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In 2005 all ECB publications will feature a motif taken from the €50 banknote.



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**Abstract**

Currently the U.S. is experiencing record budget and current account deficits, a phenomenon familiar from the "Twin Deficits" discussion of the 1980s. In contrast, during the 1990s productivity growth has been identified as the primary cause of the US current account deficit. We suggest a theoretical framework which allows to evaluate empirically the relative importance of budget deficits and productivity shocks for the determination of the current account. Using a sample of 21 OECD countries and time series data from 1960 to 2003 we find little evidence for a contemporaneous effect of budget deficits on the current account, while country-specific productivity shocks appear to play a key role.

JEL: E62, F32, F41.
Key Words: Current account, productivity, investment, budget deficit.

# Non-technical summary

The joint developments of the current account and of the budget deficit in the U.S. over the past 30 years do not appear to provide a coherent picture. Specifically, three episodes stand out. First, in the mid 1980s, both the current account and the budget deficit reached record highs. From an accounting perspective it makes sense to speak of "Twin Deficits", since a reduction in public saving, i.e., an increase in the budget deficit, should *ceteris paribus* lead to a reduction of net savings of the economy, i.e., the current account. Second, by contrast, the 1990s provide a counterexample for the Twin Deficit relationship. In particular towards the end of this decade, current account and budget balance were moving in opposite directions. By now, an alternative interpretation of these developments has been put forward, stressing the importance of the (anticipated) productivity gains in the U.S. since the mid-1990s, which triggered both huge capital inflows and high consumption expenditure and investment, both reflected in the sizeable trade deficit – see, e.g., Mann (2002). Finally, the past three years have witnessed a strong deterioration in the U.S. fiscal position together with a continuous reduction in the current account position and new record levels of both deficits have brought the Twin Deficit relationship back on the agenda.

In sum, at different times different factors - country specific productivity shock and budget deficit - appeared to be a major determinant of the U.S. current account deficit. Assessing the relative importance of these two determinants of the U. S. current account is of course of key importance for policy purposes. However, the issue also bears a more general interest and concerns a broader set of countries. First, evaluating the importance of the Twin Deficits relationship provides indirect evidence of the Ricardian Equivalence proposition in an international context – see in particular Kim and Roubini (2003) for a recent discussion. Second, productivity shocks have been identified since the work of Glick and Rogoff (1995) as one of the key driving forces behind current account movements: in their framework, country specific productivity shocks negatively affect the current account balance, while global productivity shocks do not have any significant impact. A key question, raised by Marquez (2002), is whether the distinction between country specific and global shocks is still relevant after the IT revolution of the 1990s.

In order to evaluate more systematically the relative importance of both factors, the present paper develops a comprehensive theoretical framework that incorporates both productivity and budget deficits as potential determinants of current account positions and tests it empirically using a panel of 21 OECD countries and annual data ranging from 1960 to 2003. To our knowledge, this has not been done yet and is our intended contribution to the literature. While the developments in the 1980s had triggered several efforts to establish evidence in favor or against the Twin Deficit hypothesis, the work of Glick and Rogoff (1995) suggested a rigorous framework to test for the role of productivity in the joint determination of investment and the current account. Within their framework, however, there is no role for budget deficits since the financing of government spending is irrelevant due to Ricardian equivalence holding completely. In order to relax this assumption, we proceed as suggested by Mankiw (2000), i.e., we assume that a fraction of the 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 how such a non-Ricardian feature within the framework of Glick and Rogoff leads naturally to a modification of the reduced form of the model that is brought to the data. Specifically, the *primary budget deficit* is shown to impact the current account deficit in addition to the country specific productivity innovations. The extent of this effect depends on the weight of the spenders in the population. While being simple, this framework is well suited to evaluate the issue at hand in a straightforward and yet rigorous way.

We bring this model to the data using both country specific and panel regressions, and consider different specifications and subsamples. We find a prominent role for productivity in the determination of the current account. In contrast there is little evidence for a Twin Deficit relationship, our estimates being generally smaller than 10 percent and almost always insignificant. From a policy perspective, such estimates imply that a reduction in the U. S. budget deficit may not suffice to significantly decrease its sizeable current account deficit. However, one needs to underline that our estimates correspond to an average over a long time horizon: the response of the current account to a reduction in the budget deficit could be higher due to specific factors (in particular, due to the composition of the fiscal adjustment). Finally, our results can also be interpreted as an additional validation of the Glick and Rogoff proposition, with a sample extended along the T dimension to 2003 and along the N dimension to 14 additional OECD countries.

