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CURRENT ACCOUNT DYNAMICS AND THE REAL EXCHANGE RATE: DISENTANGLING THE EVIDENCE

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Abstract

We study the main shocks driving current account fluctuations for the G6 economies. Our theoretical framework features a standard two-goods inter-temporal model, which is specifically designed to uncover the role of permanent and temporary output shocks and the relation between the real exchange rate and the current account. We build a SVAR model including the world real interest rate, net output, the real exchange rate, and the current account and identify four structural shocks. Our results suggest four main conclusions: i) there is substantial support for the two-good intertemporal model with time-varying interest rate, since both external supply and preference shocks account for an important proportion of current account fluctuations; ii) temporary domestic shocks account for a large proportion of current account fluctuations, but the excess response of the current account is less pronounced than in previous studies; iii) our results alleviate the previous puzzle in the literature that a shock that explains little about net output changes can explain a large proportion of current account changes; iv) the nature of the shock matters to shape the relationship between the current account and the real exchange rate, which explains why is it difficult to understand the role of the real exchange rate for current account fluctuations.

JEL-classifications: F32, F41
Keywords: Current account, real exchange rate, two-good intertemporal model, SVAR

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1. Introduction

The analysis of current account (CA) fluctuations plays a central role in both empirical and theoretical models of open economy macroeconomics. From a policy perspective, it is important to understand the determinants of current account balances given their implications for the assessment of external sustainability. More specifically, there has long been a strong focus on the relation between the current account and real exchange rates. In recent years, this has also become central to understanding the emergence and (recent) readjustment of global imbalances (see, for instance, Caballero, Fahri and Gourinchas, 2008, 2015, 2016, Caballero and Krishnamurthy, 2008, and Blanchard and Milesi-Ferretti, 2011).[1] This concern was already reflected in IMF (2004) who warned that one of the main risks for the global economy was a disorderly resolution of global imbalances; the IMF now publishes a review of global imbalances every year in its External Sector Report (see, for instance IMF, 2017). Furthermore, external imbalances are discussed on a regular basis by the G20, which has created in 2009 a specific working group (the Framework for Strong, Sustainable and Balanced Growth) where this issue is tackled.[2] External imbalances also matter at the regional level, which is why the EU Commission introduced in 2011 the Macroeconomic Imbalance Procedure, to review macroeconomic developments in the EU, including current accounts.

Against this background, this paper aims to better understand the sources of current account fluctuations in the G6 (G7 minus the US) countries. We use a small open economy theoretical model as a framework for the empirical model. In particular, we follow the theoretical setting of Bergin and Sheffrin (2000), which allows for the introduction of a time-varying world real interest rate and the real exchange rate (RER).[3] The inclusion of those variables in the model allows for the analysis of the role played by external shocks, which can be a major source of current account fluctuations in small economies. Making use of a four variable (i.e., the world real interest rate, the RER, net output, and the current account to net output ratio) SVAR approach and Blanchard and Quah's (1989) method to identify structural shocks, we are able to consider not only consumption smoothing effects, but also consumption tilting effects due to changes in world real interest rates and the RER. We can consider external productivity shocks, domestic permanent output shocks, preference shocks, and temporary domestic output shocks. This is a distinctive feature of our model compared with previous literature.

[1] For early surveys see Eichengreen (2006), Servén and Nguyen (2010), Bracke et al. (2010).
[2] Further details can be found at https://www.oecd.org/g20/topics/framework-strong-sustainable-balanced-growth.
[3] Their model follows the standard analysis of Dornbusch (1983) and Obstfeld and Rogoff (1996) by introducing a traded and a non-traded sector in a small open economy setting with a variable interest rate. They then test the restrictions from the present value model for Australia, Canada and the UK.

This setting also helps understand the dynamic relationship between current account and RERs, which is the focus of, for instance, Lee and Chinn (2006). Although our paper's primary focus is to use the theoretical framework to analyze the sources of current account fluctuations, we also introduce over-identifying restrictions to directly test some of the implications of the theory model.

We reach four main conclusions. First, the present value model (PVM) of the current account is consistent with the behaviour of the data for half of our countries, namely, Canada, Italy and Japan. For France, Germany and the UK, permanent domestic shocks have a long-run impact on the current account (in contrast with the theory). Secondly, external supply shocks and, mostly, preference shocks appear to play an important role in explaining current account fluctuations in our sample of countries. Our model also reduces the degree of excess response of the current account to temporary output shocks found in previous literature. This alleviates the well-established puzzle in the literature that a shock that explains little about net output changes can explain a large proportion of current account changes, except for the case of Italy. A puzzle remains, however, in the response of the current account in Canada and France to preference shocks, which appear to have the opposite sign to the theory predictions. Finally, we show that the nature of the shock matters to shape the relationship between the current account and the RER. This is one possible explanation for the difficulty faced in the literature in understanding the role of the real exchange rate on current account fluctuations. In particular, an external supply shock typically generates a negative correlation between the exchange rate and the current account, whereas a preference shock induces a positive correlation between them. It is also a useful caveat to bear in mind for policy makers: the exchange rate is not an exogenous variable and a given depreciation does not always have the same effect on the current account as it crucially depends on the nature of the shock that triggered the change in the exchange rate in the first place.

The rest of the paper is organized as follows. In Section 2, we review some of the above mentioned empirical studies. Section 3 presents the theory model. Section 4 presents the specification of the SVAR. Section 5 discusses the data and results, and Section 6 concludes.

2. Literature review

Many papers have sought to analyze the macroeconomic shocks driving the current account, often with a particular focus on the role played by the exchange rate. The canonical Mundell-Fleming-Dornbusch model, for instance, has long played a central role. Nonetheless, since the 1980s a number of studies provided the basis for the intertemporal approach to the current account that has since been dominant in the profession (see Obstfeld and Rogoff, 1995). In this approach, the current account is viewed as reflecting intertemporal consumption decisions and productivity shocks. Importantly, the intertemporal approach assumes that the current account of a small open economy is independent of global shocks and that it only responds to temporary country-specific shocks and not to permanent ones. The theory behind this basic model has been extended into many directions to include investment, time-varying interest rates, traded and non-traded goods, price rigidities, pricing to market behaviour, and monetary policy (see Obstfeld and Rogoff, 1996 and Lane, 2001). Their implications are also directly or indirectly testable, making them a logical benchmark against which to analyze the sources of current account fluctuations.

Despite the rapid improvements in open economy theory models, empirical testing somewhat lagged behind for several years. Most of the initial empirical studies were based on extensions of the Campbell (1987) and Campbell and Shiller (1987) consumption-based present value models. These works were pioneered by Sheffrin and Woo (1990a, b), Otto (1992) and Gosh (1995). Those studies found limited support for the PVM. Bergin and Sheffrin (2000) augmented the previous approach with a world real interest rate and an exchange rate. Using quarterly data from 1960:1 to 1996:4 and for Australia, Canada, and the UK, they find that the two-good intertemporal model reduces the deviation of the actual consumption path from the optimal one significantly for the first two countries. They also express the belief that this better fit is due to the inclusion of the exchange rate in the model, lending support for the two-goods version of the model. Nason and Rogers (2006) analyze fluctuations in the CA of Canada and insist on the important role of an exogenous world real interest rate.

More recently, Ca'Zorzi and Rubaszek (2012) present a novel approach to the empirical validation of the intertemporal approach to the current account that fits the euro area. Brissimis et al. (2012) find support for the CA model when taking into account private sector financing to GDP. Finally, Cerrato et al (2014) provide evidence on a heterogeneous validation of the PVM as the test fails for some countries but not for others.

Although tests of the present value approach are a core element of the literature, researchers have increasingly made use of the structural vector autoregression (SVAR) approach. Theoretical models are used to impose minimal identification restrictions on VAR models and then used to test the implications of the intertemporal model. As previously mentioned, the intertemporal model's main implication is that the CA is primarily driven by country-specific temporary shocks, and not permanent ones. Hence, in order to test the adequacy of the intertemporal model, one should be able to decompose the system shocks between temporary and permanent ones, which naturally lends itself to a SVAR structure. Ahmed and Park (1994) use a four-variable SVAR with long-run restrictions to examine macroeconomic fluctuations in seven OECD small open economies. They show that, firstly, domestic absorption shocks are the main shocks explaining movements of the trade balance and, secondly, that external shocks do not seem to play a trivial role for the trade balance. Two influential papers in the CA literature making use of the SVAR approach are Lee and Chinn (2006) and Kano (2008). In particular, Lee and Chinn (2006) estimated a bi-variate model, including the first difference of the real exchange rate and the current account to GDP ratio for the G-7 countries. Their main conclusion is consistent with most of the theoretical models: "[…] permanent shocks have large long-term effects on the real exchange rate, but relatively small effects on the current account; temporary shocks have large effects on the current account and exchange rate in the short-run, but not on either variable in the long-run" (p. 257). Kano (2008), allowing for a time-varying world real interest rate, uses a three-variable SVAR model that consists of the world real interest rate, the domestic net output change, and the CA to net output ratio. He identifies three structural shocks, which are global shocks, country-specific temporary shocks, and country-specific permanent shocks. Using data for Canada and the UK, he concludes that although country-specific transitory shocks induce very large fluctuations of the CA and thus explain most of its movements, they play a minimal role in explaining fluctuations in net output growth. The conclusion is then that consumption tilting effects must play an important role for CA movements. An important candidate to explain these consumption tilting effects is the RER, as emphasized by the literature.

In this paper, we bridge the gap that remains in the literature by augmenting Kano's (2008) SVAR model with the RER. To our knowledge, no paper has so far examined the role of both consumption smoothing effects through country-specific permanent and temporary shocks as well as consumption tilting effects through global external shocks that can arise through either changes of the world real interest rate or the RER. We build a four variable SVAR model with minimal long-run identifying restrictions *à la* Blanchard and Quah (1989), enabling us to identify four different sources of shocks. Our empirical strategy therefore includes the RER together with the current account to net output ratio, the world real interest rate, and net output. This allows us to consider not only consumption smoothing effects, but also consumption tilting effects due to changes in world real interest rates and the RER. We can consider external productivity shocks, domestic permanent output shocks, preference shocks, and temporary domestic output shocks. SVAR models are useful in our context as they not only allow testing the implications of theory models with minimal theory restrictions, but they also allow decomposing current account fluctuations by sources of shocks, going beyond mere tests of specific theoretical frameworks.

3. Theory

We briefly describe the Bergin and Sheffrin (2000) model, which we use as a benchmark for the construction and identification of our SVAR. This model considers a small open economy (SOE) producing traded and nontraded goods, and an infinite number of representative households consuming both goods. The model features incomplete markets and international bonds are assumed to be the only assets of the SOE. Given the assumption of perfect bond mobility, there is interest rate equalization. However, a non-constant world real interest rate is allowed for. We can represent the country's current account by:

$$CA_t = B_t - B_{t-1} = r_t B_{t-1} + Y_t - I_t - G_t - C_t \qquad (1)$$

where CA_t is the current account, B_t is the stock of external assets at the beginning of the period, r_t is the time-varying world real interest rate expressed in terms of tradable goods, Y_t denotes domestic output, I_t investment, G_t government spending, and C_t consumption. Consumption expenditure can be expressed in terms of traded goods as $C_t = C_{Tt} + P_t C_{Nt}$, where C_{Tt}, C_{Nt} and P_t are consumption of traded goods, consumption of non-traded goods, and the relative price of non-traded goods in terms of traded ones, respectively. Note that all variables are in real per-capita terms.

The intertemporal maximization problem for the representative agent is to choose a consumption path that will maximize lifetime utility, which depends only on consumption:

$$\max_{C_{Tt},C_{Nt}} E_0 \sum_{t=0}^{\infty} \beta^t U(C_{Tt}, C_{Nt}) \qquad (2)$$

$$\text{s.t. } Y_t - (C_{Tt} + P_t C_{Nt}) - I_t - G_t + r_t B_{t-1} = B_t - B_{t-1} \qquad (3)$$

where $U(C_{Tt}, C_{Nt}) = \frac{1}{1-\sigma}(C_{Tt}^{\alpha} C_{Nt}^{1-\alpha})^{1-\sigma}, \sigma > 0, \sigma \neq 1, 0 < \alpha < 1$,

and $\frac{1}{\sigma}$ represents the intertemporal elasticity of substitution and α is the share of traded goods in total consumption. Bergin and Sheffrin (2000) define the index of total consumption as $C_t^* = C_{Tt}^{\alpha} C_{Nt}^{1-\alpha}$ and a consumption-based price index, P_t^*, as the minimum amount of consumption expenditure expressed in terms of traded goods, $C_t = C_{Tt} + P_t C_{Nt}$, such that $C_t^* = 1$, given P_t (see Obstfeld and Rogoff, 1996).

