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How macroeconomic imbalances interact? Evidence from a panel VAR analysis

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Highlights

- We investigate the interactions between three key macroeconomic imbalances.
- We estimate a panel VAR model for a sample of 22 industrialized countries over the 1980-2011 period.
- We evidence that output-gap shocks and currency overvaluation deepen current-account deficits.

RESEARCH AND EXPERTISE
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Abstract

This paper aims at investigating the interactions between three key macroeconomic imbalances, namely current-account discrepancies (external imbalances), output gaps (internal imbalances), and exchange-rate misalignments. To this end, we rely on the estimation of a panel VAR model for a sample of 22 industrialized countries over the 1980-2011 period. Our findings show that macroeconomic imbalances strongly interact through a causal relationship. We evidence that 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, while 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.

JEL

F32; F31; C33.

How macroeconomic imbalances interact? Evidence from a panel VAR analysis♦

Blaise Gnimassoun* and Valérie Mignon**

1 Introduction

The 2000 decade was marked by various key economic phenomena, among which the huge current-account deficits in the U.S. and some European countries, the public debt crisis and economic recession in the euro zone, 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 still high in 2012 despite the adjustments that have been made since 2009.

Within this context of widespread imbalances, recent literature in international macroeconomics has focused on external disequilibria by addressing on the one side, 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 side, the question of current-account adjustment or reversal (Freund, 2005; Freund and Warnock, 2007; Clarida et al., 2007; Debelle and Galati, 2007; Algieri and Bracke, 2011; Lane and Milesi-Ferretti, 2012; Gnimassoun and Mignon, 2013).[3]

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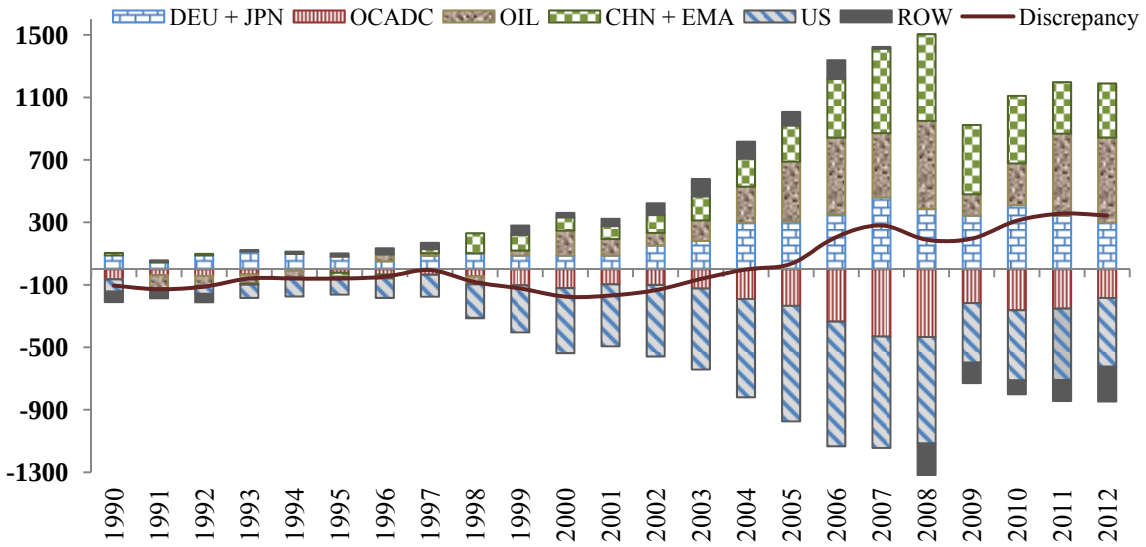
[1] This term is generally used to designate the current-account imbalances of the major economies whose magnitude is such that it threatens the stability of the global economy. For instance, Bracke et al. (2010) define global imbalances as external positions of systemically important countries that 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.

Figure 1. Global imbalances (current account, billions of U.S. dollars)



Source: World Economic Outlook, October 2013.

DEU+JNP: Germany and Japan; CHN+EMA: China and Emerging Asia (Hong Kong SAR, Indonesia, Korea, Malaysia, Philippines, Singapore, Taiwan Province of China and Thailand); OCADC[4]: 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.

This growing interest in the literature for the study of 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.[5] Indeed, as shown by Freund (2005) and Obstfeld and Rogoff (2007) among others, a reversal of the current-account deficit implies a loss of economic growth and a 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) evidence that a reversal of the U.S. current account would result in a 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), world current-account imbalances reflect, to some extent, exchange-rate misalignments. Gnimassoun and Mignon (2013) 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

[4] Other Current Account Deficit Countries.
[5] Bracke et al. (2010) provide a quick overview of large current-account imbalances since 1970 and their consequences.

current-account deficits observed recently in some countries are partly the result of intense economic activity or overly optimistic prospects in terms of economic growth. Indeed, independently 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.[6]

While it is undeniable that current account, exchange rate and economic growth are economically linked, neither economic theory nor empirical studies clearly establish 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 and *vice versa*. Such interdependence may first be simply apprehended through the definition of equilibrium exchange rates from which currency misalignments are derived. Since the equilibrium exchange rate is defined as the level of real effective exchange rate that is 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) that are themselves sources of economic recessions. Conversely, current-account surpluses may reflect a deliberate strategy, with the aim to gain a competitive advantage through an undervalued currency even if there are good economic reasons that justify an appreciation.[7] In a context where external imbalances have increased significantly, 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 1980-2011 period. 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

[6] These studies generally show that overvaluations are harmful to growth while undervaluations are growth-enhancing.