# 1 Introduction

The joint developments of the current account and of the budget deficit in the U.S. over the past 30 years do not appear to provide a coherent picture. Specifically, three episodes stand out. First, in the mid 1980s, both the current account and the budget deficit reached record highs. From an accounting perspective it makes sense to speak of "Twin Deficits", since a reduction in public saving, i.e., an increase in the budget deficit, should *ceteris paribus* lead to a reduction of net savings of the economy, i.e., the current account. Second, by contrast, the 1990s provide a counterexample for the Twin Deficit relationship. In particular towards the end of this decade, current account and budget balance were moving in opposite directions. By now, an alternative interpretation of these developments has been put forward, stressing the importance of the (anticipated) productivity gains in the U.S. since the mid-1990s, which triggered both huge capital inflows and high consumption expenditure and investment, both reflected in the sizeable trade deficit – see, e.g., Mann (2002). Finally, the past three years have witnessed a strong deterioration in the U.S. fiscal position together with a continuous reduction in the current account position and new record levels of both deficits have brought the Twin Deficit relationship back on the agenda.

In sum, at different times different factors - country specific productivity shock and budget deficit - appeared to be a major determinant of the U.S. current account deficit. Assessing the relative importance of these two determinants of the U. S. current account is of course of key importance for policy purposes. However, the issue also bears a more general interest and concerns a broader set of countries. First, evaluating the importance of the Twin Deficits relationship provides indirect evidence of the Ricardian Equivalence proposition in an international context – see in particular Kim and Roubini (2003) for a recent discussion. Second, productivity shocks have been identified since the work of Glick and Rogoff (1995) as one of the key driving forces behind current account movements: in their framework, country specific productivity shocks negatively affect the current account balance, while global productivity shocks do not have any significant impact. A key question, raised by Marquez (2002), is whether the distinction between country specific and global shocks is still relevant after the IT revolution of the 1990s.

In order to evaluate more systematically the relative importance of both factors, the present paper develops a comprehensive theoretical framework that incorporates both productivity and budget deficits as potential determinants of current account positions and tests it empirically using a panel of 21 OECD countries and annual data ranging from 1960 to 2003. To our knowledge, this has not been done yet and is our intended contribution to the literature.[1] While the developments in the 1980s

[1] A related exercise is Kollman (1998), where the role of fiscal policy and productivity shocks in explaining US trade balance dynamics is examined using a calibrated two-country Real Business Cycle model. Yet, his paper focused on the period 1975-1991 for the US only, thus missing the productivity boom of the 1990s altogether.

had triggered several efforts to establish evidence in favor or against the Twin Deficit hypothesis, the work of Glick and Rogoff (1995) suggested a rigorous framework to test for the role of productivity in the joint determination of investment and the current account. Within their framework, however, there is no role for budget deficits since the financing of government spending is irrelevant due to Ricardian equivalence holding completely. In order to relax this assumption, we proceed as suggested by Mankiw (2000), i.e., we assume that a fraction of the 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 how such a non-Ricardian feature within the framework of Glick and Rogoff leads naturally to a modification of the reduced form of the model that is brought to the data. Specifically, the *primary budget deficit* is shown to impact the current account deficit in addition to the country specific productivity innovations. The extent of this effect depends on the weight of the spenders in the population. While being simple, this framework is well suited to evaluate the issue at hand in a straightforward and yet rigorous way. We bring this model to the data using both country specific and panel regressions, and consider different specifications and subsamples. We find a prominent role for productivity in the determination of the current account. In contrast there is little evidence for a Twin Deficit relationship, our estimates being generally smaller than 10 percent and almost always insignificant. Our results can also be interpreted as an additional validation of the Glick and Rogoff proposition,[2] with a sample extended along the T dimension to 2003 and along the N dimension to 14 additional OECD countries.

The rest of the paper is organized as follows. The next section briefly reviews the main results in the literature regarding a possible Twin Deficit relationship and alternative explanations focusing on productivity developments. Section 3 outlines our model, which integrates the work of Glick and Rogoff with Mankiw's suggestion and discusses issues related to the estimation of the model. Section 4 reports the results, while section 5 concludes.

# 2 Two Tales of Current Account Deficits

In the following we discuss briefly two strands of the current account literature. First, we report some findings of the literature focusing on the budget deficit as a major cause of current account deficits (Twin Deficits). Second, we summarize some of the explanations focusing on productivity as an important factor in the determination of the current account. Both approaches share an intertemporal perspective on the current account, which is regarded in both cases as net savings of the economy.

[2] Marquez (2004) already confirmed the validity of the Glick and Rogoff results for the G7 countries, extending the sample period to 1998, and subject to data corrections.