We assume, firstly, log normality for the world real interest rate, consumption growth rate, and the percentage change in the relative price of non-traded goods and, secondly, that the variance and covariance among variables are time-invariant. From the optimization problem (2)-(3) we obtain the Euler equation:[4]

$$E_t \Delta c_{t+1} = k + \gamma E_t r^*_{t+1} \tag{4}$$

where, $r^*_{t+1} = r_{t+1} + \left[\frac{1-\gamma}{\gamma}(1-\alpha)\right] \Delta p_{t+1}$ (5)

And $\Delta c_{t+1} = \log C_{t+1} - \log C_t$, $\Delta p_{t+1} = \log P_{t+1} - \log P_t$, $\gamma = \frac{1}{\sigma}$ is the intertemporal elasticity of substitution, and k is a constant.

This condition is crucial since it shows that the consumption-based real interest rate, r^*_t, which depends on both the real world interest rate (r_t) and the relative price of non-traded goods (p_t), influences the optimal consumption path of the consumer. We can then express the consumption Euler equation as:

$$E_t \Delta c_{t+1} = k + \gamma E_t[r_{t+1}] + (1-\gamma)(1-\alpha) E_t[\Delta p_{t+1}] \tag{6}$$

With this result and the budget constraint, it is possible to obtain an analytical solution for the CA. To begin with, define R_s as the market discount factor for consumption at date *s*, such that:

$$R_s = \frac{1}{\prod_{j=1}^{s}(1+r_j)} \tag{7}$$

Recalling the budget constraint (3), we can express it as a function of net output $NO_t = Y_t - I_t - G_t$ as:

$$B_t - B_{t-1} = NO_t - C_t + r_t B_{t-1} \tag{8}$$

Iterating (8) forward, and imposing the transversality condition, $\lim_{t\to\infty} E_0(R_t B_t) = 0$ gives the following expression for the intertemporal budget constraint:

$$\sum_{t=0}^{\infty} E_0(R_t C_t) = \sum_{t=0}^{\infty} E_0(R_t NO_t) + B_0 \tag{9a}$$

where B_0 is the initial level of net foreign assets.

Equation (9a) can be re-written as:

$$C_0 + \sum_{t=1}^{\infty} R_t C_t = N_0 + \sum_{t=1}^{\infty} R_t NO_t + B_0 \tag{9b}$$

[4] All lower case letters are in logarithms except the real interest rate, for which we used $\log(1+r_t) \approx r_t$.

Then, following Huang and Lin (1993), the log-linearized intertemporal budget constraint[5] becomes:

$$no_0 - \frac{c_0}{\Omega} - \left(1 - \frac{1}{\Omega}\right) b_0 = -\sum_{t=1}^{\infty} \beta^t \left[\Delta no_t - \frac{\Delta c_t}{\Omega} - \left(1 - \frac{1}{\Omega}\right) r_t\right] \tag{10}$$

where $\Delta no_t = \log NO_t - \log NO_{t-1}$, $\Delta c_t = \log C_t - \log C_{t-1}$ and all lower case letters represent the variables in logarithms (except for the world real interest rate). Finally,

$$\Omega = 1 - \frac{\bar{B}}{\sum_{t=0}^{\infty} R_t C_t}$$

is a constant less than unity and $\bar{B}$ represents the steady state level of net foreign assets.

Taking the expectations of (10) and combining it with the Euler equation (4) yields:

$$no_t - \frac{c_t}{\Omega} - \left(1 - \frac{1}{\Omega}\right) b_t = -E_t \sum_{i=1}^{\infty} \beta^i \left[\Delta no_{t+i} - \frac{k + \gamma r_{t+i}^*}{\Omega} - \left(1 - \frac{1}{\Omega}\right) r_{t+i}\right] \tag{11}$$

Assuming that, in the steady state around which we linearize,[6] the value of net foreign assets is equal to zero, so that $\bar{B} = 0$, we have $\Omega = 1$ and finally obtain:

$$ca_t^* = -E_t \sum_{i=1}^{\infty} \beta^i \Delta no_{t+i} + E_t \sum_{i=1}^{\infty} \beta^i [\gamma r_{t+i}] + E_t \sum_{t=1}^{\infty} \beta^i [(1-\gamma)(1-\alpha)\Delta p_{t+i}] + const \tag{12}$$

where, based on (8), $ca_t^* \equiv no_t - c_t$.

Equation (12) tells us that the equilibrium current account is a function of expected output changes, the expected future evolution of interest rates, and expected future changes in RER. It illustrates two important effects. On the right hand side of the equation, the first part represents the consumption-smoothing effect. If net output is expected to fall, the CA will increase as the representative agent smooths consumption intertemporally. This leads to the standard conclusion that only temporary net output shocks produce current account fluctuations. The second two terms of the equation represent the consumption-tilting effect. An increase in the interest rate raises the CA as it induces a lower consumption below its smoothed level.[7] The relative price term also captures this effect: if the price of traded goods is temporarily low, the expected future increase makes the future repayment of a loan in traded goods more expensive in terms of the consumption bundle, reducing current consumption and improving the CA. This effect shows the impact of world real interest rates and changes in the RER, which also produce current account fluctuations.

[5] For details on the log-linearization, see Bergin and Sheffrin (2000) p. 557.

[6] The linearization procedure following Bergin and Sheffrin (2000) leads to a formula for the semi-CA. Bouakez and Kano (2008) use a linearization procedure leading to a formula for the CA. It can easily be proved that both formulas yield the same reduced-form representation.

[7] Note that this the case if the economy starts with zero net foreign assets, as assumed in the steady state of this model. However, the response to the consumption-based real interest rate can potentially change if the economy departs sufficiently from this condition: if initially the country is a large net lender, the effect could become negative.

To see the empirical implications of this equation, we can proceed as follows. Since the model is in partial equilibrium, it does not make assumptions about the determinants of net output, the RER, and interest rates. Assume that $\mathrm{no_t}$ (and $\mathrm{p_t}$) is an exogenous endowment driven by a permanent and a temporary shock, such that $\mathrm{no_t} = \eta_t + \vartheta_t$ where $\eta_t = \eta_{t\text{-}1} + \partial_t$ and ϑ_t and ∂_t are iid~N(0,1). The former is a permanent and the latter a temporary shock to net output. This then implies that $\Delta\mathrm{no_t} = \vartheta_t$-$\vartheta_{t\text{-}1}$-$\partial_t$. Assume that the temporary shock takes the value of zero at time $\ldots$, t-2, t-1 and that it takes the value of 1 at time *t*. The expected value of the change in net output between t and $\mathrm{t}+1$, given that agents observe shocks at time t, is: $\mathrm{E_t}\Delta\mathrm{no_{t+1}} = \mathrm{E_t}\vartheta_{t+1}$-$\mathrm{E_t}\vartheta_t$-$\mathrm{E_t}\,\partial_{t+1} = $ -$\vartheta_t = $ -1. That is, since the shock is temporary, agents expect output to fall between today and tomorrow. This expected change then triggers a current account reaction. In particular, the current account increases after the shock as agents distribute the gains from the temporary shock along their infinite lifetimes. This temporary increase in the current account would then have permanent effects on the cumulative current account. However, on the other hand, the permanent shock will not affect the current account. This is because output is not expected to fall in the future if the increase is due to a permanent shock, and hence the current account does not change.

As we can implicitly see, this model consists of four variables: the CA to net output ratio, changes in net output, the world real interest rate, and changes in the real exchange rate. Based on this model, those four variables can be represented as a VAR system on which we can then impose theory restrictions. We then use this SVAR to analyze the response of the CA to structural shocks and the contribution of each of these shocks to the variance of the CA. We can also analyze the main implications of the present-value model: that a domestic temporary net output shock will lead to a surplus of the current account, while domestic permanent net output shocks will have an insignificant impact on the current account. Finally, we can check the contribution of consumption tilting effects arising from changes in world interest rates and the real exchange rate. In fact, the implications of the present-value model and the significance of consumption tilting effects can be directly tested by means of over-identifying restrictions.

4. Specification of the SVAR

From the discussion above, the current account, net output, world real interest rate, and RER are the four variables that enter our VAR system. In this section, we explain the identification method used. We have a four-variable SVAR model such that $X_t' = \left(r_t, \Delta no_t, \Delta p_t, \frac{CA_t}{NO_t}\right)$. We assume that these variables are driven by four distinct shocks: external supply shocks, domestic permanent net output shocks, preference shocks and, finally, domestic temporary net output shocks. Those shocks are specified as $\varepsilon_t' = (\varepsilon^{es}, \varepsilon^{dp}, \varepsilon^{p}, \varepsilon^{dt})$, where $\varepsilon^{es}, \varepsilon^{dp}, \varepsilon^{p}\ and\ \varepsilon^{dt}$ represent the above mentioned shocks, respectively. The reason why net output and the RER appear in first differences whilst the world interest rate and the *CA* to *NO* ratio do not, will become apparent when we discuss the unit root properties of the data in *section 5.1* below.

The structural moving average representation for X_t is:

$$X_t = C(L)\varepsilon_t \tag{13}$$

where X_t is our $4*1$ vector of economic variables, ε_t is our $4*1$ vector of shocks and $C(L) = C_0 + C_1(L) + \cdots$ where $\boldsymbol{L}$ is the lag operator and C_k is a $4*4$ matrix with $c_k = [c_{ij,k}]$. $C_{ij}(L)$ will therefore represent the accumulated long run effect of the shock ε_t^j on variable X_i. Equation (13) is called the structural moving average model, since all elements of ε_t are given a structural economic interpretation, as explained above.

This model can be used to answer two important questions. Firstly, how does the system of endogenous variables responds to dynamically exogenous shocks? Secondly, which of those shocks are the primary causes of variability in the endogenous variable of interest, in our case CA_t/NO_t?

The structural VAR representation of (13) is obtained by inverting $C(L)$ to get:

$$A(L)X_t = \varepsilon_t \tag{14}$$

where $A(L)A_0 - \sum_{k=1}^{\infty} A_k L^k$ is a one-sided matrix lag polynomial. In (14), the exogenous shocks are written as a distributed lag of current and lagged values of X_t.

Now, assuming that the lag polynomial of $\boldsymbol{A(L)}$ in (14) is of order *p*, then the SVAR can be written as :

$$A_0 X_t = A_1 X_{t-1} + A_2 X_{t-2} + \cdots + A_p X_{t-p} + \varepsilon_t \tag{15}$$

Since A_0 is not restricted to be diagonal, equation (15) is a dynamic simultaneous equations model. The reduced-form of it is:

$$X_t = \Phi_i X_{t-1} + \cdots + \Phi_p X_{t-p} + e_t \tag{16}$$

where $\Phi_i = A_0^{-1} A_i$ and $e_t = A_0^{-1}\varepsilon_t$. Identification of the unknown parameters in $A_0, \dots, A_p$ follows from the assumption that ε_t is a serially uncorrelated white noise vector: $E(\varepsilon_{j,t} X_{i,t-h}) = 0\ for\ all\ i, j, t\ with\ h > 0$.

The identification restrictions must be dictated by the economic model under consideration. Sims (1980) argues that instead of identifying parameters of (16), SVAR's should be identifying using restrictions of the covariance matrix of structural shocks, $\sum \varepsilon$, the matrix of contemporaneous responses A^0, and the matrix of long-run multipliers $A(1)$. In those kinds of models, it is generally assumed that $\sum \varepsilon$ is diagonal so that structural shocks are uncorrelated. This assumption imposes $n(n-1)$ restrictions on the model, leaving only $n(n-1)/2$ additional necessary restrictions on A_0 or/and $A(1)$.

We make use of Blanchard and Quah (1989) methodology, where the set of identifying restrictions relies on long-run relationships. This methodology imposes restrictions on the sum of the long-run multipliers coefficients $A(1)$, where $A(1) = A_0 - \sum_{k=1}^{p} A_k$ for identification. Moreover, knowing that $C(1) = A(1)^{-1}$, these can also be viewed as restrictions on the sum of impulse responses.

