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Aikaterini Karadimitropoulou and Miguel A. León-Ledesma

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Aikaterini Karadimitropoulou[#] Miguel A. León-Ledesma[#]

[#]Department of Economics, University of Kent

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Abstract

We analyze the sources of current account fluctuations for the G6 economies. Based on Bergin and Sheffrin's (2000) two-goods inter-temporal framework, we build a SVAR model including the world real interest rate, net output, real exchange rate, and the current account. The theory model allows for the identification of structural shocks in the SVAR using long-run restrictions. Our results suggest three main conclusions: i) we find evidence in favour of the present-value model of the CA for all countries except France; ii) there is substantial support for the two-good intertemporal model, since both external supply and preferences shocks account for an important proportion of CA fluctuations; iii) temporary domestic shocks account for a large proportion of CA fluctuations, but the excess response of the CA is less pronounced than in previous studies.

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

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Address for correspondence: Aikaterini Karadimitropoulou, Department of Economics, University of Kent, Office B2.03, Canterbury, Kent, CT2 7NP. ak367@kent.ac.uk

1 Introduction

The analysis of current account (CA) fluctuations in open economies plays a central role in both empirical and theoretical models of open economy macroeconomics. In recent years, this has also become central to understanding the emergence and (recent) readjustment of global imbalances. The current financial crisis has been associated with the unfolding of these imbalances (see, for instance, Caballero, Fahri and Gourinchas, 2008 and Caballero and Krishnamurthy, 2008). This concern was already reflected in IMF (2004) who states that one of the main risks for the global economy was in achieving an orderly resolution of global imbalances.[1] Within this context, analyzing the main shocks that drive changes in the CA becomes of utmost importance to understanding the potential sources of global imbalances.

There are many models to analyze the macroeconomic shocks driving the CA. The canonical Mundell-Fleming-Dornbusch model, for instance, remains an important tool for policy makers and has been used to explain the impact of monetary and fiscal policy shocks. Nonetheless, in the 1980's a number of studies provided the basis for the so-called 'intertemporal approach' to the CA that has since been dominant in the profession (see Obstfeld and Rogoff, 1995). In this approach, the CA is viewed as reflecting intertemporal consumption decisions and productivity shocks. Importantly, the intertemporal approach assumes that the CA 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, interest rates, traded and nontraded goods, price rigidities, pricing to market behaviour, and monetary policy (see Obstfeld and Rogoff, 1996 and Lane, 2001). These models have helped understanding the driving factors behind CA changes and net foreign asset accumulation. Their implications are also directly or indirectly testable, making them a logical benchmark against which to analyze the sources of CA fluctuations.

Empirically, the intertemporal approach has had mixed support from the data. Early studies like Sheffrin and Woo (1990a) found only limited support by making use of the Campbell (1987) present value tests. Other works introducing a wider range of variables found stronger support for the model. Although tests of the present value approach are a core element of the literature, recently, 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

[1] For an overview of the competing explanations of global imbalances, see Eichengreen (2006), and for an analysis of the financial side of the crisis, see Brunnermeier (2008).

then used to test the implications of the intertemporal model. This is the case in studies such as Ahmed and Park (1994), Lane (2001b), Nason and Rogers (2002), Lee and Chinn (2006), and Kano (2008). 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 CA fluctuations by sources of shocks, going beyond mere tests of specific theoretical frameworks.

Following this literature, we propose a SVAR model that draws on the theoretical model of Bergin and Sheffrin (2000). They present a model of the CA that introduces a richer set of variables, allowing for the analysis of the role of the (time-varying) world interest rates and the real exchange rate (RER). 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. Bergin and Sheffrin (2000) then test the restrictions from the present value model for Australia, Canada and the UK. The introduction of variable interest rates and the RER allows for the analysis of the role played by external shocks, which can be a major source of CA fluctuations in small economies.

Based on the two-goods small open economy model of Bergin and Sheffrin (2000), we analyze the sources of CA fluctuations in the G6 (G7 minus the US) countries which allows us to introduce a time-varying world real interest rate and the RER. We build a four variable SVAR model with long-run restrictions that allows us to identify four different sources of shocks. We introduce not only the traditional permanent and temporary output shocks, but also external supply shocks and demand shocks. In particular, we identify four distinct shocks: domestic permanent, domestic temporary, demand (preferences), and external supply shocks. This will also help understand the dynamic relation between CA 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 CA fluctuations, we also introduce over-identifying restrictions to directly test some of the implications of the theory model.

The rest of the paper is organized as follows. In Section 2, we review some of the abovementioned 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

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). They essentially use tests of over-identifying restrictions arising from theory models applied to a reduced form VAR representation of the present value formula. This is also the approach used in Bergin and Sheffrin (2000). Using quarterly data from 1960:1 to 1996:4 and countries that had previously been problematic – Australia, Canada, and the UK – they concluded 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.

Recently, researchers have increasingly made use of the SVAR approach 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.[2]

Ahmed and Park (1994) use a four-variable SVAR with long-run restrictions to examine macroeconomic fluctuations in seven OECD small open economies. Using the Blanchard and Quah (1989) identification method, they are able to identify four distinct structural shocks, which are external shocks, domestic supply shocks, domestic absorption shocks and domestic price level shocks. Their results 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.

Lane (2001b) estimates a tri-variate VAR system including the first-difference of the ratio of the U.S. to world output, the consumer price levels ratio between the U.S. and the rest of the world, and the U.S. current account to GDP ratio. Using long-run neutrality restrictions, Lane (2001b) identifies three orthogonal structural shocks:

[2] Recently, Bergin (2003 and 2006) proposes direct tests of the models through maximum likelihood estimation of the parameters of the linearized model, in a fashion similar to estimated DSGE models (see Smets and Wouters, 2003).

supply, absorption, and monetary shocks. The accumulated impulse responses showed that a positive monetary shock leads first to a short-run CA deterioration and then to a persistent surplus.

Nevertheless, Lee and Chinn (2006) explain that, if in the steady-state the stock of net foreign assets is constant, then neither real nor monetary disturbances could have long-run effects on the current account to GDP ratio. They 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. They identified the structural shocks as productivity shocks (country-specific permanent shocks) and monetary shocks (country-specific temporary shocks). In accordance to both traditional intertemporal models and NOEM models, they restricted temporary shocks to have only short-run effects on the RER, but not long-run ones. This identification allows for the estimation of the short-run dynamics of the variables. They show that, in most of the countries, a positive monetary policy shock leads to a short-run real exchange rate depreciation and a short-run current account surplus. 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).

Recently, 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. The inclusion of the world real interest rate allows for the consideration of consumption tilting effects on the CA. He identifies three structural shocks, which are global shocks, country-specific temporary shocks, and country-specific permanent shocks. The identification scheme of the SVAR exploits firstly the orthogonality of the world real interest rate and country-specific shocks, and secondly, the absence of a long-run response of net output to transitory shocks. Then he tests the present value model by imposing cross equation restrictions exploiting the fact that the CA in a small open economy should be independent of global shocks, and that responses of the CA to country-specific shocks depend on the persistence of those 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 emphasised by Obstfeld and Rogoff (1996) and Bergin and Sheffrin (2000).

In our empirical model, we introduce the RER together with the CA 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, demand or preferences shocks, and temporary domestic output shocks. This is an important aspect of our model that makes it different from the previous literature and which we then use to analyze the dynamics of the CA.