Regarding the Twin Deficit approach,[3] Summers (1986) and Bernheim (1988) provide prominent examples. Bernheim argues that if world capital markets are integrated and Ricardian equivalence does not hold, an increase in the budget deficit will almost certainly contribute to the current account deficit. A regression of the current account on the budget deficit (both scaled with GDP), while controlling for business cycle effects using growth and lagged growth gives a coefficient of 0.3 on the budget deficit in the case of the U.S. and similar figures for Canada, U.K. and Germany. Similarly, Miller and Russek (1989) argue within an accounting framework and refer to non-Ricardian behavior to motivate a regression of cyclically adjusted trade deficits on cyclically adjusted budget deficits. They find a coefficient close to one, which is, however, put into perspective by a cointegration analysis which does not establish evidence in favor of a long-run equilibrium relationship between the Twin Deficits.

Roubini (1988) uses a different theoretical framework. Based on an intertemporal model with distortionary taxation, Roubini shows that tax smoothing implies a one-to-one relationship between the current account and the fiscal deficit. The underlying mechanism is that a constant tax rate induces the budget deficit to move one-to-one with public spending and therefore with the current account. By and large Roubini finds the hypothesized relationship in the data. However, Dewald and Ulan (1990) repeat these regressions with more carefully constructed data (budget balance and current account balance defined as changes in a net-asset position valued at market prices and adjusted for inflation) and find that the Twin Deficit relation is not robust vis-à-vis these corrections in the data. The coefficient on the budget deficit is found to be insignificant.

An alternative theoretical framework is suggested by Evans (1990). He derives a relationship between the current account and the budget deficit in a model where consumers have finite horizons, thus inducing a probability that the tax incidence may not fall within the life-span of current consumers. Yet, Evans provides evidence against this model and in favor of the infinite horizon specification. Specifically, he does not find a significant effect of the budget deficit on the current account. In a more recent contribution, Piersanti (2000) uses a very similar theoretical framework but a different empirical specification. He reports evidence in favor of Twin Deficits, with an implied long-run coefficient on the budget deficit of 0.15 for the G7 sample.

[3]Note that our focus is on the budget deficit. Within the baseline intertemporal model of the current account *temporary* changes in *public spending* should affect the current account. In a seminal study Ahmed (1986) investigates the impact of temporary and permant changes in government spending in UK during the 20th century. Ahmed finds that temporary changes in government spending reduces trade balance, while permanent do not. Glick and Rogoff (1995) distinguish between permanent and temporary changes in government spending by assuming that government spending follows an IMA(0,1,1) process. Eventually, the temporary component does not enter significantly in the current account regression. Glick and Rogoff argue that this finding might result from the difficulty of extracting the temporary component of government spending shocks. Marquez (2004) also includes government spending (not distinguishing between permanent and temporary), but does not report the estimates.

A different approach is adopted in Enders and Lee (1990): within a VAR-framework estimated for the US, (reduced form) innovations in government debt are found to be accompanied by a deteriorating net export position; however, they conclude that "rigorous testing of the model (...) does not allow (them) to reject the independence of the record federal government budget and current account deficits". In a different context, Normandin (1999) studies the causal relationship between the Twin Deficits using an overlapping generations model and focusing on the effect of the persistence of the budget deficit. Testing the implications of the model using quarterly data for Canada and the US over the period 1970-1993, he concludes that the Twin Deficits were statistically positively related in the case of Canada but not for the US. Using a large panel of developed and developing countries over a time span covering the period 1971-1995, Chinn and Prasad (2003) arrive at different estimates depending on the specification and the panel composition, but these estimates are generally low, between 0.08 and 0.4. More recently, Kim and Roubini (2003) use a structural VAR framework and find evidence in favor of what they call "Twin Divergence", i.e., an identified shock to the budget deficit (a rise in the deficit) increases the current account balance.

Finally, it should be noted that also numerical simulations of dynamic general equilibrium models have been used to analyze the twin deficit relationship. Baxter (1995) considers an increase in government spending and finds that it depresses the current account to GDP ratio. This holds both for temporary and permanent spending shocks, because of endogenous labor supply. Baxter further assumes that government spending is financed through debt. This assumption induces a positive correlation between the fiscal deficit and the current account deficit even though Ricardian equivalence obtains. A decrease in distortionary taxation is considered as well: Baxter finds that it depresses the current account if it is very persistent because in this case the stimulus to investment dominates the increase in labor supply. More recently, Erceg, Guerrieri and Gust (2005) analyze fiscal policy in a model where 50 percent of the households are hand-to-mouth consumers (ie, they consume disposable income in each period). They find that a partially debt financed increase in goverment spending reduces the trade balance by slightly less than 0.2 percentage points after 2-3 years.

To sum up, while there is some evidence in favor of a Twin Deficit relationship it should be noted that contradicting results have been brought forward. The relatively high dispersion of the results is not in itself surprising given that these studies used different sample periods, different specifications and focused on different countries. Yet, in any case, they suggest that the Twin Deficit relationship is either not robust or not stable through time, and in most cases below 0.3 (see also a summary of the results in Table 1).