Equation (13) is now written in its extended form using the matrix of long-run multipliers as:

$$\begin{bmatrix} r_t \\ \Delta no_t \\ \Delta p_t \\ CA_t/NO_t \end{bmatrix} = \begin{bmatrix} C_{11}(1) & C_{12}(1) & C_{13}(1) & C_{14}(1) \\ C_{21}(1) & C_{22}(1) & C_{23}(1) & C_{24}(1) \\ C_{31}(1) & C_{32}(1) & C_{33}(1) & C_{34}(1) \\ C_{41}(1) & C_{42}(1) & C_{43}(1) & C_{44}(1) \end{bmatrix} \begin{bmatrix} \varepsilon^{es} \\ \varepsilon^{dp} \\ \varepsilon^{p} \\ \varepsilon^{dt} \end{bmatrix} \tag{17}$$

Our identification scheme works as follows. Shock ε^{es} represents external supply shocks and it is the only shock that can have an accumulated impact on the level of the world real interest rate in the long-run, since it corresponds to external changes in the marginal product of capital. This shock can also (potentially) have permanent effects on the rest of the variables of the system. From the theory model, for instance, external supply shocks can change the net foreign asset (cumulative CA) position of the economy due to consumption tilting effects. Similarly, ε^{dp} shows domestic permanent net output shocks. These induce changes in net output in the long-run. However, due to the SOE assumption, they do not have an impact on the world real interest rate. We also allow permanent output shocks to have long-run impacts on the RER. Although not a feature of the basic theory framework, Balassa-Samuelson effects due to productivity changes could potentially affect the equilibrium RER. The third shock, ε^{p}, is interpreted as a preference shock which can have permanent effects on the RER and, through consumption tilting, on net foreign assets (through CA_t/NO_t). Preference shocks do not have an impact on either output or the world real interest rate in the long-run. And, finally, the domestic temporary net output shocks, ε^{dt}, can only have long-run effects on the accumulated CA to net output ratio, but not on the rest of the variables in the system.

Our identification scheme restricts $C(1)$ to be lower triangular. This enables us to apply the Cholesky decomposition on the weighted variance-covariance matrix of the reduced-form VAR to uniquely identify all elements of C(1). The SOE assumption implies that $C_{12}(1)$, $C_{13}(1)$ and $C_{14}(1)$ are equal to zero. The long-run neutrality of preference shocks translates into restricting $C_{23}(1)$ to be equal to zero. The theory assumption that the real exchange rate is determined by preferences for tradable and non-tradable goods as well as productivity shocks means that temporary net output shocks do not affect the RER in the long run. That is, $C_{34}(1)$ is restricted to be zero. Finally, the assumption that temporary domestic shocks do not have a long-run impact on net output implies that $C_{24}(1)$ is equal to zero, which completes our six restrictions. Note that as explained in the previous section, $C_{44}(1)$ is not restricted to be zero. This is because while the temporary output shock can have temporary effects on CA/NO as it is stationary, it can have permanent effects on the cumulative CA/NO (or net foreign assets). In essence, if a temporary positive shock increases the CA temporarily, then NFA will increase permanently. Hence the long-run accumulated matrix becomes:

$$\begin{bmatrix} C_{11}(1) & 0 & 0 & 0 \\ C_{21}(1) & C_{22}(1) & 0 & 0 \\ C_{31}(1) & C_{32}(1) & C_{33}(1) & 0 \\ C_{41}(1) & C_{42}(1) & C_{43}(1) & C_{44}(1) \end{bmatrix} \tag{18}$$

Since $A(1)^{-1} = C(1)$, this means that $A(1)$ is also lower triangular, and this yields the necessary identifying restrictions required to just-identify the VAR model.

As mentioned in the introduction, we can also explicitly test some of the implications of the theory model by imposing over-identifying restrictions on the SVAR by means of Wald tests. The first obvious test is the basic present-value model test that permanent output shocks do not have a long-run impact on the CA. In terms of (18) this would be a test for $C_{42}(1) = 0$. A second test of relevance relates to the fact that the Bergin and Sheffrin (2000) model contains no productivity effects on the RER (Balassa-Samuelson), since output is an endowment. In (18) we allow for long-run effects of permanent output shocks on the RER, and we can then test the assumption of the theory model by testing $C_{32}(1) = 0$. We can then test simultaneously for $C_{32}(1) = C_{42}(1) = 0$ as a joint test of the present-value and no-productivity effects. Two other over-identifying restrictions relate to the importance of consumption tilting effects through the impact of external supply and preference shocks. As mentioned in the previous sections, an important aspect of the Bergin and Sheffrin (2000) model is the introduction of a time-varying world real interest rate and the RER. We can then test separately and jointly for the hypotheses $C_{41}(1) = 0$ and $C_{43}(1) = 0$ as a test for the significance of consumption tilting effects on the CA.

5. Empirical Results

5.1. Data and descriptive statistics

We use quarterly data of the G6 countries, that is, the G7 excluding the US, which cannot be considered a small open economy. Our countries hence comprise: Canada, France, Germany, Italy, Japan, and the UK. The sample period for each country was based on data availability. In particular, for France, Germany and the UK, the sample period used was 1980:4 to 2015:3; for Canada we used 1981:4 to 2015:3; for Japan, data were available from 1994:4 to 2015:3; and finally, for Italy the sample period used was 1995:4 to 2015:3. All the data are seasonally-adjusted, in real terms, and transformed into real per capita terms using total population (except for the RER and the world real interest rate). All data were collected from the Thomson Reuters Datastream.

Net output is derived based on the identity given in section 3: $NO_t = Y_t - I_t - G_t$. We compute it as gross domestic product (GDP) less gross investment and government consumption expenditure. The CA to NO ratio for each country is plotted in **Figure 1**.

The construction of a measure for the world real interest rate, r_t, is based on the method of Barro and Sala-i-Martin (1990) and Bergin and Sheffrin (2000). We collected short-term nominal interest rates, three-month Treasury Bill rates or equivalent, on the G7 economies. Short-term interest rates are used as we adjust for inflation expectations, which are more reliable for forecast over a short-time period. We use the CPI to measure inflation in each country; an ARMA model is then constructed to obtain expected inflation. The latter is then subtracted from nominal interest rate to compute the *ex ante* real interest rate. Finally, an average world real interest rate is derived by using the weighted average of the *ex ante* real interest rate across the G7 economies, with the time varying weights for each economy based on its share of real GDP in the G7 total. This measure is used for each of the six subject countries we are studying. The weighted real interest rate is plotted in

Figure 2. Note that equations (5) and (6) show that the real world interest rate (r_t) is measured in units of the tradable good and r_t^* is the consumption-based real interest rate measured in terms of the aggregate consumption good (and hence enters the consumption Euler). However, there is no obvious definition of this relative price with which to correct r_t^*. One possibility would be to use sectoral data, but this is not available on a quarterly basis. Also, sectoral prices do not directly match into final consumption components unless one knows the input-output structure of the economy so that the value added definition can be matched to the final consumption definition. The other possibility, following Betts and Kehoe (2008), is to use the CPI/PPI index, but this is a very approximate measure and it is not necessarily clear why PPI (which includes the production of investment goods) is a good proxy for the price of tradable consumption only. Besides, once we have a measure of relative prices in the model, we would need to have prior information on the coefficient of risk aversion (and consumption shares) to be able to create a model-based measure ofr_t.[8] Hence, in our SVAR, pure shocks to the real world interest rate (r_t) would be reflected as the difference between the effect of shocks to the consumption-based real interest rate, r_t^*, and shocks to the relative price of non-traded goods (p_t). Given that our paper focuses more on the relationship between RER and the CA, we believe that separating the RER from r^* is important.

A proxy for the relative price of non-tradable to tradable goods presents more problems. Ideally, we would use a direct measure of the relative price of non-traded to traded goods by making use of a sectoral tradability classification as in Ricci et al. (2013). As mentioned above, this data is usually available only on annual basis. We used the IMF's trade-weighted Real Effective Exchange Rate (REER) index as a proxy. This obviously assumes that all the variability in the REER is due to changes in internal terms of trade and PPP holds continuously for traded goods (see Engel, 1999). Betts and Kehoe (2008) find that the correlation between bilateral CPI-based RERs and the relative price of non-traded goods for 50 countries is high, with an average correlation of 60% in levels.

We first carried out pre-tests for unit roots using the ADF and ERS tests using the MIC method of Ng and Perron (2001) for optimal lag selection. The results, available on request, show that most variables are non-stationary in levels and stationary in first differences. The only exceptions are the real interest rate when using the whole sample period and including a deterministic trend, and CA_t/NO_t for Japan for the ERS test results.

The existence of a non-stationary CA to NO ratio is at odds with the transversality condition imposed in the intertemporal budget constraint (see Taylor, 2002 and Christopoulos and León-Ledesma, 2010). In other words, it would imply that temporary shocks would have permanent effects on the CA/NO ratio, which is unlikely for the set of countries we are analyzing, as it would imply that their CA balances are not sustainable. It is well known that unit root tests suffer from important power problems when the alternative is a highly persistent process. These problems can be even more important in the presence of breaks and nonlinear adjustment. For these reasons, and to be consistent with the theory model, we continue our analysis assuming that CA_t/NO_t is

[8] We estimated the correlation between our current measure of the real interest rate and one in which we correct it by the change in the CPI/PPI, assuming reasonable values of that 1/σ = 2 and α=0.5. For a given country, the two series displayed coefficient correlations of more than 0.99, and the correlation of the current G7-weighted world real interest rate and the one in which we correct by the change in CPI/PPI is equal to 0.962.

stationary, hence entering the VAR in levels. A similar caveat applies to the world real interest rate. As shown in Neely and Rapach (2008), real interest rates appear to be very persistent, much more so than consumption growth, which is clearly stationary, to which they should be linked by the consumption Euler equation. Although accounting for structural breaks increases the likelihood of finding stationarity, the fact remains that real interest rates appear to be very persistent.[9] During the period analyzed we capture the deflation period of the early 1980s, the Great Moderation period of low real interest rates in the US, and the Great Recession period of negative real interest rates. This implies that real interest rates display a clear downward trend during the sample analyzed (see

Figure 2). Including this trend, we can reject the null of a unit root using the ADF test. The results from the ERS test are also rejecting the null of non-stationary series, independently of the sample period examined. We hence enter the real interest rate in levels, consistent with the theory model.

5.2. Model specification

The first step is to select the appropriate lag length for our reduced-form VAR model. The same lag length would then be used for our SVAR. Given that the data sample is not very long, we are inclined to seek a parsimonious model in order to preserve the degrees of freedom, and we start with a maximum of 8 lags. After performing some information-criterion-based tests, the Akaike Info Criterion (AIC) test, the Final Prediction Error (FPE) test, the Hannan-Quinn Criterion test and the Schwarz Criterion test, we found that eight lags need to be considered for Canada and Germany, five for France and the UK, and finally two for Italy and Japan.

We then estimate the VAR models and apply the Blanchard and Quah's (1989) decomposition. Making use of the full system of equations, this enables us to obtain the impulse responses of our endogenous variables to identified structural shocks, perform a variance decomposition analysis, and test for the over-identifying restrictions. Finally, we perform some counterfactual exercises measuring the correlation between CA/NO and RER conditional on each of the four identified shocks in our model.

[9] See also Ferreira and León-Ledesma (2007) for an analysis of real interest rate differentials. Despite real interest rates appearing non-stationary, differentials are found to be mean-reverting.

5.3. Expected impulse response functions sign

Using the theoretical model and the interpretation of our shocks, we can provide a clear interpretation about the sign the impulse response functions are expected to have. Theory suggests that if net output is expected to fall, the CA will increase as the representative agent smooths consumption intertemporally. This is what leads to the standard conclusion that only temporary net output shocks produce current account fluctuations. This therefore implies that one would expect a positive relationship between a shock to the CA/NO and the net foreign assets and no relationship between a shock to the change in net output and the net foreign assets. Thus $C_{44}(1) > 0$ and $C_{42}(1) = 0$. Then, an increase in the interest rate raises the CA as it induces a lower consumption below its smoothed level. We would therefore expect $C_{41}(1) > 0$. However, this is the case if the economy starts with zero net foreign assets, as assumed in the steady state of this model. If instead the country is initially a large net lender, the effect could become negative and $C_{41}(1) < 0$. Finally, the effect of changes in the relative price of non-traded goods (p_t) through consumption tilting effects can be positive or negative on the CA depending on whether the degree of risk aversion 1/σ is larger or lower than 1. This, in fact, can explain why the effect of a shock to the RER can have either positive or negative effects on the CA through consumption tilting effects and hence, $C_{43}(1)$ could display either sign. It is important to remember that we do not impose any restrictions on the effects on the CA, $C_{4.}(1)$, and thus potentially, any shock can have a significant impact on net foreign assets. We present the results of this analysis in the following sub-sections.

