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Research Article

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Current-Account Imbalances, Real Exchange-Rate Misalignments, and Output Gaps

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Abstract: This study analyzes the relationships between domestic and foreign output gaps, current-account imbalances, and real effective exchange-rate (REER) misalignments. We first set up a theoretical framework based on the elasticities and absorption approaches of the balance of payments to derive and clarify these relationships. Next, we perform panel VAR estimates in a sample of 18 advanced economies between 1986 and 2017. We find an inverse relationship between domestic output gaps and current accounts with reciprocal influences between the two variables. Moreover, we observe that increases in current accounts generally boost both temporary and structural growth. Additionally, our results indicate that REER misalignment shocks cause reactions of the opposite sign on the current account and on cyclical economic growth. We also find evidence of higher growth resulting in a real exchange-rate appreciation, which supports the Balassa-Samuelson hypothesis.

Keywords: current account imbalances, real exchange-rate misalignment, output gap, Balassa-Samuelson hypothesis, PVAR

JEL: F32, F41, F47, F49

1 Introduction

This study examines the relationship between four macroeconomic imbalances, namely current-account imbalances, domestic and foreign output gaps, and real

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exchange-rate misalignments, in 18 advanced economies during the period 1986–2017. The main motivation is that these imbalances have become increasingly relevant with a variety of signs and sizes - over the past three decades, in both developed and developing countries, and that accurate understanding and diagnosis of such relationships are key for governments in the design of policies which address macroeconomic instability and economic crises.

The analysis presented in this study contains various contributions to the literature on the issue. First, we follow a recent line of research that focuses on the interactions between macroeconomic imbalances instead of the relationship between observed variables, as in most of the traditional literature. Second, we include the foreign output gap in the analysis as a novelty in correspondence with the theoretical setup laid out in this study. As a third innovation, our analysis uses a theoretical setting based on the elasticities and absorption approaches of the balance of payments, as opposed to recent literature usually focused on empirical analysis exclusively. According to this theoretical framework, the current account has a negative relationship with the real exchange rate misalignment and the domestic output gap and a positive one with the foreign output gap. However, there may be other unidirectional or bidirectional linkages between the four variables, which we intend to unravel with our econometric analysis.

We empirically investigate the interactions between the four imbalances using a panel of 18 advanced economies for the period 1986-2017, applying a panel VAR (PVAR), which is a methodology well suited to address the potential endogeneity between these variables. We also apply a Granger test to examine possible causal links and perform impulse-response analysis to study the effects of different shocks on the significant variables. Knowledge of the causal links between the four imbalances and of the responses of the variables to different shocks is essential in the study of, for instance, whether a widening of the current account deficit is caused by currency misalignments or by variations in the output gap. Finally, we repeat the PVAR estimates using a panel of

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observed variables instead of their estimated imbalances to overcome potential biases in the estimates. We obtain results that confirm our previous findings and therefore reinforce the robustness of the whole empirical investigation.

Our main findings are summarized as follows: First, the current account and the domestic output gap show an inverse relationship with bilateral causal links. Consequently, measures to reduce the output gap are particularly efficient to increase the current account, and policies that raise the current account, such as successful export promotion or import substitution strategies, reduce the output gap. Policies that restrain growth, for instance, contractive macroeconomic measures, also promote current account increases. Second, shocks on real effective exchange-rate (REER) misalignments cause a reaction of the opposite sign on the current account and on the output gap, which implies that boosting REER undervaluation increases the current account and enhances cyclical economic growth. Third, a positive shock in the current account stimulates economic growth. Finally, we observe that higher growth levels result in real exchange-rate appreciations, a finding that supports the Balassa-Samuelson hypothesis when increases in productivity growth is triggered by factors' productivity gains.

The rest of the paper is structured as follows: Section 2 reviews the literature on this issue. Section 3 presents the theoretical approach to the relationship between current-account imbalances, real exchange-rate misalignments, and domestic and foreign output gaps. In Section 4, we estimate those relationships for 18 advanced economies and the period 1986–2017, applying PVAR estimations accompanied by causality tests, impulse–response analysis, and a robustness check. Finally, Section 5 summarizes the main conclusions and derives some policy prescriptions.

2 Literature Review

The literature has devoted special attention to studying current-account imbalances. On the one hand, it analyzes their main determinants, and, on the other hand, it examines how the correction of these imbalances impacts other macroeconomic variables. As regards the determinants, the traditional theoretical approach highlights the linkages between the current account and the real exchange rate, as in Dornbusch and Fischer (1980) or Mundell (1961). However, there is, as yet, no consensus on the causal links between these two variables in the literature. Arghyrou and Chortareas (2008) examine this relationship for Eurozone countries, concluding that the current account and the REER influence each other on a two-way causality. Blanchard and Giavazzi (2002) and Stevens (2011) focus on the levels and behavior of savings and investments to explain current-account imbalances. By estimating an structural VAR (SVAR) model using a sample composed of the G-7 plus Spain, García-Solanes, Rodríguez-López, and Torres (2011) find that most of the variability of trade and current-account imbalances is caused by real demand shocks.

As far as the impact of corrections of current account imbalances is concerned, authors have generally found a strong negative impact on growth and employment. Edwards (2004) emphasizes that the negative effects caused by current-account reversals are less intense when the adjustments are implemented gradually in a context of flexible exchange rates and with high economic openness. Edwards (2005) estimates the effects of currentaccount reversals in a panel of 157 countries for the period 1970–2000 and concludes that in large countries, a 5% reversal in the current-account deficit reduces GDP by 5.25% in the year after the adjustment.

