnimassoun and Mignon (2015)
Output gap	rogap	Actual GDP less potential GDP (as a percent of potential GDP), measured relative to the rest of the world	International Monetary Fund (IMF)
Current-account imbalances	CA_gap	Difference between observed current account and equilibrium current account	Gnimassoun and Mignon (2015)
Economic growth	growth	GDP annual growth rate (constant prices, in percent)	International Monetary Fund (IMF)
Real effective exchange rate	REER	Weighted average of bilateral exchange rates adjusted by relative consumer prices (2005 = 100)	Bank for International Settlements (BIS)
Real GDP	GDP	Gross domestic product (GDP, constant 2005 US$)	World Bank
Current-account balance	CA	Balance of goods and services plus balance of income plus balance of current transfers (% GDP)	International Monetary Fund (IMF)

TABLE A.2. Results of the current-account estimation

rdef	nfa	raging	popg	m2	open	tot	oilb
0.210***	0.0610***	0.204***	−2.570***	−0.00910**	0.0400***	0.0335***	0.414***
(0.0359)	(0.00298)	(0.0365)	(0.285)	(0.00382)	(0.00380)	(0.00891)	(0.0491)

Note: Robust standard errors are in parentheses. Only the significant values are reported.
Source: Gnimassoun and Mignon (2015).
***, **, * Significant at the 1%, 5%, 10% level.

TABLE A.3. Estimation of the cointegrating relationship

Net foreign asset position	Relative productivity
0.069**	0.400***
(0.03)	(0.15)

Note: Standard errors are in parentheses.
Source: Gnimassoun and Mignon (2015).
***, ** Significant at the 1%, 5% level.

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TABLE A.4. Results of panel unit root tests (IPS and CADF tests)

	With constant		With constant and trend	
Variable	Stat. test	*P*-value	Stat. test	*P*-value
Mis	−2.694***	0.004	−2.732***	0.003
CA_gap	−4.002***	0.000	−2.398***	0.008
rogap	−2.687***	0.000	−2.762**	0.012
REER	−1.724	0.591	−2.347	0.428
ΔREER	−2.996***	0.000	−3.043***	0.000
CA	−1.869	0.310	−2.140	0.856
ΔCA	−2.932***	0.000	−2.927***	0.001
GDP growth	−2.538***	0.000	−2.647*	0.051
HP_REER	−3.610***	0.000	−3.523***	0.000
HP_CA	−3.295***	0.000	−3.229***	0.000
HP_GDP	−2.843***	0.000	−2.731**	0.019

Notes: The tests are based on the unit root null hypothesis. Two lags are used for variables in levels, and one lag for variables in first differences, as well as for variables measuring imbalances. CADF is the cross-sectionally augmented Dickey–Fuller test of Pesaran (2007). This test was performed for all variables in order to take into account cross-sectional dependencies, except for the variables "Mis" and "CA_gap," whose calculation allows controlling for this phenomenon. For these two variables, we performed the IPS test proposed by Im et al. (2003).

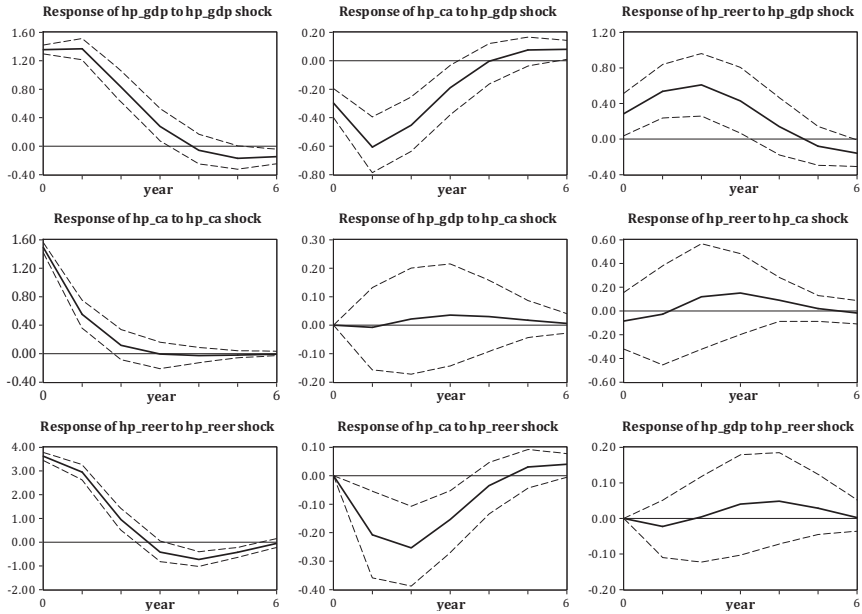

FIGURE A.1. IRFs for the whole sample (H-P filter measure of imbalances).