5.4. Impulse response analysis

Figure 3 plots the impulse response functions (IRFs) and the accumulated impulse response functions (AIRFs) of the CA/NO to one standard deviation shock for each of the four structural shocks. The first row for each country shows the IRFs and the second the AIRFs. The first column shows the impulse response of CA/NO to external supply shocks, the second one to domestic permanent output shocks, the third one to preference shocks, and the last one shows responses to domestic temporary net output shocks. We also obtained the 95% bootstrap confidence intervals represented by the two dashed lines around the IRFs and the AIRFs.

As previously mentioned any shock can have a significant impact on the AIRFs (or, in other words, an impact on net foreign assets). The present-value theory would predict that only temporary domestic shocks can affect the CA in the long-run, but not permanent ones. Since we do not impose any further restriction at this stage, we can graphically check if the PVM prediction holds for our data by looking at the AIRFs of CA/NO to a permanent output shock. In section 5.5 we check this proposition more formally.

The empirical results are fairly in line with theory for the temporary and permanent output shocks (although this assessment needs to be qualified for each individual country), whereas for the other two shocks the results tend to be less consistent with theory. More in detail, external supply shocks do not appear to be significant as can be seen from both the IRFs and AIRFs. The only exception to this is the case of Italy, where they are significant up to the fourth quarter, while for Germany they become significant for quarters 16 to 20. More precisely, it leads to a CA surplus in Italy and a CA deficit in Germany. This negative effect for Germany appears to be compatible with its large net creditor position since the early 2000's. Accumulated, the effect is insignificant for the case of Germany, while the impact of those shocks becomes insignificant after quarter 10 for Italy.

Domestic permanent net output shocks have a positive impact on the CA for France and for the UK, but only for the first six quarters. For both countries the impact of the permanent shock on the accumulated CA is significant through the 20 quarters examined. On the other hand, domestic permanent net output shocks have a significant negative impact on the CA, as well as on the net foreign assets (accumulated response), for Germany. The results therefore suggest that the response of the CA violates the predictions of the present value model for France, Germany and the UK. Interestingly, the addition of a time-varying interest rate and the RER, appears to make the results for Canada compatible with the intertemporal approach. This country has been found to be problematic in previous studies, and is the focus of, for instance, Bergin and Sheffrin (2000) and Kano (2008).

Turning now to preference shocks, the IRFs show a mixed picture for their impact on the CA of the G6 economies. Overall, they seem to have a significant positive effect on both the CA and net foreign assets of all countries, except for the UK for which the effect is negative, and for Italy where preference shocks are not found to be significant. This positive effect for the case of Canada and France is puzzling since we would expect a negative CA effect based on theory predictions. From the IRFs, preference shocks seem to have a significant effect on the CA throughout the 20 quarters after impact, except for the case of France where the effect becomes insignificant between quarters 4 and 8, for the UK it is insignificant between quarters 1 to 3, while for Japan it turns insignificant from quarter 12 onwards. For the cumulative responses and therefore the impact on net foreign assets, the shock is significant throughout the 20 quarters for all countries, except from Japan from quarter 10 onwards.

At last, as expected, all countries' CAs are positively affected by a domestic temporary net output shock. The effect is very large and persistent and, from the accumulated IRFs, it is clear that for all countries the CA improves and, therefore, net foreign assets increase. Japan becomes the only exception to this result, where a significant negative effect is observed from quarters 15 to 18. However, at the accumulated level the effect for this country is also positive and significant.

Taking everything into consideration, there are two main conclusions that can be drawn. Firstly, France, Germany and the UK seem to violate the initial assumption of the standard intertemporal model of the current account, which states that domestic temporary shocks have a long-run effect on the current account while permanent ones do not. Secondly, and importantly, the addition of time-varying interest rates and the real exchange rate appears to be important for all G6 economies.

5.5. Variance decomposition

Table 1 summarizes the variance decompositions of the CA/NO, which enable us, for an s-period ahead forecast, to calculate the proportion of the fluctuations in a series that is due to its "own" shocks versus shocks to the other variables. In this table, the second column represents the proportion of the forecast error variance attributable to external supply shocks, the third column is the proportion attributable to domestic permanent net output shocks, the fourth to preference shocks and, finally, the last column presents the proportion attributable to domestic temporary net output shocks. All those results are shown for a forecast horizon *s* equal to 1, 4, 8, 20, and 40 quarters.

The results presented in this table are in accordance with the impulse response functions for all countries. More precisely, for Canada, a quarter after impact, preference shocks explain 66% of fluctuations in the CA and 22% is explained by the domestic temporary net output shock, while the rest is equally attributable to the external supply and domestic permanent net output shocks. Ten years after the shock (40 quarters), the pattern is very similar to what was observed immediately after the occurrence of the shock. That is, the main shocks explaining current account fluctuations are still the former two, with 62% and 19% respectively.

In quarter 1, France's current account fluctuations are explained mainly by domestic permanent output shocks (54%), with temporary domestic shocks accounting for 26% of the fluctuations and preference shocks 20%. In the long-run, permanent domestic shocks and preference shocks lose some of their importance, they fall to 46% and 14% respectively, and this is gained by temporary domestic shocks, which 40 quarters after impact explain over one third of the CA fluctuations.

For Germany, a quarter after impact, domestic permanent and temporary shocks as well as preference shocks account each for approximately 1/3 of the fluctuations in the CA (39%, 30% and 31%, respectively). However, for a 10-year ahead forecast, the proportion of the forecast error variance attributable to external supply shocks increases to 41%, while that of preference shocks falls to 10%, and the remaining of the proportion is shared between domestic permanent and temporary shocks. In the case of Italy, 58% of the CA fluctuations in the short-run are explained by temporary net output shocks, 38% by external supply shocks and the remaining 4% by mainly permanent domestic shocks (3%). In the following quarters, temporary domestic shocks go up to explaining 76% of the fluctuations and external supply shocks go down to explaining 19% of the fluctuations, while the other two shocks play a minimal role and share the remaining low percentage.

For the UK, 52% of the short-run fluctuations are explained by domestic permanent shocks and another 32% are explained by domestic temporary shocks. Preference shocks also explain a non-negligible 15% of CA fluctuations and only 1% is attributed to external supply shocks. After 40 quarters, however, domestic permanent shocks more than halve their importance and this loss is gained by all other three shocks. The CA is driven by all four shocks, with the domestic temporary ones being the most important drivers and the external supply being the less important ones.

One quarter after impact, Japan's CA fluctuations are mostly explained by temporary domestic net output shocks (71 %) and an important percentage is attributed to preference shocks (22 %). Over time, temporary domestic shocks lose some of their importance and this loss is mainly gained by preference shocks going up to 32% and external supply shocks rising to 10%. Domestic permanent net output shocks play a minimal role in explaining CA fluctuations even after 40 quarters.

Kano (2008) finds that temporary output shocks explain about 80% and 72% of CA fluctuations in the long-run for Canada and the UK, respectively. He refers to the excess response of the CA to temporary output shocks as a puzzle.[10] In our results, this is reduced very substantially for Canada to 19%, and for the UK to 40%. In our results, only for Italy and Japan does the temporary domestic output shock explain over half of the CA fluctuations in the long-run, 76% and 55% respectively.[11] Despite this, we can conclude that those results reflect, perhaps, the importance of the introduction of a two-sector setting that allows for the consideration of the RER and therefore, this consumption-tilting effect. A look at **Table 2** presenting the FEVD for net output reflects that, with the exception of Italy, temporary net output shocks play some role in explaining fluctuations in net output. They are the most important drivers of net output fluctuations for France, the second most important driver for Canada, Germany and Japan, and they account for over 10% of net output fluctuations in the UK. Hence, with the exception of Italy, our results alleviate the previous well-established puzzle in the literature, that a shock that explains little about net output changes can explain a large proportion of CA changes.

To conclude, given that external supply and preference shocks account for an important proportion of current account fluctuations, our results lend support for the two-good intertemporal model, which takes into account a varying world real interest rate and real exchange rate. This is in line with the conclusions in Lee and Chinn (2006), who state that the signs of the impulse responses and the variance decompositions point toward models that differentiate tradable from non-tradable goods.

5.6. Over-identifying restrictions

As discussed in Section 2.4, we can test formally for some of the theory predictions for the behaviour of the CA by imposing over-identifying restrictions. To recap, a direct test of the present-value model would imply the restriction $C_{42}(L) = 0$ (Restriction 1) in (18). A test for the absence of permanent output shock effects on the RER implies $C_{32}(L) = 0$ (Restriction 2). A test for the relevance of consumption tilting effects through changes in the world real interest rate implies

[10] The excess volatility of the CA is a common finding in present-value tests. See Obstfeld and Rogoff (1995).

[11] It is worth noting that the sample period for Italy and Japan is substantially different for that of the rest of the countries.

$C_{41}(L) = 0$ (Restriction 3), whereas the same test through changes in the RER implies $C_{43}(L) = 0$ (Restriction 4). We also test for Restrictions 1-2 and 3-4 jointly

The results of these Wald tests and their p-values tests are presented in **Table 3**. We highlight with boldface the results that lend support for the predictions of the theory model, that is, rejection of restrictions 3 and 4 and acceptance of restrictions 1 and 2. In line with the results from the IRFs and forecast variance decompositions, we cannot reject Restriction 1 for Canada, Italy and Japan, lending support to the predictions of the present-value model. Therefore, France, Germany and the UK violate those theory predictions. Restriction 2 cannot be rejected at the 5% level for Japan. For the rest of the countries, permanent output shocks do appear to have an impact on the level of the RER, which would support the inclusion of productivity effects in the theory model. Importantly, joint Restrictions 3 and 4 are rejected for all the countries. In particular, Restriction 3 is rejected for all countries, while Restriction 4 is only accepted for the case of Italy. This supports our previous caveat about the importance of the inclusion of both variable world real interest rates and traded and non-traded sectors in models of the CA. Consumption tilting effects driven by external supply shocks and preference shocks appear to be significant driving forces of CA fluctuations.

5.7. Conditional correlations of CA and RER

Figure 4 presents the results of a simple counterfactual exercise measuring the correlation between the IRFs of the CA and RER at different horizons conditional on each of the four shocks identified in our model.

Importantly, the sign of the correlation between those two variables is varying both across countries for a given shock and across shocks for a given country. In particular, the response of the CA and the RER after an external supply shock is negatively correlated for all countries and at all horizons, except for the case of Germany in the very short-run (quarters 1 to 4) and Italy up to quarter 8. While the correlation tends to drop to zero after 20 quarters for Canada, France and Japan, it remains strongly negative in this longer horizon for Germany, Italy, and the UK. The correlation of CA and RER following a preference shock is negative for all countries and all horizons, except for the case of the UK for which it is positive and for Japan which turns positive in the longer horizon. As before, these correlations remain strong at longer horizons only for Canada, Italy and the UK, while they are close to 0 for the remaining countries. After a temporary shock, the CA and RER seem to display a high positive correlation for all countries, except Italy and the UK. This is the only shock for which correlations remain relatively high for all countries at long horizons. Finally, the conditional correlations of CA and RER after a permanent output shock display a mixed picture both in terms of signs and of magnitudes and trends over time. In particular, the correlations are positive but tend to zero over long horizons for France, Italy, and Japan, while they are negative for Germany. For Canada, up to 12 quarters after the shock the correlation is negative and then turns positive, whereas for the UK it is negative for the first year but turns highly positive in the following quarters.

Clearly, these figures reveal that it is difficult to conclude on the role of the RER on the CA as the nature of the shock is crucial to shape the relationship between those two variables. This is important to bear in mind because the nature of the shocks driving the current account varies considerably over time and across countries. Hence, looking at the unconditional correlation of both variables is not informative, as it will be the result of the frequency with which each shock hits the economy, and their conditional correlations.

In an effort to disentangle those difference further, we carry out a historical decomposition to obtain what the CA/NO would look like if there were only (i) external supply shocks, (ii) domestic permanent shocks, (iii) preference shocks, or (iv) domestic temporary shocks. **Figure 5**, which reports this historical decomposition of current account fluctuations for each country and each quarter, illustrates the above-mentioned diversity. To take just two opposite examples, the results indicate that Italy's noticeable switch from a current account deficit to a surplus in the course of the 2010 decade seems to result from domestic temporary shocks, whose effects have turned from largely negative to positive (external supply shocks, which were very negative in the early 2010s, have played a more secondary role). Conversely, the resorption of Japan's current account surplus[12] over the same period results mostly from a change in preference shocks (from positive to negative).