Atoyan, Manning, and Rahman (2013) and Lane and Milesi-Ferretti (2012) analyze the rebalancing process of the current account of EU countries in the aftermath of the financial crisis. They find that the economies that were exhibiting the biggest current account deficits before the crisis also suffered the greatest costs in terms of GDP. Darvas (2012a,b) and Tressel and Wang (2014) examine the adjustment processes in externally indebted countries of the Eurozone and find that the reversion of the current account of these economies practically ended in 2012. To accelerate the process, Darvas (2012a) suggested that the ECB depreciate the Euro. De Grauwe (2012) and Wolff (2012) stress that external rebalancing within the Eurozone is very asymmetric, forcing the Southern countries to suffer the greatest sacrifices in terms of GDP and employment. Sinn and Valentinyi (2013) advised internal devaluations as the only weapon to revert the strong current account deficits of the Southern countries of the Eurozone. Stockhammer and Sotiropoulos (2014) estimate that rebalancing the current account deficit of the peripheral countries of the Eurozone in 2007 would have required an average 47% GDP loss in all of these countries. García-Solanes, Torrejón-flores, and Ruíz-Sánchez (2018) applied the same methodology to a panel of five peripheral Eurozone countries and found that current-account reversals in these countries in the aftermath of the financial crisis inflicted significant - although individually varied - costs in terms of GDP losses, going from 32% in Greece to 6% in Ireland.

Finally, Lane and Pels (2012) link growth forecasts and current account figures, highlighting the bonds between these two variables.

Some authors focus on the relationships between pairs of macroeconomic variables other than those previously discussed in this study. For instance, Rodrik (2008) documents the relationship between real exchange rates and growth, and Béreau, Villavicencio, and Mignon (2012) associate currency misalignments and growth. Therefore, all these studies support the existence of linkages between the variables included in our analysis.

The common feature of all the above-mentioned contributions is that they examine the linkages between observed values of the variables, expressed either in levels or in variation rates. Some recent studies take a different perspective and focus on the interactions between estimated imbalances of the macroeconomic variables; i.e. on the relationship between current-account imbalances, output gaps, and real exchange rate misalignments. In particular, Gnimassoun and Mignon (2015) study a panel of 22 industrialized countries between 1980 and 2011 and conclude that the persistence of current-account imbalances depends on currency misalignments, particularly in the Eurozone, and they invite further examination of the interactions between external and internal imbalances. These authors follow their own suggestion in Gnimassoun and Mignon (2016), where they find that internal imbalances and exchange-rate misalignments cause current-account imbalances. In the same line, Comunale (2017) explores this kind of relationship in EU countries and concludes that financial and output gaps, and especially REER misalignments, impact the current account significantly. In our study, we adhere to this empirical approach and focus on the relationships between macroeconomic imbalances in a set of 18 industrialized countries.

3 Theoretical Framework

In this section, we build a basic model to clarify and make the relationships between internal, foreign, and external (current account) imbalances more explicit. Our starting points are the Marshall-Lerner elasticity framework and the absorption approach to the balance of payments.

We assume a small, open economy with a flexible exchange rate. Based on the most accepted tradition in open economy literature, we consider that the current account of this economy as a whole depends on domestic and foreign demand levels, the real exchange rate, and other structural factors such as regulations and preferences. The current account of this economy can be represented by the following function, in which the symbols below the letters indicate the sign of the partial derivatives of the current account with respect to each of its determinants:

$$CA_t = f\left(\alpha, \begin{array}{c} Q_t, \begin{array}{c} Y_t, \\ - \end{array}, \begin{array}{c} Y_t \\ + \end{array}\right)$$
(1)

In this equation, we denote for period t: CA_t the current account; Q_t the real exchange rate, being an increase of Q_t an appreciation of the domestic currency; Y_t the domestic demand; and Y_t^f the foreign demand. Also, α stands for the structural factors, which we assume constant. Equation (1) is, indeed, close to net exports equations or current account equations reported in standard macroeconomics textbooks (see, for instance, Blanchard, Amighini, and Giavazzi, 2010) or in the international economics literature (as in Greenhalgh, Taylor, and Wilson, 1994, which use a similar equation but excluding the foreign demand). Now, we introduce in equation (1) some parameters and rewrite them as follows:

$$CA_t = \alpha \, \frac{Y_t^{f^{\lambda}}}{Q_t^{\theta} Y_t^{\varphi}} \tag{2}$$

Parameters θ , λ , and φ reflect, respectively, the impact of the real exchange rate, foreign demand, and domestic demand on the current account. We can now introduce equilibrium values of the variables in equation (2) to present this identity when all variables are in balance and arrive at the following expression:

$$CA_t^* = \alpha \frac{Y_t^{*\lambda}}{Q_t^{*\phi} Y_t^{*\phi}}$$
(3)

where we denote the equilibrium values in period *t* of the current account, real exchange rate, foreign demand and domestic demand by CA_t^* , Q_t^* , Y_t^{f*} , and Y_t^* respectively. Also, we consider that, due to their structural nature, parameters θ , λ , and φ remain constant, as does α .