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. International bonds are assumed to be the only assets of the SOE. Given the assumption of perfect bond mobility, we assume interest rate equalization. However, we allow for a non constant world real interest rate. We can represent the country's current account by:

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

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 nontraded goods, and the relative price of nontraded goods in terms of traded ones, respectively. Note that all variables are in real per-capita terms.

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

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

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

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 nontraded goods and, secondly, that the variance and covariance among variables are time-invariant. From the optimization problem (2)-(3) we obtain the Euler equation:[3]

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

where

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

and $\Delta c_{t+1} = \log C_{t+1} - \log C_t$, $\Delta p_{t+1} = \log P_{t+1} - \log P_t$, $\gamma = 1/\sigma$ 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:

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

With this result and the budget constraint, it is possible to obtain an analytical solution for the CA. To begin with, following Bergin and Sheffrin (2000), we define R_s as the market discount factor for consumption at date *s*, such that:

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

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

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:

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

where B_0 is the initial level of net foreign assets. The log-linearized intertemporal budget constraint[4] 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, the value of net foreign assets is equal to zero, so that $\bar{B} = 0$, we have $\Omega = 1$ and finally obtain:

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

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

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

Equation (12) illustrates two important effects. In 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 smoothes 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.[5] 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.

As we can implicitly see, this model consists of four variables. The first one, which appears on the left hand side, represents the current account to net output ratio. Then, on the right hand side we have 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

[5] 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.

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, preferences shocks and, finally, domestic temporary net output shocks. Those shocks are specified as $\varepsilon_t^{'} = \left(\varepsilon^{es}, \varepsilon^{dp}, \varepsilon^{d}, \varepsilon^{dt} \right)$, where $\varepsilon^{es}, \varepsilon^{dp}, \varepsilon^{d}$ and ε^{dt} represent the above mentioned shocks, respectively.

The VAR in compact form is as follows:

$$BX_t = \Gamma_0 + \Gamma_1(L)X_{t-1} + \varepsilon_t \qquad (13)$$

where B is a full-rank matrix whose diagonal elements are all unity, X_t is a (4x1) vector, such that $X_t^{'} = \left(r_t, \Delta no_t, \Delta p_t, \frac{CA_t}{NO_t} \right)$, Γ_0 is a (4x1) vector representing the constant terms, Γ_1(L) is a matrix of polynomials in the lag operator, such that $\Gamma_1(L) = \Gamma_1^0 + \Gamma_1^1 L + \Gamma_1^2 L + \ldots$, and ε_t is a (4x1) vector representing the structural shocks, which are orthogonal to each other and have a contemporaneous covariance matrix, Σ.

Pre-multiplication by B^{-1} allows us to obtain the VAR model in its reduced-form. This is the model actually estimated when the off-diagonal elements of B are unknown.

$$X_t = B^{-1}\Gamma_0 + B^{-1}\Gamma_1(L)X_{t-1} + B^{-1}\varepsilon_t, \qquad (14)$$

or

$$X_t = A_0 + A_1(L)X_{t-1} + e_t, \qquad (15)$$

where $A_0 = B^{-1}\Gamma_0, A_1 = B^{-1}\Gamma_1, e_t = B^{-1}\varepsilon_t$, and e_t is a (4x1) vector of serially uncorrelated reduced-form error terms, that are composite of all structural shocks and have a covariance matrix, Ω.

Matrix Ω has $(n^2 + n)/2$ elements, where *n* is the number of variables in the model. Moreover, as previously mentioned, B is a full-rank matrix whose diagonal elements are all unity, thus it contains $n^2 - n$ unknown values. The structural model has n^2 unknown values (those of B plus the n values $Var(\varepsilon_t^j)$). Hence, in order to identify the n^2 unknowns from the known $(n^2 + n)/2$ independent elements of Ω, it is necessary to impose $n^2 - \left[(n^2+n)/2\right] = \left[n^2 - n\right]/2$ additional restrictions on the system. In other words, $(n^2-n)/2$ restrictions need to be imposed on the reduced form model in order to identify the structural VAR which amounts to 6 restrictions in our 4 variables model. From the theory model, as we will discuss below, we can impose the necessary restrictions in the form of a long-run identification scheme. We hence make use of the Blanchard and Quah (1989) decomposition, which lends itself naturally to theory-driven restrictions.

Following Blanchard and Quah (1989), we can represent equation (13) in a vector moving average form:

$$X_t = \mu + C_0\varepsilon_t + C_1\varepsilon_{t-1} + C_2\varepsilon_{t-2} + ... = \mu + C_0L^0\varepsilon_t + C_1L^1\varepsilon_t + C_2L^2\varepsilon_t + ... = \mu + C(L)\varepsilon_t \qquad (16)$$

where $C(L) = C_0 + C_1L^1 + C_2L^2 + ...$ and L is the lag operator. Each element of matrix $C(L)$, $C_{ij}(L)$, will then represent the accumulated – long-run – effect of a shock ε_t^j on variable X_i.

We can then specify the SVAR model in its vector moving average form, so as to be able to identify the structural shocks:

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

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 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 modelled in the basic theory framework, Balassa-Samuelson effects due to productivity changes could potentially affect the equilibrium RER. The third shock, ε^{d} is interpreted as a preference (demand) 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. The former arises because of the assumption that demand shocks are neutral in the long-run. The latter occurs because of the same reason, plus the assumption of SOE. 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.

We can then proceed with the identification of the structural shocks from the reduced-form VAR model, for which six identifying restrictions are needed. Our scheme restricts the $C(L)$ matrix to be lower triangular. This enables us to apply the Choleski decomposition on the weighted variance-covariance matrix of the reduced-form VAR, to uniquely identify all the elements of $C(L)$. The SOE assumption implies that $C_{12}(L)$, $C_{13}(L)$ and $C_{14}(L)$ are equal to zero. The long-run neutrality of demand shocks translates into restricting $C_{23}(L)$ 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, $C_{34}(L)$ is restricted to be zero. Finally, the assumption that temporary domestic shocks do not have a long-run impact on net output implies that $C_{24}(L)$ is equal to zero, which completes our six restrictions. Hence, the long-run impact matrix becomes the lower triangular

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

and the VAR is just-identified.

As mentioned in the introduction, although not the main focus of our investigation, 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 $C_{42}(L)=0$. 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

$C_{32}(L)=0$. We can then test simultaneously for $C_{42}(L)=C_{32}(L)=0$ as a joint test of the present-value and productivity effects. Two other over-identifying restrictions relate to the importance of consumption tilting effects through the impact of external supply and preferences 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 or jointly for the hypotheses $C_{41}(L)=0$ and $C_{43}(L)=0$ as a test for the significance of consumption tilting effects on the CA.

5 Empirical Results

5.1. Data and unit root tests

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, West Germany, Italy, Japan, and the UK. Given the discontinuity of some of the variables for Germany, we opted to use data for West Germany only, and hence the sample period for this country differs from the other five. The sample period used was 1980:1 to 2007:4, apart from West Germany for which we used 1972:2 to 1991:4. 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 IMF's International Financial Statistics.

The 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.**

We proxy world real interest rates with US real interest rates. We used the annualized 3-months Treasury Bill rate as the nominal interest rate and CPI inflation to calculate the real interest rate. Based on the Fisher equation, the real interest rate at time *t* is the nominal interest rate minus the inflation rate between *t* and *t*+4 since we use quarterly data. This assumes the existence of an i.i.d.

expectational error with zero mean and constant variance.[6] The US real interest rate is plotted in **Figure 2**.

