Productivity Shocks, Budget Deficits and the Current Account*

Matthieu Bussière† Marcel Fratzscher‡ Gernot J. Müller§

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Abstract

Productivity shocks and budget deficits are considered to be two key determinants of the current account. In order to assess formally the role of both factors in driving current account movements, the present paper extends the standard intertemporal model of the current account to allow for Non-Ricardian household behavior. Testable cross-equation restrictions for the current account and investment are derived by drawing on the distinction between country-specific and global innovations to productivity as well as to the government budget. We test the restrictions of the model against time series data for 21 OECD countries and find evidence in support of the model.

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Keywords: Current account, productivity shocks, budget deficits

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†Corresponding author, European Central Bank, Kaiserstrasse 29, D-60311 Frankfurt am Main. Email: matthieu.bussiere@ecb.int. Phone number: ++49 69 1344 7678.

‡European Central Bank. Email: marcel.fratzscher@ecb.int.

§Goethe University Frankfurt, Mertonstrasse 17, D-60325 Frankfurt am Main. Email: gernot.mueller@wiwi.uni-frankfurt.de

1 Introduction

Productivity shocks and government budget deficits are considered to be two key determinants of the current account. This follows from basic accounting, which equalizes the current account and the difference between saving and investment. On the one hand, innovations to the government budget deficit will lower overall saving and the current account (to the extent that private saving and investment do not fully off-set the fall in public saving); on the other hand, productivity innovations, will have a positive impact on consumption and investment and lower the current account (to the extent that the effects on consumption and investment exceed the immediate effect of productivity on income).

Not surprisingly, productivity shocks and budget deficits have figured prominently in the policy debate on the secular decline of the current account in the U.S. In the mid-1980s, as a result of record current account and budget deficits the notion of 'twin deficits' became popular. In the mid-1990s, by contrast, the current account and the budget balance were moving in opposite directions. Consequently, general attention turned to productivity gains as the prime suspect responsible for the current account deficit.[1] The early 2000s have again witnessed a strong deterioration in the U.S. fiscal position associated with a further decline in the current account such that the 'twin deficits' gained renewed attention. In sum, the informed analysis of current account developments during specific episodes seem to suggest an important role for productivity shocks and budget deficits.

Suggestive evidence, however, cannot make up for a rigorous analysis within a structural model. A natural framework for such an analysis is the intertemporal model of the current account, which has been tested successfully against the data in various modifications. Previous tests of the model, however, focused on the transmission of either productivity shocks or budget innovations. In the present paper, by contrast, we suggest a simple modification of the baseline intertemporal model such that i) both productivity shocks and the government budget govern the dynamics of the current account and ii) a tractable empirical specification can be obtained.

[1] See Mann (2002) who states that in the late 1990s, "the chain of causality that had related the fiscal position to the current account position in the 1980s was broken". Instead, the argument goes, "productivity gains in the U.S. economy... attracted foreign investors" stimulated investment and induced a current account deficit.

Specifically, we start from the version of the intertemporal model that Glick and Rogoff (1995) have shown to perform well empirically. Notably, the model correctly predicts that the current account falls in response to country-specific but not in response to global innovations to productivity. Investment, by contrast, rises in response to both innovations. Glick and Rogoff also stress that one cross-equation restriction implied by the model is rejected by the data: under the assumption that productivity follows a random walk, the response of the current account (in absolute value) to a country-specific productivity innovation should be higher than the response of investment.[2]

Within the baseline intertemporal model used by Glick and Rogoff, however, there is no role for budget deficits since the financing of government spending is irrelevant (Ricardian equivalence holds completely). In order to relax this assumption, we proceed as suggested by Mankiw (2000) and assume that a fraction of households behave as spenders and spend their disposable income in each period, while the rest of the population behaves as savers and consumes its permanent income, thus smoothing resources intertemporally. We show, within the framework of Glick and Rogoff, how such a non-Ricardian feature leads to a modification of the reduced form of the model that can be tested against the data. Specifically, the country-specific component of changes in the government budget is shown to impact the current account in addition to the country specific productivity innovations. The extent of this effect depends on the weight of the spenders in the population.[3]

Note that our focus is on the government budget balance and not on government spending. Within the baseline intertemporal model, temporary increases in public spending, unlike permanent changes, induce a fall in the current account. This is an implication of consumption smoothing by Ricardian agents, who do not lower consumption to the

[2] Glick and Rogoff show that if productivity innovations are not permanent the model does not imply this restrictions. Iscan (2000) and Marquez (2004) also focus on the transmission of technology shocks and subject extended versions of the model to the data.

[3] In our view, this simple analytical framework serves a purpose complementary to more richly specified DSGE models. Those have been used to study extensively the transmission of productivity and fiscal shocks –see, e.g., Baxter and Crucini (1993), Backus, Kehoe and Kydland (1994), Baxter (1995) and, in particular Kollmann (1998), Erceg, Guerrieri and Gust (2005) and Corsetti and Müller (2006). While new insights into the transmission mechanism is provided by these models they are usually not formally tested against the data. This also holds for VAR models, the use of which has been recently extended to address the transmission of fiscal shocks in the open economy, see Kim and Roubini (2008), Müller (2008), Corsetti and Müller (2006) and Monacelli and Perotti (2006).

same extent as government spending increases if the increase in spending is temporary. Ahmed (1986) tests the model using the distinction between temporary and permanent changes in government spending and reports evidence in favor of the model using data for the U.K.[4] The presence of non-Ricardian households, by contrast, allows for an additional transmission channel of budget deficits: to the extent that households are 'spenders', a temporary fall in the government budget resulting from spending increases *or* from tax cuts will not be offset by an increase in private saving. As a result, the current account will decline as overall saving falls.

To test the model, we follow Glick and Rogoff and derive cross-equation restrictions for the joint behavior of the current account and investment in response to country specific and global shocks. We test these restrictions against a panel of 21 OECD countries and long data series starting in 1960.[5] Overall, we find that the model performs well. Most interestingly, we find a significant, albeit contained, effect of the country-specific component of the primary government budget balance on the current account. By contrast, the global component of the government balance does not affect the current account, but instead significantly impacts investment behavior, as suggested by the model. Regarding productivity shocks, we confirm earlier results by Glick and Rogoff (1995) whereby global innovations to technology affect only investment but not the current account. Country specific innovations to productivity, instead, do affect both variables.

However, the data also points to one dimension where the model appears to give an insufficient account of the transmission of budget deficits. In our small country version of the model the interest rate is assumed to be unaffected by country-specific shocks. Hence, only global shocks to the government budget may alter interest rates and investment behavior. In the data we find that also country-specific shocks to the government budget impact investment behavior –albeit by a much smaller extent than global shocks. This suggests that budget developments may affect the economy through other channels than

[4] Note that Glick and Rogoff (1995) find no significant effect of temporary government spending shocks.

