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Twin Deficits: Squaring Theory, Evidence
and Common Sense

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Abstract

In this paper we reconsider the twin deficit hypothesis (that fiscal shocks generating budget deficits also worsen external trade) both from a theoretical point of view and by analyzing data for Australia, Canada, the UK and the US. First, we assess the joint dynamics of budget and trade deficits along the business cycle, uncovering a strikingly recurrent S-shaped relation between the two. The correlation is actually negative, suggesting twin divergence. This observation however cannot rule out the possibility that government spending expansions and/or tax cuts may cause trade deficits, as the overall correlation is likely to be dominated by cyclical factors. Second, we reconsider the transmission of government spending in a standard two-country two-good model: we find that openness and the persistence of fiscal shocks are major determinants of the magnitude (or even sign) of the response of the trade balance to fiscal shocks. For a given persistence of the fiscal shock, the closer an economy, the larger the crowding out effect on investment, the lower the deterioration of the trade balance. Third, we take this insight to the data, investigating the transmission of fiscal shocks in a VAR framework in the four countries in our sample. Our empirical findings tend to support our view. In the US and Australia, which are relatively less open than Canada and the UK, and where government spending shocks are less persistent, we find that the external impact of fiscal policy is rather limited. Instead, private investment responds substantially. The reverse is true for Canada and the UK. These findings confirm and put into perspective earlier results, whereas fiscal expansions in the US are found to have on average a negligible effect on the country's trade balance. However, we emphasize that these results are consistent with a call for a US fiscal retrenchment to address global imbalances: the impact of budget cuts on the US external trade is muted by their positive effect on domestic investment, strengthening the US ability to generate resources against future interest and debt repayment.

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1. Introduction

The fiscal deterioration in the US during the first George W. Bush administration at a time of persistent imbalances in the country's external trade brought the 'twin deficits' hypothesis back on the agenda. This hypothesis stems from informed analyses of specific episodes of fiscal deterioration, such as the tax cuts by the Reagan administration, which were associated with sharp worsening of the current account. Many policy circles and institutions strongly advocate domestic fiscal consolidation as a necessary measure to correct US trade deficits, and therefore as a contribution to manage global imbalances (e.g. IMF WEO (2004, 2005), The Economist (2005) and Chinn (2005)). According to many observers, the argument gained support especially after the hurricane Katrina in September 2005 has reminded the US administration about the potential magnitude of the fiscal and external risks associated with natural disasters and/or terrorist attacks.

How strong is the evidence of 'twin deficits', and the theoretical case for it? While fiscal consolidation may be desirable in the US regardless of its external implications, recent works have strengthened doubts about its quantitative relevance for the current account, at least in the short run, e.g. Kim and Roubini (2003), Erceg, Guerrieri and Gust (2005), Bussière, Fratzscher and Müller (2005). To some extent, the results of these works are consistent with a larger body of evidence on fiscal policy, pointing out a weakening of its overall macroeconomic effects in the last two decades (Perotti (2005)). But some authors, namely Kim and Roubini, have gone as far as questioning the existence of 'twin deficits' for the US altogether.

In this paper, we reconsider the theoretical foundations of twin deficits and carry out a systematic investigation of budget and trade deficits at business cycle frequency and across countries. While many recent studies focus on the US, we find it appropriate to revisit their main findings in a comparative perspective. Thus, in addition to the US, we include in our sample three medium-sized OECD economies - the UK, Canada and Australia - which differ in the degree of openness and integration in the world markets. Indeed, as we argue in this paper, openness (together with the persistence of shocks) is an important dimension in the international transmission of fiscal policies.

We make three main points. First, we clear our way into our policy-oriented analysis by removing an often-heard objection against the twin deficit hypothesis, that the two deficits are actually negatively correlated in the data (simple correlation points to twin divergence). The fallacy in this objection is apparent. It identifies the 'twin deficit hypothesis' --- which emphasizes exogenous tax and spending shocks as the *cause* of a positive correlation between the fiscal and the trade deficit --- with a statement about the endogenous joint dynamic response of external trade and fiscal budgets to all the shocks underlying business cycles. Indeed, in response to nominal and real (technology) shocks causing cyclical fluctuations, one may well expect 'twin divergence,' rather than 'twin deficit': an upsurge of economic activity would typically improve the fiscal outlook (via automatic stabilizers), while worsening net exports (typically, import demand rises with income), see Corsetti and Müller (2005).

As a contribution to the debate, we propose a novel summary of the business cycle movements of trade and fiscal deficits, explicitly looking at their joint behaviour over time. We calculate the correlation of current fiscal deficit with contemporaneous and lagged net exports. Remarkably, our approach leads us to identify a systematic dynamic pattern which is robust across countries and sample periods. The correlation between the budget and the trade balance is typically S-shaped: the correlation between the budget deficit and the trade deficit in the same period is negative (current fiscal surpluses are systematically associated with current trade deficits); the correlation between the budget balance and future realizations of net exports is instead positive (current fiscal improvement is associated with a delayed increase in net exports). Our findings thus generalize and qualify the intuitive argument of 'twin divergence' at business cycle frequency, by adding a dynamic dimension.

Second, having clarified that the twin deficits argument refers to the dynamic response of the economy of an exogenous change in fiscal policy, we reconsider its theoretical foundations in light of economic theory. Typically, the twin deficit hypothesis is stated by using either a relative price argument, or an intertemporal argument. According to the first argument, a fiscal loosening (either a spending increase of a tax cut) raises domestic demand relative to output: restoring equilibrium requires a real appreciation (making domestic goods more expensive relative to foreign), which crowds

out net export. The second argument is best exposed with respect to a deficit-financed, temporary increase in domestic government spending. In response to higher spending, current consumption falls, but less than one-to-one, since permanent income only adjusts by the permanent increase in taxes required to satisfy government solvency. The country borrows from abroad to close the gap in national saving. A similar argument applies to tax cuts, but only if Ricardian equivalence fails.

The intertemporal and static (relative price) dimensions of twin deficits, however, are in fact strongly interconnected. International price movements feed into the intertemporal price of consumption and the value of firms thereby affecting investment decisions. The question we ask is to what extent an explicit account of the interdependence of the relative price and the intertemporal dimension improves our understanding of the theoretical foundations of twin deficits, allowing us to bring new insights into the policy debate.

To address this question, we reconsider the transmission of government spending shocks using a standard two-country two-good Dynamic Stochastic General Equilibrium (DSGE) framework. Specifically, we analyze the macroeconomic impact of spending shocks with a different degree of persistence, in economies with a different degree of openness --- measured by the 'Home bias' in their private consumption and investment expenditures.[2] We show that the response of external trade to spending shocks tends to be weaker (the correlation between the two deficits may even become positive) in economies that are less open to external trade (with a stronger Home bias in expenditure), and when the shock to government spending is not very persistent. Key to this result is the behaviour of investment: in the case of large and relatively closed economies, investment tends to fall more in the domestic economy than abroad.

[2]Note that in general terms our analysis shares the view of the international economy that many authors --- most notably Obstfeld and Rogoff (2001) --- place at the heart of policy analysis in general equilibrium. These authors argue that, despite globalization, national economies remain quite 'insular', in the sense that international real and financial markets remain segmented along national borders for a variety of reasons. This might be reflected in trade costs and incomplete markets, or distribution sectors, price discrimination, and preferences generating a substantial degree of Home bias in consumption and portfolio decisions. As a result, production, consumption and investment decisions respond to a set of prices that may be quite different from the set of prices abroad --- although the two are related in general equilibrium at world level. While presenting an articulated analysis of insularity is beyond the scope of this paper, one way to interpret our results is that increasing the level of 'insularity' (i.e. decreasing openness) in standard numerical work-horse models in international economics tends to have significant effects on the international spillovers from fiscal policy.

These results provide us with a working hypothesis to bring to the data, namely, that the evidence on twin deficits may vary systematically across countries that differ in their integration in the world economy (openness) and the persistence of spending shocks.

Third, we investigate to what extent fiscal shocks drive trade movements in our sample of OECD countries. We specify and run a VAR model where spending shocks are identified following the approach suggested by Blanchard and Perotti (2002). For the US we corroborate the findings by Kim and Roubini (2003), that a typical fiscal expansion has a negligible or even positive effect on the trade balance, generating no twin deficits. At the same time spending shocks substantially depress investment. The same pattern emerges from an analysis of Australian time series. What is remarkable is that, relative to the UK and Canada, these two economies are less open, and spending shocks are less persistent.

For Canada and the UK, instead, a higher degree of openness is associated with evidence of higher persistence of fiscal shocks: in these cases, we find evidence that fiscal spending shocks induce twin deficits. As predicted by most standard models, spending crowds out net exports. Different from the US and Australia, its effects on investment are contained.

These findings, which stress the differential impact on investment vs. trade, provide a way to reconcile the existing empirical evidence with the received wisdom and common sense in policy making, regarding the desirability of prudent budget policies when the current account is excessive. For the US, the contemporaneous quantitative effect of fiscal consolidation on trade is on average small because of the endogenous response of US investment. However, this is no reason for playing down the contribution of US fiscal policy to restoring global balance. Even if *current* net exports respond little to budget retrenchments, the positive implications for investment would nonetheless contribute to the sustainability of US external debt in an intertemporal perspective.