[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.

euro area member countries and non-member 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 is 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 being not sufficient to perform an economic policy analysis since it does not provide enough information about the causal impact of shocks (Moneta et al., 2013), we then perform 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 issues, including the analysis of global imbalances and their interactions.[9] Indeed, impulse-response functions (IRFs) and variance decomposition (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:

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

where i $(i = 1, \dots, N)$ denotes the country, and t $(t = 1, \dots, T)$ 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 by our three macroeconomic imbalances, namely the output gap (*ogap*), current-account gap (*CA_gap*), and exchange-rate misalignment (*mis*):

$$Y_{i,t} = (ogap_{i,t}, CA\_gap_{i,t}, mis_{i,t})' \quad (2)$$

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

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 Equation (1) are a way to overcome the restriction on the parameters to the extent that they capture individual heterogeneity. 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 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 IFRs and VDCs using the Cholesky decomposition. Neither economic theory nor empirical studies allow us to unambiguously choose the order to retain for the variables in the Cholesky decomposition. 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 Equation (2), and test the robustness of our results to changes in this ordering.

2.2 Causality analysis

To specify the causal direction of the transmission mechanism between imbalances, we rely on the panel non-causality 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 consists in the following heterogeneous autoregressive model: [10]

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

where x and y are two stationary variables, observed on T periods for N countries. The individual effects are assumed to be fixed and the lag-order K is supposed to be common.[11] $\gamma_i^{(k)}$ denote the autoregressive parameters, and $\delta_i^{(k)}$ are the regression coefficients' slopes; both parameters differing across countries. By definition, x causes y if and only if the past

[10] This test is briefly presented in this paper. For more details, the reader can refer to Dumitrescu and Hurlin (2012).
[11] We consider several values for this parameter to test the robustness of our findings.

values of the variable x observed on the i^{th} country improve the forecasts of the variable y for this country i only. The test is based on the null hypothesis of homogeneous non-causality (HNC), i.e., there is no causal relationship from x to y for all the countries of the panel ($\delta_i = \left(\delta_i^{(1)}, \dots, \delta_i^{(K)}\right)' = 0, \ \forall i = 1, \dots, N$). 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 individual Wald statistics defined for the Granger non-causality 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 one is based on the exact asymptotic moments of the individual Wald statistics (Z_{HNC}), and the second one on approximated moments for finite T samples ($\tilde{Z}_{HNC}$).[12]

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.[13] Data are annual and cover the period from 1980 to 2011. Internal imbalances are proxied by the output gaps calculated by the IMF. External, current-account imbalances are measured by the current-account gap, defined as the difference between the observed current account and its estimated equilibrium value. Similarly, exchange-rate misalignments are defined as the difference between the observed real effective exchange rate and its estimated equilibrium level.[14] All data used and their sources are given in Table A.1 in the Appendix. We perform panel unit root tests to ensure that our variables have suitable properties. Results presented in Table A.2 in the Appendix show that the three variables measuring macroeconomic imbalances are stationary. Those findings are not surprising since they indicate that imbalances are stabilizing, although strong persistence can sometimes be observed, requiring painful corrective policies.

[12] 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.

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

[14] Equilibrium values for both the current account and the real effective exchange rate are derived from the estimation of models including usual fundamentals (Gnimassoun and Mignon, 2013). Specifically, regarding the current account, the following determinants have been retained: relative fiscal balance, lagged net foreign asset position, relative level of PPP-adjusted GDP per capita, relative GDP growth rate, aging rate, old-age dependency ratio, population growth rate, M2 to GDP ratio, degree of openness, terms of trade, and oil balance. Turning to the equilibrium exchange-rate model, we have expressed the real effective exchange rate as a function of the net foreign asset position (in percentage of GDP) and a proxy for relative productivity.