Regarding the second approach, the seminal work by Glick and Rogoff (1995) aiming at testing the intertemporal model shifted the focus on productivity shocks in an attempt to understand current account developments. They emphasize that while global productivity innovations stimulate investment, they should not affect the current account, since they have a simultaneous impact on all countries. The distinction between country-specific and global productivity shocks is supposed to play a key role in accounting for the low (in absolute value) correlation of investment and the current account. Overall, the intertemporal model is shown to perform well if confronted with the data. However, 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, which is not confirmed by the data.

Mann's (2002) discussion of the current account developments in the U.S. also resorts to the productivity hypothesis. In particular, she states that when in the late 1990s the budget deficit and the current account moved into different directions, "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 " triggered investment and induced a current account deficit. In the above mentioned paper by Kollman (1998), productivity shocks appear to be "the main source of fluctuations in net exports" for the US during the period 1975-1991, and seem to have contributed to the sharp drop in US net exports in the first half of the 1980s.

# 3 Theoretical Framework

In this section we outline 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 budget deficit. The aggregate supply part of the model, i.e., production and investment decisions, follows Glick and Rogoff (1995).

Aggregate demand, on the other hand, is specified following the savers-spenders suggestion by Mankiw (2000). 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, David Lopez-Salido and Valles (2003).

## 3.1 Current Account

As in Glick and Rogoff (1995) 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. For an empirical implementation of the model it is convenient to consider the first difference of (1),

$$\Delta CA_t = rCA_{t-1} + \Delta Y_t - \Delta I_t - \Delta G_t - \Delta C_t, \tag{2}$$

and to substitute for the first differences on the right hand side using the solution to the optimization problems of the agents in the model as outlined in the following.

## 3.2 Output and Investment

Per capita output is determined by 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 country-specific total factor productivity $A_t^c$

$$Y_t = \alpha_I I_t + \alpha_K K_t + \alpha_A A_t^c, \tag{3}$$

where $\alpha_I < 0$ due to costs of adjustment, and both $\alpha_K$ 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

$$I_t = \beta_1 I_{t-1} + \eta_1 \sum_{s=1}^{\infty} \eta_2^s \left( E_t A_{t+s}^c - E_{t-1} A_{t+s-1}^c \right), \tag{4}$$

where $0 < \beta_1, \eta_2 < 1$ 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, (4) simplifies to

$$I_t = \beta_1 I_{t-1} + \beta_2 \Delta A_t^c, \tag{5}$$

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 country-specific productivity

$$\Delta I_t = (\beta_1 - 1) I_{t-1} + \beta_2 \Delta A_t^c. \tag{6}$$

Substituting (6) into the first difference of the linearized production function (3) gives

$$\Delta Y_t = \left[\alpha_I \left(\beta_1 - 1\right) + \alpha_K\right] I_{t-1} + \left(\alpha_I \beta_2 + \alpha_A\right) \Delta A_t^c, \tag{7}$$

thus relating the change in output to lagged investment and innovations to country-specific total factor productivity.

## 3.3 Private and Public Consumption

Regarding aggregate demand, we assume that the economy is populated by two types of agents. As outlined above, 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 consumption $C_t$ is given by the weighted average of non-Ricardian consumption $C_t^{NR}$ and Ricardian consumption $C_t^R$, with weights $\lambda$ and $1 - \lambda$, respectively,

$$C_t = \lambda C_t^{NR} + (1 - \lambda) C_t^R. \tag{8}$$

### 3.3.1 Spenders

In each period non-Ricardian consumption equals disposable per capita income, i.e. output $Y_t$ less investment $I_t$ and taxes $T_t$,

$$C_t^{NR} = Y_t - I_t - T_t. \tag{9}$$

### 3.3.2 Savers

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

$$Max\ E_t \sum_{s=t}^{\infty} \beta^{s-t} u(C_s^R), \tag{10}$$

$$\text{s.t. } B_{s+1}^R = (1 + r) B_s^R + Y_s - T_s - I_s - C_s^R, \tag{11}$$

i.e., Ricardian agents maximize the expected infinite sum of utility discounted by $\beta$. $B_t^R$ represents the net financial assets held by a representative Ricardian agent at the end of period $t - 1$. Iterating (11) and imposing a "no-Ponzi game" condition yields the intertemporal budget constraint,

$$E_t \sum_{s=t}^{\infty} \frac{C_s^R}{(1 + r)^{s-t}} = (1 + r) B_t^R + E_t \sum_{s=t}^{\infty} \frac{Y_s - T_s - I_s}{(1 + r)^{s-t}}. \tag{12}$$