2. Basic accounting and a first look at the data

The twin deficit hypothesis is rooted in the accounting identity relating the external deficit to the difference between investment and domestic saving

$$\text{Current Account Deficit} = \text{Investment} - \text{Saving}$$

Since domestic saving is the sum of private and public saving, and the latter is the negative of the budget deficit, the above can be written as

$$\text{Current Account Deficit} = \text{Investment} - \text{Private Saving} + \text{Budget Deficit}$$

From an accounting perspective, holding investment and private saving constant, a deterioration of the fiscal position must worsen the external balance.

Specific episodes, notably in the US, seem to square well with this accounting perspective. In Figure 1 we display the primary *budget balance* and the *trade balance* for the US, the UK, Australia and Canada.[3] Before turning to these episodes in detail, note that we are using the trade balance, rather than the current account, as a measure of a country's external position. Net exports differ from the current account because they do not include interest payments on national debt. However, the two measures move closely together at business cycle frequencies (see Baxter (1995)), since the stock of debt adjusts very slowly. Unless interest rates are extremely volatile, the difference between net exports and the current account can be observed mostly in the low-frequency components of the data. Moreover, net exports have an advantage over the current account, in that they always have a well defined counterpart in our models, independently of our assumptions regarding the structure of international financial markets.[4] For these reasons, we will mostly use net exports in our analysis below.

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[3] While the joint evolution of the budget and the trade deficit in the US has traditionally been the focus of the policy dabate, we analyze the time series of three additional countries. Here, our sample choice is largely determined by considerations regarding the feasibility of the VAR analysis in section 4 below.

[4] Correspondingly, we also exclude interest payments from our measure of a country fiscal position. In other words, in the analysis below we use the primary budget balance. The normalization of net exports by GDP, i.e. the trade balance, also allows us to compute simple cross-country comparisons. Observe that to

Figure 1: Four OECD countries 1980-2004 - Twin Deficits?
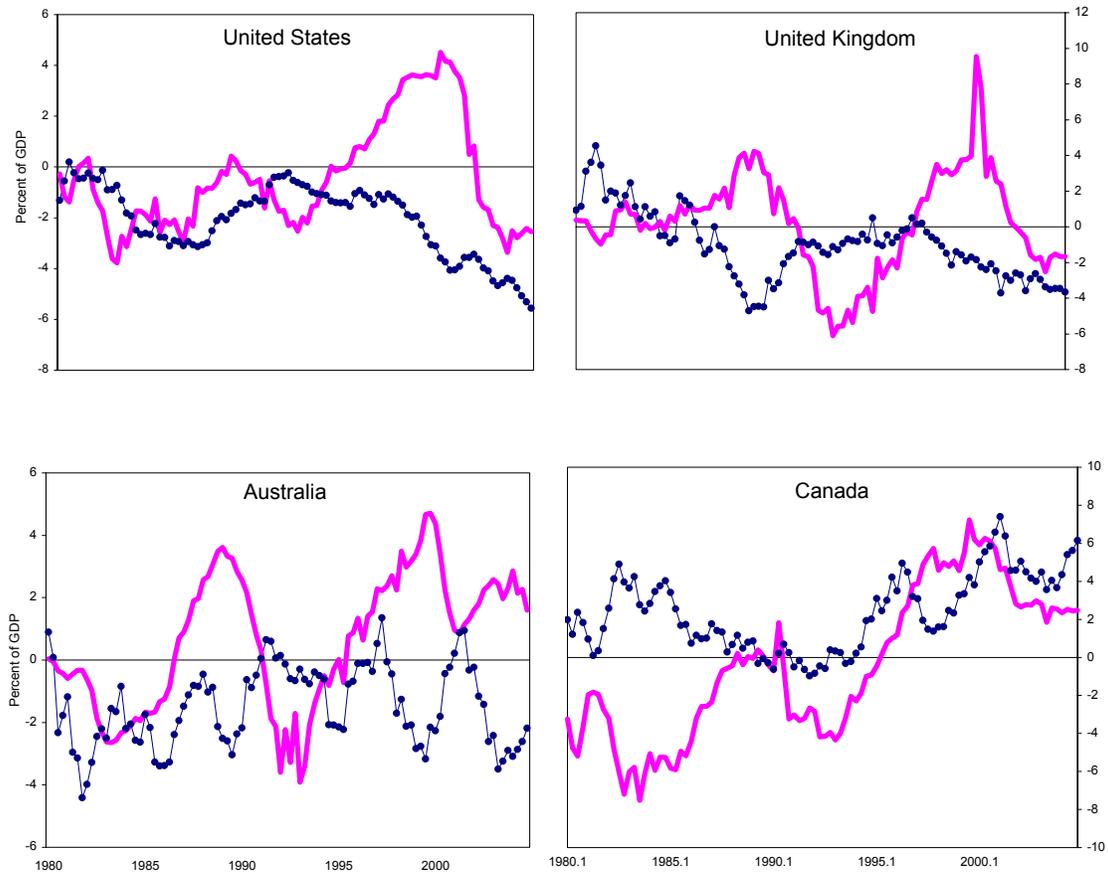
Straight line: Primary budget balance; Dotted line: trade balance; Source: OECD, for more details on data, see appendix.

Turning to the time series displayed in Figure 1, the reason why the twin deficit hypothesis gained popularity at certain times, and less so in others, is apparent. The US budget and trade balance move closely together in the mid-1980s and both fall sharply during the last four years. As both periods are characterized by considerable fiscal expansions, many observers have pointed to these policies as an important factor driving the US trade deficit (in line with the accounting identity discussed above) --- while at the same calling for fiscal retrenchment to correct this country external imbalance. However, there is a remarkable divergence of the two deficits during the late 1990s. Also, the

the extent that fiscal shocks raise the risk premium on a country debt, twin deficit may emerge from rising cost of internal and external borrowing.

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pattern is less clear-cut for the UK and Australia, whereas one can spot several periods of twin divergence. In Canada the two time series appear to covary strongly since the early 1990s.

Overall, we take Figure 1 as a good illustration of the fact that an accounting perspective on the twin deficits can be quite misleading: budget deficits deteriorate for a variety of reasons and factors that at the same time affect investment and consumption decisions, thus also driving net exports.

Another way to represent the evidence is to compute the correlation of the two time series. We find that the correlation is negative in all four countries: -0.24 in the US, -0.25 in the UK, -0.1 in Canada and -0.36 in Australia. This simple statistical result is sometimes used as the basis for a crude argument, stating that the 'twin deficits do not exist in the data.' Such argument is faulty, for the same reason as the account perspective is insufficient: it fails to recognize the obvious cyclical nature of the fiscal stance. Typically, a macroeconomic boom will at the same time improve the budget deficits, as --- given fiscal policy --- tax revenues rise with income and some categories of spending fall with the level of economic activity, while the external position deteriorates. This argument applies whether the expansion is associated to a supply (technological) shock or to a demand shock. To the extent that these shocks (other than fiscal) can account for most of macroeconomic fluctuations, a negative correlation between government budgets and external trade may not tell us much about the response of these two aggregates to spending and tax shocks - which is the essence of 'twin deficits.'

To explore further the joint cyclical behaviour of the trade and the budget balance, we compute not only the contemporaneous correlation, but also the correlation between the budget balance and leads and lags of the trade balance as a synthetic representation of the joint dynamic of these two variables.[5] In order to do so, we isolate the short-run fluctuations at business cycle frequency from long-run movements in the data by applying the HP-Filter (using a smoothing parameter of 1600) to both series.

The results are shown in Figure 2. For each country, we plot the cross-correlation functions for the trade balance, *nx*, and the primary government balance, *bb*, for leads and

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[5] This exercise follows Backus, Kehoe and Kydland (1994) who find a robust cross-correlation function for the terms of trade and the trade balance which resembles a horizontal 'S.'

lags up to 2 years. In all countries, the pattern resembles a horizontal 'S': the contemporaneous correlation is negative, but the correlation between the trade balance and lagged values of the budget balance (right hand side of Figure 2) becomes positive. It is mostly negative for trade balance and future values of the budget balance (left hand side of Figure 2). This pattern could be dubbed 'Twin Deficits Business Cycle Dynamics', to draw a sharp distinction with the Twin Deficit Hypothesis. The pattern turns out to be quite robust to changes in the sample size, to the filter applied to the raw data, or to the inclusion of more countries in the analysis.[6]

Figure 2. Cross-correlation function for trade and budget balance
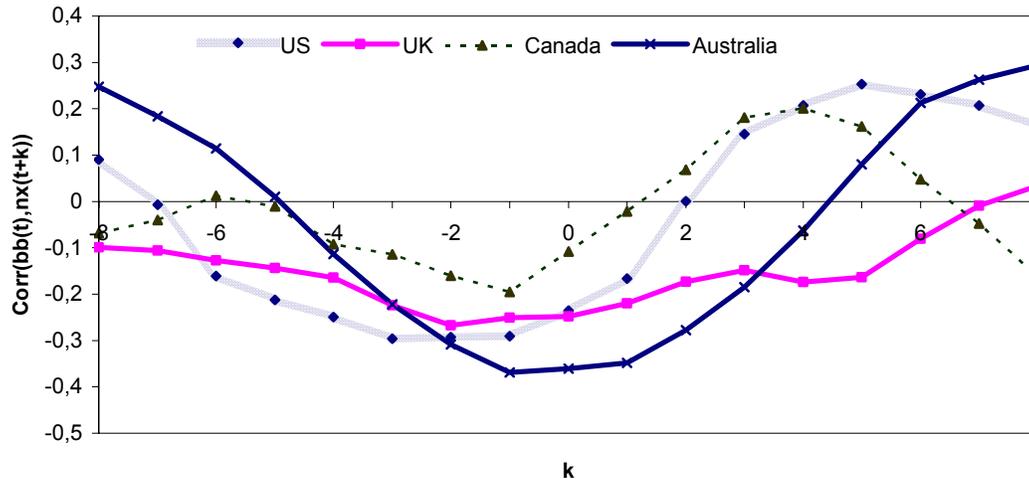
Source: own calculations on the basis of OECD Economic Outlook data 1980-2004, see text for details