To examine the relationship between the current account and its equilibrium level in period t, we divide equations (2) and (3), and simplify the result to obtain:

$$\frac{\mathrm{CA}_{t}}{\mathrm{CA}_{t}^{*}} = \frac{Q_{t}^{*\theta}Y_{t}^{*\varphi}Y_{t}^{f^{\lambda}}}{Q_{t}^{\theta}Y_{t}^{\varphi}Y_{t}^{f^{*\lambda}}}$$
(4)

To express the above equation in rates of change, we take logs on both sides of the equation and take derivatives with respect to time. As a result, we obtain equation (5):

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$$\widehat{CA}_t - \widehat{CA}_t^* = -\theta(\hat{Q}_t - \hat{Q}_t^*) - \varphi(\hat{Y}_t - \hat{Y}_t^*) + \lambda(\hat{Y}_t^f - \hat{Y}_t^{f*})$$
(5)

where capital letters with hat denote the rate of change in period t of the respective variable. Note that for the case of domestic demand, the difference between the two rates of growth is

$$(\hat{Y}_t - \hat{Y}_t^*) = \frac{Y_t - Y_{t-1}}{Y_{t-1}} - \frac{Y_t^* - Y_{t-1}^*}{Y_{t-1}^*}$$
(6)

Assuming that the economy is in equilibrium in the initial period t-1 ($Y_{t-1} = Y_{t-1}^*$), we have

$$\frac{Y_{t} - Y_{t-1}}{Y_{t-1}} - \frac{Y_{t}^{*} - Y_{t-1}^{*}}{Y_{t-1}^{*}} = \frac{Y_{t} - Y_{t-1}^{*} - Y_{t}^{*} + Y_{t-1}^{*}}{Y_{t-1}^{*}}$$

$$= \frac{Y_{t} - Y_{t}^{*}}{Y_{t-1}^{*}} = (y_{t} - y_{t}^{*})$$
(7)

where y_t and y_t^* are the logs of Y_t and Y_t^* , respectively. Consequently,

$$(\hat{Y}_t - \hat{Y}_t^*) = (y_t - y_t^*)$$
 (8)

The same procedure can be applied to the deviation of the current account from its equilibrium level $(\widehat{CA}_t - \widehat{CA}_t^*)$, the real exchange rate misalignment $(\hat{Q}_t - \hat{Q}_t^*)$, and the foreign output gap $(\hat{Y}_t^f - \hat{Y}_t^{f*})$, so that

$$(\widehat{CA}_t - \widehat{CA}_t^*) = (ca_t - ca_t^*)$$
(9)

$$(\hat{Q}_t - \hat{Q}_t^*) = (q_t - q_t^*)$$
(10)

$$(\hat{Y}_t^f - \hat{Y}_t^{f^*}) = (y_t^f - y_t^{f^*})$$
(11)

where lowercase letters denote logs of the corresponding variables.

Taking the above derivations into account, equation (5) can be rewritten as

$$ca_{t} - ca_{t}^{*} = -\theta(q_{t} - q_{t}^{*}) - \varphi(y_{t} - y_{t}^{*}) + \lambda(y_{t}^{f} - y_{t}^{f^{*}})$$
(12)

According to equation (12), we should expect that the deviation of the current account from its equilibrium level $(ca_t - ca_t^*)$ depends negatively on the real exchange-rate misalignment $(q_t - q_t^*)$ and the domestic output gap $(y_t - y_t^*)$, and positively on the foreign output gap $(y_t^f - y_t^{f*})$. We expect, then, that overvaluation of the domestic currency, an overheated economy, and/or a global demand performing below its potential level push the domestic current account towards levels below equilibrium.

Equation (12) is in line with Arghyrou and Chortareas (2008) and Gnimassoun and Mignon (2015, 2016), among

others, in regard to the relationship between the variations of the current account and the real exchange rate. It is also in line with Gnimassoun and Mignon (2016) and Comunale (2017) in including domestic output gaps in the analysis of these imbalances. The introduction of the foreign output gap is, to the best of our knowledge, an innovation of our study, while it is indirectly consistent with previous literature as Comunale (2017), who uses world GDP growth to control for global factors. It is also consistent with the common idea, also pointed out by several authors such as Roeger, Mc Morrow, Hristov, and Vandermeulen (2019), that buoyant external demand conditions can foster current account surplus.

4 Empirical Analysis

In the case of a panel of N counties and T periods, equation (12) is presented as

$$(ca - ca^{*})_{it} = \theta_{i} + \beta_{1}(q - q^{*})_{it} + \beta_{2}(y - y^{*})_{it} + \beta_{3}(y^{f} - y^{f^{*}})_{it} + \varepsilon_{it}$$
(13)

$$i = 1, 2, ..., N \quad t = 1, 2, ..., T$$

The term ε_{it} is the random error, which is distributed with zero mean and constant variance, and θ_i is a fixed effect. Finally, β_1 , β_2 , β_3 are the model parameters that we will estimate.

Our empirical analysis consists of the following steps: We first use the panel data to estimate a PVAR based on equation (13), and then we perform causality tests; next, we carry out impulse-response analysis based on our previous PVAR estimations. This methodology is well suited to address the potential endogeneity between the variables and also allows us to examine the interactions and the causal links between the variables involved. Yet, it is important to take into account the fact that PVARs do not directly reveal the underlying structure of the relationships between variables, and that is why it is relevant to complement them with theoretical developments as those presented in Section 3. Additionally, PVAR coefficients are hard to interpret due to their large number and the interrelations between them, requiring other tests to clarify the results, such as impulse-response analysis. In the same way, they necessitate a large number of observations as they rely on a high number of parameters. Also, our PVAR relies on unobserved variables, which may suffer from estimation bias. Therefore, in the final part of the study, we repeat the PVAR estimation and the impulse-response

analysis using a new panel with observed macroeconomic variables - instead of deviations from equilibrium - in order to avoid potential estimation biases, which may be a consequence of using non-observable variables.

4.1 Sample Data

Our panel includes 18 advanced economies: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Portugal, Spain, Sweden, the UK, and the US over a 32 year period between 1986 and 2017, for which there is sufficient information from data sources of recognized institutions. Our analysis starts from the second half of the 1980s, once the economies overcame the structural changes that characterized the first half of that decade, including a general revision of the macroeconomic policy framework, which led to the start of the period known as "the great economic moderation."