[5] We considered including emerging market economies (EMEs) in the analysis. Unfortunately, the data coverage is significantly more limited for these countries and prevents the same in-depth analysis as for the OECD countries. In addition, the current account balance of EMEs tends to be affected by very specific factors, which questions the appropriateness of pooling these countries in the same panel as OECD countries.

the consumption behavior of non-Ricardian households (spenders), which is the focus of the present contribution. We leave the exploration of these channels within the intertemporal model for future work.

Our results regarding the extent of non-Ricardian behavior can be related to other tests of the intertemporal model, which are similar in spirit to the present paper, but do not simultaneously explore the implications of productivity shocks and budget deficits for the current account. Roubini (1988) shows that optimal tax smoothing implies a one-to-one relationship between the current account and the fiscal deficit; he also provides evidence in support of the model. Another approach, similar in spirit to our modification of the baseline model, is followed by Johnson (1986) in an early test of the intertemporal model. He rejects the fully Ricardian version of the intertemporal model in favor of a model where private agents do not internalize the government budget constraint. Evans (1990), Normandin (1999) and Piersanti (2000), consider variants of the model where households have a finite life span. As a result, consumption and thus the current account depends on current, but also on expected future budget deficits. These three papers adopt different strategies to model budget expectations and find different results. Evans finds evidence against the model and in favor of the infinite horizon specification, while Normandin and Piersanti find evidence in favor or the finite horizon specification. There is therefore a lot of heterogeneity in existing empirical evidence on the relation between the fiscal and the current account deficits.

The remainder of the paper is organized as follows. Section 2 outlines our model, which integrates the work of Glick and Rogoff with Mankiw's suggestion. It also derives cross-equations restrictions for the change in investment and the current account. Section 3 reports the results for our sample together with various robustness tests. Section 4 concludes.

2 Theoretical Framework

In this section we sketch a structural model of an open economy in which investment and consumption and eventually the current account respond to exogenous shocks to

productivity and the government budget balance. The model is similar to the one put forward by Glick and Rogoff (1995), but allows for the possibility that a fraction of the population does not smooth consumption intertemporally.

2.1 Current Account

We assume that countries can trade riskless assets on world capital markets at a constant real interest rate r. In this framework the current account CA_t represents the change in the net foreign asset position B_t or the net savings of an open economy

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

where Y_t, I_t, G_t and C_t denote output, investment, government spending and consumption in real per capita terms, respectively.

2.2 Output and Investment

A representative firm is making investment and production decisions on the basis of a Cobb-Douglas production function, which incorporates a quadratic resource cost of adjusting the capital stock. Labor is supplied inelastically and normalized to unity. Capital does not depreciate. Taking a log-linear approximation around the sample average implies the following linear relationship between per capita output, investment, capital K_t and domestic total factor productivity A_t

$$Y_t = \alpha_I I_t + \alpha_K K_t + \alpha_A A_t, \tag{2}$$

where $\alpha_I < 0$ due to costs of adjustment, and both α_K and $\alpha_A > 0$.

In the presence of capital adjustment costs, the investment decision is the solution to a dynamic problem. A log-linear approximation to the optimal investment rule is given by

$$I_t = \beta_1 I_{t-1} + \eta_1 \sum_{s=1}^{\infty} \eta_2^s \left(E_t A_{t+s} - E_{t-1} A_{t+s-1} \right), \tag{3}$$

where $0 < \beta_1 < 1, 0 < \eta_2 < 1$ and $\eta_1 > 0$. E_t denotes the expectations operator. The optimal level of investment thus depends on past investment and expected changes in

total factor productivity. Moreover, if total factor productivity follows a random walk, (3) simplifies to

$$I_t = \beta_1 I_{t-1} + \beta_2 \Delta A_t, \tag{4}$$

with $\beta_2 = \eta_1 \eta_2 / (1 - \eta_2)$. Subtracting I_{t-1} from both sides gives the change in investment as a function of lagged investment and the innovation to productivity

$$\Delta I_t = (\beta_1 - 1) I_{t-1} + \beta_2 \Delta A_t. \tag{5}$$

2.3 Consumption

Regarding household behavior, we depart from Glick and Rogoff (1995) and assume that the economy is populated by two types of agents. Specifally, we assume that a given fraction of the population spends its disposable income in each period (spenders / non-Ricardian consumers), while the other fraction adjusts spending so as to smooth consumption intertemporally (savers / Ricardian consumers). While this specification is very simple, it provides a remedy for the shortcomings of the canonical model of intertemporal consumption smoothing. Indeed, according to Mankiw, the standard approach suffers from two major shortcomings. First, consumption smoothing as implied by different variants of the model is far from perfect. Contrary to the implication of the baseline model of the intertemporal consumption allocation, Campbell and Mankiw (1989), among others, find that consumption tracks current income to a substantial extent. Second, many people have net worth near zero, such that saving is not a normal activity to the extent it is implied by the intertemporal consumption smoothing-model. While Mankiw does not outline a specific model, a formal exploration within a general equilibrium analysis of fiscal policy can be found in, e.g., Galí, López-Salido and Vallés (2007).

Specifically, we assume that non-Ricardian consumers (spenders) make up for a fraction $\lambda \in [0, 1]$ of the population, which otherwise consists of Ricardian consumers (savers). Hence, aggregate (per capita) consumption C_t is given by the weighted average of non-Ricardian consumption C_t^{NR} and Ricardian consumption C_t^R, with weights λ and $1 - \lambda$,

respectively,

$$C_t = \lambda C_t^{NR} + (1-\lambda) C_t^R. \tag{6}$$

2.3.1 Spenders

Per capita output Y_t is distributed equally across households after subtracting taxes T_t and investment expenditures I_t of the representative firm. This is the only source of income for spenders.[6] As spenders consume their disposable income in each period, non-Ricardian consumption equals per capita output Y_t less per capita investment I_t and per capita taxes T_t,

$$C_t^{NR} = Y_t - I_t - T_t. \tag{7}$$

2.3.2 Savers

In each period a representative Ricardian agent chooses consumption in order to solve the following intertemporal problem

$$\begin{aligned} \max \ E_t \sum_{s=t}^{\infty} \beta^{s-t} u(C_s^R), \\ \text{s.t. } B_{s+1}^R = (1+r)B_s^R + Y_s - T_s - I_s - C_s^R, \end{aligned} \tag{8}$$

and a no-Ponzi game condition. In words, Ricardian agents maximize the expected infinite sum of utility discounted by $0 < \beta < 1$. B_t^R represents the net financial assets held by a representative Ricardian agent at the end of period $t-1$. We assume that the intratemporal utility function u is quadratic in C_s^R and that the subjective discount factor β equals the (world) market discount factor $1/(1+r)$. In this case the first order condition to (8) is given by $E_t C_{s+1}^R = C_s^R$. Moreover, we can write the consumption function of Ricardian agents as follows:

$$C_t^R = rB_t^R + \frac{r}{1+r} E_t \sum_{s=t}^{\infty} \frac{Y_s - T_s - I_s}{(1+r)^{s-t}}. \tag{9}$$

[6] To clarify, per capita income differs across savers and spenders, because the former also receive interest payments on bond holdings (see Section 2.3.2).