What does the empirical regularity unveiled by Figure 2 tell us about the dynamics of the two deficits in the business cycle? In principle, it is consistent with two, non-mutually-exclusive, explanations. As current fiscal surpluses are associated with future trade surpluses, one may point to the possibility of a *delayed* twin deficit

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[6] We also applied the Band Pass Filter suggested by Christiano and Fitzgerald (2003) instead of the HP filter, and extend our analysis by using data from the earliest available data point, 1964Q1, without significant effect on the shapes of the cross-correlation functions. By the same token, using the current account instead of net exports does not affect the results. In addition to the four countries discussed in the text, we computed the cross-correlation patter for the Czech Republic, Finland, France, Germany, Iceland, Ireland, Japan, Korea, Netherlands, New Zealand, Sweden and Switzerland. In most countries a S curve proved to provide a robust characterization of the cross-correlation pattern of the trade balance and the budget balance. A somewhat different pattern emerges for Finland, Ireland, and Sweden.

relationship. To the extent that changes in the fiscal stance are transmitted only slowly through the economy, they may affect the trade balance only with delay. Given that under this interpretation current fiscal expansions are causing future trade deficits, this would be a version (augmented with dynamic considerations) of the twin deficit hypothesis.

However, what seems more natural is that the cross-correlation pattern above is induced by many factors (some of which more important than fiscal), causing business cycle movements. This interpretation is also supported by results in Kollmann (1998) and Freund (2000), suggesting that the trade balance is mostly driven by technology shocks or, more generally, move with the business cycle. While we further explore this issue in related work (Corsetti and Müller (2005)), in this paper we are interested in understanding the role of fiscal shocks as the candidate cause for twin deficits, thereby assessing the twin deficit hypothesis *per se*.

To do so, in the next sections we will abandon the accounting perspective as well as simple correlation analysis. Instead, we will first rely on a structural model to reassess the theoretical underpinnings of the twin deficit hypothesis. Then, we will use structural econometric methods to analyze the joint dynamics of budget and trade balance *conditional* on a fiscal shock. Most of our analysis will focus on the effects of a temporary but lasting increase in government spending, for given tax rates.

3. Theoretical insights on the private sector response to fiscal shocks: the trade off between 'borrowing from abroad' or 'borrowing from the future'

What does theory say about the mechanisms through which exogenous fiscal expansions can cause a trade deficit? Once a mechanical accounting perspective is abandoned, the main issue is to understand the private sector reaction to the news about the fiscal stance, i.e. what happens to private savings and investment plans. One may think of reasons why the response of private savings may offset, at least in part, the reduction in public saving. The response of investment however can go either way, depending on the endogenous response of both interest rates and international relative prices (driven to a significant extent by the exchange rate). If only for this reason, a

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general equilibrium perspective is indispensable. In addition, a rigorous theoretical analysis also needs to distinguish between tax cuts or spending innovations as the economics primitives deteriorating the fiscal. As is well known, these tend to have different macroeconomic effects.

To begin with, it is important to recognize that the literature does not make an unambiguous case for the twin deficit hypothesis. In box 1, we give a brief and selective account of the general equilibrium literature on the external effects of fiscal policies (a more extensive discussion of the theoretical literature is provided by Kim and Roubini (2003)). While fiscal expansions are generally found to lower the trade balance, there is considerable disagreement about the order of magnitude of these effects. In what follows, we will expose our main contribution to the current theoretical and policy debate, by identifying a set of economic features which theory implies being the main determinants of the sign and magnitude of the twin deficits.

Box 1. Twin Deficits in General Equilibrium

As argued in the main text, an accounting perspective is insufficient to assess the twin deficit hypothesis. In this box we present a set of results on the twin deficits from the literature using standard general equilibrium models. A recurrent theme in this literature is that the general equilibrium effects of fiscal expansions on the trade balance are quantitatively different, depending on the extent to which domestic and foreign goods are substitutes/complements in private consumption and investment.

Consider first the extreme case of a world with one homogeneous goods. In a well known contribution, Baxter (1995) analyzes this case in a two country model, finding that, in response to an increase in government spending, net exports unambiguously fall by about 1/2 the fiscal expansion, thus generating twin deficits. In this model, both a negative wealth effect (due to the higher tax burden) and the increase in the world interest rates (due to excess demand in the world good markets) provide domestic households with an incentive to cut consumption and increase labour supply. The response of labour supply is crucial in determining the response of investment: as the wealth shock motivates households to provide more labour, the marginal productivity of capital rises, driving up investment --- a case of 'crowding in' of domestic capital. An investment

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boom however is not crucial for twin deficits. Assuming that labour supply is perfectly un-elastic, the model can still predict a deterioration of the trade balance (Kollmann 1998). This is because the trade balance deterioration reflects different mechanisms households can use to sustain their consumption at an optimal level in response to the higher government demand on output: if financial markets are incomplete, the trade deficit corresponds to consumption smoothing via borrowing from the rest of the world; if financial markets are complete, the trade deficit merely reflects a transfer of resources which is the consequence of efficient risk sharing. Interestingly, Baxter also finds that short-lived income tax cuts may induce *twin divergence*: agents take advantage of temporary fall of tax rates by substituting labour for leisure, thus raising output and exports, with limited effects on investment. This result is remarkable, as it shows that even the most stylized model can generate patterns of correlation at odds with the twin deficit hypothesis.

Realistically, however, a full general equilibrium model should also allow for imperfect substitutability between domestic and foreign goods. What are the implications of working with multi-good models? In the seminal contribution by Backus, Kehoe and Kydland (1994), which specifies a two-country model with nationally differentiated goods, government spending shocks generate twin deficits. However, these shocks crowd out, rather than crowding-in, domestic investment. As a result, the elasticity of the trade balance is lower than found in the one-good model by Baxter: only about 20 percent of the increase in government spending crowds out net exports.

More recently, Erceg, Guerrieri and Gust (2005) analyze fiscal transmission in a two-good model which also features nominal frictions and Rule-of-Thumb consumers (i.e. a fraction of households mechanically consume their current income). In their benchmark calibration the trade balance falls by about 0.15 percent of the increase in government spending.

3.1 Integrating static and intertemporal channels

In order to discuss the theoretical basis for the twin deficit hypothesis - the idea that expansionary fiscal shocks should worsen the trade balance - it is useful to start with

a reference to the two main transmission channels traditionally emphasized in the policy debate: a static (relative price) transmission mechanism, and an intertemporal (borrowing and lending) mechanism.

In the Mundell-Fleming tradition, an expansionary fiscal shock raises disposable income and internal demand. To make room for this additional demand for domestic output, a real exchange rate appreciation crowds out demand from abroad. The impact is stronger for spending hikes than for tax cuts. The external deficit may be somewhat reduced to the extent that the excess demand raises the domestic interest rate, and this crowds out domestic investment. But overall this is an essentially static mechanism linking fiscal deficit to excess demand and relative price movements.

In the simplest intertemporal model, instead, a fiscal shock that reduces resources available to the private sector can produce an external deficit, as households borrow and lend in international markets to smooth consumption against fluctuations in the wedge between their disposable income and their permanent income. The effects on trade will be different not only depending on whether the deficit corresponds to spending or tax changes (with different implications for private wealth), but also as a function of the persistence of fiscal shocks. The argument here is essentially dynamic, stressing saving and investment decisions in response to endogenous changes in the intertemporal price of consumption.

The static and intertemporal mechanisms emphasized by these arguments provide useful and important building blocks to understand twin deficits in the context of actual fiscal policy making. However, we will strongly argue below that empirically-sound analysis must proceed by recognizing the interaction of the two. In this sense, we develop our argument by adopting an analytical framework which can consistently integrate the two views above: this is a small-scale intertemporal DSGE model of the international economy. We closely follow the specification suggested by Backus, Kehoe and Kydland (1994), i.e. a contribution that is well established in the literature, with well-understood features, see Box 2. We should note here that, although stylized, the architecture of this model is closely related to those of larger DSGE models, increasingly employed by policy makers (i.e. central banks) and international institutions (such as the IMF). While

the analysis below is rooted on extensive quantitative assessment of such model, a simple analytical insight lies at the heart of our argument.

Box 2. Theoretical Framework

Most of our theoretical discussion in this paper is based on an intertemporal two-country two-good model, providing a framework for understanding the *interaction* of intertemporal and intratemporal considerations guiding saving and investment plans by the private sector in response to fiscal shocks. Extensive experiments, partly reported in Müller (2004), have established that nominal rigidities and monetary policy do not alter the basic mechanisms and results we stress in our analysis. For this reason, we keep our analysis close to Backus, Kehoe and Kydland (1994), assuming that all prices are perfectly flexible. The contribution by Backus, Kehoe and Kydland analyzes the transmission of technology and government spending shocks in a frictionless two-country two-good world, stressing the role of capital accumulation. To focus sharply on our main contribution, we simplify the analysis relative to the original specification of the model, assuming that labor supply is fixed, and government demand falls on domestically produced goods only. The latter assumption reflects the fact - discussed in section 3.2 of the main text - that the import content of government spending is substantially lower than the import. This difference in import content is not immaterial to our reasoning.