A proxy for the relative price of nontradable to tradable goods presents more problems. Ideally, we would use a direct measure of the relative price of nontraded to traded goods by making use of a sectoral tradability classification as in Ricci et al. (2008). However, this data is usually available only in annual terms and up to 2004. 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). Recently, Betts and Kehoe (2008) find that the correlation between bilateral CPI-based RERs and the relative price of nontraded goods for 50 countries is high, with an average correlation of 60% in levels. Nevertheless, we also run the model proxying the relative price by the ratio between CPI and PPI price indexes following Engel (1999) and Betts and Kehoe (2008). The results, available on request, did not change the main conclusions of the study regarding the dynamics of the CA and output, although we did find some differences in the dynamic responses of the RER to the identified shocks.

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 the UK (at the 10% level).

The existence of a nonstationary 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, 2009). 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 stationary, hence entering the VAR in levels. A similar caveat applies to the world real interest rate. As shown in Neely

[6] Using a 4-quarters moving average to proxy for inflation expectations did not change the results in any significant way.

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.[7] During the period analysed we capture the deflation period of the early 1980s and the Great Moderation period of low real interest rates in the US. This implies that real interest rates display a clear downward trend during the sample analysed (see **Figure 2**). Including this trend, we can reject the null of a unit root using the ADF test. We hence enter the real interest rate in levels, consistent with the theory model.[8]

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 and the Final Prediction Error (FPE) test show that two lags need to be considered for Canada, four for the UK, one for West Germany, two for France, three for Italy, and finally, two for 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 and do variance decomposition analysis.

5.3 Impulse Response Functions 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 raw 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 permanent output shocks, the third one to preferences (demand) shocks, and the last one shows responses to domestic

[7] 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.
[8] We also run the model using the first difference of the real interest rate. The results did not change qualitatively in general terms, although it affected the outcome for some countries.

temporary net output shocks. We also obtained the 95% bootstrap confidence intervals represented by the two dashed lines around the IRFs and the AIRFs.

It is important to remember that the SVAR allows for any of the shocks to have long-run effects on the CA/NO. Hence, potentially, 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 expected theoretical sign of these shocks on the cumulative CA/NO can be observed in equation (13). Positive world supply shocks that increase the world interest rate would improve the CA;[9] positive domestic permanent shocks to output should have no long-run effect on the CA; positive preference shocks that increase the real exchange rate would worsen the current account as agents expect a future depreciation; positive temporary net output shocks would improve the CA as agents expect it to fall in the future.

For Canada, Japan and the UK, external supply shocks appear to be significant as it can be seen in both the IRFs and AIRFs. More precisely, it leads to a CA surplus for the UK as expected, but a negative one for both Canada and Japan. The negative effect for Japan can be related to its large position as net creditor for the whole sample period. However, the negative effect for Canada does not appear to be compatible with its net debtor position. For the rest of the countries, the effect is only significant for Italy between 4 and 8 quarters and for Germany for the first 2 quarters. However, the accumulated response is statistically insignificant.

Domestic permanent net output shocks have a positive impact on the CA for France and for the UK only for the first four quarters (and negative between 11 and 15 quarters). However, for the UK the impact of the permanent shock on the accumulated CA becomes insignificant after 6 quarters. It is only for France that the response of the CA violates the predictions of the present value model. Interestingly, the addition of a time-varying interest rate and the RER, appears to make the results for Canada and the UK compatible with the intertemporal approach. Both countries have been found to be problematic in previous studies, and are the focus of, for instance, Kano (2008). These results are hence important for empirical tests of

[9] This is provided that income effects do not compensate for the consumption tilting effect as commented earlier, which can potentially be the case for countries with large creditor positions. The same logic applies to the effect of preferences shocks.

the PVM model of the CA, since they support the model for all but one country, namely France.

Turning now to preferences shocks, the IRFs show a very similar picture to the impact of external supply shocks. They essentially reproduce the dynamic path of the external supply shocks but, as expected, with the opposite sign. The exception to this is the UK, where preferences shocks do not appear to have any significant impact on the CA. The puzzle, of course, remains in the case of Canada, since we would expect a negative CA effect.

At last, as expected, all countries 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.

Taking everything into consideration, there are two main conclusions that can be drawn. Firstly, except for France, the analysis is in line with 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 Canada, Japan and the UK.

5.4 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 preferences 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, the external supply shock explains 40% of fluctuations in the current account and 41% is explained by the domestic temporary net output shock, while the rest (16%) is attributable to preferences shocks. Even 10 years after the shock (40 quarters), the main shocks explaining current account fluctuations remain these three.

In quarter 1, France's current account fluctuations are explained mainly by domestic permanent output shocks, with temporary domestic shocks accounting for 33% of the fluctuations and external supply shocks 22%. As with Canada, this structure remains stable throughout.

For Germany, it is external supply and domestic temporary shocks that mostly drive the CA in the short-run. In the long-run, however, the external supply shocks reduce their proportion to 27%, whereas domestic temporary shocks gain in importance by explaining almost all of the rest. Preferences shocks only explain 4% of the current account fluctuations.[10]

In the case of Italy, 84% of the CA fluctuations in the short-run are explained by temporary net output shocks. External supply shocks, however, gain in importance and explain 21% just after 8 quarters. Both domestic permanent and preferences shocks have only small participation.

For the UK, 50% of the short-run fluctuations is explained by domestic temporary shocks and the other 50% is explained by external and domestic permanent shocks. After 40 quarters, however, domestic permanent shocks halve their importance and the CA is driven equally by external supply and domestic temporary shocks.

Japan is the case in which changes in the forecast variance of the CA are less driven by domestic temporary output shocks. It is external shocks that drive around 60% of these fluctuations. In the longer run, preference shocks also seem to explain a sizeable proportion.

It is important to note that Kano (2008) refers to the excess response of the CA to temporary output shocks as a puzzle, since they explain about 80% and 72% of CA fluctuations in the long-run for Canada and the UK respectively. In our results, these are reduced very substantially to 36% and 46% reflecting, perhaps, the importance of the introduction of a two-sector setting that allows for the consideration of the RER. However, a look at **Table 2** presenting the FEVD for net output, still reflects that, with the exception of France and Italy, temporary net output shocks contribute very little to explain fluctuations in net output. Hence, it remains puzzling that a shock that explains little about net output changes can explain a large proportion of CA changes. Nevertheless, in our results the puzzle is alleviated, as the domestic temporary shock explains less than 50% of CA fluctuations in four of our countries.

[10] It is worth noting that the sample period for West Germany is substantially different to that for the rest of the countries.

To conclude, given that external supply and preferences shocks account for an important proportion of current account fluctuations, our results lend some 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. France appears as the main exception, since the basic predictions of the PVM of the CA are clearly violated.

5.5 Over-identifying restrictions

As discussed in Section 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 $C_{41}(L)=0$ (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 all countries except France, lending support to the predictions of the present-value model. Restriction 2 cannot be rejected at the 5% level only for Germany, Japan and the UK. 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, Restrictions 3 and 4 are rejected for all the countries except Restriction 4 for France. 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 preferences shocks appear to be significant driving forces of CA fluctuations.