An optimal allocation of consumption requires the following Euler equation to hold in every period $s \geq t$,

$$u'(C_s^R) = (1 + r) \beta E_t \quad u'(C_{s+1}^R) \} . \tag{13}$$

Under the assumption that the intratemporal utility function $u$ is quadratic in $C_s^R$ and that the subjective discount factor $\beta$ equals the (world) market discount factor $1/(1+r)$, condition (13) simplifies to $E_t C_{s+1}^R = C_s^R$. This allows to substitute for expected consumption in (12) and to obtain the consumption function of Ricardian agents,

$$C_t^R = rB_t^R + \frac{r}{1+r} E_t \sum_{s=t}^{\infty} \frac{Y_s - T_s - I_s}{(1+r)^{s-t}}. \tag{14}$$

#### 3.3.3 Government

Finally, we consider a government, which spends resources $G_t$ in a purely dissipative way. In each period the government faces the flow budget constraint

$$B_{t+1}^G = (1+r)B_t^G + T_t - G_t, \tag{15}$$

where $B_t^G$ denotes government net assets in per capita terms. Iterating (15) and imposing a "no-Ponzi game" condition gives the intertemporal government budget constraint:

$$E_t \sum_{s=t}^{\infty} \frac{G_s}{(1+r)^{s-t}} = (1+r)B_t^G + E_t \sum_{s=t}^{\infty} \frac{T_s}{(1+r)^{s-t}}, \tag{16}$$

For future reference, it is also convenient to define the surplus, $S_t$, as the change in the net asset position of the government, and the primary surplus, $S_t'$, as the surplus less interest income,

$$S_t' \equiv B_{t+1}^G - (1+r)B_t^G = T_t - G_t. \tag{17}$$

In the following we assume that the primary surplus can be characterized as an exogenous and stationary process. Note finally, that net per capita assets $B_t$ are given by

$$B_t = (1-\lambda)B_t^R + B_t^G.$$

#### 3.3.4 Aggregate Consumption Changes

An expression for aggregate consumption is obtained by substituting for $C_t^{NR}$ and $C_t^R$ in (8) using (9) and (14) and substituting for future expected taxes using the intertemporal government budget constraint (16),

$$C_t = \lambda\left(Y_t - T_t - I_t - rB_t^G\right) + rB_t + \frac{(1-\lambda)r}{1+r} E_t \sum_{s=t}^{\infty} \frac{Y_s - G_s - I_s}{(1+r)^{s-t}}. \tag{18}$$

Note that substituting for consumption in (2) and using the definition of the surplus gives

$$\Delta B_t = \lambda S_{t-1} + (1-\lambda)\left(Y_{t-1} - I_{t-1} - G_{t-1}\right) - \frac{(1-\lambda)r}{1+r} E_{t-1} \sum_{s=t-1}^{\infty} \frac{Y_s - G_s - I_s}{(1+r)^{s-(t-1)}}.$$

Now taking first differences of (18) and substituting for $\Delta B_t$ gives the change in aggregate consumption as a function of the change in disposable income and news about the permanent income,

$$\Delta C_t = \lambda \left(\Delta Y_t - \Delta T_t - \Delta I_t\right) + \frac{(1-\lambda)r}{1+r} \sum_{s=t}^{\infty} \frac{\left(E_t - E_{t-1}\right)\left(Y_s - G_s - I_s\right)}{(1+r)^{s-t}}. \qquad (19)$$

## 3.4 Estimation Equations

We are now in a position to rewrite (2), substituting for the change in investment, output and consumption using (19) and (17),

$$\begin{aligned} \Delta CA_t = {} & rCA_{t-1} + \lambda \Delta S'_t + (1-\lambda)\left(\Delta Y_t - \Delta I_t - \Delta G_t\right) \\ & - \frac{(1-\lambda)r}{1+r} \sum_{s=t}^{\infty} \frac{\left(E_t - E_{t-1}\right)\left(Y_s - G_s - I_s\right)}{(1+r)^{s-t}}. \end{aligned} \qquad (20)$$

### 3.4.1 Properties of Exogenous Variables

Equation (20) still contains the change in the expected net present value of future resources, i.e., news about permanent income. Under the assumption that both government spending and productivity follow a random walk, these news can be related to shocks as shown in the appendix of Glick and Rogoff (1995). Specifically, the random walk assumption together with the production function (5) and optimal investment behavior (4) imply the following relationship

$$\sum_{s=t}^{\infty} \frac{\left(E_t - E_{t-1}\right)\left(Y_s - G_s - I_s\right)}{(1+r)^{s-t}} = \frac{1+r}{r}\left[\left(\frac{r\left(\alpha_I - 1\right) + \alpha_K}{1+r-\beta_1}\beta_2 + \alpha_A\right)\Delta A_t^c - \Delta G_t\right]. \qquad (21)$$