In what follow we outline the basic structure of the model. The world economy consists of two countries, labeled country 1 and 2. Occasionally, we refer to country 1 as the home country and to country 2 as the foreign country.

Through the allocation of consumption expenditure, $c_{1,t}$, the representative household in country 1 maximizes:

$$E_0 \sum_{k=t}^{\infty} \beta^t \log c_{1,t}$$

The same applies to the representative household in country 2. Regarding production, each country specializes in a single intermediate good – good a in country 1 and good b in country 2. Government spending, g, falls entirely on the intermediate domestic good. Total private absorption (by both countries) of Home intermediate goods, $a_{1t} + a_{2t}$,

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is equal to home gpd, $y_{1,t}$, net of government spending $g_{1,t}$. Similarly, total absorption of the Foreign intermediate goods, $b_{1t} + b_{2t}$, is equal to the Foreign gdp net of government spending:

$$a_{1t} + a_{2t} = y_{1t} - g_{1t}$$
$$b_{1t} + b_{2t} = y_{2t} - g_{2t}$$

In each country, intermediate goods are produced by combining capital, k, and labor, n. In the Home country, we have $y_{1,t} = k_{1,t}^{\theta} n_{2,t}^{1-\theta}$. Production functions are identical in the two countries. In the following we assume that labor supply is constant.

Consumption, c, and investment, x, are composites of the domestic and foreign intermediate goods:

$$c_{1t} + x_{1t} = \left[\omega^{\frac{1}{\sigma}} a_{1t}^{\frac{\sigma-1}{\sigma}} + (1-\omega)^{\frac{1}{\sigma}} b_{1t}^{\frac{\sigma-1}{\sigma}} \right]^{\sigma/(\sigma-1)}$$

$$c_{2t} + x_{2t} = \left[(1-\omega)^{\frac{1}{\sigma}} a_{2t}^{\frac{\sigma-1}{\sigma}} + \omega^{\frac{1}{\sigma}} b_{2t}^{\frac{\sigma-1}{\sigma}} \right]^{\sigma/(\sigma-1)}$$

The parameters σ and ω measure the intratemporal elasticity of substitution between the domestic and foreign intermediate good and the Home bias in private expenditure, respectively. At the same time $1-\omega$ measures the degree of openness, i.e. the ratio of imports to net output.

The dynamic behavior of the economy is determined by the evolution of the capital stock. Let δ denote the depreciation rate of capital. The capital stock grows with investment net of depreciation. For the Home country, we can write

$$k_{1,t+1} = (1-\delta) k_{1,t} + x_{1,t}$$

To close the model, we assume that international asset markets are complete: country specific risk can be fully insured.[7] While this assumption simplifies the analysis a great deal, extensive numerical experimentation shows that it is not central for our main

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[7] With complete markets, efficient risk sharing removes any need for borrowing and lending to smooth consumption - the dynamic of trade is driven by dynamic consumption and investment decisions responding to relative price movements. Complete markets also change the economic meaning of the external deficits, as in a world with perfect risk sharing trade deficits do not correspond to external imbalances - it is odd to talk about twin deficits. Having said so, models with complete markets shed light on many mechanisms that turn out to characterize the transmission of fiscal policy also in models where risk sharing is not perfect.

conclusions, see Müller (2004). We are interested in the dynamic adjustment of the world economy to a country-specific temporary increase in government spending. We assume that Home spending shocks follow an AR(1) process: $g_{1t} = \gamma g_{1t-1} + \varepsilon_{1t}$, while foreign government spending remains constant.

In the main text we discuss in detail the determinants of the response of the terms of trade and the consumption and investment differentials between the two countries, to a fiscal shock. To introduce our discussion in the text with a technical note, it is useful to single out a core analytical result of our model. In particular, let $p_{d,t}$ and $p_{f,t}$ denote the price of intermediate good a and b, respectively, both measured in units of the composite good in country 1, so that the terms of trade are defined as $p_t = p_{f,t} / p_{d,t}$. The domestic trade balance is defined as the ratio of net exports to output $nx_t = \left(a_{2,t} - p_t b_{1,t} \right) / y_{1,t}$. A first order approximation around a symmetric and non-stochastic steady state gives:

$$\frac{nx_t}{1-\omega} \simeq \left(c_y + x_y \right)\left(2\omega\sigma - 1 \right)\hat{p}_t - c_y \hat{c}_t^D - x_y \hat{x}_t^D$$

where c_y and x_y denote the steady state shares of consumption and investment in output. $\hat{p}_t$ denotes the percentage deviation of the terms of trade, while $\hat{c}_t^D$ and $\hat{x}_t^D$ denote the differential between the domestic and foreign percentage deviation of consumption and investment from their respective steady state values.

Now, under complete international asset markets, the consumption differential is a function of the terms of trade: $\hat{c}_t^D = \left(2\omega - 1 \right)\hat{p}_t$. It is then convenient to rewrite the trade balance above as a function of the terms of trade and the investment differential response to the shock. The response of the investment differential is thus a key determinant of the response of the trade balance. It can be shown that relative investment does not change (i.e. $x_t^D = 0$, Home investment is neither crowded-in nor crowded-out relative to the Foreign investment) for combinations of openness, $1-\omega$ and persistence of spending shock γ satisfying the following condition

$$1-\omega = \frac{1-\gamma}{2\left(1-\gamma\beta\left(1-\delta \right) \right)}$$

We display this condition graphically in Figure 3 and discuss its economic meaning in the main text (a formal derivation is available in an appendix posted on the authors' webpages).

3.2 Home bias in public and private spending

Consider the effects of a temporary but lasting increase in government spending, for given tax rates. A first important question concerns whether and to what extent government demand falls on foreign produced goods, rather than domestic goods. If it falls on foreign goods, a positive fiscal shock would clearly have a direct and immediate effect on imports. For instance, if the import content of public spending were as high as 20 percent, other things equal, a 1 dollar increase in spending would deteriorate the trade balance by 20 cents. In general, however, the import content of fiscal expenditure is quite low. In Table 1 we report the import content of various GDP components for two countries in our sample. Imports generally account for no more than 10 percent of government expenditure. They make up for over 30 percent of investment and more than 40 percent of the change in inventories (UK), with the import content of private consumption ranging somewhere in the middle. In light of this evidence, in what follows we assume that government demand falls entirely on domestic goods. This is a way for us to focus sharply on the transmission of fiscal shock to net exports, via changes in consumption and investment.

Table 1. Import content of GDP components

	US	UK	Canada	Australia	Notes
Government spending (public consumption & investment)	NA	0.115	NA	0.104	UK: 1995 (only government consumption); Australia: 1998-99; USA: 1997
Private consumption	NA	0.203	NA	0.168	
Private Investment	NA	0.359	NA	0.258	UK: import content of total investment
Change in inventories	NA	0.456	NA	0.357	

Sources. US: "Benchmark Input-Output Accounts of 1997" in Survey of Current Business Bureau of Economic Analysis December 2002. Table 2 on p. 107; UK: Valerie Herzberg, Maria Sebastia-Barriel, Simon Whitaker "Why are UK imports so cyclical?" Quarterly Bulletin Bank of England. Summer 2002; 42, 2. pg. 203; Australia: Australian National Accounts: Input-Output Table 18. 1998-99. Cat.no. 5209.0.55.001. Australian Bureau of Statistics.

A second important question is to what extent the goods market is integrated across countries. We are now aware that, despite globalization, markets remain quite fragmented. Because of barriers to trade and other frictions, there are persistent cross-border price differentials for identical goods. More in general, as apparent from Table 1, the import content of consumption and investment goods is quite limited. For these reasons, the literature often introduces the idea that private spending is biased towards home goods, as a way to capture such considerations in an analytically tractable way. In what follows, we will also assume 'Home bias' in private spending: other things equal, households and firms would have a preference for domestically produced goods. Some authors associate this phenomenon with the term 'insularity' (e.g. Obstfeld and Rogoff 2001).

Because goods market are not fully integrated, the price of national consumption baskets typically differ across countries (technically, purchasing power parity fails to hold). This is so because, with Home bias, the CPI of each country gives a very large weight to domestic good prices. Thus, also the domestic real interest rate (which by definition is the price of consumption at different dates) need not be equal across countries. Perhaps thanks to The Economist regular reporting on the price of the Big Mac in different markets, there is wide awareness of the importance and pervasiveness of such price (and rate) differentials.

Since Home bias is reflected in the import content of private expenditures and thus in the share of imports in total GDP, it is closely related to the degree of openness of an economy. Note that, in our theoretical model (Box 2), Home bias is just the negative of openness: the same parameter determines both. In what follows we will use either term to refer to the same phenomenon: that the typical consumption and investment basket contains more domestically produced than imported goods.

Home bias in public and private spending, together with price and rate differentials across borders, are two characteristic of the world economy which are crucial when it comes to understanding the effects of a temporary but persistent fiscal expansion on the current account. We explain the reason why in the next section.

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3.3 Is investment crowded out more in relatively closed economies?

By definition, the trade balance is the difference between exports and imports. Exports, in turn, depend on consumption and investment demand in the rest of the world, while imports depend on consumption and investment demand in the home country. It is therefore convenient to analyze the behaviour of the trade balance in terms of the difference between domestic and foreign demand. In particular, as outlined in Box 2, we can use an approximation of net export distinguishing three elements: the differential between domestic and foreign investment demand, the difference between domestic and foreign consumption demand, and changes in the terms of trade. We organize our discussion around these components. In this subsection, we start with investment differentials.