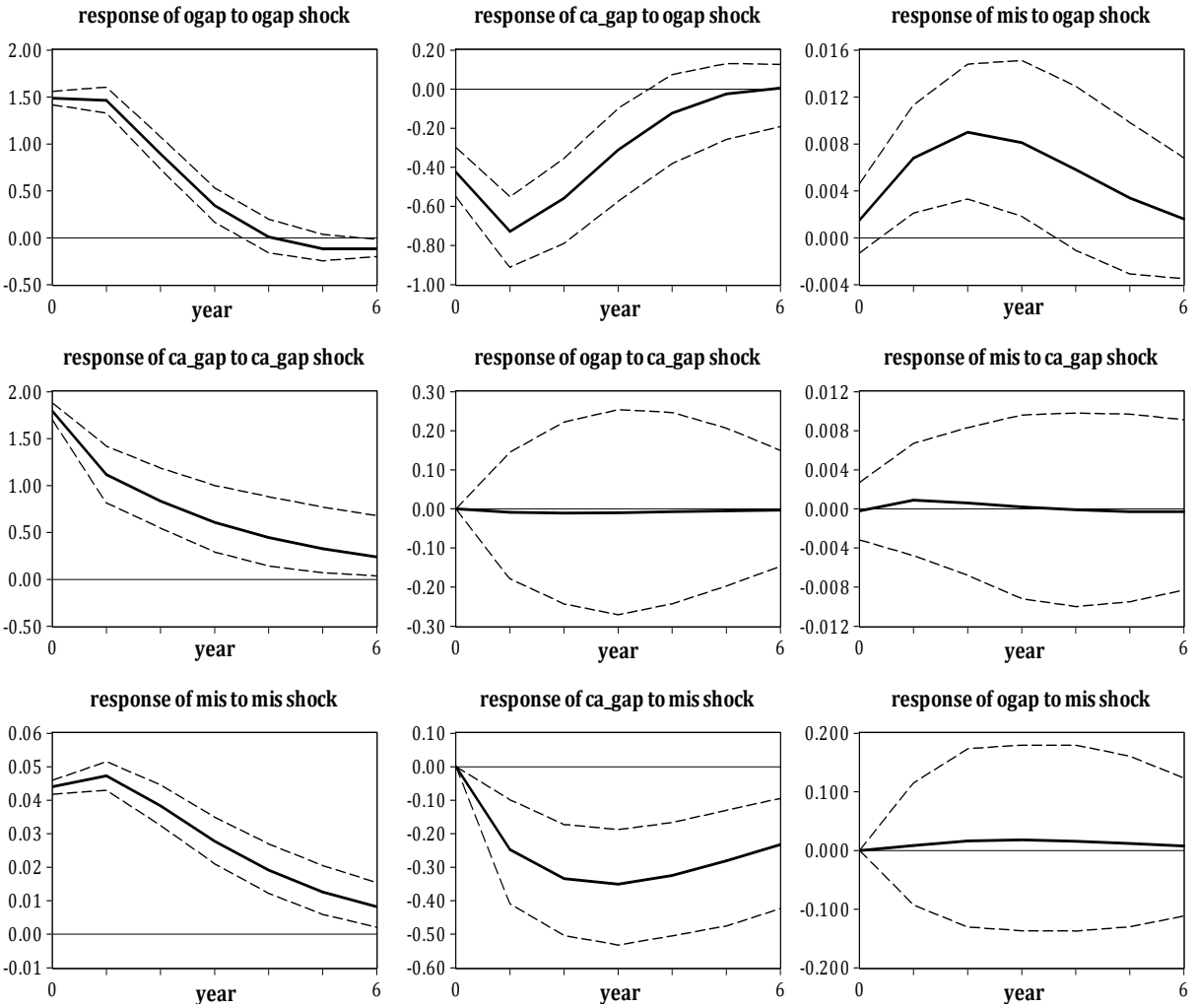
3.2 Panel VAR results

We focus on the impulse response functions (IRFs) derived from the estimation of Equation (1),[15] and also briefly comment 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 on 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, an economic overheating generates a huge current-account deficit together with a currency overvaluation. This finding could be explained by a demand effect or price effect that implies 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 15% economic overheating shock results in an instantaneous current-account deficit of about 4%. This deficit is maximal after one year, reaching 7% before the beginning of adjustment towards equilibrium. This output-gap shock also generates a relatively low and gradual overvaluation, being maximal around 1% after two years before the start of adjustment towards equilibrium. Regarding the current account, a shock on the current-account gap significantly affects neither exchange-rate misalignments nor output gap. Finally, turning to the last imbalance, our findings evidence that misalignment shocks significantly impact current-account disequilibria, with overvaluation gradually accentuating the current-account deficit before starting the reversion towards equilibrium. 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 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.[16]

[15] 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 usual information criteria.
[16] Complete results are available upon request to the authors.

Figure 2. Impulse-response functions for the whole sample

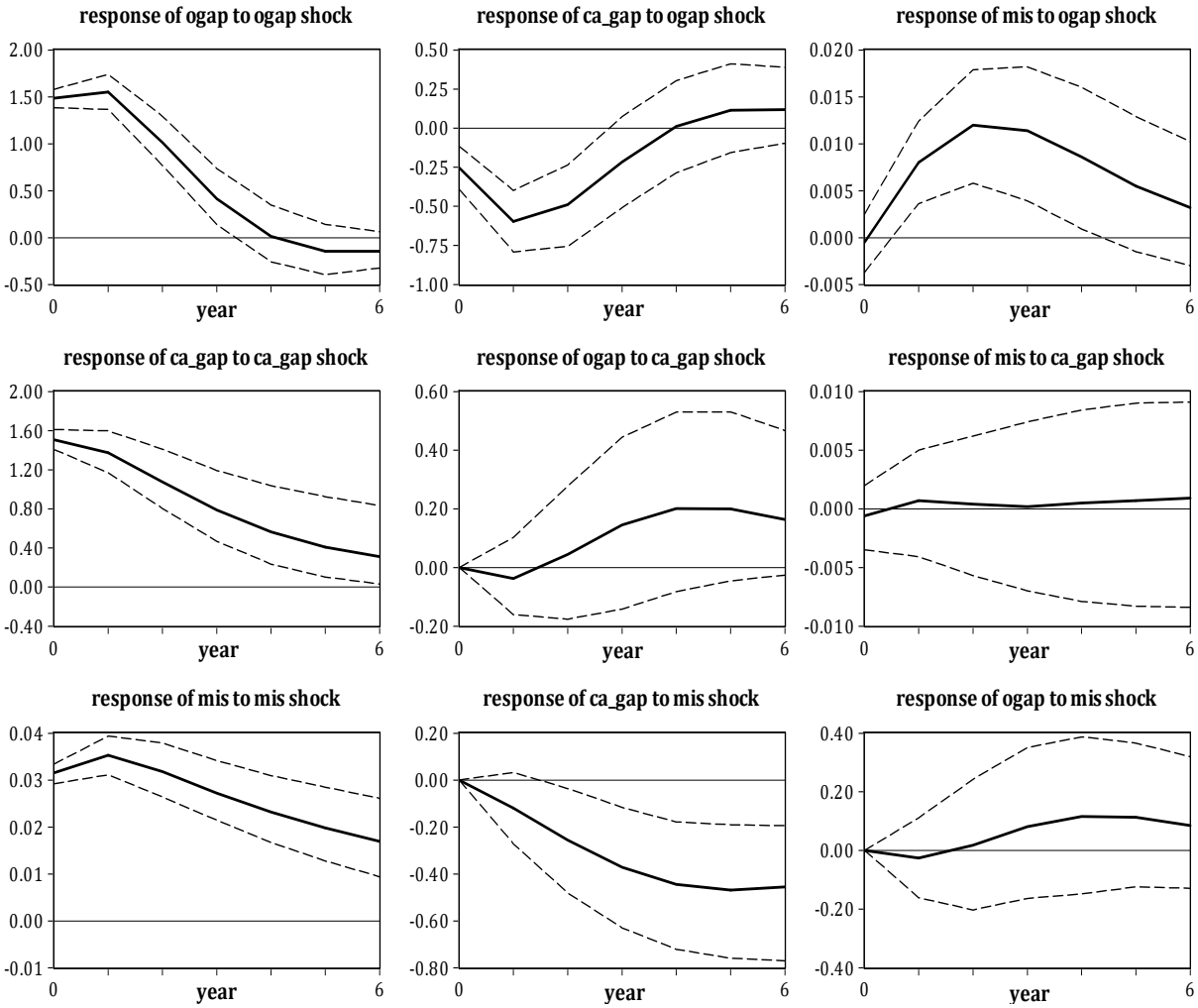


Note: Impulse-responses are represented by solid lines. Standard-error bands (dashed lines) are generated through Monte-Carlo simulations with 1000 repetitions.