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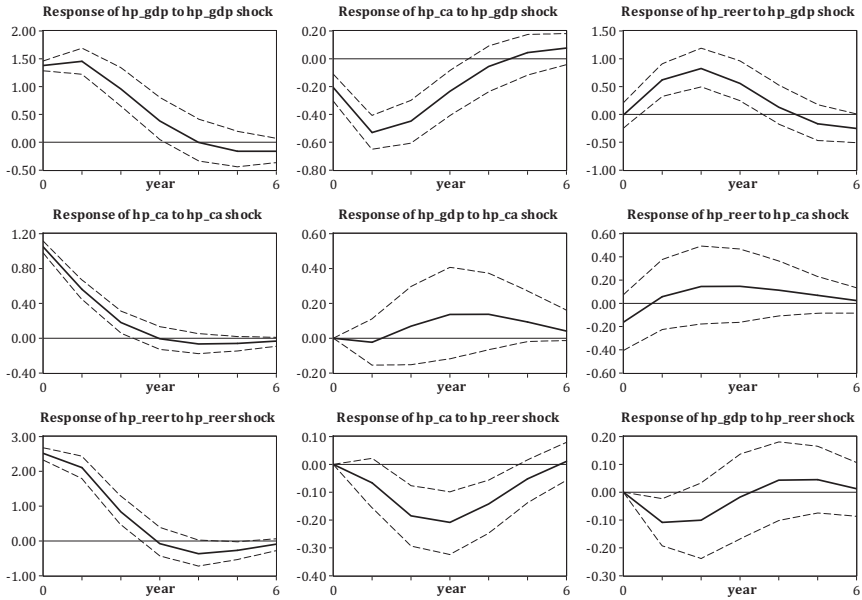

FIGURE A.2. IRFs for eurozone members (H-P filter measure of imbalances).

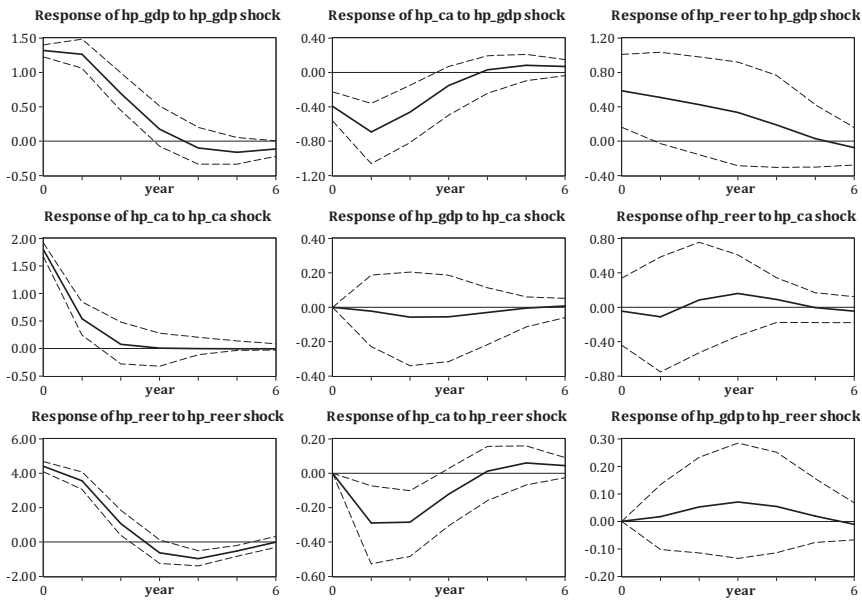

FIGURE A.3. IRFs for non-eurozone members (H-P filter measure of imbalances).