So far, we have treated productivity as country specific. However, as discussed by Glick and Rogoff, it seems sensible to assume that innovations in productivity are composed of a country and a global component. Global innovations in productivity should not impact the current account, since all countries respond in the same way (under the assumption that initial net foreign assets are zero). With respect to its effect on investment both components have a positive effect, while the effect of global innovations is supposed to be smaller, because it affects also world interest rates (a channel not considered explicitly here). Imposing these assumptions and substituting for output (7) and investment change (6) as well as for the news (21) in (20) gives

$$\Delta CA_t = rCA_{t-1} + \lambda \Delta S'_t + \gamma_1 I_{t-1} + \gamma_2 \Delta A_t^c + \gamma'_2 \Delta A_t^g, \qquad (22)$$

where

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

and

$$
\begin{gathered}
\Delta I_t = (\beta_1 - 1) I_{t-1} + \beta_2 \Delta A_t^c + \beta_3' \Delta A_t^g, \qquad (23)\\
\beta_2 > \beta_3 > 0 \qquad \text{and} \qquad 0 < \beta_1 < 1
\end{gathered}
$$

Thus we derived two equations which can be brought to the data. Apart from the coefficient on the change in the primary surplus, the reduced form coefficients are functions of the deep parameters of the model. We aim not at recovering the latter, but try to evaluate the model using the sign restrictions implied by the reduced form coefficients.

Note that while in the framework of Glick and Rogoff (with $\lambda = 0$) it is required that $|\gamma_2| > \beta_2$, i.e., the absolute value of the response of the current account to country-specific productivity innovations should be larger than the investment response (if productivity changes are expected to be permanent under the random walk assumption), the current framework weakens this implication. Whether $|\gamma_2| > \beta_2$ eventually depends on $\lambda$, specifically on whether[4]

$$
(1-\lambda)(1-\alpha_I) > 1.
$$

### 3.4.2 Error Specification

For the estimation, we follow Glick and Rogoff and introduce the error terms $\mu_{I,t}, \mu_{Y,t}, \mu_{R,t}$ and $\mu_{NR,t}$to the investment (5), output (3) and consumption (14), (9) equation, respectively. The error terms in equations (6) and (7) for $\Delta I$ and $\Delta Y$ become $\mu_{I,t}$ and $\alpha_I \mu_{I,t} + \Delta\mu_{Y,t}$, respectively. Defining $\mu_{C,t} \equiv (1-\lambda)\mu_{NR,t} + \lambda\mu_{R,t}$, the error term in equation (22) is given by

$$
\varepsilon_t \equiv \frac{(\alpha_I - 1)(1-\beta_1) + \lambda(\alpha_I - 1) r + (1-\lambda)\alpha_K}{1 + r - \beta_1}\mu_{I,t} + \Delta\mu_{Y,t} - \frac{r(1-\lambda)}{1+r}\mu_{Y,t} - \Delta\mu_{C,t}.
$$

The explicit specification of the error term allows to address the issue of endogeneity in the estimation equations (22) and (23). It follows immediately that $CA_{t-1}$ is endogenous in (22), i.e.,

$$
E(CA_{t-1}\varepsilon_t) = E\left[(rB_{t-1} + Y_{t-1} - I_{t-1} - C_{t-1})\varepsilon_t\right] \neq 0.
$$

[4] Here we used a condition implied by the optimality of the firms investment decision, 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.

Therefore, we follow Glick and Rogoff and define $CA_t^* \equiv \Delta CA_t - rCA_{t-1}$, which will be used as the dependent variable in the regressions below. $I_{t-1}$ can be treated as predetermined both in (22) and (23). While being exogenous in the model, in the data the change in the primary surplus $\Delta S_t'$ is likely to be correlated with $\varepsilon_t$, since notably tax revenues may be affected by cyclical movements in output, i.e., $E\left(\Delta S_t' \Delta \mu_{Y,t}\right) \neq 0$. Therefore, we use a *cyclically adjusted* primary surplus in the estimation below.

# 4 Empirical Results

## 4.1 Data

We use annual data from the OECD Economic Outlook database up to the year 2003. All data, which were originally in billions of national currency, are converted in USD using the bilateral dollar exchange rate (EXCH)[5]. Since the model is formulated in real per capita terms we scale all the 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). Alternatively, for means of comparability, we also construct Solow residuals for the G7 economies following Glick and Rogoff. First, for each country, Solow residuals are formed using the shares of labor in manufacturing output. The data used are from BLS, 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. Second, a global productivity measure $A_t^w$ is constructed using a GDP weighted average, where the weights are given by the average nominal GDP (in USD) in the total G7 GDP over the sample period 1960-2002.[6] Third, the country specific component of total factor productivity $A_t^c$ is obtained as the deviation from the global average.

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 most important variables are plotted on Chart 2.