2.4 Government and Model Solution

Letting G_t denote government spending, the government budget contraint evolves as follows:

$$B_{t+1}^G = (1+r)B_t^G + T_t - G_t, \tag{10}$$

where B_t^G denotes government net assets in per capita terms. Per capita assets are then given by $B_t = (1-\lambda)B_t^R + B_t^G$. We assume that while government spending may provide benefits to households, it enters the utility function in an additively seperable way, such that it neither alters the marginal utility of consumption nor enters the consumption function of Ricardian agents.[7] We do not explicity allow for government spending to be productive. Yet our empirical specification should accommodate such a possbility, as we include different productivity measures.[8]

We assume that productivity, government spending and taxes are determined exogenously. Yet while all three variables are assumed to follow a random walk, we assume that spending and taxes are cointegrated such that the primary surplus $\tilde{S}_t = T_t - G_t$ is stationary. Is then possbile to obtain the following solution for the change in the current account

$$\begin{aligned} \Delta CA_t &= rCA_{t-1} + (1-\lambda)\left[(\alpha_I - 1)(\beta_1 - 1) + \alpha_K\right] I_{t-1} + \lambda \Delta \tilde{S}_t \\ &\quad + (1-\lambda)\beta_2 \left[\frac{(\alpha_I - 1)(1-\beta_1) - \alpha_K}{1 + r - \beta_1}\right] \Delta A_t, \end{aligned} \tag{11}$$

see our working paper for details.

[7] Alternatively, it would be possible to assume an additively non-separable specification and yet arrive at a solution for the current account identical to the one derived under the addively separable specification: if, as in Christiano and Eichenbaum (1992), we define a consumption bundle $\hat{C}_t^R = C_t^R + \alpha G_t$, while assuming that $u(\hat{C}_t^R)$ is quadratic and G_t follows a random walk.

[8] Adopting the specification of Baxter and King (1993) it is possible to obtain a solution for investment and the current account which also includes public investment. In fact, in this case the responses of the current account and investment to public investment are quite similar to those to total factor productivity. Yet to test for a possible 'productivity'-effect of government investment it would be necessary to obtain TFP measures which are purged of such effects in order to controll for purely technology driven changes in TFP. To the best of our knowledge, such measures are not available.

2.5 Estimation Equations

Our model thus provides us with two equations for the change in the current account (11) and investment (5). By distinguishing between a global and country-specific shocks we will derive testable cross-equation restrictions. So far, we have treated productivity as well as fiscal variables as purely domestic. However, it seems sensible to assume that innovations to productivity and, albeit to a lesser extent, fiscal shocks are composed of a country-specific and a global component. In the case of the former, productivity shocks can have a global component if a technological innovation in a given country quickly spreads to other countries. In case of the latter, one example for a global component is the common effort of European countries to consolidate public balances under the Maastricht treaty.

Most importantly, as stressed by Glick and Rogoff, global innovations should not impact the current account, since all countries will respond in the same way and hence there is no scope for gains from intertemporal trade (under the assumption that initial net foreign assets are zero). This holds true for the global component of productivity innovations as well as for the global component of innovations to the primary balance.[9]

By contrast, the global component both of productivity innovations and the primary balance is likely to impact investment decisions. Regarding productivity, Glick and Rogoff note that the effect of country specific shocks is likely to be larger than the effect of global shocks, because of the interest rate effect of the latter. A similar reasoning applies in the case of changes in the primary government balance. Only to the extent that these changes are global, we expect an effect on interest rates, while - by assumption - country specific shocks to the primary government balance leave global interest rates unaffected. As a result, only the global, but not the country-specific component of changes in the primary government balance will have an influence on investment behavior. Specifically, we expect a global improvement in the government primary balance to lower global interest rates

[9] To gain intuition, consider the example of a global improvement of TFP. First, from a partial equilibrium perspective (which underlies the small open economy model), this provides an incentive to increase investment and consumption in every country and hence, will tend to lower the current account in all countries. Second, there is a general equilibrium dimension to this shock to the extent it is global: if all countries aim to invest more, this induces an upward pressure in global interest rates, which, in equilibrium, offsets the first effect.

and hence to induce an increase in investment.[10]

In order to state these considerations formally, we amend equations (5) and (11) as follows:

$$\Delta I_t = \eta_1 \Delta \tilde{S}_t^c + \eta_2 \Delta \tilde{S}_t^g + \eta_3 \Delta A_t^c + \eta_4 \Delta A_t^g + \eta_5 I_{t-1}, \tag{12}$$

$$\Delta CA_t^* = \gamma_1 \Delta \tilde{S}_t^c + \gamma_2 \Delta \tilde{S}_t^g + \gamma_3 \Delta A_t^c + \gamma_4 \Delta A_t^g + \gamma_5 I_{t-1}, \tag{13}$$

where superscripts 'c' and 'g' denote the country-specific and global components, respectively. To address the endogeneity of CA_{t-1} in the current account equation (11) we have defined a new dependent variable $CA_t^* = \Delta CA_t - rCA_{t-1}$. For the same reason we use the cyclically adjusted primary balance below as the empirical counterpart for $\tilde{S}_t$.[11]

Turning to the cross-equation restrictions of the model, the above arguments and equation (11) imply for the coefficients in equation (13):

$$\begin{aligned}
0 \leqslant \gamma_1 &\leqslant 1, (\gamma_1 = \lambda) \\
\gamma_2 &= 0, \\
\gamma_3 &= (1-\lambda)\beta_2 \left[\frac{(\alpha_I - 1)(1-\beta_1) - \alpha_K}{1 + r - \beta_1} \right] < 0, \\
\gamma_4 &= 0, \\
\gamma_5 &= (1-\lambda)\left[(\alpha_I - 1)(\beta_1 - 1) + \alpha_K\right] > 0.
\end{aligned}$$

For the coefficients in equation (12), instead, we have:

$$\begin{aligned}
\eta_1 &= 0, \\
\eta_2 &\geqslant 0, \\
\eta_3 &> 0, \\
\eta_3 > \eta_4 &> 0, \\
\eta_5 &= \beta_1 - 1 < 0,
\end{aligned}$$

[10] As in Glick and Rogoff, we do not model the interest rate channel formally in order to maintain the analytical tractability of the model.

[11] See our working paper for further discussion.

Hence, by allowing for the presence of non-Ricardian consumers in the intertemporal current account model, we obtain additional cross-equation restrictions that can be tested against the data. However, the introduction of non-Ricardian agents also implies that one restriction of the baseline model that Glick and Rogoff found to be rejected by the data can be relaxed. In the baseline model with $\lambda = 0$ and productivity following a random walk, the absolute value of the response of the current account to country-specific productivity innovations should be larger than the investment response, i.e. in that case the model implies $|\gamma_3| > \eta_3$. With $\lambda \geqslant 0$, by contrast, $|\gamma_3| > \eta_3$ is implied only if $(1-\lambda)(1-\alpha_I) > 1$.[12] Intuitively, in case $\lambda > 0$, consumption responds less to permanent productivity shocks than in case $\lambda = 0$ and hence the effect of productivity shocks on investment may exceed the effect on the current account.