6. Conclusions

Research on the sources of current account fluctuations has played an important role in international macroeconomics in the last decades. This is because of, first, the recent current account imbalances in the world economy and, secondly, the implications it has for present-value models of the current account. In this paper we have analyzed the main shocks driving current account fluctuations in the G6 (G7 minus the US) countries by separating domestic temporary and permanent shocks, and also external supply shocks and preference shocks. We follow the theoretical setting of Bergin and Sheffrin (2000), which allows for the introduction of a time-varying world real interest rate and the existence of tradable and non-tradable sectors. Based on the implications of

[12] Note that Figure 6 plots the demeaned current account.

this model, we then estimate a SVAR model with minimal long-run identifying restrictions *à la* Blanchard and Quah (1989).

Our results show four main conclusions. First, there is substantial support for the two-good intertemporal model with time-varying interest rate, since both external supply and preference shocks account for an important proportion of current account fluctuations. Second, temporary domestic shocks account for a large proportion of current account fluctuations, but the excess response of the current account is less pronounced than in previous studies. Third, our results alleviate the previous well-established puzzle in the literature that a shock that explains little about net output changes can explain a large proportion of current account changes. Fourth, the nature of the shock matters to shape the relationship between the current account and the real exchange rate, which may explain why is it difficult to uncover the role of the real exchange rate on current account fluctuations. This is especially important as different shocks appear to play a different role at different times: a given change in the exchange rate can potentially be associated with very different current account changes, depending on the nature of the underlying shock.

Figure 1: CA to Net output ratios

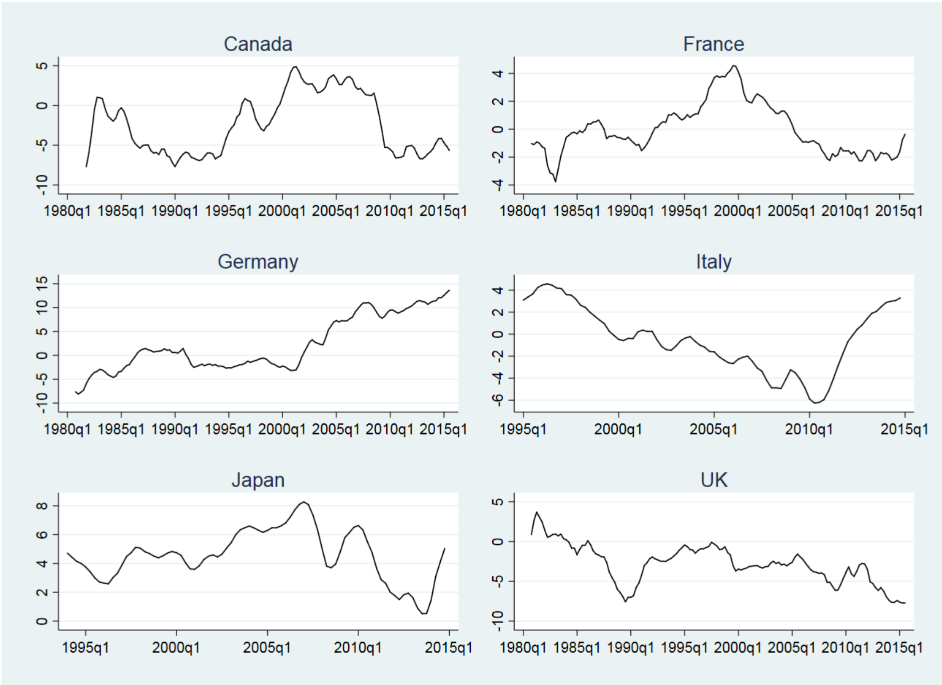


Figure 2: Weighted G7 Real Interest Rate

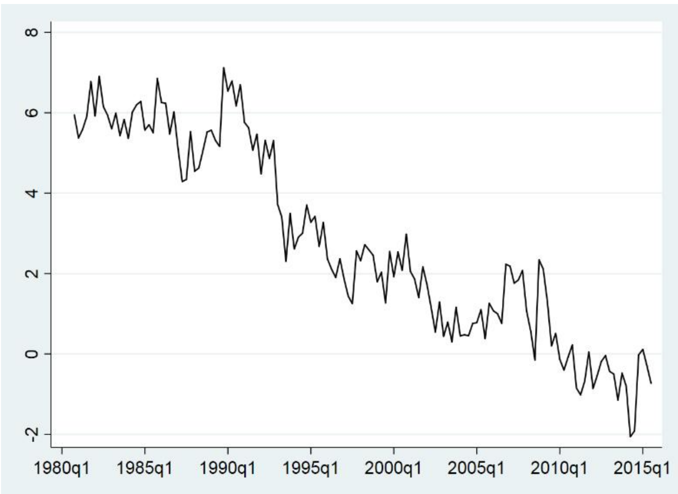
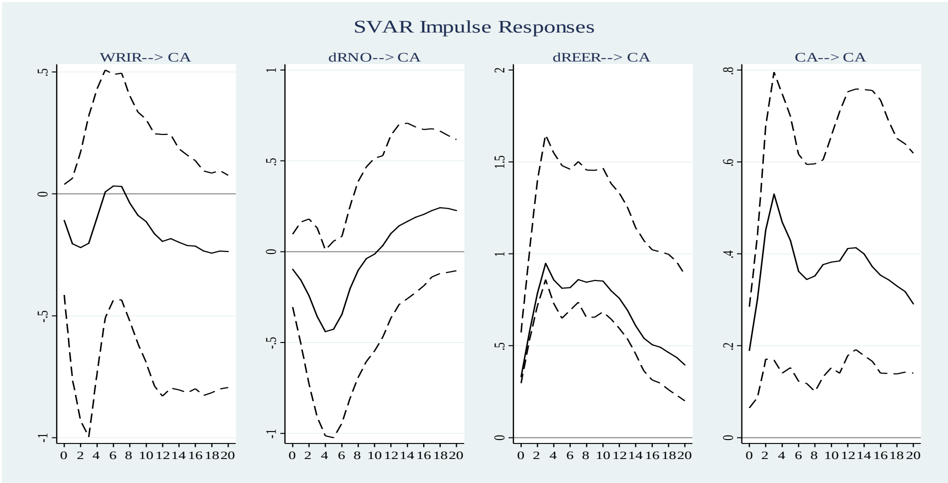
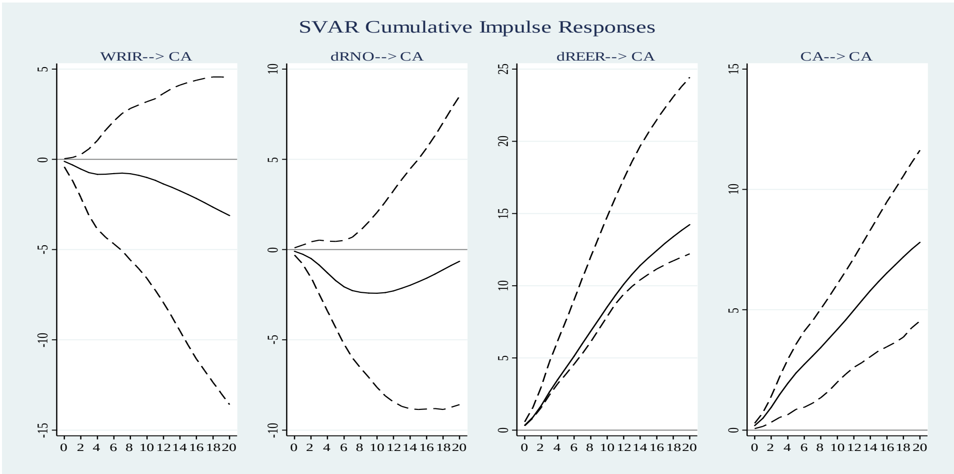