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 in two sub-samples: 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, an economic overheating leads to currency overvaluation and important current-account deficit, and a currency-overvaluation shock tends to deepen current-account deficit. However, imbalances' magnitude and persistence in the euro area differ from those of the whole panel. Indeed, for an equivalent output-gap shock, the response of the current-account gap is less important in the euro area, while overvaluation is larger. As for the whole panel, adjustment towards equilibrium begins after one year for the current-account gap, and after two 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%.

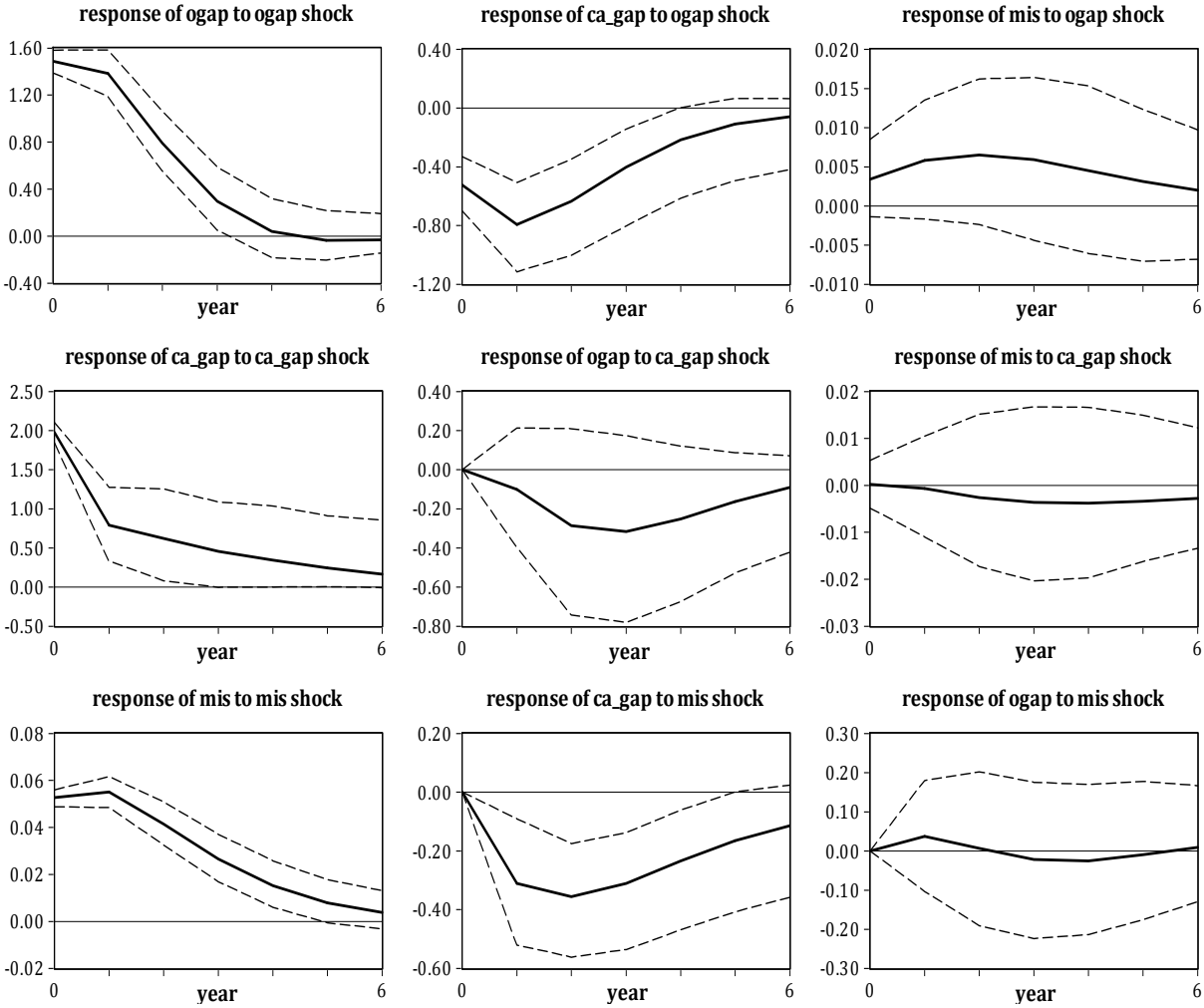
Figure 3. Impulse-response functions for euro area members



Note: Impulse-responses are represented by solid lines. Standard-error bands (dashed lines) are generated through Monte-Carlo simulations with 1000 repetitions.

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 a significant currency overvaluation. However, for a similar output-gap shock, current-account imbalances are larger than in eurozone. By cons, for a similar misalignment shock, current-account deficits are less important than in the euro area. Persistence of current-account imbalances is also weaker and adjustment towards equilibrium occurs more rapidly, the reversion beginning after two years.

Figure 4. Impulse-response functions for non-eurozone countries



Note: Impulse-responses are represented by solid lines. Standard-error bands (dashed lines) are generated through Monte-Carlo simulations with 1000 repetitions.