6 Conclusions

Research on the sources of current account (CA) fluctuations has played an important role in international macroeconomics in the last decades. This is because of, first, the recent CA imbalances in the world economy and, secondly, the implications it has for present-value models (PVM) of the CA. In this paper we have analyzed the main shocks driving CA fluctuations in the G6 (G7 minus the US) countries by separating domestic temporary and permanent shocks, and also external supply shocks and preferences 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 this model, we then estimate a SVAR model with minimal long-run identifying restrictions *à la* Blanchard and Quah (1989).

Our results show two main conclusions. First, the PVM of the CA is consistent with the behaviour of the data for all countries except for France, where permanent domestic shocks have a long-run impact on the CA. Secondly, preferences shocks and, mostly, external supply shocks appear to play an important role in explaining CA fluctuations in our sample of countries. Our model also reduces the degree of excess response of the CA to temporary output shocks found in previous literature. A puzzle remains, however, in the response of the CA in Canada to external supply and preferences shocks, which appear to have the opposite sign to the theory predictions.

Figure 1. CA to Net output ratios

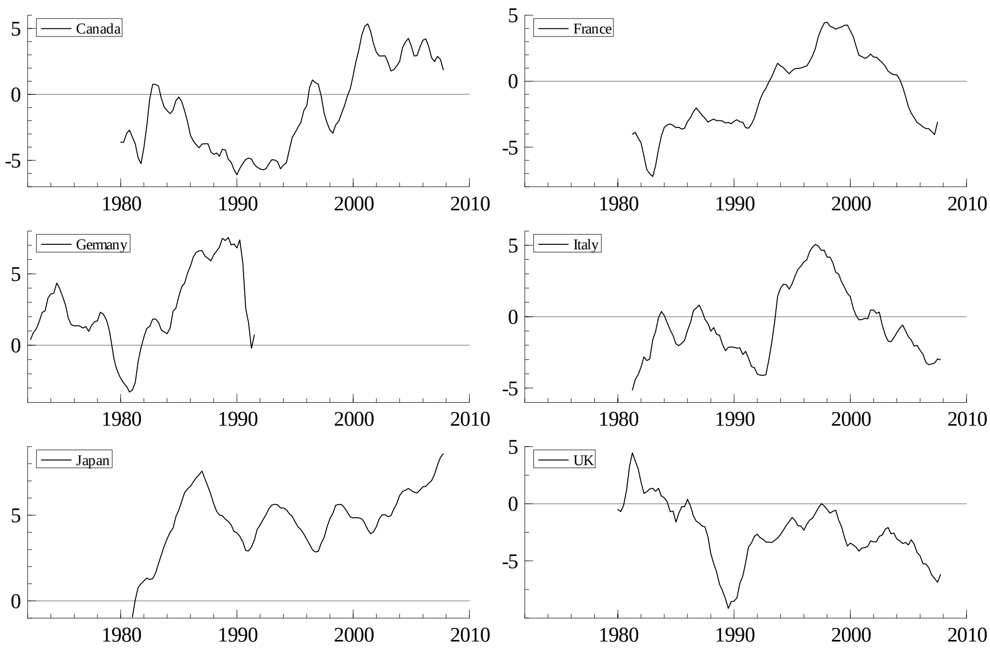


Figure 2. US Real Interest Rate

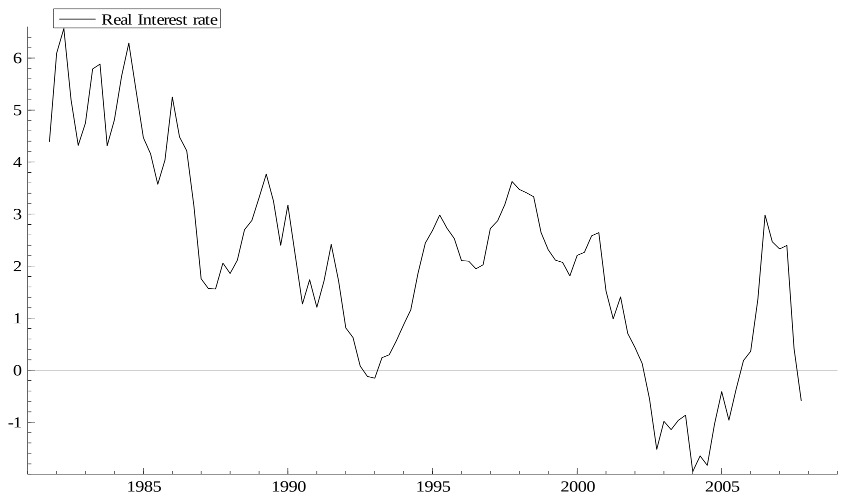
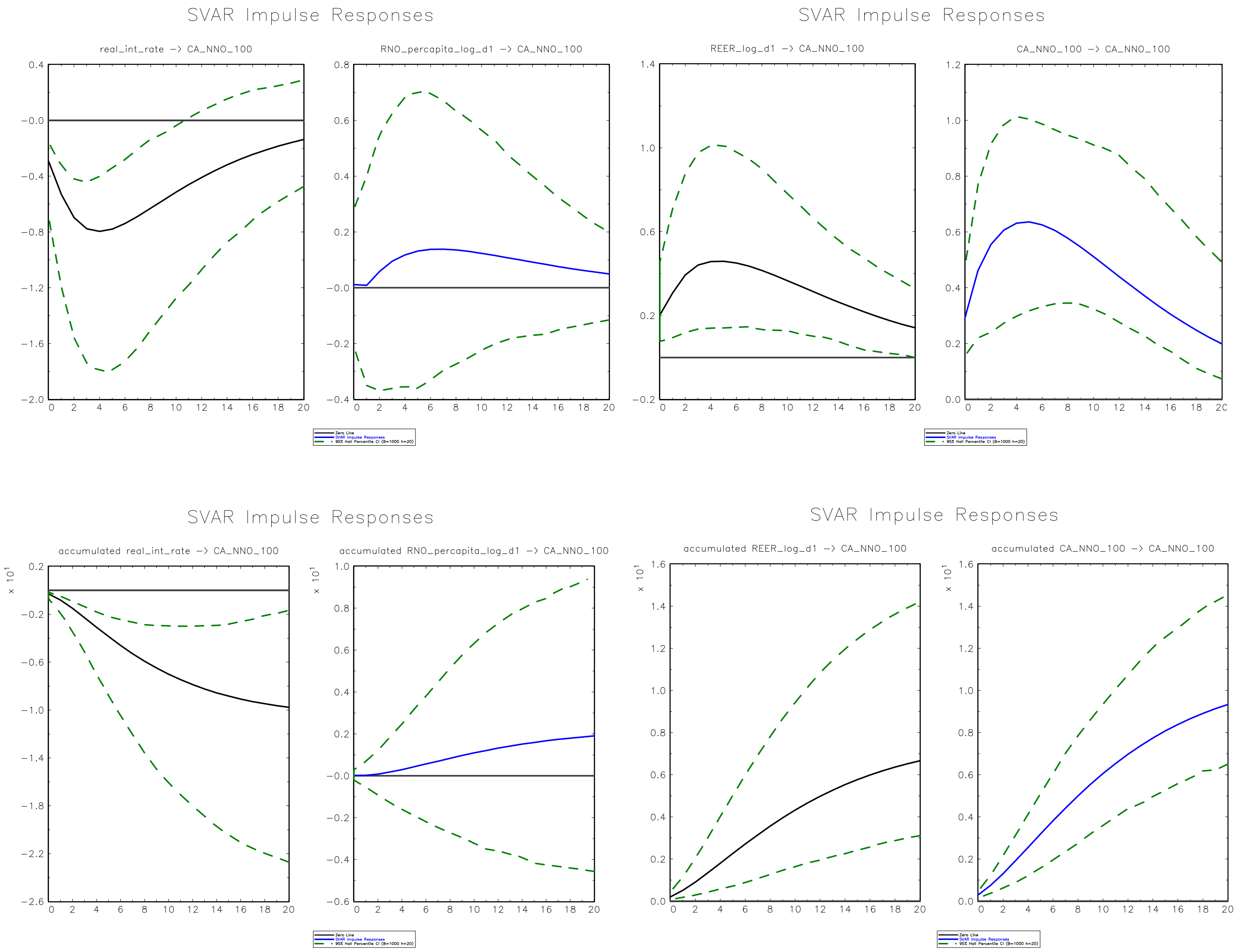
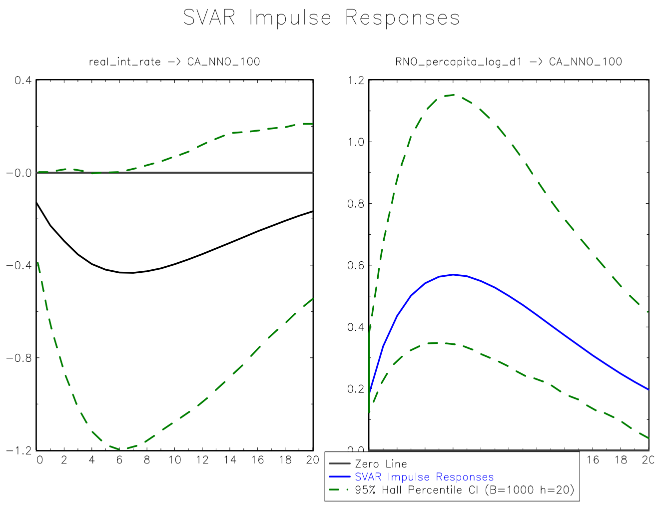