As predicted by the traditional view, a sustained increase in government demand for domestic goods has a lasting positive effect on their price relative to foreign goods. That is, it leads to a lasting terms of trade appreciation. The favourable terms of trade movement improves revenues in real terms (i.e. in terms of domestic consumption) earned from domestic investment projects. Hence, the fiscal expansion tends to raise the expected return to investment in the domestic capital. At the same time, however, it also raises the domestic real interest rate, which discourages investment. The response of investment depends on the relative strength of these two effects.

The degree of Home bias in domestic spending and the persistence of the fiscal shocks over time are crucial in determining the extent to which better terms of trade in response to a fiscal shock improve the marginal revenues from investment.

Intuitively, a large Home bias means that domestic good prices have a large weight in the CPI. Holding the price of imports constant, an increase in domestic good prices appreciating the terms of trade also induces a substantial increase of the CPI. Thus, the price of domestic goods in terms of domestic consumption does not change much. For a given physical marginal product of capital, expected future appreciation of the terms of trade has a limited effect on the marginal revenue from capital, i.e. a limited effect on the real expected return to domestic projects.

To see this most clearly, consider a simple definition relating the real return to investment to the price of domestically produced goods (denoted P_d, as opposed to import prices P_f), the consumer price index (CPI) and the marginal product of capital. Ignoring depreciation for simplicity, we can write:

$$\text{Real return to investment} = \frac{P_d}{CPI} \text{ (marginal product of capital in physical units)}$$

Now, the CPI is a weighted average of domestic good prices P_d and import prices P_f. Say that the weight are ω and $1-\omega$, respectively, so that the size of ω is the measure of Home bias and $1-\omega$ provides a measure for openness, see Box 2. Then any change in the P_d:CPI ratio can be approximated by the following expression involving only changes in the terms of trade:

$$\text{Change in } \frac{P_d}{CPI} = (1-\omega) \text{ Change in } \frac{P_d}{P_f}$$

For a given marginal product of capital in physical units, an appreciation of the terms of trade (P_d increases relative to P_f) improves the rate of return on domestic investment by $(1-\omega)$: the larger the Home bias (ω going to 1), the lower the improvement in the return.

In equilibrium the rate of return on investment must be equal to the real interest rate. In each country, the real interest rate measures the relative price of consumption in the future relative to consumption today. Without Home bias, the price of consumption and therefore the real interest rate is equalized across countries: the real interest rate is equalized at Home and abroad. With Home bias, an appreciation of the terms of trade will tend to raise the domestic interest rate relative to the foreign one.

Of course, the magnitude of the response of the terms of trade to a fiscal shock also varies with the Home bias, so does the domestic real interest rate. However, our argument is that the net effect of fiscal spending shocks in economies with high Home bias is that of discouraging domestic investment by lowering its return relative to domestic interest rate.

Together with Home bias, the second crucial element is the degree of persistence of fiscal shocks. A persistent increase in spending clearly raises the financial burden falling on the private sector. For our argument, however, there is another effect which is more relevant. As the public demand for domestic goods tends to remain high in the future, so will the relative price of domestic goods, raising the expected return on domestic capital. Indeed the improvement of domestic terms of trade tends to be stronger, the longer the spending shock lasts. We therefore expect the response of investment to increase in the degree of persistence of the fiscal shock.

The above arguments apply to the foreign investment demand as well, but with the opposite sign. A fiscal expansion in one country worsens the terms of trade abroad, reducing the return to investment in terms of consumption, thus discouraging capital accumulation. At the same time, the foreign real interest rate rises, even if not to the same extent (in the presence of Home bias) as in the domestic economy.

Putting these arguments together, one may reasonably expect that there are different combinations of Home bias (or Openness) and degree of persistence of fiscal shocks which may generate the same investment response to a fiscal shock. Indeed Figure 3 plots the combinations of openness (measured by the import content of private goods) and shock persistence which, according to a formal assessment of the model described in Box 2, would generate *no change* in domestic investment relative to foreign investment. This is of particular interest since, in our view, the response of relative investment to fiscal shocks is the main driving force shaping the overall impact of these shocks on the trade balance at business cycle frequency. In Figure 3, the area above the dotted line is one of (relative) crowding in of domestic investment, the area below the line one of (relative) crowding out.

Figure 3: Crowding in or out?
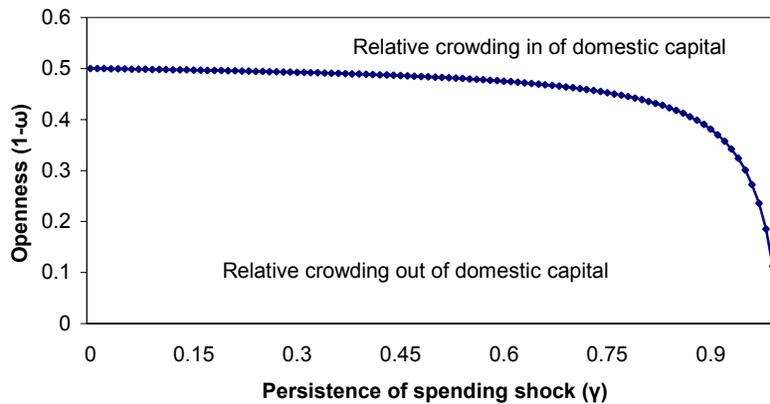
Source: own calculation on the basis of the formula at the end of box 2, assuming that β=0.99 and δ=.025.

Start from a point *on* the dotted line: raising shock persistence for a given degree of openness leads to relative crowding in; conversely, lowering the degree of openness, i.e. increasing Home bias, for a given degree of shock persistence, leads to a fall in domestic investment relative to foreign investment, as discussed above.

In order to gain further insights on the logic of the argument, consider the extreme case of fiscal shocks with no persistence at all --- government spending is raised exclusively in the current period. Without Home bias (imports account for 50 percent of private spending, $\omega = 0.5$) there will be no change in relative investment. This is so because a temporary shock has no lasting sizeable effects on the terms of trade, so that there is little or no impact on expected return to capital. The interest rate increases. However, with no Home bias, the interest rate will be identical at Home and abroad. As a result, investment will respond negatively, but symmetrically, in the two countries.

If, with temporary shocks, we allow for some Home bias (an import content in consumption less than 1/2), the real interest rates increases in the domestic economy more than abroad: domestic investment falls by more.

Now, start from the extreme case of no Home bias, and consider a lasting spending shock. As argued above, without Home bias, the real interest rate increases identically in both countries --- discouraging investment. However, the expected return on investment is now higher for domestic capital, because a lasting terms of trade

appreciation in the Home economy raises the return to domestic capital. This is why domestic investment increases relative to foreign.

These effects on relative investment transpire into changes in domestic investment levels. Through numerical experimentation, we systematically find that Home investment is crowded out as long as the government spending shock is not too persistent, and there is some Home bias. In other words, we find that economic openness and shock persistence are crucial factors in driving also the absolute (in addition to the relative) response of domestic investment to a government spending shock. Combinations of little openness and persistence (South West region of Figure 3) will induce a fall in the domestic capital stock, while combinations of a high degree of openness and more persistent spending shocks (North East region of Figure 3) induce a surge in domestic investment in response to a government spending shock.

3.4 Consumption and terms of trade

To the extent that Ricardian equivalence holds, the overall tax burden from the expanded government spending (irrespectively of when taxes are levied) tends to lower current consumption. For given taxes, this raises private saving, offsetting in part the fall in public saving. The magnitude of the impact on private wealth and thus on consumption depends on the degree to which households share idiosyncratic risk across countries. Under complete international asset markets, households in home and foreign would equally share the burden of the domestic fiscal expansion. However, we should observe here that, even in the absence of efficient portfolio diversification, a terms of trade improvement in response to government spending shocks would tend to transfer some of the burden from the domestic fiscal shock onto foreign households. This is because a Home appreciation reduces the value of Foreign output relative to the domestic one, depressing Foreign consumption.[8] Overall, consumption falls in both countries.

A second dimension of the relative consumption response to fiscal shocks concerns the growth rate of consumption. The growth rate of consumption at home and

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[8] As our main focus is investment, the model outlined in box 3 makes the simplifying assumption that consumers are Ricardian, and markets are complete. In light of the role of terms of trade movements pointed out in the text, the latter assumption is less consequential than one may expect.

abroad is determined by the real interest rate. Here we are back to the Home bias story: with a strong Home bias, domestic households will experience a rise in the real interest rate relative to foreign, which may depress current domestic consumption even further.

Above, we have extensively referred to the terms of trade as a crucial determinant of relative demand for consumption and investment goods. Clearly, in addition to their effects on the demand level, the terms of trade determine the composition of these goods. A domestic appreciation temporarily raises the import content of domestic consumption and investment, while the reverse occurs in the foreign countries. This composition effect tends to lower the domestic trade balance, depending on the price elasticity of imports. At the same time, there is a 'valuation effect': the domestic appreciation will tend to improve the trade balance, by raising the value of exports relative to imports. In our theoretical analysis, the substitution effect dominates the valuation effect: ceteris paribus an appreciation (of the terms of trade) will reduce the trade balance as the equivalent of the Marshall-Lerner-Robinson (MLR) conditions is assumed to hold in general equilibrium (see Tille (2001) and Müller (2004) for further analysis).