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 and non-members, with a greater impact for the latter. However, 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 non-members, with a more persistent impact for the former.

To complete our findings, we perform variance-decomposition analysis for assessing more precisely the percentage of variation in a variable explained by another variable. Results presented in Table 1 indicate that a change in 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 2.5% of the variation in output gap for eurozone members and 5.7% for non-members. Turning to external imbalances, output gap and misalignments respectively contribute for 8.3% and 17.2% in explaining current-account disequilibria in the eurozone, while these percentages amount to

21% and 5.8% for non-members. Our findings thus show that variations in current-account imbalances mainly result from exchange-rate misalignments in the euro area, and from output gap for non-eurozone members. Changes in currency misalignments mostly come from themselves, being however explained for about 7.5% by the output gap for the eurozone.

Table 1. Variance-decomposition results

	Ogap	Ca_gap	Mis
		All sample	
Ogap	99.97	0.01	0.02
CA_gap	14.75	77.24	8.00
mis	3.32	0.02	96.65
		Eurozone members	
Ogap	96.69	2.57	0.74
CA_gap	8.29	74.55	17.16
mis	7.46	0.06	92.48
		Non-eurozone members	
Ogap	94.22	5.70	0.09
CA_gap	21.05	73.12	5.82
mis	1.82	0.71	97.48

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

Our results are consistent with previous studies evidencing that expansionary fiscal policies, particularly in the economic convergence context, can lead to economic overheating which increases current-account deficits (Blanchard and Giavazzi, 2002). Beyond the convergence phenomenon, Lane and Pels (2012) also show that excessive current-account deficits are partly explained by overly optimistic prospects of economic growth. The importance of exchange-rate misalignments in explaining global imbalances, especially in the euro area, is consistent with the findings of Gnimassoun and Mignon (2013). The latter indeed show that low overvaluations can lead to strong persistence in current-account imbalances in the euro area, while it 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.

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.[17] 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 non causality (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 ($\tilde{Z}_{HNC}$) 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. The reverse causality hypothesis cannot be rejected for $K = 1$ and with $\tilde{Z}_{HNC}$. Regarding misalignments and the output gap, the HNC hypothesis from output gap to misalignments is generally rejected, while it is significantly rejected only for the Z_{HNC} statistic when considering the misalignment to output gap direction.

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 output gap to current-account imbalances seems to be clearly established, as well as from 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; 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 an 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.

[17] 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.

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

Lag order	*Statistic tests*								
	W_{HNC}	Z_{HNC}	$\tilde{Z}_{HNC}$	W_{HNC}	Z_{HNC}	$\tilde{Z}_{HNC}$	W_{HNC}	Z_{HNC}	$\tilde{Z}_{HNC}$
	mis to CAgap			**Ogap to CAgap**			**Ogap to mis**		
$K = 1$	2.34	4.45a	3.67a	2.57	5.20a	4.33a	2.21	4.02a	3.29a
$K = 2$	3.29	6.04a	2.23a	4.86	13.43a	5.37a	3.06	4.97a	1.78
$K = 3$	5.16	12.41a	2.96a	6.32	19.09a	4.79a	6.19	18.31a	4.58a
	CAgap to mis			**CAgap to Ogap**			**mis to Ogap**		
$K = 1$	1.522	1.73	1.29	1.39	1.28	0.90	1.60	2.00a	1.53
$K = 2$	2.603	2.83a	0.87	2.51	2.37a	0.67	2.75	3.50a	1.15
$K = 3$	4.202	6.91a	1.46	4.55	8.92a	2.01a	3.87	4.98a	0.93

Notes: "X to Y" means that we test the null hypothesis of homogenous non causality (HNC) from X to Y. The letter "a" indicates rejection of null hypothesis at the 5% significance level.

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

3.4 Robustness analysis

3.4.1 Alternative measures of macroeconomic imbalances

To check the robustness of our results, we perform again the IRF analysis 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 and Valdes (1999) and Béreau et al. (2012), among others. The output gap is constructed in the same way as being 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 to be homogeneous. 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 sub-panels. 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.

3.4.2 Interactions between the observed macroeconomic variables

Whatever the approach retained—being based on economic fundamentals or statistical method—macroeconomic imbalances are determined after estimating an "equilibrium level" 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. Given that 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 attempt 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 on the real effective exchange rate (a real appreciation) leads to a current-account deficit for all the considered panels. Similarly, a positive shock on 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 positively responds to a positive shock on current account for all samples. Finally, it is worth noting that responses to shocks are generally more persistent in case of 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 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.[18] Our results show that (i) a shock on economic growth or on 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.

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

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

external imbalances in developed countries given the challenge 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 strongly interact through a causal relationship. Specifically, current-account imbalances respond positively and significantly to an output-gap shock. Such pressure on the economy also generates an 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 against deep current-account deficits. Such deficits occur when these countries tend to produce beyond their level of potential output, in response e.g. of strong demand. Moreover, a currency overvaluation shock deepens the current-account deficit, with a more pronounced persistence for euro area members. Our findings are consistent with 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 to 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 absorption of internal imbalances—output gaps—and plummeting exchange-rate misalignments.

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Appendix

Table A.1. Sources of variables

Variables	Notation	Definition	Sources
Exchange-rate misalignments	Mis	Difference between actual exchange rate and equilibrium exchange rate	Gnimassoun and Mignon (2013)
Output gap	Ogap	Actual GDP less potential GDP (as a percent of potential GDP)	International Monetary Fund (IMF)
Current-account imbalances	CA_gap	Difference between observed current account and equilibrium current account	Gnimassoun and Mignon (2013)
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 panel unit root tests (IPS and CADF tests)

Variable	With constant		With constant and trend	
	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
Ogap	-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

The tests are based on the unit root null hypothesis. 2 lags are used for variables in levels, and 1 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, Pesaran and Shin (2003).