Figure 3. IRF's and AIRF's of the CA/NO

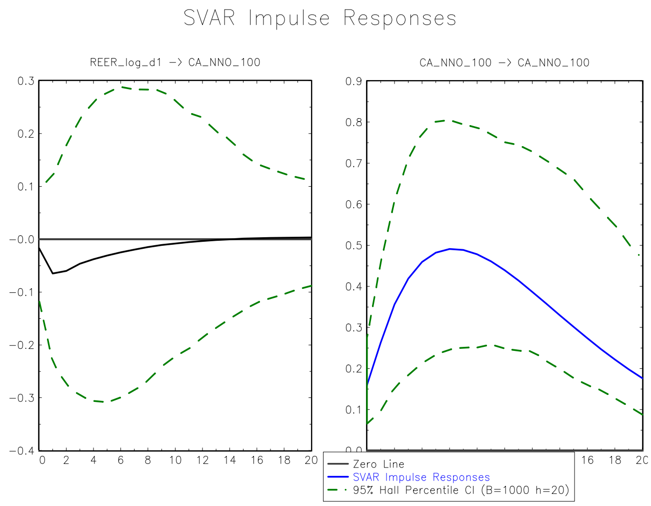
CANADA:



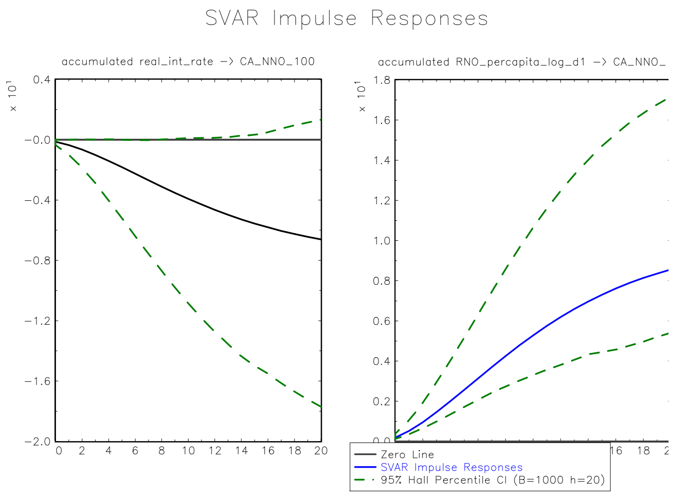
FRANCE:



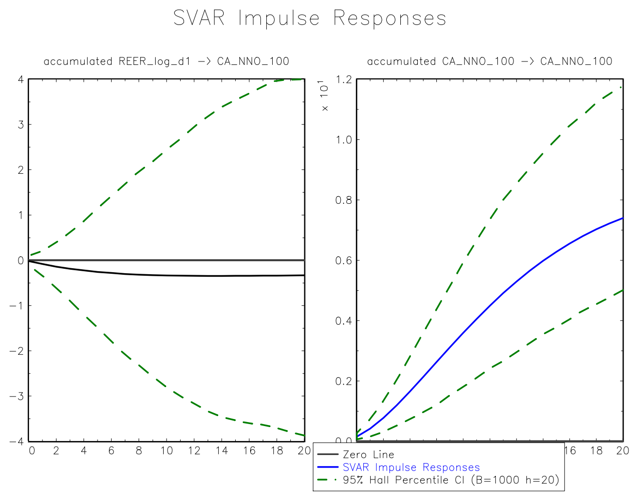
SVAR Impulse Responses
real_int_rate -> CA_NNO_100
RNO_percapita_log_d1 -> CA_NNO_100
Zero Line
SVAR Impulse Responses
95% Hall Percentile CI (B=1000 h=20)



SVAR Impulse Responses
REER_log_d1 -> CA_NNO_100
CA_NNO_100 -> CA_NNO_100
Zero Line
SVAR Impulse Responses
95% Hall Percentile CI (B=1000 h=20)

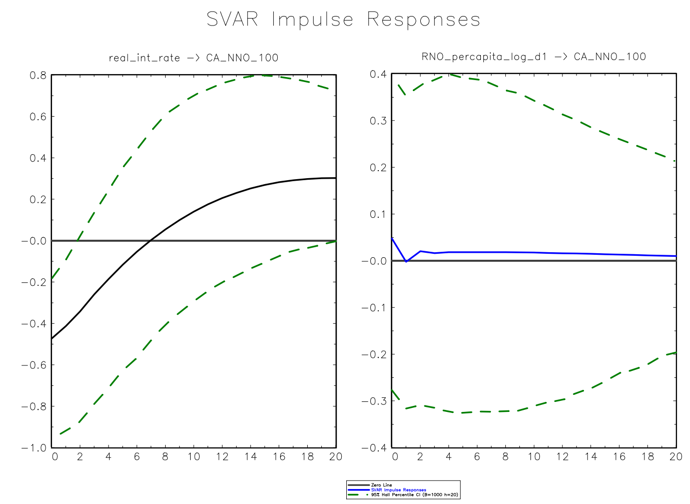


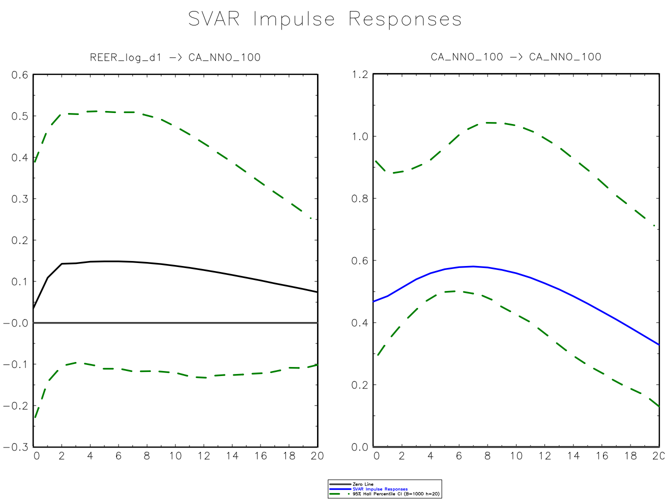
SVAR Impulse Responses
accumulated real_int_rate -> CA_NNO_100
accumulated RNO_percapita_log_d1 -> CA_NNO_
Zero Line
SVAR Impulse Responses
95% Hall Percentile CI (B=1000 h=20)