Observe that the elasticity of substitution between domestic and foreign goods determines the strength of the response of the terms of trade to fiscal shocks, therefore playing a (quantitatively) important role in the response of the trade balance --- a point stressed also by Erceg, Guerrieri and Gust (2005). However, in the two-country model outlined in box 2, the elasticity of substitution does not determine the sign of the relative investment response --- which are driven by the degree of openness and shock persistence (see the formula at the bottom of box 2).

3.5 Summing up

In this section, we have analyzed in detail different mechanisms through which a fiscal shock translates into changes in private saving and investment determining the trade balance. An intuitive way to synthesize these mechanisms consists of emphasizing the trade offs between borrowing from abroad (intratemporal substitution), and 'borrowing from the future,' (intertemporal substitution) --- their relative importance being to a large extent determined by openness and shock persistence. The domestic

private sector faces this trade-off when the government raises its claims on domestic output. Borrowing from abroad is attractive when there is no strong preference for the home good (as in a relatively open economy): by raising the demand for foreign goods, agents can prevent a fall in consumption below their permanent income, as well as a fall in the capital stock. Actually, if the government demand is persistent enough, it is efficient to raise the domestic capital stock, against higher future demand for domestic output, as well as to service foreign debt incurred in response to the shock. This is clearly the scenario underlying "Twin Deficits."

When there is a strong preference for the Home Goods, instead, the economy is relatively closed: in response to a fiscal shock subtracting domestic goods from private use, borrowing foreign goods from abroad is less attractive, relative to using own goods. A temporary contraction of investment (borrowing from the future) becomes the relevant strategy to prevent a fall in consumption. This is true as long as the fiscal shock is not too persistent, in which case running down the domestic capital may not be efficient vis-à-vis the need to sustain high future government claims on domestic output.

We find this intuition quite useful in addressing the insights from literature. Overall, the net effect of a fiscal expansion on the external trade of a country results from several factors, many of which opposing each other. These factors shape not only the size, but even the sign of the response. In contrast to popular reading of the received wisdom, it cannot be ruled out that fiscal expansion improve temporarily the trade balance. In our reading, crowding out vs. crowding in of investment, in turn related to Home bias and shock persistence, is the dominant factor in the outcome.

Finally, note that we have focused our analysis on expansionary government spending shocks as a cause of twin deficits/divergence. Clearly, tax cuts are also likely to play an important role in the joint dynamics of the budget and the trade balance. As mentioned in box 1, Baxter (1995) reports that in this case one may find either twin deficits or twin divergence, depending on the degree of persistence of the tax cut. In addition, also in the case of tax cuts the home bias in private expenditure can be expected to influence the trade balance response to fiscal shocks, through essentially the same transmission channel analyzed above. However we do not study tax cuts any further,

mainly because of the difficulty in identifying tax shocks in the data using our empirical methodology. To this we turn in the next section.

4. The Transmission of Fiscal Shocks: time series evidence

What is the evidence on the effects of fiscal expansions on the trade balance? As is well known, there are specific case studies suggesting twin deficits. The question we address in this section is whether there is any statistical support for the hypothesis that government spending induces both budget and trade deficits in a systematic way.

A large body of empirical literature has tested the twin deficit relationship based on single equation techniques dating back at least to Summers (1986). Generally, the quantitative effect of fiscal deficits on trade deficits uncovered by this strand of the literature varies considerably across studies. Some studies have helped to establish the notion that about a third of the increase in the budget deficit is reflected in the trade deficit, e.g. Chinn and Prasad (2003). More recently, however, the reported value has become considerably lower. Bussière et al. (2005), Gruber and Kamin (2005) and Chinn and Ito (2005) find that only some 1 to 20 percent of the increase in the public deficit is reflected in the trade deficit, whereas the effect is statistically significant only according to the last study.

While structural vector autoregression (VAR) techniques are well established in the analysis of monetary policy, these techniques have been extended to analyse the dynamic effects of fiscal policy only recently, e.g. Blanchard and Perotti (2002) and Fatás and Mihov (2001). Within this literature, a few studies have focused on the effects of fiscal policy on foreign trade, including Clarida and Prendergast (1999), analyzing the effects of budget deficits on the real exchange rate, Canzoneri, Cumby and Diba (2003), focusing on output spillovers of US fiscal policies on foreign GDP and Giuliodori and Beetsma (2004), using European data in an investigation of the effects of government spending on imports, and especially Kim and Roubini (2003).

Kim and Roubini (2003) is the first study to address the twin deficit issue explicitly within a VAR framework. Using US data they find that a negative innovation to the budget balance actually increases the current account, i.e. a result of 'twin

divergence.' This finding is shown to be qualitatively similar in response to tax and spending shocks, in addition to budget shocks (i.e. when they identify tax and spending innovations, instead of innovations to the budget balance). Twin divergence is also obtained by Müller (2004), who identifies spending innovations in the US time series. In what follows, we will build on the same approach.

Different from these authors, however, we will analyze possible cross-country variations in the external effects of fiscal policy by extending the analysis to a sample of four countries, Australia, Canada, the UK and US. The composition of this sample is the same as in Perotti (2005), who applies the VAR approach to fiscal policy developed in Blanchard and Perotti to closed-economy issues.[9]

4.1 Structural Vector Autoregressions

Adopting a structural VAR model allows us to capture the dynamic interdependence of macroeconomic aggregates within a linear model, where the value of each variable is expressed in terms of its own past values, past values of the all the other variables in the VAR and an error term. While serially uncorrelated, the error terms associated with each variable are likely to be mutually correlated, if contemporaneous relationships between variables are not taken into account. Structural VAR models therefore allow for some contemporaneous relationships between variables and pre-specify or exclude others in order to ensure identification.

To identify government spending shocks we follow Blanchard and Perotti (2002) and assume that government spending does not contemporaneously respond to changes in the other variables, while allowing these other variables to be immediately affected by government spending. Once identified, we track the dynamic effects of a typical spending innovation on the other variables in the VAR, controlling for other changes in the economic environment which may also induce co-movements between fiscal and other macroeconomic variables. Like all statistical techniques, the quality of our results depends on their correct application. An important issue affecting identification is that

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[9] Different from Perotti (2005), we focus on external trade, rather than pursuing a complete and exhaustive characterization of the macroeconomic effects of fiscal policy. We should note here that Perotti also considers time series for West Germany for up to 1989.

spending and tax policy changes are usually announced before effective implementation and therefore may affect behaviour through expectations before the fiscal shock shows up in fiscal data --- one of the points stressed by Mountford and Uhlig (2004). Perotti (2005) takes up this and other possible complications, providing arguments to support the application of structural VAR models to identify the effects of fiscal policy. We discuss technical aspects of our approach in Box 3.

Box 3. Structural Vector Autoregression

Our empirical results are based on an estimated structural VAR model. The baseline specification of the VAR includes seven variables: government spending, g_t, and output, y_t, both in logs of real per capita terms; the quarterly inflation rate, π_t, the long term nominal interest rate, r_t, the terms of trade, p_t, the budget balance, bb_t, and the trade balance, nx_t. Further details on the construction of the variables are provided in the appendix. In addition, we also allow for linear and quadratic terms in time as well as for quarterly dummies in each equation, but omit them in the discussion below.

Letting Z_t denote a vector which contains these variables in the same order as they were introduced above, we consider the following structural model

$$A_0 Z_t = \sum_{i=1}^{4} A_i Z_{t-i} + \varepsilon_t,$$

where ε_t is a vector of mutually uncorrelated innovations. The coefficient matrix A_0 reflects contemporaneous relationships among the variables in Z_t. It is not possible to estimate A_0 and therefore identify the innovations ε_t without further assumptions. Therefore we assume that A_0 is a lower triangular matrix (which is equivalent to estimating a reduced from VAR model and computing the Choleski factorization for the reduced from VAR covariance matrix, see the discussion of a recursive VAR in Stock and Watson 2001). Given that government spending is the first variable in Z_t, this boils down to the assumption that government spending responds to the other variables with a delay of one lag. Under this assumption, we can estimate the VAR consistently by applying OLS recursively.

Once the structural VAR is estimated, we generate impulse response functions on the basis of its reduced form. These responses provide a convenient way to summarize the macroeconomic dynamics triggered by fiscal innovations. More precisely, an impulse response at horizon k is the difference between the expected value of a variable in period $t+k$ conditional on a spending innovation in period t and its expected value in the period before the shock. We also report cumulative impulse responses at the time horizon k by simply adding up the impulse responses up to this horizon. We compute standard errors for the impulse response functions by bootstrapping based on 1000 replications. In order to keep dimensions manageable, we estimate a second VAR where we replace the trade balance with investment, x_t, and report the impulse responses of investment obtained from this VAR together with the results for our baseline specification.

4.2 Testing a refined prediction from theory

Before turning to our estimated VAR model, it is worth reconsidering briefly the main results from our theoretical analysis so far. In the previous section, based on a standard two-country two-good business cycle model, we have stressed that theory does not yield clear-cut *unconditional* predictions regarding the magnitude and the sign of the response of the trade balance to fiscal shocks. Instead, we have singled out two structural features of the economy, openness and the persistence of fiscal expansion, as crucial determinants of the international transmission of fiscal policy. In this sense, our theoretical analysis provides us with a *refined prediction*: the extent to which a temporary increase in government spending reduces the trade balance depends on the persistent of fiscal shocks and/or the degree of openness of the economy. Provided that shocks are persistent enough, and/or the economy is quite open, a temporary increase in government spending will have a limited effect on investment, but a relatively strong effect on net exports. On the other hand, when shocks are not persistent, and the economy is rather closed, the response of investment will mute the effects on the trade balance. The four countries in our sample display structural differences along both dimensions.