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

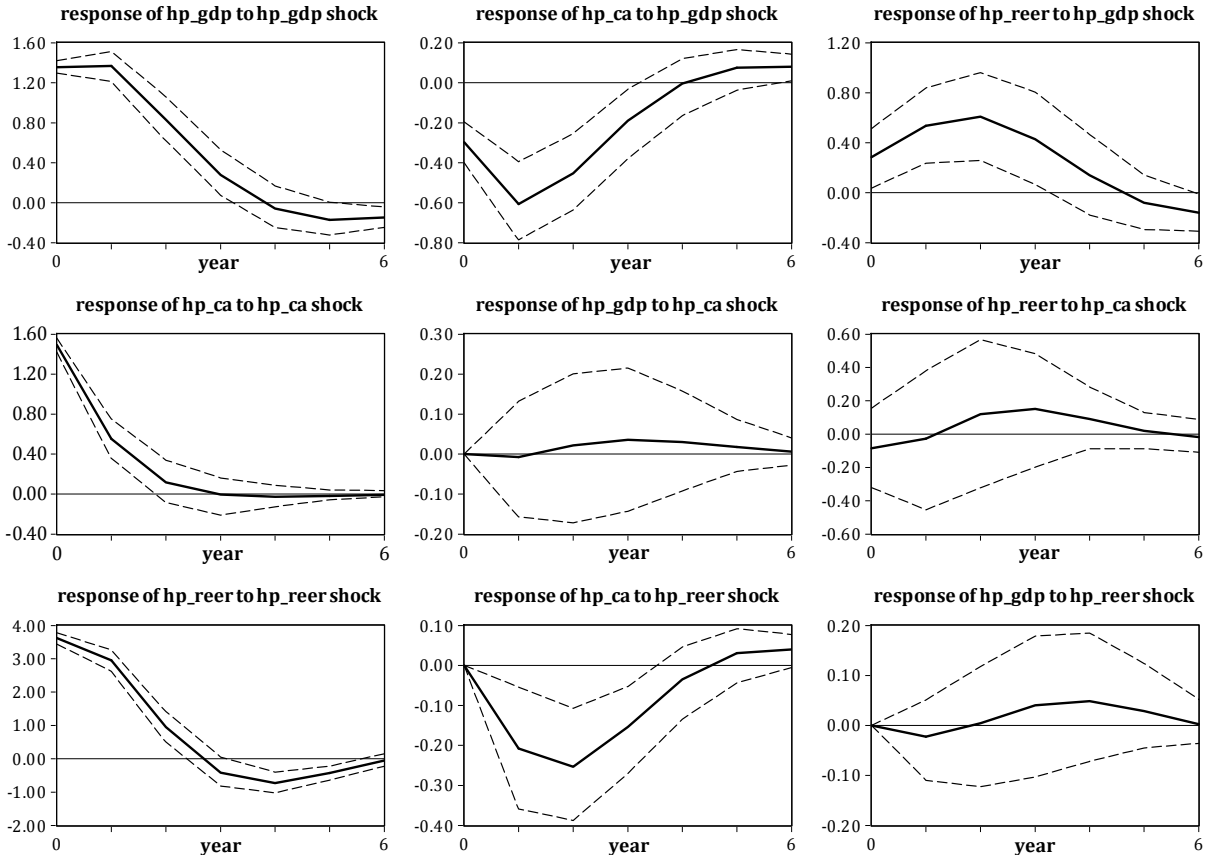

Figure A.2: IRFs for eurozone members (H-P filter measure of imbalances)