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

[6] The wieghts were as follows: U.S. 0.48, U.K. 0.07, Italy 0.06, Germany 0.10, France 0.08, Canada 0.04, Japan 0.16.

## 4.2 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 $A_t^c$ and real per capita government spending $G_t$ 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 equation (22) are all stationary, except for real private investment, for which the two panel tests yield conflicting results.

## 4.3 Baseline Specification

We now turn to the estimation of the current account and the investment equations (respectively, equation (22) and (23) p.9),[7] using a panel of 21 OECD economies (see complete country list in Appendix II). However, for comparability with Glick and Rogoff (1995) we also report results using a smaller panel of G7 countries, as well as country specific times series regressions for these seven large economies. Overall, the panel regressions yield much more tightly estimated coefficients due to the higher number of observations: the country equations are estimated with 31 to 42 observations, against 207 for the G7 sample and 561 for the OECD sample. However, as panel regressions come at the cost of imposing slope homogeneity across countries, the country equations provide a useful check of the results. In the panel estimations, the global productivity variable corresponds to 7 or 21 countries, whether we use the G7 or the OECD sample. Yet the productivity averages using these two sample compositions are strikingly similar (Chart 1), since the weight of the G7 countries in the broader sample is close to 90%.

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 heteroscedasticity 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

[7]Note that our dependent variable is $CA_t^* \equiv \Delta CA_t - rCA_{t-1}$, for the reasons indicated above.

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.

The estimation results for the current account equation are presented in Table 3 (panel results) and 4 (country equations). In Table 3, the first two columns report the results using the OECD measure of productivity (for the G7 sample and for the full OECD sample). The OECD measure is our preferred source because it is available for many countries; yet, to check the robustness of our results, we also ran the same regressions using a Solow residual computed from BLS sources (results are reported in the third column of Table 3). The country specific productivity measure enters negatively and significantly at the 1% level in all three cases (coefficient $\gamma_2$ in equation (22)), whereas the coefficient of the global productivity variable (coefficient $\gamma_2'$ in equation (22)) is either insignificant or – in the case of the Solow residual – significant but lower in absolute value, as suggested by the model. The coefficient of the country specific productivity reported in the last column, which is most directly comparable with Glick and Rogoff (1995), is almost identical (at 0.15) to their point estimate (equal to 0.16). As the productivity variable is multiplied by average GDP, this coefficient can be interpreted the following way: a 1% increase in country specific productivity would trigger a decrease in the current account balance by 15% basis points of *average* GDP. This first set of results broadly confirms the findings of Glick and Rogoff (1995) and shows that they are robust to the introduction of an additional regressor and to the extension of the sample in both T and N directions: compared to their sample, which spanned the years 1960-1990, our sample goes up to 2003 and therefore includes both the productivity boom of the second half of the 1990s and the subsequent fall in productivity. In addition, the results are robust to extending the country composition to 14 other OECD countries (comparing the first two columns of Table 3 gives the same qualitative results). However, one must also underline that different data sources (using the OECD productivity or the Solow residual) yield different coefficients, particularly for the global productivity. This may result from the fact that the Solow residual is much more volatile than the OECD measure of productivity (Chart 1). Note that lagged investment does not enter with the expected sign ($\gamma_1$). However the coefficient is not significant and close to zero (as in Glick and Rogoff, 1995).

The second important set of results that emerges from Table 3 is that the impact of the budget balance on the current account is remarkably low. For the G7 countries, the budget balance does not enter the regression significantly and with the full OECD sample, its coefficient is equal to 0.07.[8] For the G7 economies, the country by country regression results are reported in Table 4 and largely confirm the panel

[8] The fact that the coefficient of the budget balance is much larger in the OECD sample than in the G7 sample seems to be mostly driven by small European countries. For instance, country by country regressions reveal that this coefficient is almost equal to 0.5 in the case of Finland.

results of Table 3.[9] The country specific productivity measure enters the regression significantly in most countries, while the global productivity measure does not. The only exception is the US, for which the coefficient of the global productivity measure is negative and significant at the 10% level. One likely explanation is that the weight of the United States in the global mean is very high (around 40%), implying that for this country, the country specific and the global series are not very different. Another important insight from Table 4 is that the coefficient of the budget balance is significant for none of the G7 economies, highlighting the strong disconnect between the budget and the current account balances.

Turning to the investment equation, results are very similar to those of Glick and Rogoff: in the panel estimation (Table 5), both the country specific productivity and the global productivity measures are significant with a positive sign, while this is also the case for most of the individual equations of the G7 countries (Table 6). Interestingly, the comparison of the two equations does not lead to the puzzle identified by Glick and Rogoff. In their results, the coefficient of the country specific productivity is twice as high in the investment equation as in the current account equation. This is a puzzle because one might expect the opposite, considering the fact that a (permanent) rise in productivity should not only increase investment, but also consumption (if the share of non-Ricardian households is low) and therefore decrease the current account balance by a larger amount. In our results, by contrast, the coefficient of this variable in the current account and in the investment equations is roughly equal for the G7 countries, while it is indeed larger for the full OECD sample.