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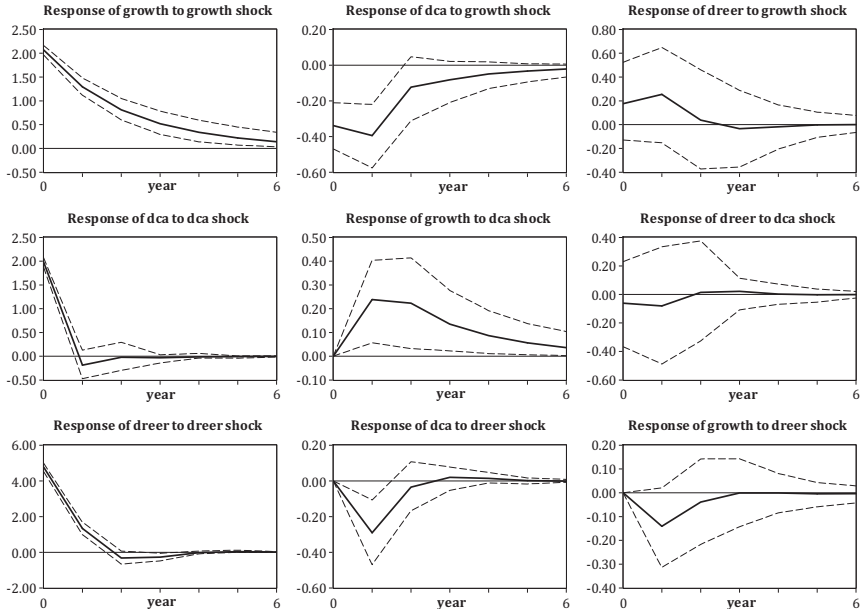

FIGURE A.4. IRFs for the whole sample (interactions between growth, CA, REER).

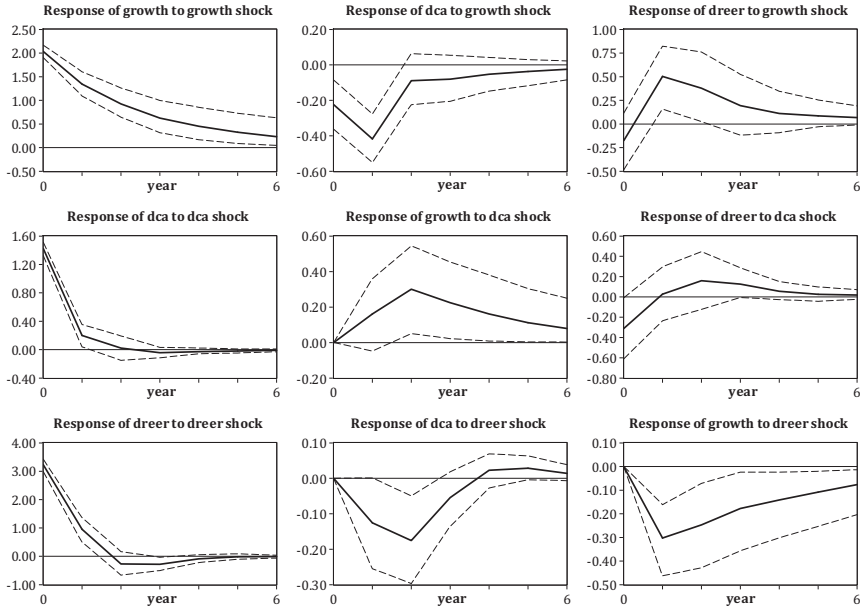

FIGURE A.5. IRFs for eurozone members (interactions between growth, CA, REER).

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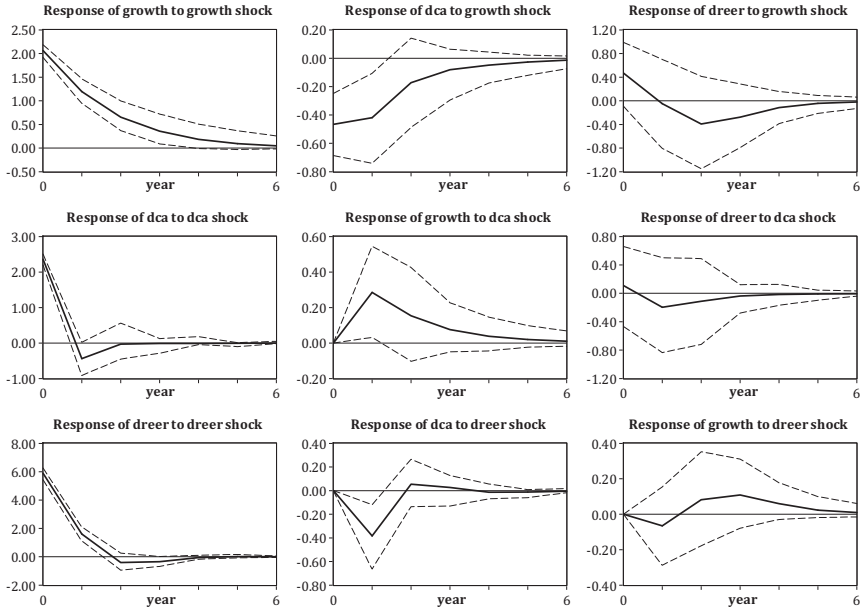

FIGURE A.6. IRFs for non-eurozone members (interactions between growth, CA, REER).

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