The empirical counterpart of openness can be easily computed from the data. For the four countries in our sample, the first row of Table 2 reports a standard measure of the

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degree of openness, the ratio of imports to net output (GDP net of government consumption and government investment). Overall, we observe a considerable degree of heterogeneity. While Canada and the UK are characterized by a high degree of openness (the ratio of imports to net output is 0.4 and 0.35, respectively), the weight of US imports in private output is only 0.14. Australia, with a value of 0.24, is characterized by an intermediate degree of openness.

Table 2: Key determinants of trade balance response

	US	UK	Canada	Australia
Openness (import: net-output ratio)*	0.14	0.35	0.40	0.24
Sum of coefficients on lagged spending**	0.90	1.00	1.01	0.75

*Source: OECD Economic Outlook 1980-2004 averages.
**Regression coefficients from first equation of VAR, see Box 3.

The degree of persistence of fiscal shocks can hardly be observed directly. However, as we identify fiscal shocks using our VAR model, we can use the same model to compute a measure of their persistence. Specifically, the second row of Table 2 reports the sum of the coefficients on the lagged values of government spending obtained from estimating the first equation of our VAR model.[10] According to this measure of shock persistence, the UK and Canada are characterized by very persistent fiscal shocks, while a typical government spending shock displays less persistence in the US --- even less in Australia.

In light of the evidence in Table 2, we may state our empirical hypothesis in light of our 'refined prediction' regarding the effects of spending shocks on trade deficits. In the countries where import share is low (US and Australia), spending shocks happen to be less persistent: in these cases we expect a substantial and negative effect on investment and only a mild effect on the trade balance, in response to a spending innovation. In contrast, in the countries where the degree of openness is high (UK and Canada), and

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[10] An alternative measure for the persistence of the shock is provided by its half-life. However, its computation is complicated by the fact that the decline in the effects of the spending shock need not to be monotone.

spending shocks happen to be more persistent, we do not expect a substantial crowding out of private investment, but a stronger decline in the trade balance.

4.3 The Evidence

We assess the hypotheses spelled out above by studying the dynamic effects of a government spending innovation equal to one percent of GDP. Specifically, we focus on the dynamic adjustment process, i.e., the impulse responses of the variables of interest triggered by these shocks. Figure 4 displays the responses of the budget balance and the trade balance together with the response of investment in the four countries in our sample. In this figure, impulse responses are measured in percentage points of trend output (vertical axes), while the horizontal axis gives the time horizon in quarters. Each dotted line displays the point estimate, while the straight lines display the two symmetric one standard error bands, computed by bootstrapping based on 1000 replications.

The first row of Figure 4 shows the response of the budget balance to a spending innovation. Spending innovations lead to a budget deficit in all countries: to a considerable extent government spending innovations are thus debt financed everywhere in our sample. However, the magnitude of the effect differs across countries. The strongest effect of the spending shock on the budget deficit is for Canada, the weakest for Australia, in line with the results reported by Perotti (2005).[11]

The second row of Figure 4 displays the response of the trade balance. Note that we take spending rather than budget deficits as the primitive shock. But since we have observed above that spending innovations induce budget deficits, we are de facto reconsidering the Twin Deficit hypothesis by looking at the effect of spending innovations on trade deficits. The figure shows significant effects on the trade balance for the UK and Canada: in the UK the impact effect is about -0.4 percent of trend output and a maximum effect of -0.54 is reached after six quarters; in Canada the impact effect is

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[11] In the theoretical analysis we did not explore the consequences of debt financing in addition to the direct effects of spending shocks, since our analysis is based on a model where Ricardian equivalence holds. Of course, in a non-Ricardian world the extent of debt financing also matters. Erceg et al. (2005) calibrate a DSGE model with non-Ricardian households to the US. They find that the effects of government spending shocks are only mildly affected by the share of non-Ricardian households in total population.

about -0.45 and the maximum effect of -0.65 is reached in the second quarter after the shock. Given that the spending innovation is one percent of trend output, these effects are quantitatively substantial if compared with results reported in the empirical literature adopting a single equation approach.

Figure 4. Selected responses to spending shock
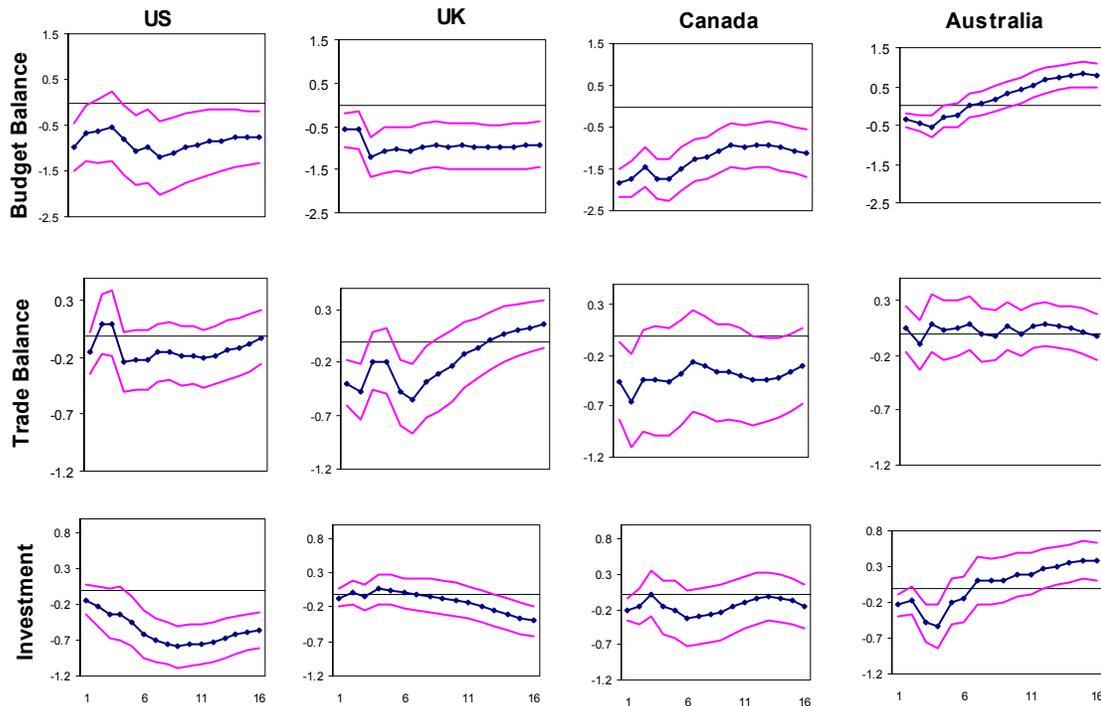
Turning to the response of the trade balance in the US and Australia, there are, in fact, no significant effects. While for the US the point estimates are still negative, in both countries the trade response is mildly positive at some point over time. This confirms earlier findings by Kim and Roubini (2003) and Müller (2004) for the US. Relative to these studies, we find a somewhat smaller response of the trade balance.[12]

The last row of Figure 4 shows the response of investment. In our sample, the economies with the higher degree of openness, Canada and the UK, also tend to experience more persistent spending shocks. Consistent with our hypothesis, the capital

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[12] Further experiments (not reported) suggest that these differences likely results from different sample periods, notably, from changing the starting date. Kim and Roubini start in 1975, Müller in 1973. Perotti (2005) suggests a break date in fiscal policy transmission around 1980. Consistently, we use 1980Q1 as the first observation (for the dependent variable). Our last observation is Q4 of 2004 for all countries.

stock of these countries is hardly affected by fiscal expansion: investment does not fall significantly. In contrast, both the US and Australia, being less open to international trade and experiencing less persistent shocks, see a substantial decline in investment: investment falls by about 0.8 percent of trend output in the US and by about 0.5 percent in Australia.

The three rows of Figure 4 together are consistent with our 'refined twin deficit prediction': twin deficit emerges in response to spending shocks in countries which are quite open to trade, and where spending shocks tend to be persistent. In case of relatively closed economies (which also experience less persistent shocks) one may even observe twin divergence.

We complete our analysis by briefly discussing the responses of the other macro variables included in our VAR model. To give a concise summary of our results, we compute cumulated impulse responses for the first year and for three years after the spending shock. Table 3 displays the results for the eight variables in our model.

The first line reports the cumulative response of government spending to an innovation in government spending, providing another measure of how long a fiscal expansion lasts in each country. In contrast to the measure of persistence reported in the second row of Table 2, the cumulative response reported in Table 3 also takes into account the *endogenous* response of government spending to variations in the other variables in the VAR.[13] Shock persistence is highest in the case of Canada, lowest in the case of Australia. The value is similar for the US and the UK.

The second line reports the response of output: hardly any significant effect is observed - broadly in line with the results by Perotti (2005), who argues that the overall macroeconomic effect of fiscal policy tends to fall in the post-1980 period relative to a pre-1980s sample.

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[13] Following standard practice, in the DSGE model (box 2) we assume that government spending is characterized by an exogenous AR(1) process; in the VAR we allow for an effect of four lags of government spending on current government spending, as well as for an effect of four lags (but not of current values) of the other variables included in the VAR. Therefore, spending is predetermined but not exogenous in the VAR.