3 Empirical Results

3.1 Data

We use annual data from the OECD Economic Outlook database covering the period 1960-2003. The current account variable, which was originally in billions of USD, is converted in national currency using the bilateral dollar exchange rate (EXCH).[13] Since the model is formulated in real per capita terms we scale all variables with the population (POP) and the GDP deflator (PGDP).

As in Glick and Rogoff we use the world interest rate series constructed by Barro and Sala-i-Martin (1990) for the construction of our dependent variable CA_t^*. For the post-1990 period we calculate the ex post real rate, using the country weights given by the share of each country in world GDP (nominal GDP (GDP) times the dollar exchange rate (EXCH)). The new series is chainlinked with the Barro-Sala-i-Martin data on world interest rates provided by Glick and Rogoff.

The OECD also provides a measure for productivity (PDTY). Moreover, for means of comparability with Glick and Rogoff, we also construct Solow residuals for the G7

[12] Here we used a condition implied by the optimality of the investment decision of the firm, which is not invoked in Glick and Rogoff, but in Gruber (2002): $\alpha_K/r = -(\alpha_I - 1)$, the discounted marginal return to capital equals the marginal cost of investment.

[13] The codes of the OECD database are in capital letters.

economies. First, for each country, Solow residuals are formed using the shares of labor in manufacturing output. The data used are from BLS[14], where for the U.S. the original data provided by Glick and Rogoff are used up to 1977 (i.e. for the period where it is not available at BLS anymore) and chainlinked to the current BLS series.

For the primary balance, we use the cyclically adjusted series (NLGXA) while for investment we use private investment (IPV). We also use the series CGV to establish the unit root property of government consumption. The variables are plotted in Chart 2 for the G7 countries.

Finally, we compute a GDP-weighted average to obtain the global component of three time series: of CA_t^*, of the changes in productivity and of the changes in the primary government balance. The weights are given by the average nominal GDP (in USD) in the total GDP over the sample period 1960-2003. Chart 1 displays the results, showing a substantial 'global component' for all three time series. As, by definition, the current account positions of all countries should net out to zero, we subtract the weighted average from CA_t^* assuming that the 'global component' represents trade with those countries not included in our sample and therefore not accounted for in our model. The resulting time series will be used as the dependent variable in the regressions below. The global component of productivity shocks and of changes in the cyclically adjusted primary government balance is also substantial. This lends support to our analytical distinction between the global and the country-specific component of both shocks. For our baseline specification we obtain the country-specific component by subtracting the global component from the original series.

To check the extent to which our productivity measures are dependent on this aggregation measure based on GDP weights, we extract, as an alternative proxy, global and country-specific productivity components using a principal component analysis. It turns out that the first principal component accounts for more than 90% of the variation across the individual countries' productivity series, so that a single principal component should be sufficient to capture the global/common productivity dynamics. We then extract the country-specific productivity element as the difference between a country's series and this

[14] The data are available on-line: http://www.bls.gov/fls/prodsupptabletoc.htm

common global component.

3.2 Unit Root Tests

Before turning to the estimation of the model, it may be appropriate to test the assumptions made with respect to the stochastic properties of total factor productivity and government spending. The derivations of the estimation equations are based on the assumption that both country-specific total factor productivity and real per capita government spending follow a random walk. In order to test the plausibility of this assumption we carry out conventional Dickey - Fuller tests, as well as two panel tests for the G7 sample (Levin, Lin and Chu (2002) and Im, Pesaran and Shin (2003), see results in Table 2). We cannot reject the unit root null at conventional significance levels for these two variables. On the other hand, the tests show that the dependent and the independent variables used in our regression equations are all stationary, except for real private investment, for which the two panel tests yield conflicting results.

3.3 Baseline Specification

We now turn to the estimation of the current account and the investment equations. Our baseline results are based on panel estimates for 21 OECD economies (see complete country list in Table 1). It includes 587 observations. Two issues need to be considered in the panel estimation. First, as the variables are expressed in real domestic currency, we need to account for the heteroskedasticity that would arise from pooling the data together. For that purpose, we follow Glick and Rogoff (1995) in scaling the observations with the standard deviation of the residuals of individual country equations (using OLS), and follow a generalized least squares approach. The use of generalized least squares also accounts for cross-country correlation and for autocorrelation within countries. Second, we used country dummy variables to account for unobservable country specific effects. Including the country dummies in the specification did not qualitatively affect the results but as some of the dummies were significant, we kept them in the regressions. In addition, we created two dummy variables equal to 1 in 1991 in Germany and the United States, to account for the German unification and for the first Gulf war, respectively. The coefficients

of these two dummy variables turned out to be highly significant with the correct signs (negative for the German 1991 dummy and positive for the US 1991 dummy), both in the country equations for Germany and the US and in the panel regression. Before turning to the results, note that the baseline specification is based on the OECD measure for productivity.

In panel A of Table 3 we report the results from estimating equation (12) and (13), respectively. For equation (12), when the dependent variable is ΔI, the coefficients on $\Delta \tilde{S}^g$, ΔA_t^c and ΔA_t^g have the correct sign and are significant at the 1 percent level. In other words, productivity shocks drive up investment as do innovations in the global component of the primary government budget balance. However, in contrast to what the model suggests, also the innovations in the country-specific component of the primary government budget balance crowd-in investment. This suggests that fiscal policy affects investment behavior through other channels than through their impact on global interest rates (as considered here). Nonetheless, the estimated coefficient on the global component of the primary government budget balance is about 3 times larger than the estimated coefficient of the country-specific component - in line with the prediction of the model according to which a global improvment of goverment budgets lowers world interest rates and thereby crowds-in investment. From a quantitative point of view, it is also interesting to note that the point estimates $\hat{\eta}_3$ and $\hat{\eta}_4$ are in a similar order of magnitude to those reported in Glick and Rogoff. Notably, $\hat{\eta}_4$ somewhat exceeds $\hat{\eta}_3$, in contrast to the predictions of the model. The coefficient on lagged investment, $\hat{\eta}_5$, is negative and significant, as predicted by the model.

Regarding the ΔCA equation (13), the results confirm the predictions of the model. The country specific shocks, $\Delta \tilde{S}^c$ and ΔA_t^c, have a significant impact on the current account. By contrast, the global components have no significant effect, thereby supporting the notion that gobal shocks leave little scope for gains from intertemporal trade. The coefficient on lagged investment, $\hat{\gamma}_5$, is negative but close to zero and insignificant. From a quantitative point of view, our estimates also appear plausible. The coefficient of the country-specific productivity shocks, $\hat{\gamma}_3 = -0.11$, is close to the panel estimate of Glick and Rogoff (-0.17). As the productivity variable is multiplied by average GDP, this coef-

ficient can be interpreted the following way: a 1% increase in country specific productivity would trigger a decrease in the current account balance by 0.11 percentage points of average GDP. Regarding the effect of country-specific innovations to the government primary balance, we find a point estimate of $\hat{\gamma}_1 = 0.14$. This estimate is significant and can be interpreted as follows: a deterioration in public savings by one percentage point of GDP will lower the current account by 0.14 percentage points of GDP. This number is similar to other estimates obtained on the basis of reduced form regressions. While early studies of Summers (1986) and Bernheim (1988) and more recently, Chinn and Prasad (2003) report estimates in an order of magnitude twice as high, more recent estimates point to a lower value, see, for instance, Chinn and Ito (2005) and Gruber and Kamin (2007) who report values of 0.21 and 0.09, respectively.