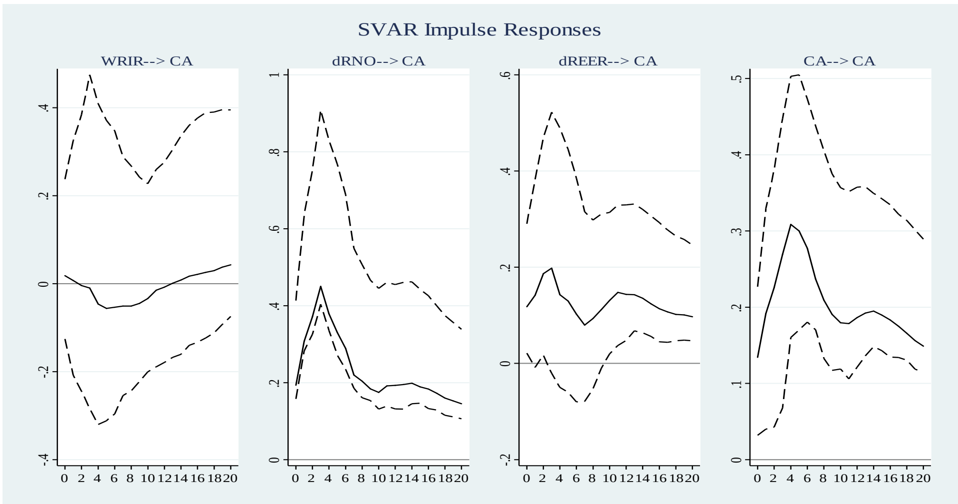
Figure 3: IRF's and AIRF's of the CA/NO

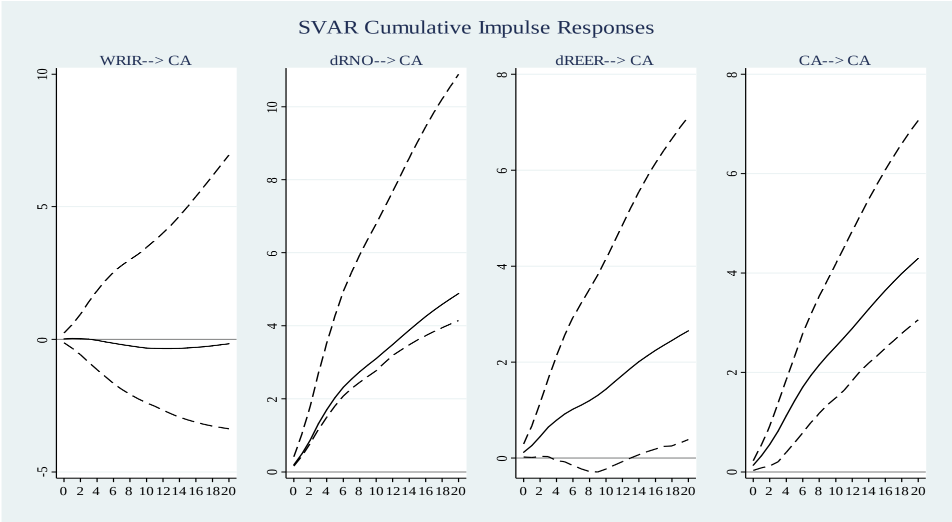
CANADA



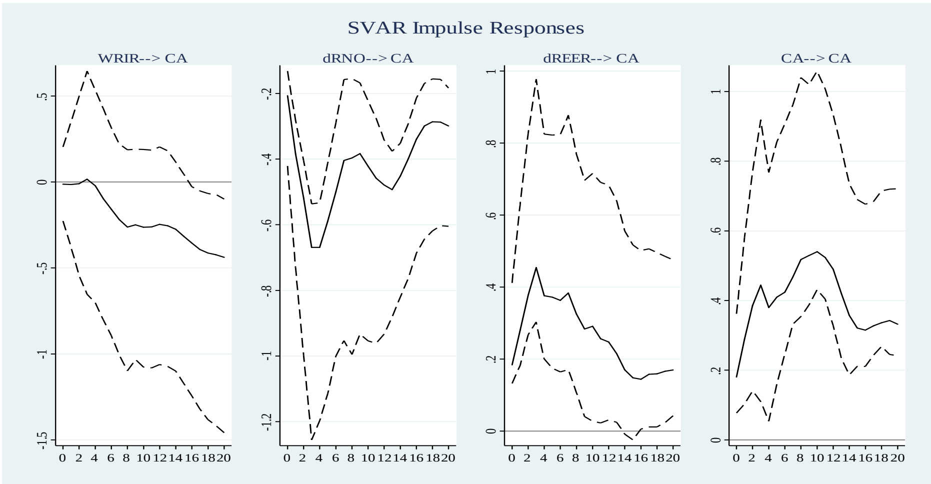


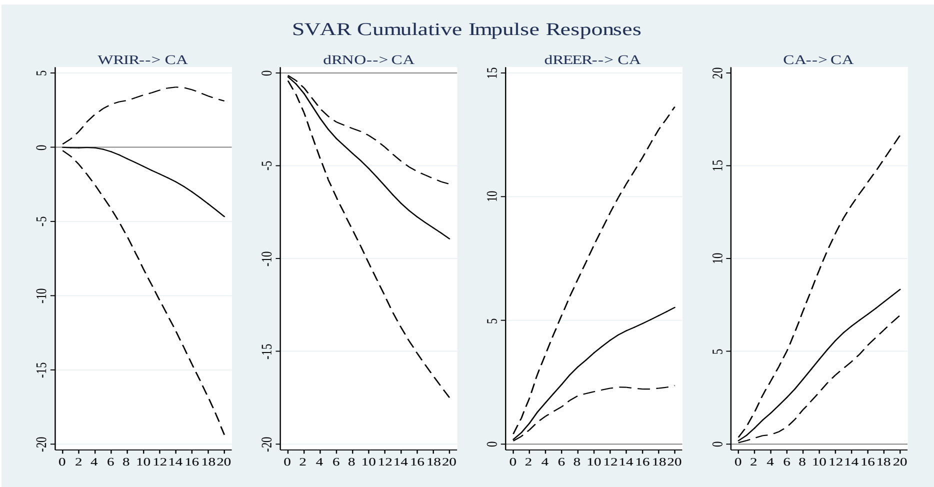
FRANCE



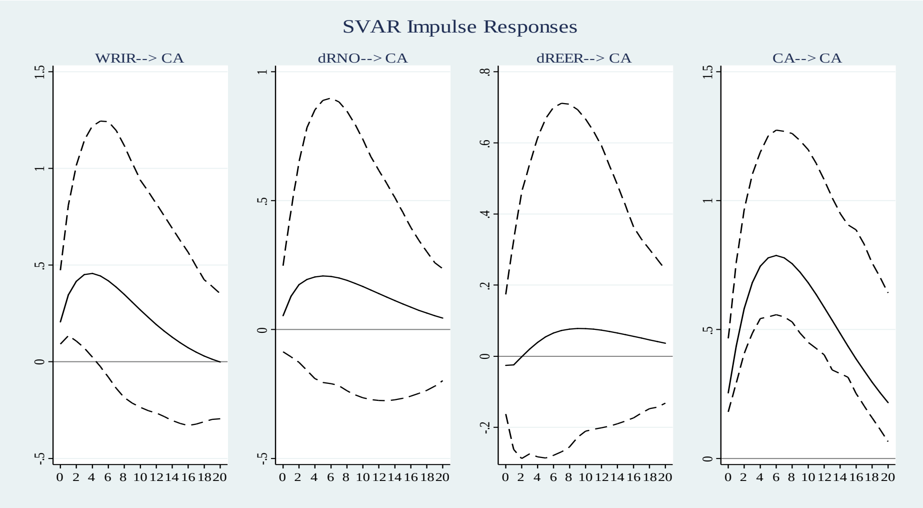

SVAR Cumulative Impulse Responses
WRIR--> CA
dRNO--> CA
dREER--> CA
CA--> CA

GERMANY

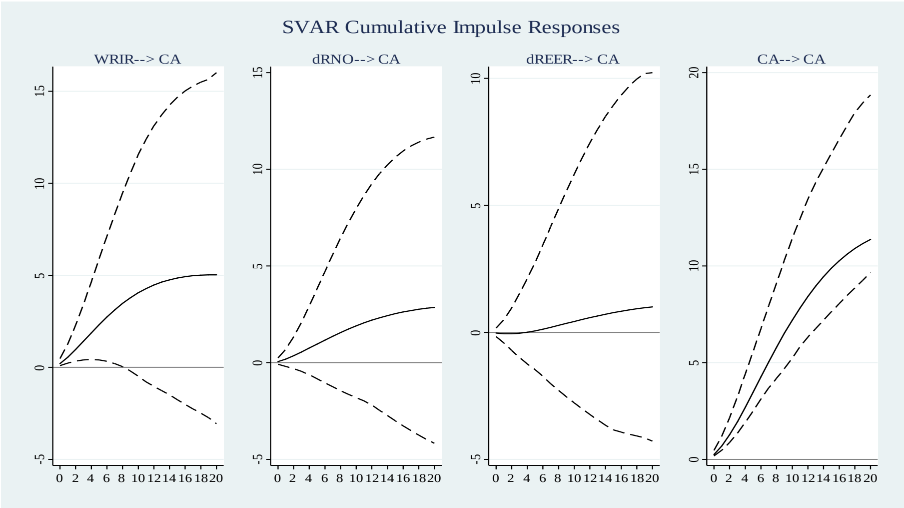

SVAR Impulse Responses
WRIR--> CA
dRNO--> CA
dREER--> CA
CA--> CA


SVAR Cumulative Impulse Responses
WRIR--> CA
dRNO--> CA
dREER--> CA
CA--> CA

ITALY

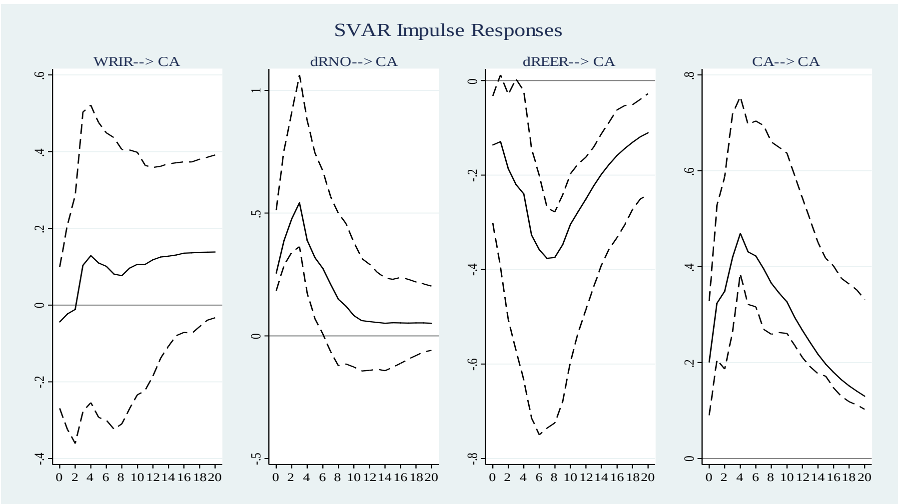


SVAR Impulse Responses
WRIR--> CA
dRNO--> CA
dREER--> CA
CA--> CA

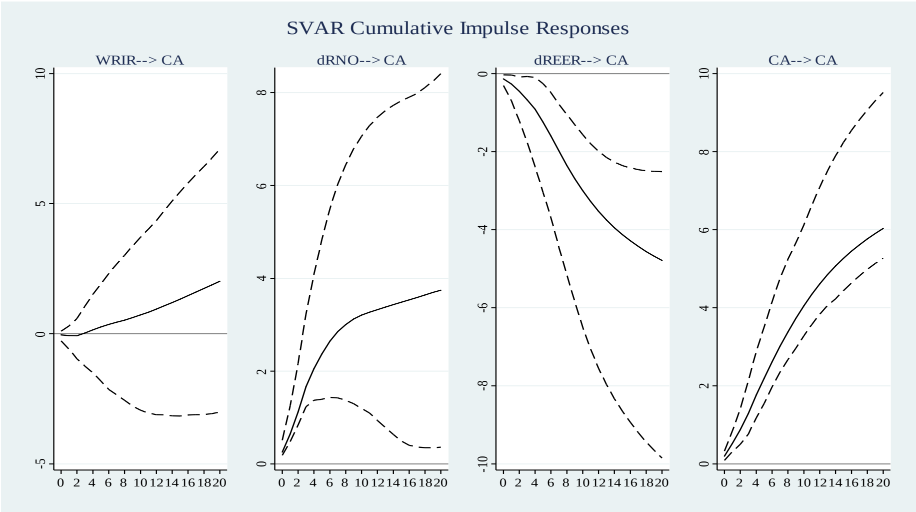


SVAR Cumulative Impulse Responses
WRIR--> CA
dRNO--> CA
dREER--> CA
CA--> CA

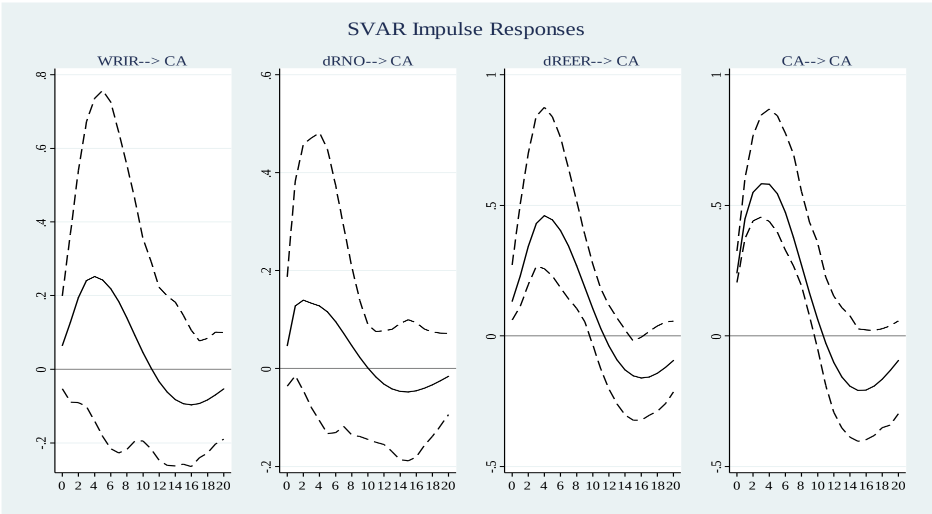
UK



SVAR Impulse Responses
WRIR--> CA
dRNO--> CA
dREER--> CA
CA--> CA


SVAR Cumulative Impulse Responses
WRIR--> CA
dRNO--> CA
dREER--> CA
CA--> CA

JAPAN


SVAR Impulse Responses
WRIR--> CA
dRNO--> CA
dREER--> CA
CA--> CA

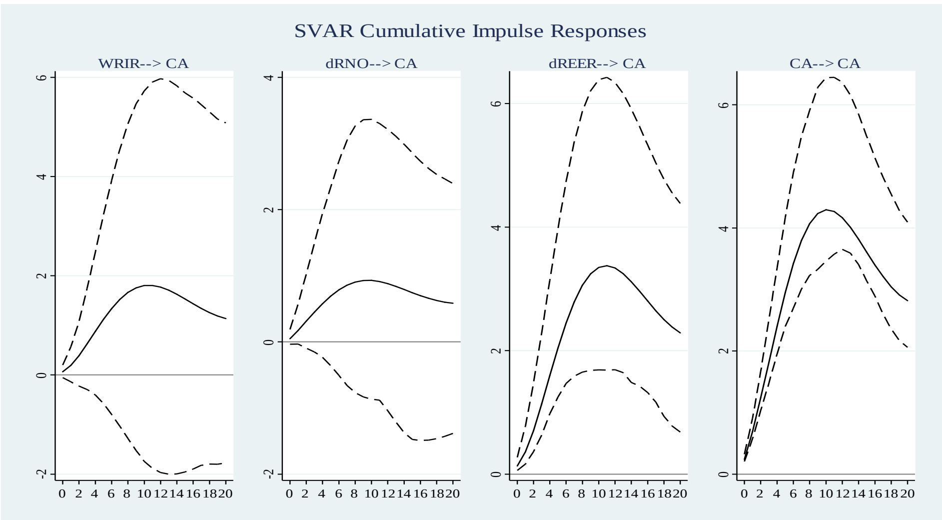

SVAR Cumulative Impulse Responses
WRIR--> CA
dRNO--> CA
dREER--> CA
CA--> CA

Figure 4: Conditional Correlations of CA/NO IRFs and RER IRFs

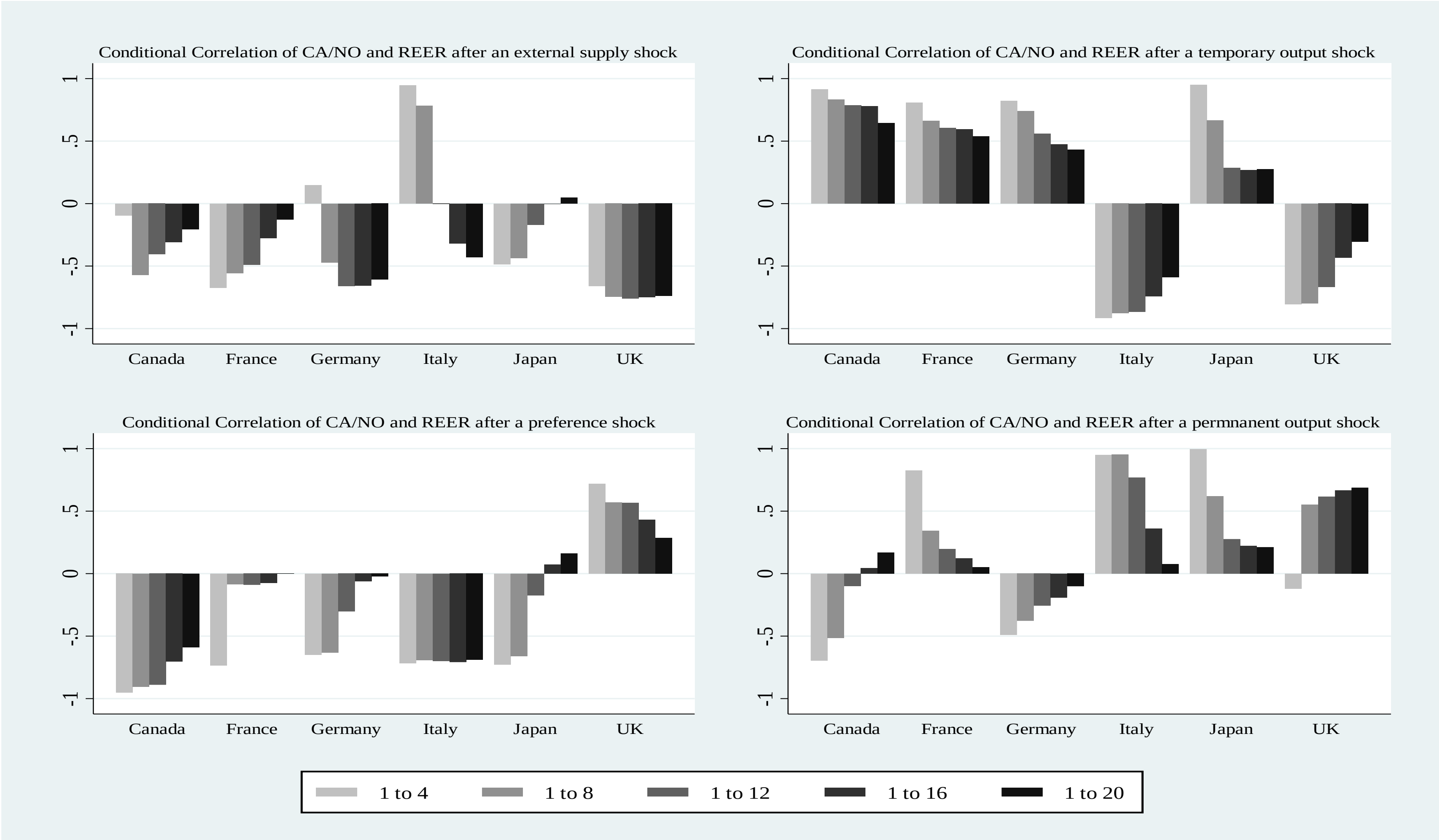


Figure 5: Historical Decomposition of CA fluctuations

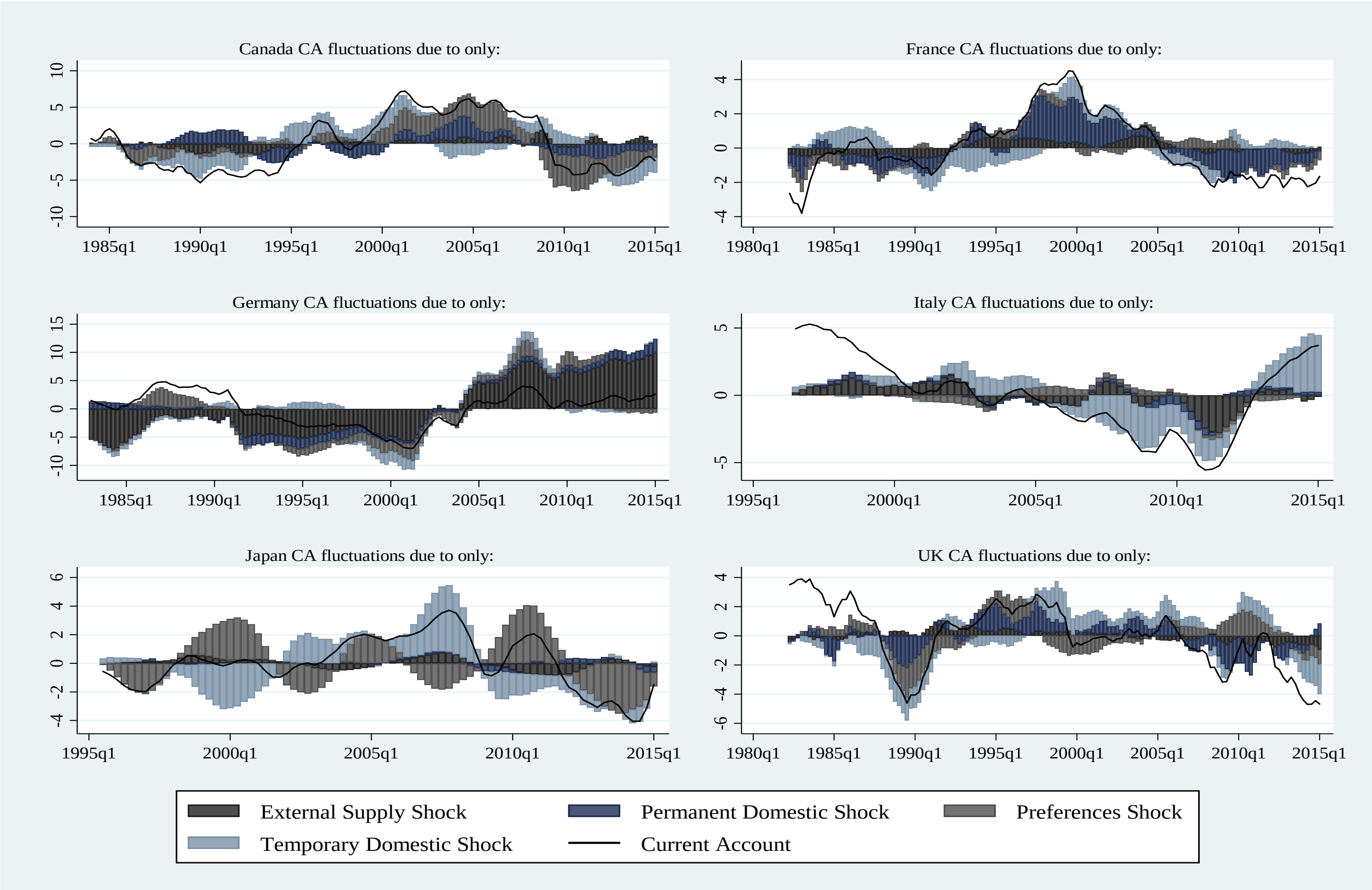


Figure 6: Conditional Correlations of CA/NO and REER

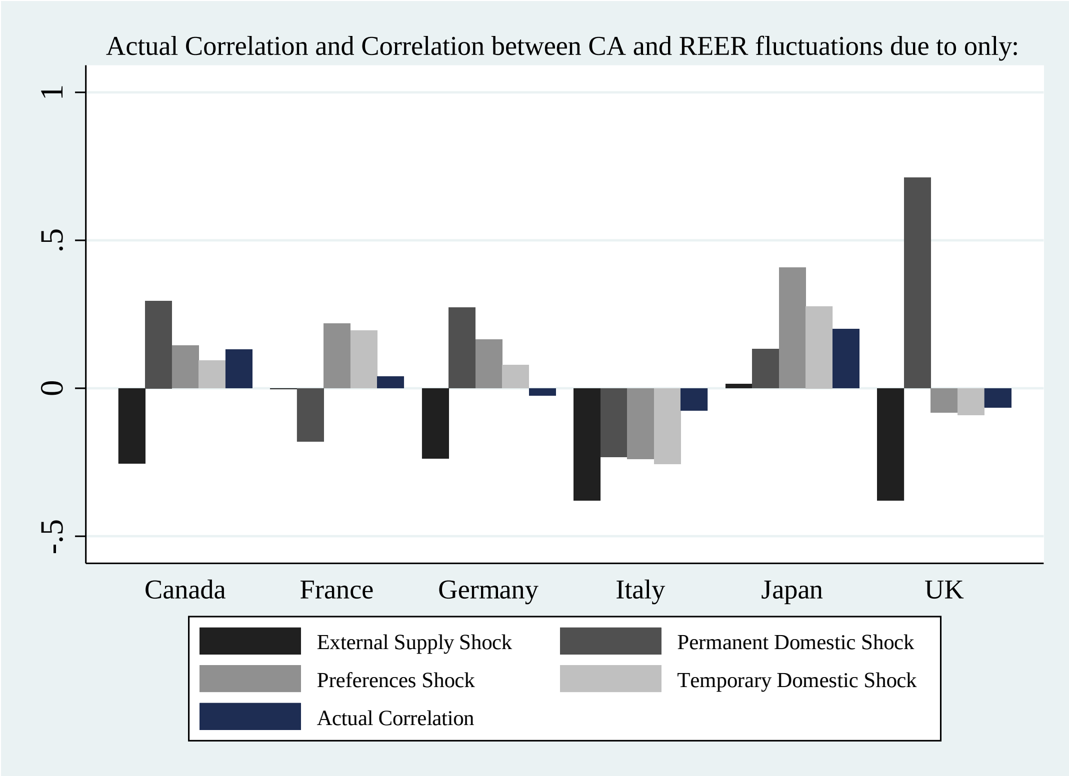


Table 1: SVAR Forecast Error Variance Decomposition

	Proportions of forecast error in $\mathbf{CA_t/NO_t}$ accounted for by:			
forecast horizon	**External Supply**	**Permanent Domestic**	**Preferences**	**Temporary Domestic**
		Canada		