Table 3. Cumulative response to a government spending shock

	Horizon	US	UK	Canada	Australia
Government spending	4	0,68*	0,76*	0,92*	0,57*
	12	1,66*	1,53*	2,3*	0,89*
GDP	4	0,66*	0,07	0,48*	0,20
	12	-0,19	0,39	1,57	0,82
Inflation	4	0,06	-0,01	-0,31	-0,15
	12	0,02	0,22	-0,06	0,10
Nominal interest rate	4	0,11	-0,01	-0,04	-0,04
	12	-0,13	0,06	-0,04	-0,05
Terms of trade	4	-0,27	1,08*	2,16*	1,17*
	12	1,08	2,12*	0,87	5,93*
Budget balance	4	-0,7*	-0,86*	-1,69*	-0,41*
	12	-2,68*	-2,84*	-4,11*	0,08
Trade balance	4	-0,05	-0,31	-0,5*	0,01
	12	-0,41	-0,84	-1,23	0,10
Investment	4	-0,25*	-0,01	-0,13*	-0,36*
	12	-1,63*	-0,13	-0,53*	-0,20

Notes: Annualized responses, i.e. spending impulse is one percent of annual GDP;
all quantities are expressed in percent of GDP; Horizon is in quarters. Sample Period
is 1980Q1-2004Q4, see Box 3 for details. An asterisk "*" indicates that zero
is outside the region between the two one-standard error bands obtained
by bootstrap based on 1000 replications.

As shown in the third and fourth line, with the exception of the US, the responses of inflation and interest rates are negative at almost all horizons. This has been noted by several authors (see Mountford and Uhlig (2004) and Perotti (2005)), and is yet to be fully understood. In light of theory, we would expect a positive response of inflation.

The fifth line of the table shows that the terms of trade tend to worsen following a fiscal shock in all our countries, although they initially appreciate in the case of the US. The response of the terms of trade does not square well with our theoretical model, according to which an appreciation of the terms of trade is an important component of the international transmission of fiscal shocks. However, we should note here that the terms of trade response is not very robust across various specifications of our empirical VAR

analysis.[14] In this sense, our empirical analysis of the international transmission of fiscal shocks adds a new dimension to the list of open issues in related analyses of fiscal transmission in closed economy. Further analysis is needed to understand not only the response of inflation and the interest rate, but also the behaviour of the terms of trade and the real exchange rate. Finally, the last three rows of Table 3 provide an alternative representation of the evidence in Figure 4.

To sum up, the results from our VAR analysis provides evidence in line with the predictions developed in the theoretical section above. It appears that the effects of fiscal expansions on the trade balance are related to the response of investment, which in turn depends on the degree of openness and the persistence of the spending shock. We find that in relatively closed economies with little shock persistence, such as the US and Australia, fiscal expansions tend to crowd out investment, and have little effects on net exports. The reverse is true for UK and Canada, countries with considerably larger import content in GDP and more persistent spending shocks.[15]

5. Fiscal expansions and global imbalances

Our study confirms an important policy-related finding of the literature, that the effects of fiscal (i.e., government spending) shocks on external trade are quite contained for relatively closed economies such as the US. Suppose that we take such a result at face value: does it follow that fiscal policy would not play any significant role in correcting the unprecedented stream of large current account deficits run by the US in recent years? In other words, can the US fiscal authorities be relieved from the responsibility of contributing to rebalancing the US external account, simply because fiscal instruments

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[14] Müller (2004) finds an appreciation of the terms of trade in the US using data from 1973-2003 and a similar identification scheme than the one employed in the present paper.

[15] Note again that we limited ourselves to the empirical analysis of government spending shocks. While Blanchard and Perotti (2002) and Perotti (2005) have carried out empirical analysis of tax shocks in a VAR framework, both the identification of tax shocks and the correspondence between the tax process in the VAR and the model is less straightforward. Because of these distinct economic and technical issues, the analysis of tax shocks is best developed in an independent paper.

would not have a strong effect on net exports? We believe that such a conclusion would be a severe misreading of the above results.

Both theoretical arguments and empirical evidence shows that the fiscal transmission channel has either an external or an internal intertemporal component. Facing an increasing claim by the government on domestic resources, firms and households can choose to sustain their consumption and investment plans at their optimal level by either borrowing from abroad, or by 'borrowing from the future', through a reduction of investment. Even if the contemporaneous impact on the current account is limited, the impact on the future capital stock of shocks crowding out investment is by no means irrelevant for external solvency. Everything else equal, a lower capital in the future means that the US is pledging future resources at the expense of future consumption. Unless the differential in the rate of growth of productivity between the US and the rest of the world is bound to remain large in the future, delaying a fiscal correction may create macroeconomic and political risk.

In addition, there may be reasons for a large fiscal correction in the US to have stronger effects than we find in our study. One cannot exclude that the average macroeconomic impact of fiscal shocks picked up by VAR analysis be magnified when fiscal authorities takes drastic measures. Would this argument rescue a strong version of the Twin deficit hypothesis for large spending corrections? An element raising doubts on this possibility is that previous studies analyzing substantial current account adjustments fail to find any significant impact of fiscal policy, see e.g. Freund (2000).

While we have not explicitly addressed tax policy shocks, our analysis above suggests a number of arguments to assess their impact on the trade balance. Suppose that Ricardian equivalence does not hold because of liquidity constraints, lack of intergenerational altruism, or the presence of non-fully optimizing ('rule-of-thumb') consumers, so that a cut in taxes raises current consumption. Depending on the degree of Home bias, a higher domestic consumption directly raises import, worsening the trade balance. On top of this direct effect, the change in demand has an indirect impact on investment. For a given labour supply, the impact is likely to be negative in economies with a strong home bias, and where the tax shock is temporary, for exactly the same reasons discussed in the previous sections.

In conclusion, our analysis suggests that a US fiscal correction is important for rebalancing the US current account. According to our result, however, the transmission mechanism is mainly intertemporal via investment, rather than intratemporal through foreign trade.

6. Conclusions

In this paper we reconsider the twin deficit hypothesis --- that fiscal shocks generating budget deficits also worsen external trade --- both from a theoretical point of view and by analyzing data for Australia, Canada, the UK and the US. First, we emphasize the distinction between the twin deficit analysis and statistical correlation between the budget and trade deficits during the business cycle. Both variables have a strong cyclical component. Hence it is not surprising to find that such correlation is negative, as economic expansions tend to improve the fiscal balance, while income expansions tend to worsen the trade balance. We contribute to the debate by uncovering a strikingly recurrent S-shaped relation between the budget and trade deficits at different horizon: *current* budget deficits are associated with *current* trade surpluses, but the correlation between current budget deficits and future trade surpluses has the opposite sign.

Second, we reconsider general equilibrium theories of the transmission of government spending. Using a standard two-country two-good model, we find that openness and the persistence of fiscal shocks are major determinants of the magnitude (or even sign) of the response of the trade balance to fiscal shocks. For a given persistence of the fiscal shock, the crowding out effect on investment is stronger in a relatively closed economy. In this case, the deterioration of the trade balance is contained. Given openness, crowding out is stronger when the fiscal shock is persistent. This provides us with a refined twin deficit hypothesis, whereby the magnitude of the external effects of fiscal policy is made conditional on the degree of openness of the economy, and the persistence of fiscal shocks.

Third, we take this refined hypothesis to the data, investigating the transmission of government spending shocks in a VAR framework in the four OECD countries. Our

empirical findings support our hypothesis. In the US and Australia, which are relatively less open than Canada and the UK, and where government spending shocks are less persistent, we find that the external impact of fiscal policy is rather limited. Instead, private investment responds substantially. The reverse is true for Canada and the UK. These findings confirm and put into perspective earlier results, whereas fiscal expansions in the US are found to have on average a negligible effect on the country's trade balance. However, we emphasize that these results are consistent with a call for a US fiscal retrenchment to address global imbalances: the impact of budget cuts on the US external trade is muted by their positive effect on domestic investment, strengthening the US ability to generate resources against future interest and debt repayment.

Appendix

Data Definitions

All data are obtained from the OECD Economic Outlook database. OECD mnemonics are given in capital letters. Our sample is based on data for Australia, Canada, the UK and the US for the period 1979Q1-2004Q4.

While the budget balance, *bb*, is directly provided (NLGXQ: Primary government balance, percent of GDP), we construct the trade balance, *nx*, as (XGS-MGS)/GDP, where XGS = exports of goods and services, value, local currency; MGS =imports of goods and services, value, local currency; GDP = Gross domestic product (market prices), value.

Government spending, *g*, is given by the sum of CGW= Government Consumption, Wages (Australia: not available, use CGAA Government consumption) and CGNW = Government Consumption, Excluding Wages and IGAA = Fixed Investment, Government.

In the VAR model we use the variables: PMGS = import price, goods and services, local currency; PXGS = export price, goods and services, local currency; IRL = interest rate, long run; POPT =population, total (between 15&64 years old); GDPV = gross domestic product (market prices), volume; IPV= private fixed investment (excl. stockbuilding), volume. We compute the GDP deflator as GDP./GDPV and carry out the following transformation in order to obtain the time series for our VAR: $g = \log(g/\text{deflator.}/\text{POPT})$; $y = \log(\text{GDPV}/\text{POPT})$; $\pi = \log(\text{deflator}(t)/\text{deflator}(t-1))$; $r = \text{ilr}/400$; $p = \log(\text{PMGS.}/\text{PXGS})$; $x = \log(\text{IPV.}/\text{POPT})$.

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