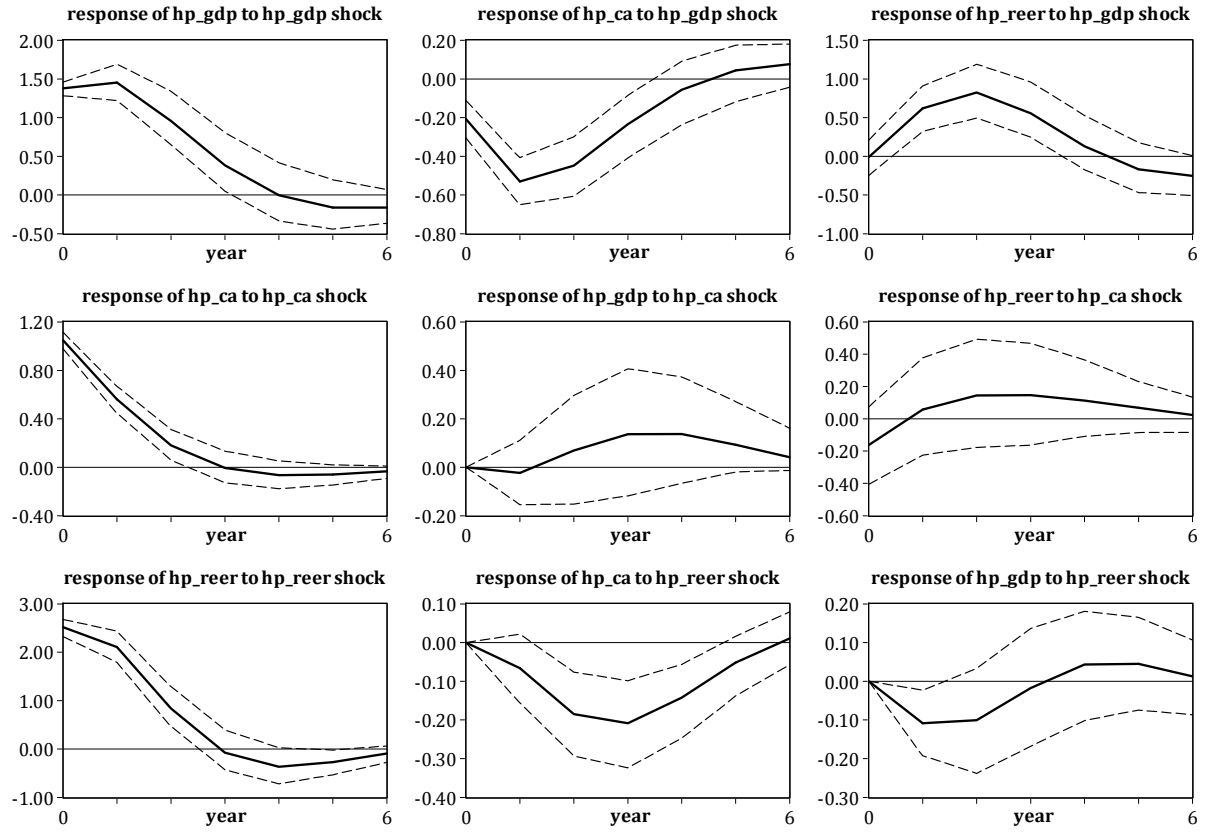

Figure A.3. IRFs for non-eurozone members (H-P filter measure of imbalances)

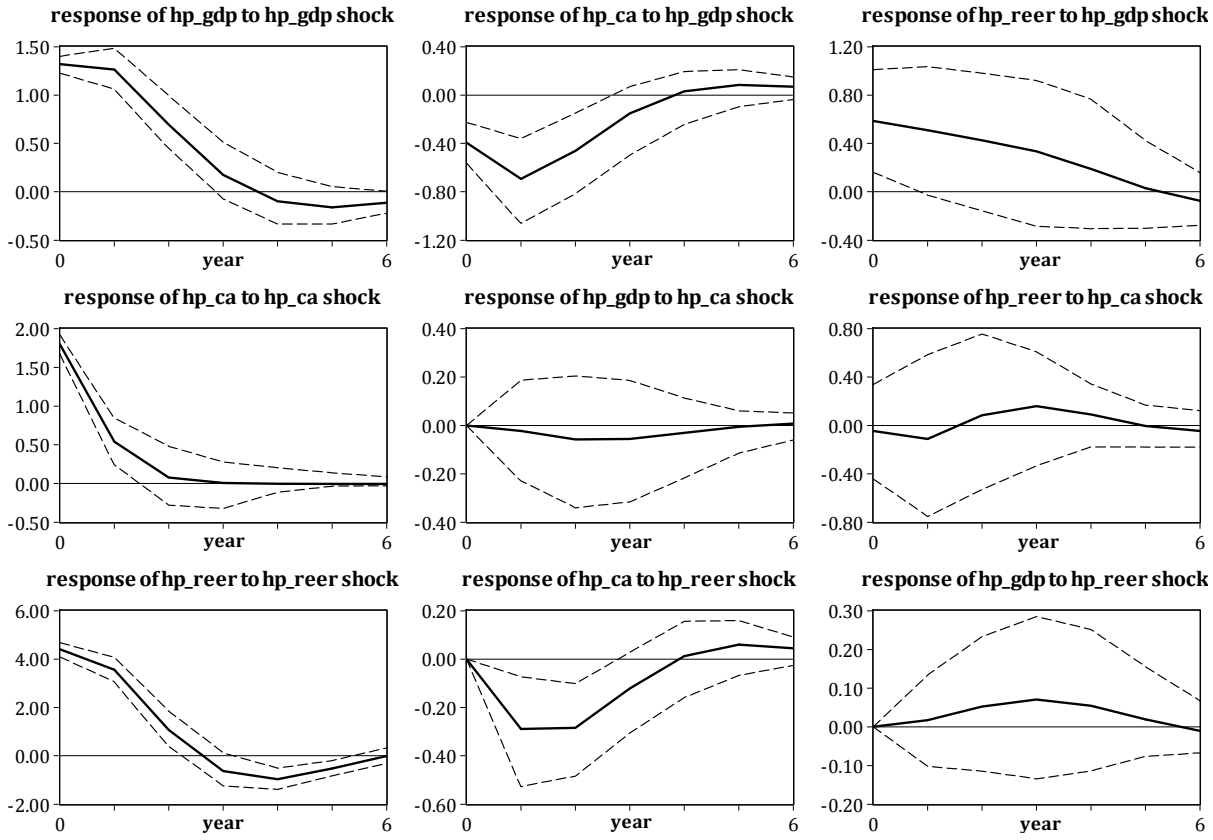

Figure A.4. IRFs for the whole sample (interactions between growth, CA, REER)