As detailed in Table 1, we obtain most of the data for our panel from the IMF and the World Bank. We use the current-account balance as a percentage of GDP as a proxy for current-account imbalances. This assumes that the equilibrium level of the current account is zero for each country, thus avoiding *ad hoc* estimations of the equilibrium current account, which are controversial and not provided by internationally recognized sources. In addition, we use the output gap of advanced economies as the foreign output gap. It is an appropriate proxy of the "effective" foreign output gap since most of the external economic relationships of the countries in the sample concentrate on advanced economies. Another advantage of the latter assumption is that the IMF database includes this variable, and thus it is calculated using criteria consistent with the rest of the domestic output gap data of our panel.

As far as REER misalignments are concerned, the literature includes several approaches to calculate equilibrium exchange rates and REER misalignments. For instance, one common method is the fundamental equilibrium exchange rate approach (FEER) developed by Williamson (1983, 1994), which considers that the equilibrium real exchange rate must be compatible with balanced internal and external equilibria, and thus uses medium- to long-term fundamentals to estimate the equilibrium exchange rate. Another popular method is the behavioral equilibrium exchange rate approach (BEER) proposed, among others, by Alberola, Cervero, López, and Ubide (1999), Clark and MacDonald (1999), and Farugee (1994), which relies on the estimation of a long-term relationship between the real exchange rate and its determinants. In our study, we use REER misalignments from the CEPII Exchange database of Couharde, Delatte, Grekou, Mignon, and Morvillier (2018). In this database, REER misalignments are expressed as a percentage of their equilibrium level, with an increase in that variable representing an appreciation of the domestic currency. We believe that this estimation is appropriate for our research since it uses a BEER methodology, which has a long-run approach coherent with our time sample of more than three decades. Moreover, it contains a large number of countries and years calculated with a consistent methodology, and therefore it provides enough consistent data for our panel and estimations. The definitions and sources of the data that we use in our panels to perform our empirical analysis are summarized in Table 1.

Current-account balance	IMF World Economic Outlook October 2019. Current-account balance in percentage of GDP.
REER misalignments	CEPII Exchange, Couharde et al. (2018). Currency misalignments are the difference between the observed REER and its equilibrium level, for 186 trading partners, with a moving weighting scheme based on 5-year non- overlapping averages. Data from November 2019. More details in http://www.cepii.fr/ CEPII/fr/bdd_modele/presentation.asp?id=34.
Output gap and advanced economies output gap	IMF World Economic Outlook October 2019. Actual GDP less potential GDP (in % of potential GDP).
GDP growth	World Bank World Development Indicators. Data from December 2020. Annual percentage growth rate of GDP at market prices.
REER change	Obtained calculating interannual % change from the REER index from the World Bank World. Development Indicators. Data from December 2020. Year-on-year % change.

Table 1: Data sources and definitions

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Figure 1: Scatter plot of the sample of 18 advanced economies between 1986 and 2017.

To gain a first insight into the relationship between the current account and the output gap, the REER misalignment, and the advanced economies output gap, in Figure 1 we represent the three respective scatter plots with a regression line that suggests negative relationships. In the case of the first two scatter plots, which include the output gap and the REER misalignment, these negative relationships are coherent with our theoretical development. Yet, in the case of the foreign output gap, this outcome is not in line with our theory, which could suggest a lack of significance of the variable. Additionally, this could be a result of the influence of other variables or of the atypical structure of the scatter plot due to the fact that the foreign output gap series is the same for all countries in the sample. In any case, as presented in our theoretical development, other variables affect these interactions, and thus Figure 1 provides only a first graphic overview, which is by no means conclusive. Therefore, it is appropriate to apply quantitative analysis to our panel to analyze these relationships.

4.2 PVAR

4.2.1 Panel Stationarity

PVAR approach is particularly useful to examine the interactions and causal relationships between these imbalances for the whole sample as it appropriately addresses the potential endogeneity problems between the variables involved. First, we test for cross-sectional dependence between the variables, which is usually present in international macroeconomic panels as a result of external shocks, contagions between countries, or other unobservable factors (more in Baltagi & Pesaran, 2007). We apply four cross-sectional dependence tests: the Breusch–Pagan LM test (1980), the Pesaran LM scaled test (2004), the Pesaran CD test (2004), and the Baltagi, Feng, and Kao bias-corrected scaled LM test (2012). The results, shown in Table 2, indicate that there is cross-sectional dependence with a 1% significance level in all cases but one. Thus, we consider it reasonable to assume that there is cross-sectional dependence in the data.

Estimation of a PVAR requires verifying the stationarity of the variables. A visual analysis of the series (available in Figure A1 in the Annex) suggests that they are stationary, as theoretically expected. To test formally whether the variables are stationary, we use four different unit root tests with specific properties to address the presence of crosssectional dependence: the Levin, Lin and Chu test (2002); the Breitung test (2000) using a version of the statistic based on Breitung and Das (2005) that is robust to crosssectional dependence; and the Hadri Lagrange multiplier stationarity test (2000) using a variant that is robust to heteroscedasticity across panels. As suggested by Levin, Lin, and Chu (2002), we remove cross-sectional means in the Levin, Lin and Chu test and the Hadri test to mitigate the impact of cross-sectional dependence. In addition, to address the cross-sectional correlation problem, the Breitung test uses a version of the statistic based on Breitung and Das (2005) that is robust to cross-sectional correlation. Finally, we apply a second-generation test also robust to cross-sectional dependence problems, the covariate augmented dickey-fuller (CADF) unit root test (Pesaran, 2007), for two lags and alternatively with only a constant and with a constant and a trend. In the case of the advanced economies output gap series, we use the ADF test on the individual time series as it is the same for all countries. The results (available in Table 2) show stationarity at a 5% significance level for a vast majority of the