Finally, note that as in Glick and Rogoff we find that country-specific productivity shocks have larger effects on investment than on the current account. As discussed above, however, this constitutes a puzzle only within the baseline intertemporal model with $\gamma_1 = \lambda = 0$ and productivity following a random walk. As long as λ is non-negative, the effect of productivity shocks on the investment may exceed those on the current account.

Overall, we thus find that the model conforms well with the data. Its prediction regarding the responses of investment and the current account to the country-specific and the global component of productivity shocks and innovations to the primary government budget balance are borne out by the data. An exception is the significant effect of country-specific budget innovations on investment, leaving open the question of additional channels through which fiscal innovations affect investment behavior in the open economy.[15]

3.4 Robustness Tests and Further Results

We consider alternative specifications to explore the robustness of the results obtained for the baseline specification. First, we consider a measure for productivity obtained from Solow residuals as in Glick and Rogoff. In this case, for comparability with Glick and Rogoff we also report results using a smaller panel of G7 countries, Panel B of Table 3

[15] Using a two-country DSGE model Corsetti and Müller (2006) analyze the role of the terms of trade for the transmission of fiscal shocks in the open economy *via investment behavior*.

displays the results, which are similar to the baseline results.

Next, we consider country-specific times series regressions for the G7 countries. Results are given in Table 4. By and large, the results from the panel estimation are confirmed. Overall, not considering the coefficient on lagged investment, we obtain the signs predicted by the model except for the coefficients on the country-specific component of the budget balance for the U.S. and France and of productivity shocks in the U.K. and Canada (ΔCA equation). However, there appears to be substantial cross-sectional heterogeneity. Also, given the limited number of observations, it appears difficult to obtain significant estimates for the country-specific primary government balance in the ΔCA equation (13). This also applies to the coefficients in the investment equation.

We therefore turn to another robustness test, where we remove from the list of countries those that may not fulfill all the hypotheses of the theoretical model, notably the small open economy assumption. We also remove countries from our sample which might be potential outliers because of a history of large fiscal deficits. Table 5 shows that our results are very robust with respect to the composition of our sample both regarding the ΔCA equation (Panel A) and the ΔI equation (Panel B).

Another potential concern is that the relation between the 'twin deficits' may have changed over time (for instance because the share of liquidity constrained consumers might have fallen with the development of financial markets in the past decades). However, suggestive evidence indicates that the relation is robust: restricting the sample to a 20 year long estimation window moving from 1985 to 2003 shows that the value of the coefficient of the fiscal variable does not significantly vary over time (Chart 3)[16].

Moreover, we address another concern which arises with the possibility that the relation between public and private saving may be non-linear, as noted in Giavazzi and Pagano (1990), Alesina and Perotti (1995, 1996) and Perotti (1999). In particular, such non-linear effects can be expected in countries with a very large ratio of debt to GDP, or in countries that implemented large consolidation programs. We therefore tested whether

[16] We start in 1985 to have enough observations to estimate the model. Even so, the model is estimated with a substantially less observation in 1985 (201) than from the 1990s onwards (above 300). Splitting the sample in the mid-1980s and running two separate regressions before and after 1985 yields however very similar coefficients (0.15 and 0.13 respectively).

our panel results were sensitive to removing countries with a high debt to GDP ratio and the observations corresponding to strong fiscal consolidations as identified in Alesina and Perotti (1996). The results of these tests, displayed in Table 5, show that our findings are not affected by these particular cases.

Turing to the robustness regarding the empirical specification of independent variables, we use alternative specifications of the global and country-specific productivity components using a principal component analysis. For this proxy, the global component is the first principal component among all countries' productivity series, and the country-specific productivity element is the difference between a country's series and this common global component. Panel B of Table 6 shows that the results are similar to those of the benchmark model of Table 3. In particular, the parameters that we are primarily interested in – the coefficients for country-specific productivity and the country-specific measure of the government primary balance – are statistically significant and similar in magnitude to those of the benchmark specification shown in Table 3.

A final issue concerns the robustness of the results across different sub-periods. An obvious break point when the relationships identified in the data may have changed is the demise of the Bretton Woods system of fixed exchange rates in the mid-1970s. Panel A of Table 6 shows the results when re-estimating the benchmark model for the investment equation and the current account equation starting in 1975. The estimates indicate that overall the findings are robust to this alternative specification. In particular, the main parameters of interest – the coefficients for country-specific productivity and the government primary balance – are very close to those of the benchmark specification shown in Table 3.

4 Conclusion

In this paper, drawing on earlier work by Glick and Rogoff (1995) and Mankiw (2000), we have developed a comprehensive and tractable framework to analyze jointly the role of changes in the government budget balance and productivity shocks in the intertemporal model of the current account. Within this model we have derived cross-equation restric-

tions for changes in the current account and investment. According to the model, only country-specific innovations in productivity and the primary government balance may affect the current account, but not the global components of those shocks. Investment, by contrast, is predicted to respond to global innovations in productivity and the primary budget balance, but not to country-specific innovations in the primary government budget balance.

We have tested these predictions against data covering 21 countries and the period 1960-2003. Overall, the model performs well. Its restrictions are not rejected by the data, except for a response of investment to country-specific innovations to the primary government balance. In our view, our results lend support to the notion that in addition to productivity shocks, budget deficits are an important determinant of current accounts. More specifically, our structural model suggests a particular transmission mechanism of how budget deficits impact the current account: because a fraction of households does not internalize the government budget constraint (non-Ricardian households), improvements in the government budget balance are not fully off-set by private saving and will therefore raise overall savings, i.e. the current account.

In the present paper we do not investigate possible reasons for non-Ricardian behavior, but resort instead to an ad-hoc assumption as our focus is to explore the consequence of such behavior for current account developments. Moreover, our results also suggest that non-Ricardian behavior is not the only channel through which budget deficits affect the open economy, because we find investment to respond to country-specific innovations to the budget deficit. We leave the exploration of further channels for future work.

Regarding the quantitative interpretation of our results, it is interesting to note that our point estimate of 0.14 entails that an increase in the government budget deficit by one percentage point of GDP will on average lower the current account by 0.14 percentage points of GDP, which in turn implies a relatively substantial Ricardian behavior of households in our country sample. This estimate is somewhat lower than numbers obtained from reduced form regressions in early work, e.g. Summers (1986) and Bernheim (1988). However, our estimate is in the middle of the range given by more recent results, e.g. Chinn and Prasad (2003), Chinn and Ito (2005) and Gruber and Kamin (2007), and -although

one should be very careful when linking the coefficient on the country-specific budget balance with the share of non-Ricardian consumers- it is consistent with an increasing share over time of Ricardian agents in OECD economies.