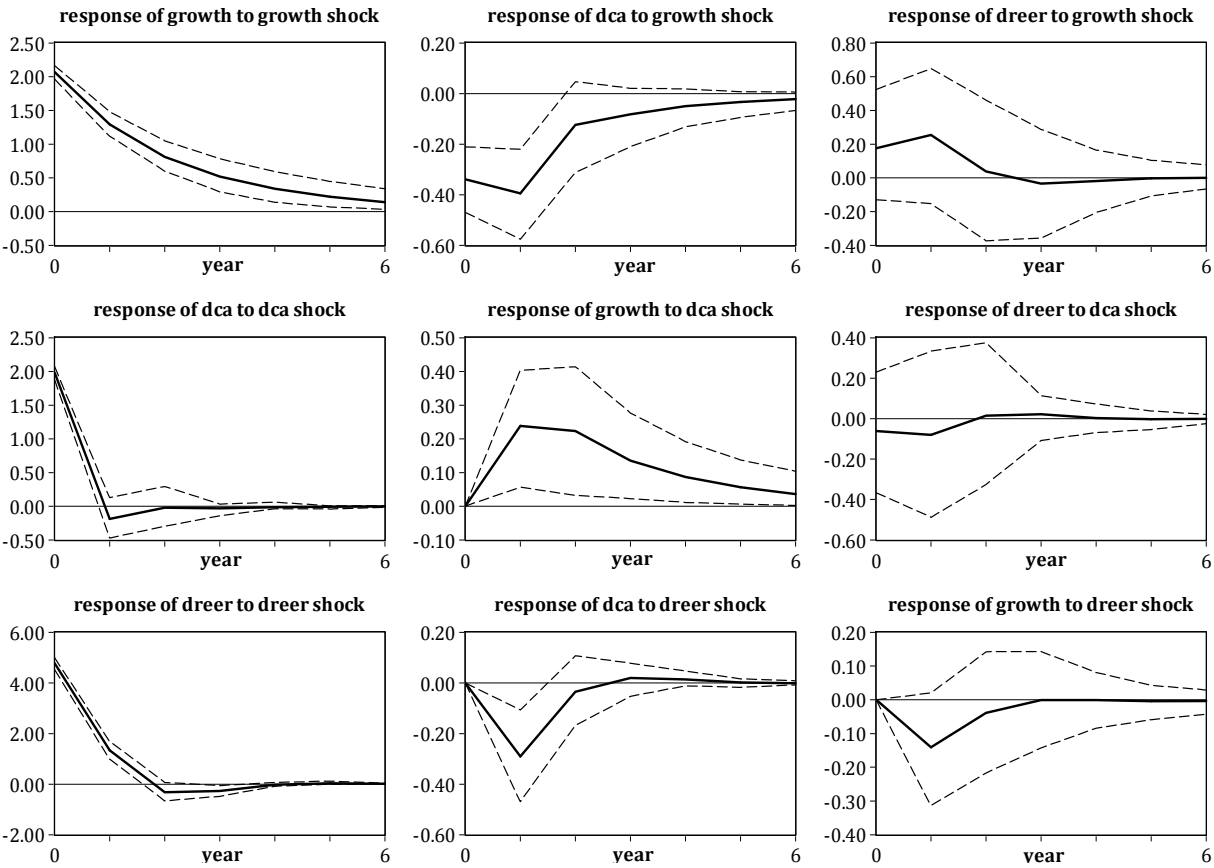

Figure A.5. IRFs for eurozone members (interactions between growth, CA, REER)

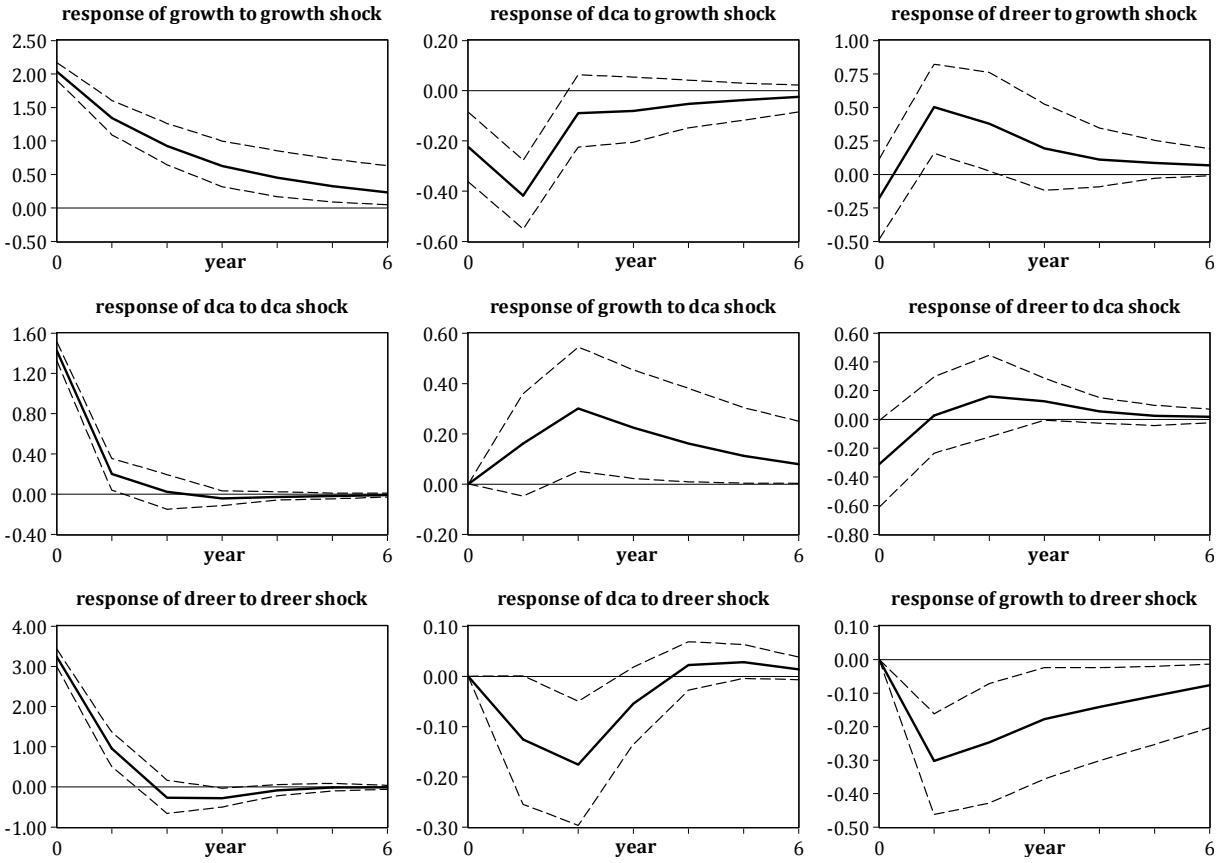

Figure A.6. IRFs for non-eurozone members (interactions between growth, CA, REER)