		Cross-sectional depende	ence tests		
	Breusch–Pagan LM	Pesaran scaled LM	Bias-corrected scaled LM	Pesaran CD	
Current account	926.383***	44.211***	43.92103***	1.4794	
REER misalign.	824.183***	38.367***	38.07863***	3.9550***	
REER change	1070.87***	52.471***	52.18068***	14.580***	
Output gap	1393.28***	70.902***	70.61162***	34.436***	
GDP growth	1603.44***	82.916***	82.62570***	37.593***	
Null hypothesis: No	cross-sectional dependence	9			

Table 2: Cross-sectional dependence and unit root tests

	· · · ·	nit root tests			
	Levin, Lin, and Chu <i>t</i> *	Breitung	Hadri		Pesaran CADF
				w/constant	w/constant and trend
Current account	-36.443***	-28.983***	272.45***	2.076	2.334
REER misalign.	-63.151***	-20.801***	287.95***	-1.149	0.865
REER change	-181.388***	-38.867***	-0.398	-6.428***	-4.754***
Output gap	n.a. ⁽¹⁾	n.a. ⁽¹⁾	n.a. ⁽¹⁾	-3.274***	-2.842***
GDP growth	-122.922***	-18.879	63.72***	-5.112***	-2.272**
Adv. Ec. output Gap	Augmented Dickey-Fuller (ADF) test	-3.08***			

Null hypothesis: series is not stationary.

N: 18; *t*: 32 (1986–2017); obs.: 576. ***indicates significance at a 1% level; **5% level; *10% level. Hadri test applied in a variant that is robust to heteroskedasticity across panels. ADF and Levin, Lin, and Chu *t** test applied with no constant; ADF, Levin, Lin, and Chu *t** test and Im, Pesaran and Shin test applied with a number of lags chosen by the Akaike information criterion with a maximum of two, and Breitung test and Pesaran CADF tests applied with two lags. ⁽¹⁾n.a.: not applicable since it requires a balanced panel.

tests and variables, and most of them at a 1% significance level. We then conclude that all the variables in the model are I(0), as would be theoretically expected.

4.2.2 PVAR Estimation

We estimate a PVAR with the current-account balance, REER misalignment, domestic output gap, and the advanced economies output gap as endogenous variables. To choose the number of lags, we start estimating the PVAR with four lags, since the data are annual, and then use the information criteria of Akaike, Hannan-Quinn, Schwarz, and the final prediction error to select the optimum number of lags (results in Table 3). Two of the four tests select three lags, while the Hannan-Quinn criteria are nearly equal for two or three lags. Thus, we use three lags.

Then, we test whether there is residual autocorrelation using a Residual Serial Correlation LM Test based on Breusch–Godfrey with the Edgeworth corrective expansion. The results, in Table 4, indicate that the residuals do not present autocorrelation for three lags at a 5% significance level. Finally, we confirm that the PVAR is Table 3: VAR lag selection criteria

	Lags			
_	1	2	3	4
Final prediction error	46.096	33.996	32.312*	32.519
Akaike I.C.	15.182	14.878	14.827*	14.833
Schwarz I.C.	15.351	15.182*	15.266	15.407
Hannan-Quinn I.C.	15.249	14.997*	14.999	15.059

*indicates number of lags selected by the criterion. Balanced panel. *N*: 18; *t*: 32 (1986–2017); obs.: 499.

Table 4: PVAR residual serial correlation LM test

Lags	LRE stat	Prob.
1	25.17	0.07*
2	20.63	0.19
3	16.13	0.44
4	25.56	0.06*
5	21.41	0.16

Null hypothesis: no serial correlation at lag X.

N: 18; *t*: 32 (1986–2017); obs.: 518. ***indicates significance at a 1% level; **5% level; *10% level.

stationary since all the inverse roots of its characteristic polynomials are inside the unit circle. The estimated PVAR with three lags (available in Table 5) shows that variables have relevant *t*-statistics in general, thus supporting their significance, with the exception of the advanced economies output gap, which presents low *t*-statistics.

4.2.3 Granger Causality Tests and Impulse-Response Analysis

To examine the structure of the causal links between these variables, we apply a VAR Granger causality/Block exogeneity Wald Test. This is a statistical hypothesis test to determine whether one variable is useful for forecasting

Table 5: PVAR estimation 1986-2017

	Current Account	REER Misalign.	Output Gap	Adv. Ec. Output Gap
C. Account(-1)	0.914475	0.068720	-0.102953	0.000624
	[20.1362]	[0.49389]	[-2.06422]	[0.01803]
C. Account(-2)	0.079988	-0.243346	-0.047764	-0.050511
	[1.25371]	[-1.24492]	[-0.68169]	[-1.03877]
C. Account(-3)	-0.041874	0.067874	0.207635	0.065240
	[-0.87788]	[0.46445]	[3.96373]	[1.79460]
REER Misalign.(-1)	0.009485	1.103619	-0.029279	0.003488
	[0.65869]	[25.0167]	[-1.85155]	[0.31780]
REER Misalign.(-2)	-0.060310	-0.340853	0.035605	0.000133
	[-2.88066]	[-5.31398]	[1.54857]	[0.00832]
REER Misalign.(-3)	0.066557	0.070681	-0.030181	-0.008069
	[4.58476]	[1.58919]	[-1.89312]	[-0.72934]
Output Gap(-1)	-0.242164	0.218350	1.078313	-0.025738
	[-4.31719]	[1.27055]	[17.5045]	[-0.60205]
Output Gap(-2)	0.255283	-0.201170	-0.456250	-0.010060
	[3.19703]	[-0.82231]	[-5.20285]	[-0.16531]
Output Gap(-3)	-0.039932	0.030293	0.068520	-0.000490
	[-0.73770]	[0.18266]	[1.15264]	[-0.01188]
Adv.Ec.Output Gap(-1)	0.023512	-0.094651	-0.116282	0.813164
	[0.28606]	[-0.37588]	[-1.28826]	[12.9814]
Adv.Ec.Output Gap(-2)	-0.063756	0.081512	0.071704	-0.270693
	[-0.60831]	[0.25385]	[0.62297]	[-3.38880]
Adv.Ec.Output Gap(-3)	-0.022727	0.089430	-0.016230	-0.048547
	[-0.29784]	[0.38254]	[-0.19368]	[-0.83478]
Constant	0.021869	0.086341	-0.137800	-0.260076
	[0.33598]	[0.43296]	[-1.92772]	[-5.24258]
<i>R</i> -squared	0.900294	0.765365	0.711208	0.460061
F-statistic	379.9916	137.2732	103.6387	35.85752
Number of coefficients		52		