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Appendix I: Econometric Results

Table 1: Country list

Australia	Germany	New Zealand
Austria	Greece	Norway
Belgium	Iceland	Portugal
Canada	Ireland	Spain
Denmark	Italy	Sweden
Finland	Japan	UK
France	Netherlands	US

Table 2: Unit Root Tests, Levels and First Differences[1/]

	Productivity		Current account		Gov. balance		Gov. cons.	Priv. inv.
	Level	FD[1/]	Level[3/]	FD[1/]	Level[3/]	FD[1/]	Level[3/]	Level[3/]
Levin-Lin								
Coefficient	-0.174	-0.991	-0.179	-0.982	-0.349	-1.034	-0.014	-0.182
t-star	*-0.100*	*-5.316*	*1.084*	*-3.970*	*2.709*	*-1.894*	*0.304*	*-1.737*
Probability of null	0.460	0.000	0.861	0.000	0.997	0.029	0.620	0.041
Im-Pesaran-Shin								
Probability of null	0.907	0.000	0.974	0.001	0.935	0.001	0.996	0.215
Time span[2/]	1972-2003	1972-2003	1975-2003	1975-2003	1981-2003	1981-2003	1963-2003	1963-2003

All tests include one lag, a constant and a trend except for government consumption, which does not have a trend.
1/ The variables denoted FD refer to the variables in first differences used in the estimation (equations 12 and 13). Productivity is the difference between country specific and global productivity, while the current account and the government balance are first differenced real variables, adjusted for population changes.
2/ To balance the panel, the test is performed with fewer observations than the estimation.
3/ The current account, the government balance, the government consumption and private investment have been converted into US dollars.

Estimated equation (as in equations (12) and (13) in the text):

$$\mathbf{\Delta Z_t = b_1\, \Delta S^C{}_t + b_2\, \Delta S^G{}_t + b_3\, \Delta A^C{}_t + b_4\, \Delta A^G{}_t + b_5\, \Delta I_{t-1} + \ldots}$$

Where ΔZ_t is the dependent variable, i.e. either ΔCA_t or ΔI_t. When the dependent variable is the change in investment, the regression includes a linear trend, as in Glick and Rogoff (1995). All panel regressions include fixed country-specific dummy variables (the trend and the dummies are not reported).

Table 3: Regression Results, Current Account Equation

Country sample	ΔZ	b_1		b_2		b_3		b_4		b_5		R^2	# obs.
Panel A: Full Sample													
	ΔI	**0.13**	*0.03* ***	**0.47**	*0.06* ***	**0.28**	*0.03* ***	**0.44**	*0.05* ***	**-0.06**	*0.02* ***	0.35	587
	ΔCA	**0.14**	*0.04* ***	**-0.09**	*0.07*	**-0.11**	*0.04* ***	**-0.01**	*0.06*	**-0.01**	*0.01*	0.13	561
Panel B: G7 sample													
	ΔI	**0.15**	*0.05* ***	**0.30**	*0.08* ***	**0.13**	*0.03* ***	**0.19**	*0.03* ***	**-0.06**	*0.03* *	0.40	217
	ΔCA	**0.11**	*0.06* *	**-0.01**	*0.08*	**-0.14**	*0.03* ***	**-0.02**	*0.03*	**0.01**	*0.01*	0.28	207

Standard errors in italics; regressions include dummy variables for Germany and the US in 1991.
, **, * indicate significance at the 10%, 5% and 1% resp.*

Table 4: Country by Country Regression Results (G7 Economies)

Country:	ΔZ	b_1		b_2		b_3		b_4		b_5		R^2	# obs.
U.S.	ΔI	**0.62**	*0.18* ***	**0.42**	*0.17*	**0.33**	*0.10* ***	**0.43**	*0.10* ***	**-0.03**	*0.06*	0.70	37
	ΔCA	**-0.03**	*0.20*	**-0.13**	*0.19*	**-0.25**	*0.10* **	**-0.19**	*0.11* *	**-0.03**	*0.03*	0.40	37
Japan	ΔI	**0.46**	*0.10* ***	**0.92**	*0.16* ***	**0.94**	*0.09* ***	**0.88**	*0.16* ***	**0.08**	*0.05* *	0.88	30
	ΔCA	**0.10**	*0.15*	**-0.11**	*0.23*	**-0.39**	*0.14* ***	**0.07**	*0.23*	**-0.03**	*0.03*	0.28	30
Germany	ΔI	**-0.18**	*0.14*	**0.31**	*0.20*	**0.19**	*0.18*	**0.55**	*0.18* ***	**-0.29**	*0.13* **	0.50	31
	ΔCA	**0.34**	*0.18* ***	**-0.08**	*0.26*	**-0.26**	*0.23*	**-0.05**	*0.23*	**0.04**	*0.07*	0.60	31
France	ΔI	**0.21**	*0.17*	**0.11**	*0.21*	**1.03**	*0.21* ***	**0.76**	*0.18*	**-0.02**	*0.12*	0.61	30
	ΔCA	**-0.14**	*0.26*	**-0.17**	*0.30*	**-0.63**	*0.35* ***	**-0.14**	*0.35*	**-0.10**	*0.11*	0.18	27
Italy	ΔI	**-0.07**	*0.09*	**-0.14**	*0.23*	**0.25**	*0.10* **	**0.20**	*0.14*	**-0.14**	*0.12*	0.27	39
	ΔCA	**0.12**	*0.18*	**0.13**	*0.43*	**-0.59**	*0.22* **	**-0.32**	*0.34*	**-0.25**	*0.12* **	0.26	32
U.K.	ΔI	**0.29**	*0.14* **	**0.31**	*0.24*	**-0.05**	*0.13*	**0.59**	*0.21* **	**-0.07**	*0.11*	0.44	30
	ΔCA	**0.02**	*0.27*	**-0.19**	*0.43*	**0.13**	*0.23*	**-0.28**	*0.41*	**-0.01**	*0.07*	0.07	30
Canada	ΔI	**0.24**	*0.29*	**0.86**	*0.34* **	**0.24**	*0.30*	**1.07**	*0.36* ***	**0.11**	*0.18*	0.58	22
	ΔCA	**0.05**	*0.40*	**0.15**	*0.60*	**0.51**	*0.46*	**-0.42**	*0.65*	**0.12**	*0.16*	0.13	22

Standard errors in italics; regressions include dummy variables for Germany and the US in 1991.
, **, * indicate significance at the 10%, 5% and 1% resp.*

Estimated equation (as in equation (12) and (13) in the text):

$$\Delta Z_t = b_1\, \Delta S^C{}_t + b_2\, \Delta S^G{}_t + b_3\, \Delta A^C{}_t + b_4\, \Delta A^G{}_t + b_5\, \Delta I_{t-1} + \ldots$$

Where ΔZ_t is the dependent variable, i.e. either ΔCA_t or ΔI_t. When the dependent variable is the change in investment, the regression includes a linear trend, as in Glick and Rogoff (1995). All panel regressions include fixed country-specific dummy variables (the trend and the dummies are not reported).