1	0.07	0.06	0.66	0.22
4	0.05	0.08	0.67	0.21
8	0.02	0.11	0.69	0.18
20	0.04	0.07	0.69	0.20
40	0.08	0.11	0.62	0.19
		France		
1	0.00	0.54	0.20	0.26
4	0.00	0.62	0.14	0.23
8	0.01	0.56	0.11	0.33
20	0.01	0.50	0.14	0.36
40	0.05	0.46	0.14	0.35
		Germany		
1	0.00	0.39	0.31	0.30
4	0.00	0.50	0.25	0.25
8	0.02	0.48	0.23	0.27
20	0.12	0.39	0.16	0.33
40	0.41	0.27	0.10	0.23
		Italy		
1	0.38	0.03	0.01	0.58
4	0.32	0.05	0.00	0.63
8	0.25	0.05	0.00	0.69
20	0.19	0.05	0.01	0.76
40	0.19	0.05	0.01	0.76
		UK		
1	0.02	0.52	0.15	0.32
4	0.01	0.56	0.09	0.34
8	0.02	0.38	0.19	0.41
20	0.05	0.26	0.27	0.42
40	0.11	0.23	0.26	0.40
		Japan		
1	0.05	0.03	0.22	0.71
4	0.08	0.04	0.26	0.62
8	0.09	0.03	0.31	0.56
20	0.10	0.03	0.32	0.55
40	0.10	0.03	0.32	0.55

Table 2: SVAR Forecast Error Variance Decomposition of Δno_t

	Proportions of forecast error in Δno_t accounted for by:			
forecast horizon	**External Supply**	**Permanent Domestic**	**Preferences**	**Temporary Domestic**
Canada				
1	0.03	0.10	0.66	0.21
4	0.09	0.09	0.61	0.21
8	0.13	0.16	0.51	0.20
20	0.13	0.16	0.51	0.20
40	0.14	0.16	0.51	0.20
France				
1	0.01	0.47	0.09	0.43
4	0.02	0.41	0.14	0.44
8	0.03	0.39	0.16	0.42
20	0.05	0.38	0.16	0.40
40	0.06	0.38	0.16	0.40
Germany				
1	0.15	0.01	0.55	0.28
4	0.15	0.06	0.53	0.26
8	0.15	0.08	0.49	0.28
20	0.15	0.10	0.48	0.27
40	0.15	0.10	0.48	0.27
Italy				
1	0.06	0.86	0.07	0.01
4	0.07	0.81	0.10	0.02
8	0.07	0.81	0.10	0.02
20	0.07	0.81	0.10	0.02
40	0.07	0.81	0.10	0.02
UK				
1	0.12	0.75	0.00	0.14
4	0.13	0.66	0.07	0.13
8	0.14	0.66	0.07	0.13
20	0.14	0.65	0.07	0.13
40	0.15	0.64	0.07	0.13
Japan				
1	0.05	0.82	0.04	0.09
4	0.07	0.76	0.06	0.11
8	0.07	0.75	0.06	0.12
20	0.07	0.74	0.07	0.12
40	0.07	0.73	0.07	0.12

Table 3: Over-identifying restrictions.