Included observations: 518 after adjustments; t-statistics in [].

				Dep	oendent			
	Current	Account	REER M	isalign.	Outp	ut gap	Adv.Ec.(Dutput gap
Excluded	Chi-sq.	Prob.	Chi-sq.	Prob.	Chi-sq.	Prob.	Chi-sq.	Prob.
C. Account	N.A.	N.A.	6.70	0.08*	28.31	0.00***	4.18	0.24
REER Misalign.	21.70	0.00***	N.A.	N.A.	9.07	0.03**	1.25	0.74
Output Gap	20.22	0.00***	1.69	0.64	N.A.	N.A.	2.36	0.50
Adv.Ec.Output Gap	1.58	0.66	0.67	0.87	1.80	0.61	N.A.	N.A.
All	56.65	0.00***	9.56	0.39	46.73	0.00***	6.99	0.64

Table 6: VAR granger causality/block exogeneity Wald tests

N: 18; *t*: 32 (1986–2017); obs.: 518. Null: Excluded variable does not Granger-cause the dependent variable. ***indicates significance at a 1% level; **5% level; *10% level.

another. We present the results in Table 6, with the excluded variables listed in the first column under the heading "Excluded," and the dependent variables heading the rest of the columns. The null hypothesis is that the excluded variable does not Granger cause the dependent variable. Hence, if the null is rejected, the results from this test verify that the excluded variable Granger causes the variable on the corresponding column.

Results in Table 6 indicate that some variables have causal links in both directions. In particular, the current account and the output gap Granger cause each other at a 1% significance level. The current account and the REER misalignment also Granger cause each other, even though the significance level is higher for the REER misalignment Granger causing the current account than the other way around. In Table 6 we observe that REER misalignments Granger cause output gaps, while we do not find evidence of the opposite being true. These results are coherent with findings by Arghyrou and Chortareas (2008), Gnimassoun and Mignon (2015, 2016), and Comunale (2017) in determining that current account and real exchange rates are closely linked, with stronger evidence supporting the causality direction from the REER misalignment to the current account rather than vice versa. Additionally, they are in tune with Lane and Pels (2012), Gnimassoun and Mignon (2016), and Comunale (2017) in that variations in output gaps, or growth, impact the current account. The results are consistent too with Lane and Pels (2012), among others, which link economic growth forecasts with the current-account balance. They are also coherent with Rodrik (2008) and Béreau, Villavicencio, and Mignon (2012), among others, who associate currency misalignments with GDP growth.

Finally, as observed in Table 6, we do not find evidence of causality in any direction between the advanced economies' output gap and the other variables. This result is fully consistent with the low *t*-statistics in the PVAR estimation, suggesting a lack of significance of the coefficients of this variable. It may be one of the reasons why the foreign output gap has been traditionally excluded in the analysis of this issue. It could also reveal difficulties in the analysis of this variable at an aggregate level as not all current accounts can evolve in the same direction as a response to a variation of the foreign output gap, and also due to its close links to domestic output gaps, in particular those of major economies.

Next, to analyze the dynamics of this PVAR, we perform an impulse–response analysis using a time horizon of six periods, as in Gnimassoun and Mignon (2016) and focus on the four relationships with a Granger causality significant at a 5% level. The results are presented in Figure 2.

The impulse-response analysis indicates that domestic economic overheating generates current account deficits. In particular, the results in Figure 2 show that a shock in the output gap causes the opposite response in the current account. These responses are in line with our theoretical setting and with other research in the literature, such as Comunale (2017), Gnimassoun and Mignon (2016), or Phillips et al. (2013). We also observe in Figure 2 that a currency overvaluation shock increases current account deficits in the medium term and restrains economic activity from the outset. In more detail, a REER misalignment positive shock, which could reflect a REER appreciation, causes an inverted "J curve" effect on the current account: a slightly positive response in the first two periods and then a negative response between periods 3 and 5. Nevertheless, this response is not assured in all cases since the confidence interval also includes the possibility of neutral or positive reactions. The negative impact of the REER misalignment on the current account would agree with Comunale (2017) and Gnimassoun and



Response to Cholesky One S.D. (d.f. adjusted) Innovations ± 2 S.E.

Figure 2: Impulse–response analysis. Solid lines represent impulse–response and dashed lines are standard error bands created by Montecarlo simulations with 10,000 repetitions.

Mignon (2015, 2016). Additionally, the REER misalignment shock also causes a negative response in the output gap, which would be in tune with the common idea that a currency appreciation curbs the demand for domestic goods and thus moderates economic activity.

Finally, a positive shock on the current account reduces the output gap. This negative impact is less conventional and suggests that positive current-account shocks could increase the potential output more than the current output; i.e., their permanent or structural effects on output are greater than temporary ones.