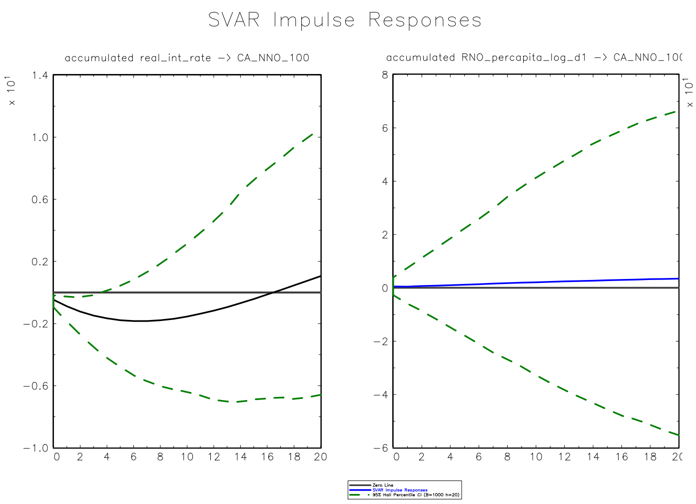


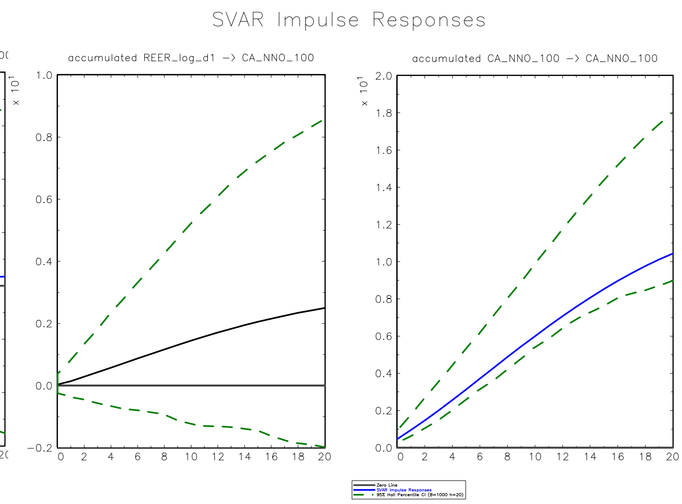
SVAR Impulse Responses
accumulated REER_log_d1 -> CA_NNO_100
accumulated CA_NNO_100 -> CA_NNO_100
Zero Line
SVAR Impulse Responses
95% Hall Percentile CI (B=1000 h=20)

WEST GERMANY:

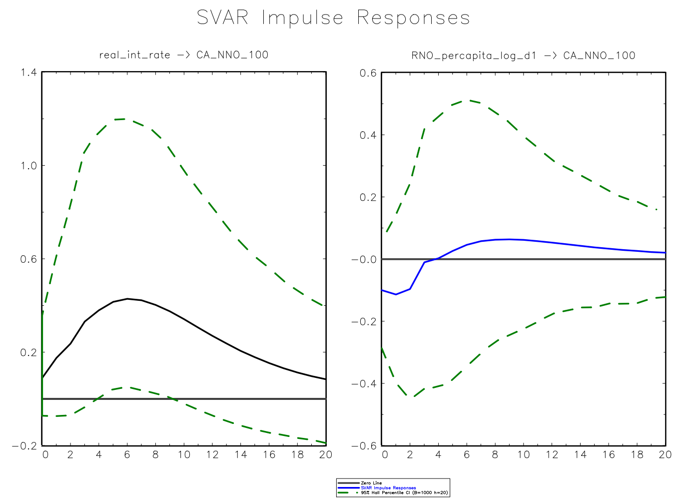








ITALY:


SVAR Impulse Responses
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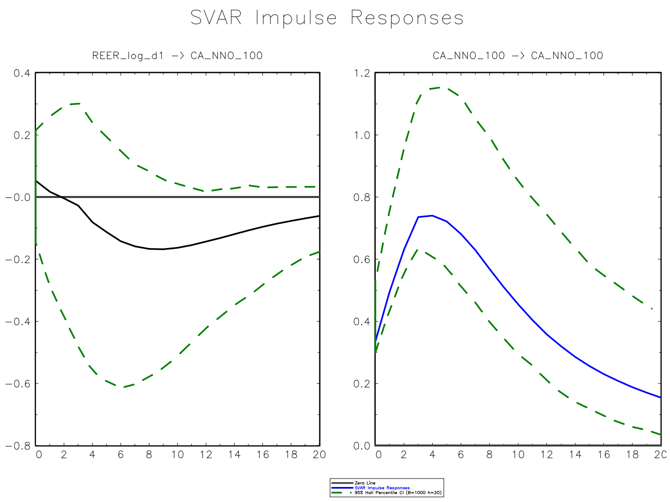
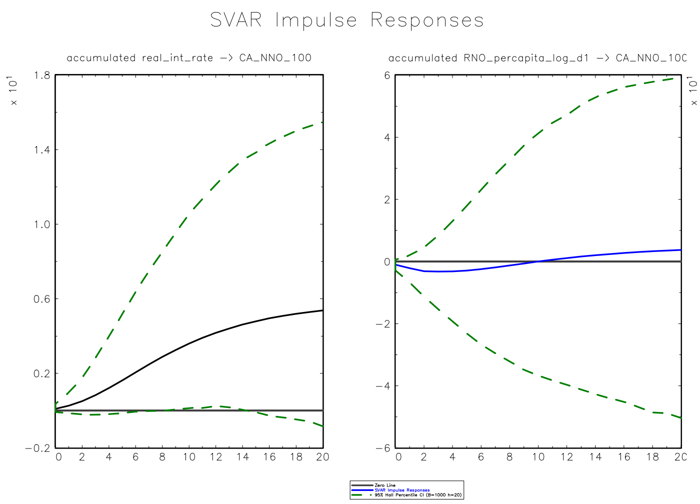
RNO_percapita_log_d1 -> CA_NNO_100