Table 5: Robustness Tests, Excluding Potential Outliers

		b_1		b_2		b_3		b_4		b_5		R^2	# obs.
Panel A: Current Account Equations													
Baseline	ΔCA	**0.14**	*0.04* ***	**-0.09**	*0.07*	**-0.11**	*0.04* ***	**-0.01**	*0.06*	**-0.01**	*0.01*	0.13	561
Sample excluding:													
U.S.	ΔCA	**0.14**	*0.04* ***	**-0.10**	*0.08*	**-0.09**	*0.05* **	**0.09**	*0.08*	**-0.01**	*0.01*	0.11	524
Germany	ΔCA	**0.12**	*0.04* ***	**-0.10**	*0.07*	**-0.11**	*0.04* ***	**-0.01**	*0.07*	**-0.02**	*0.01*	0.08	530
Italy	ΔCA	**0.14**	*0.04* ***	**-0.09**	*0.07*	**-0.10**	*0.04* ***	**-0.00**	*0.07*	**-0.01**	*0.01*	0.13	529
Belgium	ΔCA	**0.14**	*0.04* ***	**-0.07**	*0.07*	**-0.13**	*0.04* ***	**-0.03**	*0.07*	**-0.01**	*0.01*	0.12	534
AP episodes[1]	ΔCA	**0.14**	*0.04* ***	**-0.09**	*0.07*	**-0.11**	*0.04* ***	**-0.01**	*0.07*	**-0.01**	*0.01*	0.13	533
Panel B: Investment Equations													
Baseline	ΔI	**0.13**	*0.03* ***	**0.47**	*0.06* ***	**0.28**	*0.03* ***	**0.44**	*0.05* ***	**-0.06**	*0.02* ***	0.35	587
Sample excluding:													
U.S.	ΔI	**0.11**	*0.03* ***	**0.43**	*0.06* ***	**0.28**	*0.04* ***	**0.43**	*0.06* ***	**-0.07**	*0.02* ***	0.32	550
Germany	ΔI	**0.14**	*0.03* ***	**0.48**	*0.06* ***	**0.28**	*0.03* ***	**0.44**	*0.05* ***	**-0.06**	*0.02* ***	0.35	556
Italy	ΔI	**0.14**	*0.03* ***	**0.50**	*0.06* ***	**0.29**	*0.04* ***	**0.47**	*0.07* ***	**-0.06**	*0.02* ***	0.36	548
Belgium	ΔI	**0.13**	*0.03* ***	**0.48**	*0.06* ***	**0.27**	*0.03* ***	**0.45**	*0.05* ***	**-0.06**	*0.02* ***	0.35	557
AP episodes[1]	ΔI	**0.12**	*0.03* ***	**0.47**	*0.06* ***	**0.27**	*0.03* ***	**0.44**	*0.05* ***	**-0.07**	*0.02* ***	0.36	559

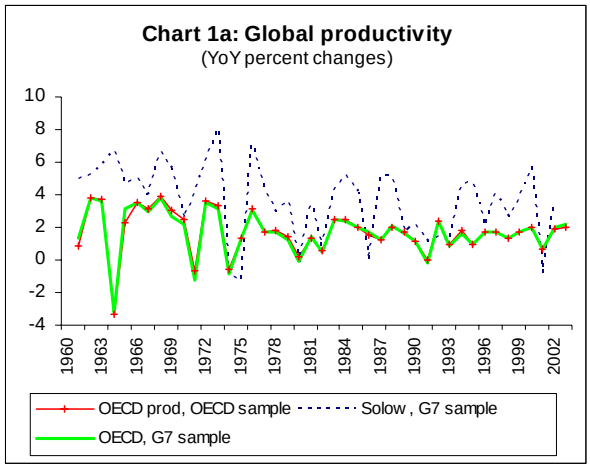
1/ Consolidation times as in Alesina and Perotti (1996): Denmark, 1983-86, Ireland 1987-89, Belgium, 1984-87, Canada, 1986-88, Italy 1989-92, Portugal 1984-86, Sweden 1983-89.
Standard errors in italics; regressions include dummy variables for Germany and the US in 1991.
, **, * indicate significance at the 10%, 5% and 1% resp.*

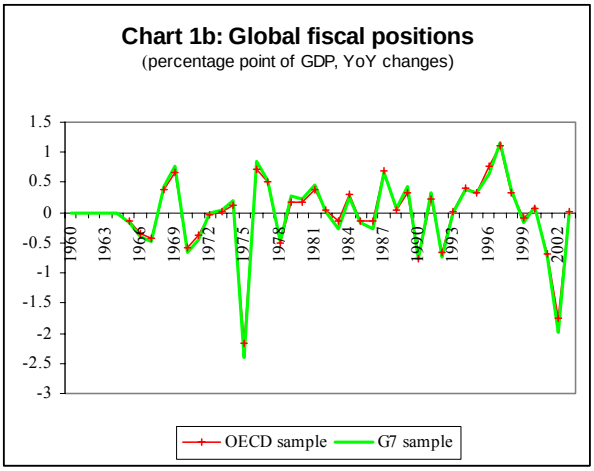
Table 6: Robustness Tests, Post Bretton Woods period and alternative productivity proxy

Country sample	ΔZ	b_1		b_2		b_3		b_4		b_5		R^2	# obs.
Panel A: Post Bretton Woods period													
	ΔI	**0.09**	*0.03* ***	**0.41**	*0.07* ***	**0.31**	*0.07* ***	**0.07**	*0.03* **	**-0.09**	*0.02* ***	0.27	530
	ΔCA	**0.14**	*0.04* ***	**-0.10**	*0.08*	**-0.11**	*0.05* **	**0.03**	*0.08*	**-0.02**	*0.01*	0.13	530
Panel B: Alternative productivity proxy (principal component)													
	ΔI	**0.10**	*0.03* ***	**0.40**	*0.06* ***	**0.29**	*0.07* ***	**0.07**	*0.02* ***	**-0.10**	*0.02* ***	0.29	573
	ΔCA	**0.15**	*0.04* ***	**-0.10**	*0.07*	**-0.09**	*0.06* *	**0.01**	*0.02*	**-0.01**	*0.01*	0.12	555

Standard errors in italics; regressions include dummy variables for Germany and the US in 1991.
, **, * indicate significance at the 10%, 5% and 1% resp.*