4.2.4 Robustness Check Using Observed Variables

The REER misalignment and output gap data – domestic and foreign – used in our panel analysis are constructed as the difference between the observed value of the variable and its estimated equilibrium value. While this procedure is consistent with the concept of macroeconomic imbalance and with the theoretical relationships derived in Section 3 of this study, it is important to be aware of the potential for estimation bias. Moreover, it is worth noting that, in practice, government policy actions are often guided more by the observed or predicted changes in the macroeconomic variables than by estimates of their corresponding imbalances, which are nonobservable and thus controversial. In order to account for these considerations, we repeat the PVAR estimate, the Granger causality test, and the impulse–response analysis using a new panel with observable variables, as in Gnimassoun and Mignon (2016). Note that in this way, we carry out a robustness exercise of the results obtained in the previous sections.

In this section, we work with a new panel with the same sample of countries and the same time span (1986–2017) as in the previous section, but using the following variables: the current account as a percentage of GDP, the interannual REER percentage change, and economic growth measured as the GDP interannual percentage change (data sources and definitions in Table 1). We exclude foreign growth figures from this analysis due to their lack of significance in our previous PVAR. Given the close relationships between these observed variables and the ones used in the previous PVAR, we should expect patterns of behavior and responses similar to those in the previous analysis, although not strictly identical.

To estimate this new PVAR, we first repeat the crosssectional dependence tests on the variables used in this estimation (results in Table 2). They confirm the existence of cross-sectional dependence, and thus we repeat the same unit root tests presented before (results in Table 2), which verify that these variables are stationary. Next, we estimate the PVAR with current-account balances, REER changes, and GDP growth as endogenous variables. To choose the number of lags, we start by estimating the PVAR with three lags, which was the number used in the previous PVAR. We then use the information criteria of Akaike, Hannan-Ouinn, Schwarz, and the final prediction error to select the optimum number of lags, which in most cases select three lags, as in the previous PVAR (results can be found in Table 1 of the Appendix to this article, Table A1). We then test whether there is residual autocorrelation using a Residual Serial Correlation LM Test based on Breusch-Godfrey with the Edgeworth corrective expansion. The results (Table A2) indicate that the residuals do not present autocorrelation for three lags. Finally, we confirm that the PVAR is stationary since all the inverse roots of its characteristic polynomials are inside the unit circle. The estimated PVAR with three lags (Table A3) presents high t-statistics for most variables, suggesting that the variables are significant in general.

To examine the structure of the causal links between these variables, we apply a VAR Granger causality/Block exogeneity Wald Test again, using the same procedure as in the previous PVAR (results in Table 7). These results show that the current account and growth Granger cause each other at a 1% significance level, in line with the results of the previous PVAR, while we also find evidence of growth Granger causing REER change and REER changes Granger causing the current account, all at a 1% significance level. These results are consistent with the findings in the previous PVAR.

To analyze the dynamics of this PVAR, we perform an impulse–response analysis (Figure 3), focusing on the four relationships with a significant Granger causality.

Responses are very similar to our previous results in most cases, supporting their robustness. In particular, a positive growth shock results in a decline of current account figures and an appreciation of the REER, reducing the competitiveness of the country. It is interesting to note that while in the previous analysis, the variations of the output gap did not influence the real exchange rate, in the present exercise, an increase in economic growth significantly appreciates the real exchange rate, and Granger causes that appreciation. This confirms the Balassa-Samuelson hypothesis provided that increases in economic growth are led by improvements in the factors' productivity, as is usual in the vast majority of cases with long-term horizons. Figure 3 also shows that REER appreciation results in a deterioration of the current account, which can be explained by adverse switching effects on the demand for domestic products as stipulated by conventional macroeconomics textbooks. And again, results do not rule out a "J curve" effect as this effect is possible within the standard error bands.

Finally, a current-account shock impacts slightly negatively on economic growth during the first two periods, even though this first response is uncertain due to confidence intervals that include positive and negative responses, while the response is positive from period three onwards. The final effect of a current-account shock on economic growth is consistent with the negative response of the output gap to the same shock found in the previous impulse-response analysis once we take into account that behind the effects on the output gap there is an increase in both the current and the potential output. Thus, these results suggest that the latter increases to a greater extent, in particular during the first periods. All in all, this robustness check is generally coherent with our previous findings and with the literature explored previously in this study.

The empirical results obtained from the complementary tests performed on our sample of advanced

Table 7: VAR	granger	causality/	block	exogeneity	/ Wald	tests
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			Depe	endent		
	Current	account	REER	change	GDP	growth
Excluded	Chi-sq.	Prob.	Chi-sq.	Prob.	Chi-sq.	Prob.
Current account	N.A.	N.A.	0.75	0.86	17.37	0.00***
REER change	21.30	0.00***	N.A.	N.A.	1.31	0.73
GDP growth	63.67	0.00***	16.49	0.00***	N.A.	N.A.
All	84.02	0.00***	19.75	0.00***	18.82	0.00***

N: 18; *t*: 32 (1986–2017); obs.: 522. Null: Excluded variable does not Granger-cause the dependent variable. ***indicates significance at a 1% level; **5% level; *10% level.



Response to Cholesky One S.D. (d.f. adjusted) Innovations ± 2 S.E.

Figure 3: Impulse–response analysis. Solid lines represent impulse-responses and dashed lines are standard error bands created by Montecarlo simulations with 10,000 repetitions.

economies allow us to derive some policy recommendations. Most of them confirm policy implications derived from several different pieces of the empirical literature. As the suggested measures vary according to the type and sign of the imbalances registered in each country, we concentrate on the most frequent cases in advanced economies, which are REER overvaluation, current-account deficits, and negative output gaps. In addition, we will take into account that reducing some imbalances entails increasing others.