SVAR Impulse Responses
REER_log_d1 -> CA_NNO_100
CA_NNO_100 -> CA_NNO_100


SVAR Impulse Responses
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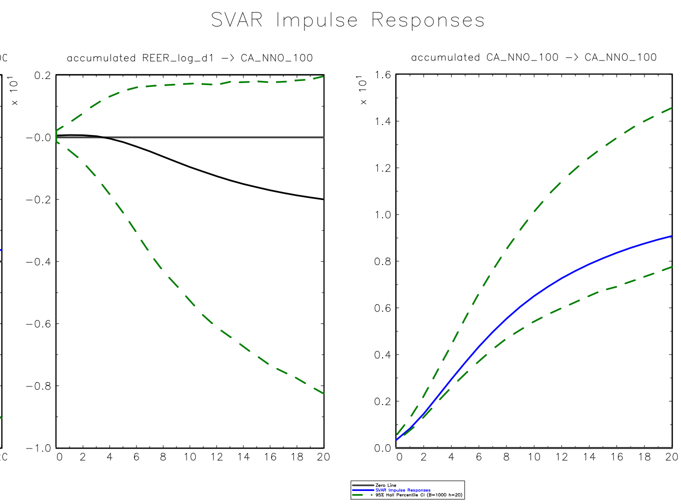
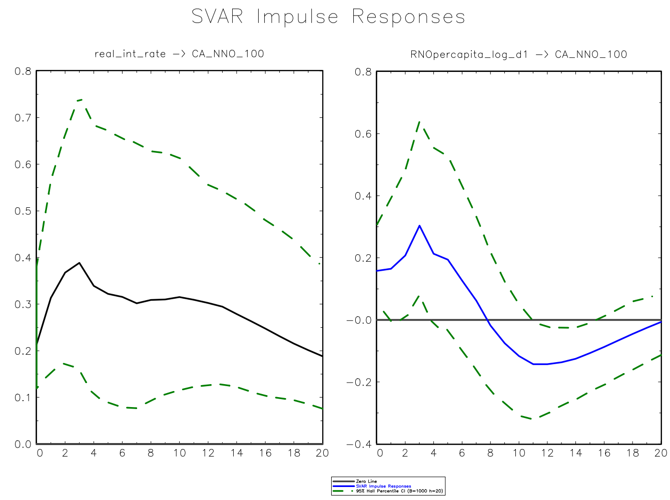
accumulated RNO_percapita_log_d1 -> CA_NNO_100


SVAR Impulse Responses
accumulated REER_log_d1 -> CA_NNO_100
accumulated CA_NNO_100 -> CA_NNO_100

UK:


SVAR Impulse Responses
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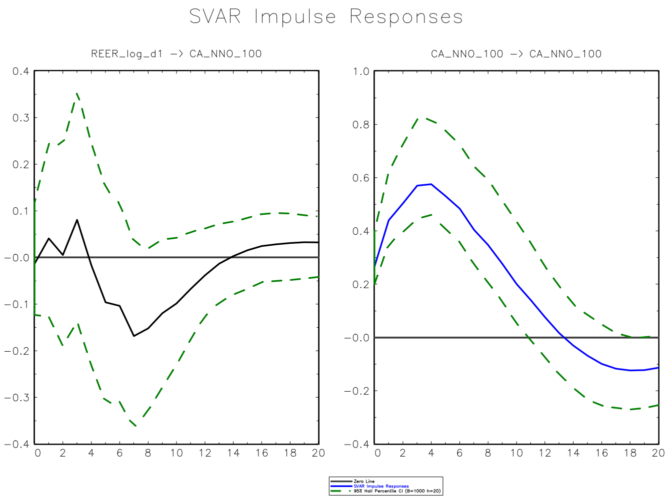
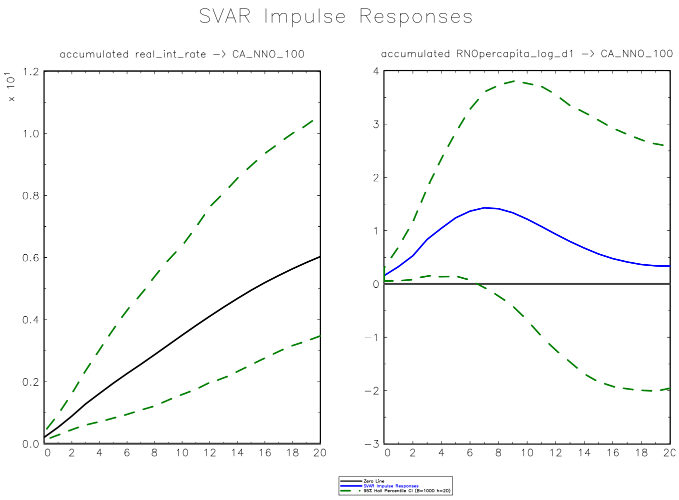
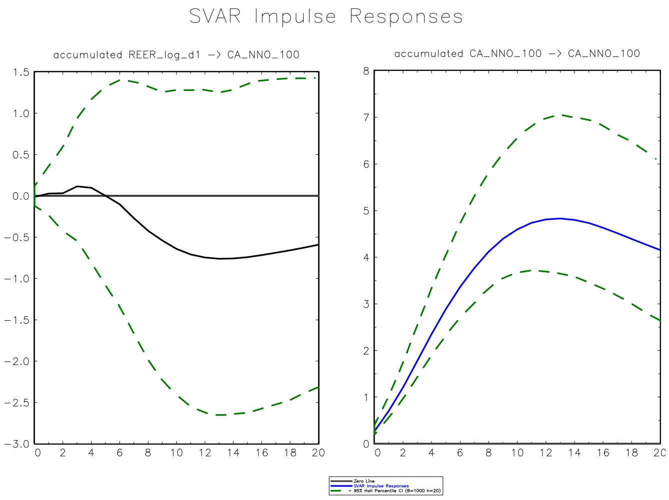
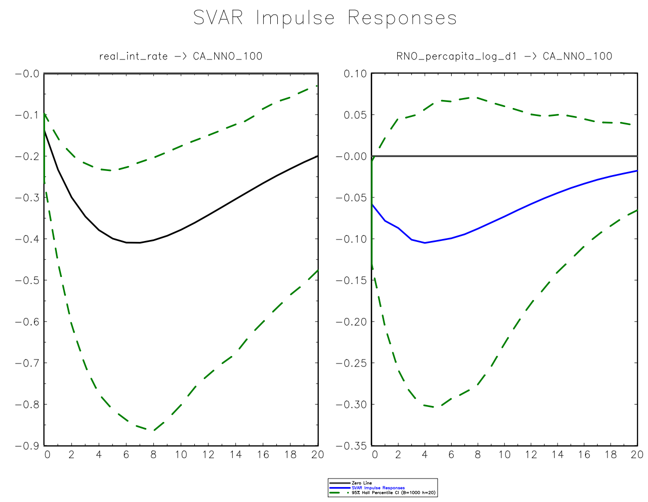
RNOpercapita_log_d1 -> CA_NNO_100

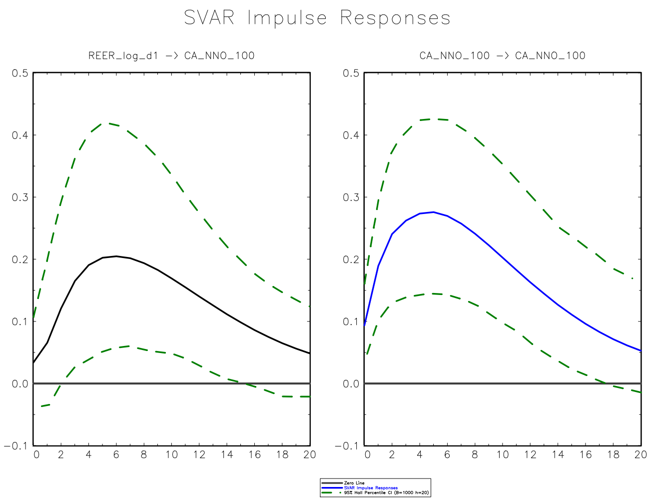

SVAR Impulse Responses
REER_log_d1 -> CA_NNO_100
CA_NNO_100 -> CA_NNO_100


SVAR Impulse Responses
accumulated real_int_rate -> CA_NNO_100
x 10^1
accumulated RNOpercapita_log_d1 -> CA_NNO_100