Null hypothesis	Canada	France	Germany	Italy	Japan	UK
Rest. 1 $C(L)_{42}=0$	**1.918** **(0.166)**	84.62 (0.000)	82.53 (0.000)	**1.195** **(0.274)**	**2.23** **(0.135)**	27.57 (0.000)
Rest. 2 $C(L)_{32}=0$	42.42 (0.000)	34.22 (0.000)	51.29 (0.00)	5.52 (0.019)	**0.1813** **(0.670)**	13.63 (0.000)
Rest. 1 and 2 $C(L)_{42}= C(L)_{32}=0$	135.1 (0.000)	160.2 (0.000)	86.27 (0.000)	10.62 (0.005)	**5.104** **(0.078)**	82.78 (0.000)
Rest. 3 $C(L)_{41}=0$	**128.9** **(0.000)**	**68.6** **(0.000)**	**472.9** **(0.000)**	**9.274** **(0.002)**	**7.322** **(0.007)**	**122.5** **(0.000)**
Rest. 4 $C(L)_{43}=0$	**158.9** **(0.000)**	**41.38** **(0.000)**	**42.68** **(0.000)**	0.7302 (0.393)	**39.42** **(0.000)**	**64.4** **(0.000)**
Rest. 3 and 4 $C(L)_{41}= C(L)_{43}=0$	**287.8** **(0.000)**	**110.0** **(0.000)**	**515.6** **(0.000)**	**10.0** **(0.007)**	**46.75** **(0.000)**	**186.9** **(0.000)**

Notes: Wald tests of over-identifying restrictions on the long-run cumulative impact matrix C(L) and p-values in parentheses. Bold numbers indicate that the null cannot be rejected at the 5% level for Restrictions 1 and 2, and rejection of the null for Restrictions 3 and 4.

Table 4: Conditional Correlations of CA fluctuations

	Correlation of actual CA fluctuations and CA fluctuations due to only:			
	Ext. Supply	**Permanent Dom.**	**Preferences**	**Temporary Dom.**
Canada	0.607	0.395	0.801	0.330
France	0.657	0.906	0.254	0.162
Germany	0.665	0.414	0.322	-0.093
Italy	0.679	0.515	-0.202	0.662
Japan	0.101	0.044	0.471	0.456
UK	0.348	0.585	0.342	0.369

Table 5: Conditional Correlations of REER fluctuations

	Correlation of actual REER fluctuations and REER fluctuations due to only:			
	Ext. Supply	**Permanent Dom.**	**Preferences**	**Temporary Dom.**
Canada	0.432	0.419	0.643	0.462
France	0.391	0.399	0.761	0.314
Germany	0.400	0.275	0.575	0.635
Italy	0.031	0.155	0.880	0.446
Japan	0.289	0.147	0.755	0.516
UK	0.458	0.217	0.701	0.439

References

Ahmed, S., and Park J. H. (1994). Sources of Macroeconomic Fluctuations in Small Open Economies. *Journal of Macroeconomics*, 16(1):1-36.

Barro, R. J., and Sala-i-Martin, X. (1990), World Real Interest Rates, O. J. Blanchard, S. Fischer (Eds.), *NBER Macroeconomics Annual 1990*, MIT Press, Cambridge, MA.

Bergin P. R. (2003). Putting the 'New Open Economy Macroeconomics' to a test. *Journal of International Economics*, 60:3-34.

Bergin, P. R. (2006). How well can the New Open Economy Macroeconomics explain the exchange rate and current account? *Journal of International Money and Finance*, 25(5):675-701.

Bergin, P. R., and Sheffrin S. M. (2000). Interest Rates, Exchange Rates and Present Value Models of the Current Account. *The Economic Journal*, 110(463):535-558.

Betts, C. M., and Kehoe, T. J. (2008). Real Exchange Rate Movements and the Relative Price of Non-traded Goods, *NBER Working Paper No. 14437*.

Blanchard, O. J., and Quah D. (1989). The Dynamic Effects of Aggregate Demand and Supply Disturbances. *American Economic Review*, 79(4):655-673.

Blanchard, O. J., and G. M. Milesi-Ferretti (2011). (Why) Should Current Account Balances Be Reduced?. IMF Staff Discussion Note SDN/11/03 (Washington: International Monetary Fund).

Bouakez, H., and Kano, T. (2008). Terms of trade and current account fluctuations: The Harberger-Laursen-Metzler effect revisited. *Journal of Macroeconomics*, 30:260-281.

Bracke, T., M. Bussière, M. Fidora and R. Straub (2010). "A Framework for Assessing Global Imbalances," The World Economy, Wiley Blackwell, vol. 33(9), pages 1140-1174, 09.

Brissimis, S. N. G., Papazoglou, H. C., Tsaveas, N. T., and Vasardani, M. A. (2012). Current Account Determinants and Extenal Sustainability in Periods of Structural Change. *Economic Change and Restructuring*, 45(1-2):71-95.

Caballero, R. J., Farhi E., and Gourinchas P. O. (2008). An Equilibrium model of "Global Imbalances" and Low Interest Rates. *American Economic Review*, 98(1):358-393.

Caballero, R. J., Farhi E., and Gourinchas P. O. (2015). Global Imbalances and Currency Wars at the ZLB. NBER Working Papers 21670, National Bureau of Economic Research, Inc.

Caballero, R. J., Farhi E., and Gourinchas P. O. (2016). Safe Asset Scarcity and Aggregate Demand. *American Economic Review: Papers and Proceedings*, Vol. 106, No. 5, pp. 513–18.

Caballero, R.J., and Krishnamurthy, A. (2008). Global Imbalances and Financial Fragility. *Mimeo, MIT*.

Campbell, J. Y. (1987). Does saving anticipate declining labor income? An alternative test of the permanent income hypothesis. *Econometrica*, 55(6):1249-1274.

Campbell, J. Y., and Shiller R. (1987). Cointegration and tests of present value models. *Journal of Political Economy*, 95(5):1062-1088.

Ca'Zorzi, M., and Rubaszek, M. (2012). On the empirical evidence of the intertemporal current account model for the euro area countries. *Review of Development Economics* 16(1):95-106.

Cerrato, M., Kalyoncu H., Hassan N. N., and Tsoukis, C. (2014). Current accounts in the long run and the intertemporal approach: a panel data investigation. *World Economy*, 38(2):340-359.

Chinn M. D., and Lee J. (2006). Current Account and Real Exchange Dynamics in the G7 Countries. *Journal of International Money and Finance*, 25(2):257-274.

Christopoulos, D.K. and Leon-Ledesma, M. A. (2010). What did we really know about current account sustainability in the USA?. *Journal of International Money and Finance*, 29(3), 442-459.

Cova, P., Pisani, M., Batini, N., and Rebucci, A. (2008). Productivity and Global Imbalances: The Role of Nontradable Total Factor Productivity in Advanced Economies. *IMF Staff Papers*, 55(2): 312-325.

Dornbusch, R. (1983). Real interest rates, home goods and optimal external borrowing. *Journal of Political Economy*, 91(1):141-153.

Eichengreen, B. (2006). The Blind Men and the Elephant. *Issues in Economic Policy*, Brookings Institution, 1:1-25.

Engel, C. (1999). Accounting for U.S. Real Exchange Rate Changes. *Journal of Political Economy*, 107:507-538.

Ferreira, A. L., and León-Ledesma, M. A. (2007). Does the Real Interest Parity Hypothesis Hold? Evidence for Developed and Emerging Markets. *Journal of International Money and Finance*, 26(3):364-382.

Ghosh, A. R. (1995). International capital mobility among the major industrialised countries: too little or too much? *The Economic Journal*, 105(428):107-128.

Gourinchas, P.-O. and H. Rey (2007), "From World Banker to World Venture Capitalist: US External Adjustment and the Exorbitant Privilege," in Richard Clarida, ed., G-7 Current Account Imbalances: Sustainability and Adjustment, University of Chicago Press, Chicago, 2007, pp. 11–55.

Hoffmann, M., 2013. What drives China's current account?. *Journal of International Money and Finance*, Elsevier, 32(C), 856-883.

Huang, C. H. (2010). International Capital Mobility: An alternative test based on intertemporal current account models. *International Review of Economics and Finance*, 19:467-482.

Hunt, B., and Rebucci, A. (2005). The US Dollar and the Trade Deficit: What accounts for the Late 1990s? *International Finance*, Blackwell Publishing, 8(3):399-434.

International Monetary Fund (2004), *World Economic Outlook*. IMF, Washington DC.

International Monetary Fund (2017), *External Sector Report*. IMF, Washington DC.

https://www.imf.org/en/Publications/Policy-Papers/Issues/2017/07/27/2017-external-sector-report.

Kano, T. (2008). A Structural VAR Approach to the Intertemporal Model of the Current Account. *Journal of International Money and Finance*, 27(5):757-779.

Lane, P. R. (2001). Money Shocks and the Current Account, In *Money, Factor Mobility and Trade: Essays on Honor of Robert Mundell*. Guillermo Calvo, Rudiger Dornbush, and Maurice Obstfeld (ed.). Cambridge: MIT Press.

Lee, J. and Chinn, M. D. (2006). Current Account and Real Exchange Dynamics in the G7 Countries. *Journal of International Money and Finance*, 25(2):257-274.

Nason, J. M., and Rogers, J. H. (2002). Investment and the Current Account in the Short Run and the Long Run. *Journal of Money, Credit and Banking*, 34(4):967-986.

Nason, J. M., and Rogers, J. H. (2006). The present-value model of the current account has been rejected: round up the usual suspects. *Journal of International Economics*, 68(1):159-187.

Neely, C. J., and Rapach D. (2008). Real Interest Rate Persistence: Evidence and Implications. *Federal Reserve Bank of St. Louis*, Working Paper Series 2008-018A.

Ng, S., and Perron, P. (2001). Lag Length Selection and the Construction of Unit Root Tests with Good Size and Power. *Econometrica*, 69:1519-1554.

Nguyen, H. And Servén, L. (2010). Global Imbalances Before and After the Global Crisis. *The World Bank*, Policy Research Working Paper Series 5354.

Obstfeld, M., and Rogoff K. (1996). Foundations of International Macroeconomics, *The MIT Press*.

Obstfeld, M., and Rogoff, K. (1995). The intertemporal approach to the current account. In *Handbook of International Economics*. Gene M. Grossman and Kenneth Rogoff (ed.). North Holland Publishing Co., New York, 3:731–1799.

Otto, G. (1992). Testing a present value model of the current account: evidence from U.S. and Canadian time series. *Journal of International Money and Finance*, 11(5):414-430.
Otto, G. (1992). Testing a present value model of the current account: evidence from U.S. and Canadian time series. *Journal of International Money and Finance*, 11(5):414-430.
Ricci, L.A., Milesi-Ferretti, G.M., and Lee, J. (2013). Real Exchange Rates and Fundamentals: A Cross-Country Perspective, *Journal of Money, Credit and Banking,* 45(5):845-865.

Sheffrin, S., and Woo W.T. (1990a). Testing an optimizing model of the current account via the consumption function. *Journal of International Money and Finance*, 9(2):220-233.

Sheffrin S., and Woo W.T. (1990b). Present value tests of an intertemporal model of the current account. *Journal of International Economics*, 29(3-4):237-253.

Sims, C. A. (1980). Macroeconomics and Reality. *Econometrica*, 48(1):1-48.

Taylor, A. M. (2002). A century of current account dynamics. *Journal of International Money and Finance*, 21(6):725-748.

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