Appendix II: Charts





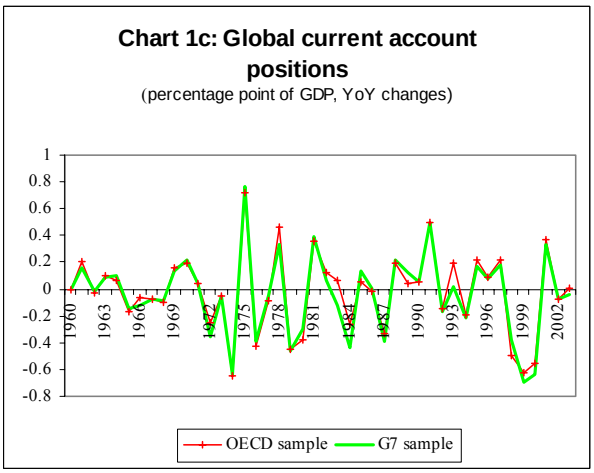
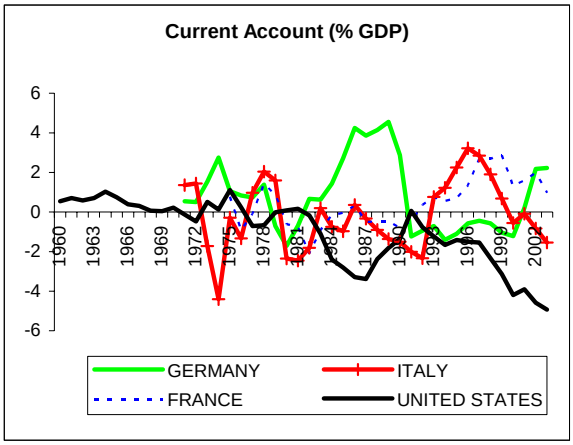
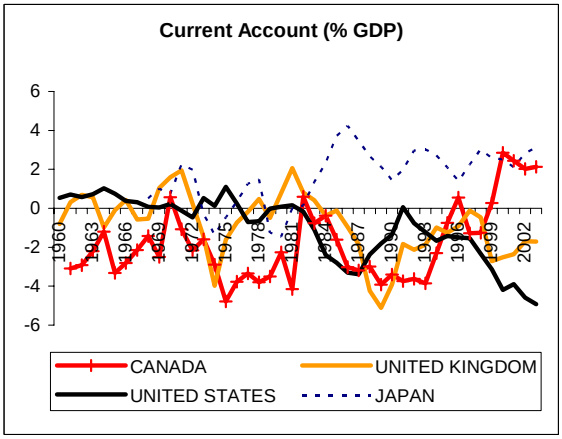
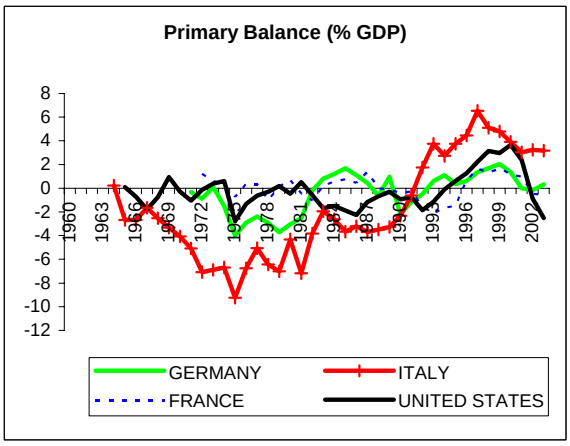
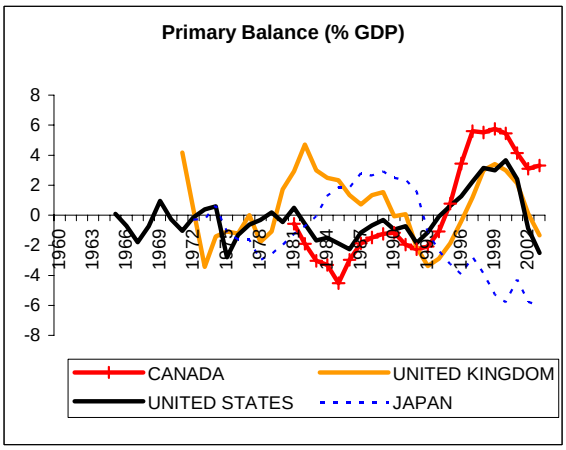


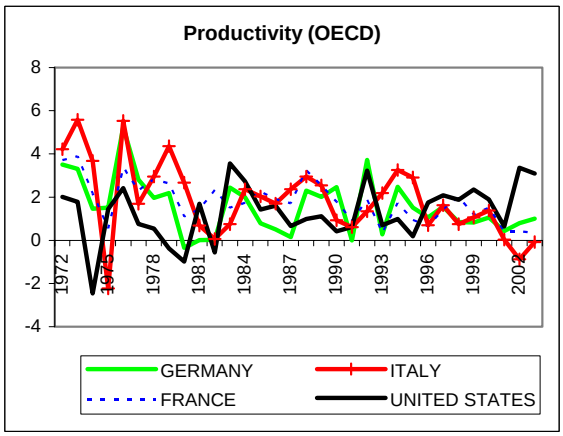
Chart 2: Selected Variables, G7 economies











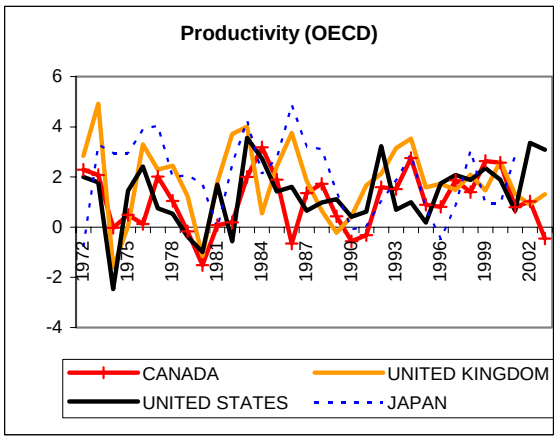
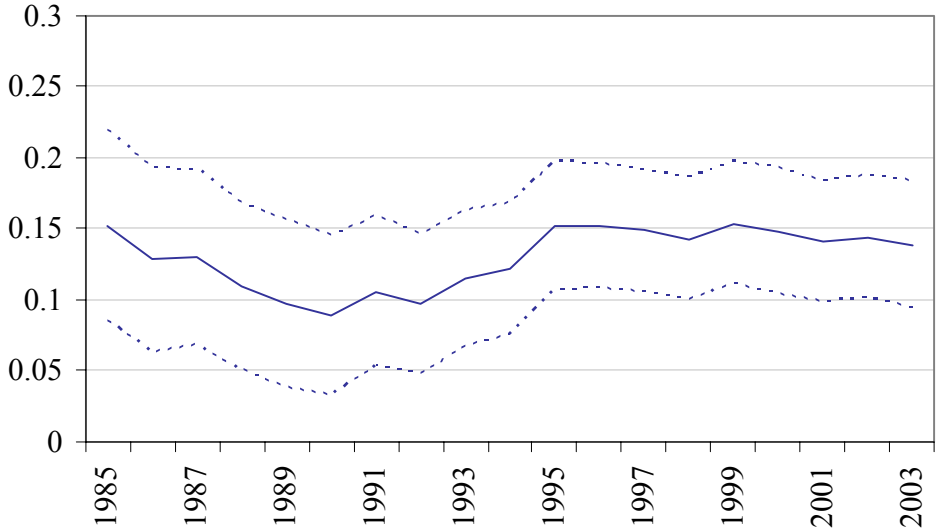


Chart 3: Coefficient of the Fiscal Variable and Confidence Interval

(rolling window, 20 year interval; ending year on the X axis)