SVAR Impulse Responses
accumulated REER_log_d1 -> CA_NNO_100
accumulated CA_NNO_100 -> CA_NNO_100

JAPAN:


SVAR Impulse Responses
real_int_rate -> CA_NNO_100
RNO_percapita_log_d1 -> CA_NNO_100


SVAR Impulse Responses
REER_log_d1 -> CA_NNO_100
CA_NNO_100 -> CA_NNO_100


SVAR Impulse Responses
accumulated real_int_rate -> CA_NNO_100
accumulated RNO_percapita_log_d1 -> CA_NNO_100

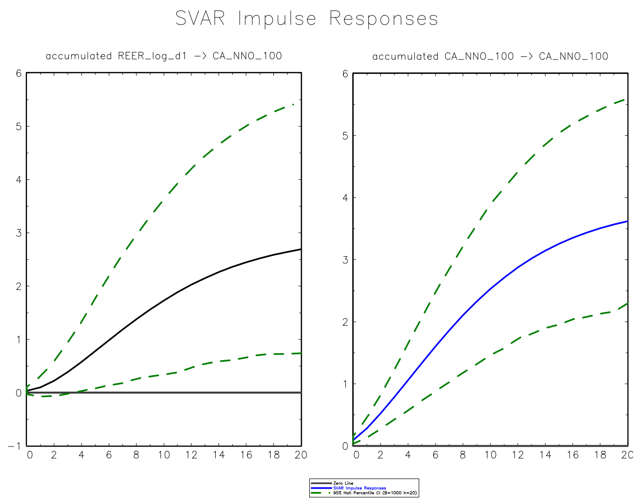

SVAR Impulse Responses
accumulated REER_log_d1 -> CA_NNO_100
accumulated CA_NNO_100 -> CA_NNO_100

Table 1. SVAR Forecast Error Variance Decomposition

	Proportions of forecast error in CA_t/NO_t accounted for by:			
forecast horizon	Ext. Supply	Permanent Dom	Preferences	Temporary Dom
	Canada			
1	0.40	0.00	0.19	0.41
4	0.50	0.00	0.17	0.33
8	0.49	0.01	0.17	0.33
20	0.44	0.02	0.18	0.36
40	0.43	0.02	0.19	0.36
	France			
1	0.22	0.44	0.00	0.33
4	0.22	0.46	0.01	0.31
8	0.24	0.44	0.00	0.32
20	0.25	0.43	0.00	0.32
40	0.25	0.43	0.00	0.32
	West Germany			
1	0.50	0.01	0.00	0.49
4	0.35	0.00	0.03	0.61
8	0.20	0.00	0.05	0.75
20	0.19	0.00	0.05	0.77
40	0.27	0.00	0.04	0.69
	Italy			
1	0.06	0.08	0.02	0.84
4	0.13	0.02	0.00	0.84
8	0.21	0.01	0.02	0.77
20	0.25	0.01	0.04	0.70
40	0.24	0.01	0.04	0.70
	UK			
1	0.32	0.18	0.00	0.50
4	0.29	0.13	0.01	0.57
8	0.28	0.10	0.02	0.61
20	0.39	0.09	0.03	0.49
40	0.43	0.09	0.02	0.46
	Japan			
1	0.59	0.10	0.04	0.27
4	0.53	0.05	0.09	0.32
8	0.56	0.04	0.13	0.28
20	0.63	0.03	0.12	0.22
40	0.66	0.03	0.11	0.20

Table 2. SVAR Forecast Error Variance Decomposition of Δno_t

	Proportions of forecast error in Δno_t accounted for by:			
forecast horizon	Ext. Supply	Permanent Dom.	Preferences	Temporary Dom.
	Canada			
1	0.07	0.86	0.07	0.00
4	0.09	0.81	0.10	0.00
8	0.10	0.80	0.10	0.00
20	0.10	0.80	0.10	0.00
40	0.10	0.80	0.10	0.00
	France			
1	0.00	0.69	0.17	0.14
4	0.03	0.60	0.26	0.11
8	0.03	0.60	0.26	0.12
20	0.03	0.60	0.26	0.12
40	0.03	0.60	0.26	0.12
	West Germany			
1	0.03	0.90	0.07	0.00
4	0.05	0.82	0.13	0.00
8	0.05	0.82	0.13	0.00
20	0.05	0.82	0.13	0.00
40	0.05	0.82	0.13	0.00
	Italy			
1	0.17	0.50	0.06	0.27
4	0.16	0.47	0.08	0.29
8	0.16	0.47	0.08	0.29
20	0.16	0.47	0.08	0.29
40	0.16	0.47	0.08	0.29
	UK			
1	0.05	0.80	0.09	0.06
4	0.06	0.77	0.12	0.06
8	0.06	0.71	0.17	0.07
20	0.06	0.69	0.16	0.08
40	0.06	0.69	0.16	0.08
	Japan			
1	0.07	0.80	0.05	0.08
4	0.07	0.80	0.05	0.08
8	0.08	0.80	0.05	0.08
20	0.10	0.78	0.05	0.08
40	0.10	0.77	0.05	0.08

Table 3. Over-identifying restrictions.

Null hypothesis	Canada	France	Germany	Italy	Japan	UK
Rest. 1	**1.2680**	97.9249	**2.8136**	**3.2268**	**3.5675**	**3.1790**
$C(L)_{42}=0$	**(0.2601)**	(0.000)	**(0.0931)**	**(0.0701)**	**(0.0511)**	**(0.0750)**
Rest. 2	44.3243	46.2207	**1.2827**	10.4124	**0.5176**	**0.1665**
$C(L)_{32}=0$	(0.0000)	(0.000)	**(0.2574)**	(0.0013)	**(0.9354)**	**(0.6832)**
Rest. 1 and 2	86.6006	117.4064	**2.9136**	17.2205	**4.0948**	**3.2047**
$C(L)_{42}= C(L)_{32}=0$	(0.0000)	(0.000)	**(0.0878)**	(0.0002)	**(0.1291)**	**(0.2014)**
Rest. 3	**52.7391**	**31.5532**	**20.9835**	**32.7493**	**86.1989**	**150.5096**
$C(L)_{41}=0$	**(0.0000)**	**(0.000)**	**(0.000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**
Rest. 4	**72.6438**	0.0225	**3.8570**	**7.2997**	**40.3577**	**22.3989**
$C(L)_{43}=0$	**(0.0000)**	(0.8807)	**(0.0495)**	**(0.0069)**	**(0.0000)**	**(0.0000)**
Rest. 3 and 4	**81.9481**	**31.5757**	**24.8406**	**40.0940**	**126.5566**	**185.5250**
$C(L)_{41}= C(L)_{43}=0$	**(0.0000)**	**(0.000)**	**(0.000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**

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.

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