To improve the current-account balance, our results present a range of options. First, policymakers should aim to reduce the overvaluation of the real exchange rate of their economies. Although this measure initially deteriorates the current account, the net effect is clearly positive after a few periods, in correspondence with the "J curve" hypothesis. Furthermore, this measure contributes to increasing the output gap. If a government wishes to enhance the positive impact on current accounts, they can complement these measures with contractionary demand policies; however, they should take the disadvantage of weakening the output gap and economic growth into account. Second, governments should take measures to increase the competitiveness of their economies (and produce a positive current-account shock) since these actions improve not only current accounts immediately but also increase potential GDP growth, laying the basis for more vigorous growth in current GDP in the medium term. Finally, measures that increase the factors productivity of their economies and, thus, boost economic growth appreciate the real exchange rate (Balassa–Samuelson effect).

5 Concluding Remarks

The expansion of global imbalances and the integration of world economies have drawn attention to macroeconomic imbalances and their causes. In this study, we aim to shed light on this issue by analyzing the interactions and causal links between current-account imbalances, REER misalignments, and domestic and foreign output gaps. As these imbalances can result in macroeconomic instability and crisis, it is key for economic authorities to gain a fuller understanding of these forces for the effective design of sound economic policies.

Prior to our empirical analysis, with a view to clarifying the relationships between the four imbalances involved, we set up a theoretical framework based on the elasticities and absorption approaches of the balance of payments. We then perform empirical estimates on a panel of 18 advanced economies between 1986 and 2017. We carry out PVAR estimates with causality tests and impulse-response analysis based on the previous econometric estimates.

From our sample of advanced economies, we derive empirical results that are in general consistent with our theory and with previous literature on the issue. They indicate that there is a significant and inverse interaction between the current account and the output gap with bilateral causal links. We also find that an increase in REER overvaluation could deteriorate the current account. Finally, our analysis reveals unidirectional causality between the REER and the domestic output gap, in the sense that while an increase in REER overvaluation decreases the output gap, there is no significant impact the other way around.

To gain further insight into the relationships between these macroeconomic variables and to avoid estimation biases, we perform new PVAR estimates using a different panel of observed variables - instead of their corresponding imbalances - namely the current-account balance as a percentage of GDP, the REER interannual percentage change, and the interannual GDP growth. In general, the new results follow our previous findings, including the fact that a positive shock on the current account stimulates economic growth, in correspondence with a decline in the output gap caused by an increase in the potential output of the economy. We also obtain another relevant finding: higher growth levels result in real exchange-rate appreciations, which fully supports the Balassa-Samuelson hypothesis when the increase of economic growth is due to improvements in factors' productivities.

Finally, various policy guides can be drawn from our results to address or prevent undesired imbalances. REER undervaluation helps to increase current account figures and output gaps. Additionally, macroeconomic policies that increase factors productivity and economic growth lead to real exchange-rate appreciation. Also, contractive macroeconomic measures that reduce the output gap or growth figures help raise the current account balance. Lastly, it is likely that measures that raise the currentaccount balance, such as successful export promotion or import substitution policies, have a relevant positive impact on both potential output and economic growth.

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Appendix

Table A1: VAR lag selection criteria

		L	ags	
	1	2	3	4
Final prediction error Akaike I.C. Schwarz I.C.	180 13.70 13.81*	173 13.66 13.84	167* 13.63* 13.88	169 13.64 13.97
Hannan-Quinn I.C.	13.744	13.733	13.728*	13.769

*indicates number of lags selected by the criterion. Balanced panel. *N*: 18; *t*: 32 (1986–2017); obs.: 504.

Table A2: PVAR residual serial correlation LM test

Lags	LRE stat	Prob.
1	10.88	0.28
2	13.10	0.16
3	11.17	0.26
4	18.32	0.03**
5	12.19	0.20

Null hypothesis: no serial correlation at lag X.

N: 18; *t*: 32 (1986–2017); obs.: 522. ***indicates significance at a 1% level; **5% level; *10% level.

	C. Account	REER change	Growth
C. Account(-1)	0.950790	-0.054159	-0.065884
	[21.3693]	[-0.37054]	[-0.84652]
C. Account(-2)	0.062125	-0.044733	0.320478
	[1.00207]	[-0.21965]	[2.95516]
C. Account(-3)	-0.055114	0.074167	-0.187641
	[-1.22927]	[0.50357]	[-2.39258]
REER change(-1)	-0.006408	0.215287	-0.013791
	[-0.49104]	[5.02160]	[-0.60409]
REER change(-2)	-0.057731	-0.111725	-0.011224
	[-4.25385]	[-2.50600]	[-0.47280]
REER change(-3)	0.004474	-0.181748	0.016907
	[0.35041]	[-4.33318]	[0.75698]
Growth(-1)	-0.191301	0.225394	0.488745
	[-7.73859]	[2.77554]	[11.3026]
Growth(-2)	0.051754	-0.118899	-0.058152
	[1.77058]	[-1.23827]	[-1.13733]
Growth(-3)	-0.005552	0.246943	0.129443
	[-0.20157]	[2.72905]	[2.68647]
Constant	0.367798	-0.916996	0.891798
	[4.17120]	[-3.16577]	[5.78188]
<i>R</i> -squared <i>F</i> -statistic Number of coefficients	0.906480 551.4176	0.132743 8.707419 30	0.284539 22.62477

Included observations: 522 after adjustments *t*-statistics in [].

Table A3: PVAR estimation 1986-2017

92

- NU

Sweden - 06 _

Spain - 88

UK - 92

REER change

Italy - 16

Italy - 16

Netherlands -02

Netherlands - 02 Spain - 88 Sweden - 06

Denmark - 08

Germany - 12 Ireland - 98

Advanced economies Ouput gap

France - 94

France - 94 Germany - 12 Ireland - 98

Denmark - 08



Figure A1: Series graphs (1986-2017).