## 4.4 Robustness Tests and Further Results

As the distinction between country specific and global productivity shocks plays a prominent role in the model, we also tested the robustness of the results to the use of an alternative method to extract the global component from the country time series. To obtain alternative country-specific and global productivity measures, we therefore use principal component analysis as a different aggregation method. More specifically, the first step entails calculating principal components from all country-specific productivity measures. The intuition behind this analysis is that each principal component captures the share of the movements that all country-specific measures have in common. A specific characteristic is that all of the principal components are orthogonal to one another. However, it turns out that the first principal component explains on average about 95% of the variations of the country-specific productivity measure – both for the OECD as well as the Solow measures of productivity. We therefore use this single principal component as our alternative proxy for global productivity. We then obtain the alternative country-specific productivity measures by extracting them from the principal component.

[9] These results were computed using the OECD productivity measure but they were by and large similar when the Solow residual was used.

The results shown in Table 7 confirm the robustness of our benchmark results. The point estimate of our alternative country-specific productivity measure ($\gamma_2$) is negative and statistically significant. By contrast, the coefficient of the global productivity measure ($\gamma_2'$) is not statistically significant. Both of these results are in line with those of our benchmark model. Note, however, that the size of the coefficients cannot directly be compared to the benchmark model due to the normalization of the principal components.

We also tested the robustness of the panel results by removing from the list of countries those that may not fulfill all the hypotheses of the theoretical model. For instance, we use in the model the small country assumption, which is questionable for countries like the United States, Germany or Japan. However, removing these countries does not significantly affect the results (Table 8, column 1-3). Another concern 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 our panel results were sensitive to removing countries with a high debt to GDP ratio (Table 8, column 4-5) and the observations corresponding to strong fiscal consolidations as identified in Alesina and Perotti (1996) (Table 8, column 6). The results of these tests show that our findings are not affected by these particular cases.

Last, as the above results are all based on the cyclically adjusted fiscal balance, we also provide results for the non-cyclically adjusted fiscal balance (Table 9). As explained in Kim and Roubini (2003), the non-cyclically adjusted balance should be even less strongly correlated with the current account than the cyclically adjusted one due to the effect of business cycle fluctuations. Usually, the current account is generally found to be *counter*-cyclical: for instance, during a boom, investment rises strongly, which has a negative effect on the current account, as already noted in Backus, Kehoe and Kydland (1992), whereas the unadjusted fiscal balance is *pro*-cyclical. The results show indeed that the point estimate of the unadjusted fiscal balance is lower than when the cyclically adjusted balance is used. However, the coefficient is not significant at any usual confidence level, so it is not possible, on the basis of this result, to speak of "Twin Divergence".

# 5 Conclusion

In this paper, we have developed a comprehensive and tractable framework to analyze the role of the government budget balance and of productivity shocks in the determination of the current account. This framework yields a parsimonious reduced form equation where changes in the real current account are defined as a function of global and country specific shocks, changes in the government (primary, cyclically adjusted) budget balance and lagged investment. Taking the model to the data using 21 OECD countries, we find that the effect of the budget balance on the current account is very small (less than 10%), whereas the impact of productivity shocks is comparatively much larger. These findings are consistent with a number of stylised facts, in particular the decoupling experience of the U. S. in the 1990s. From a policy perspective, these results suggest that a reduction of the U. S. government deficit may not suffice to lower its sizeable current account deficit. However, one needs to underline that our estimates correspond to an average over a long time horizon: the response of the current account to a reduction in the budget deficit could be higher due to specific factors (in particular, due to the composition of the fiscal adjustment). In addition, the results can also be interpreted as a validation of the Glick and Rogoff proposition, with a sample extended along the T dimension to 2003 and along the N dimension to 14 additional OECD countries.

Many open questions remain. We believe that the fact that we do not detect any robust link between government deficits and current account developments, but find a seminal role for productivity, is an important result that puts into perspective the current experience of several OECD economies with Twin Deficits. Our results imply that either there is no causal relationship through which government deficits are an important driving force behind current account developments, or alternatively, at least that this relationship is not sufficiently stable across countries and over time. Understanding better the precise nature of this relationship, and possibly its variability over time, is an issue we leave for future research. In particular, a natural extension of the model is to better distinguish between adjustments in the budget deficit that come from a change in government spending or in taxes.

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# Appendix I: Econometric Results

**Table 1: A Synthetic Summary of the Literature, Effect of a 1% Increase in the Budget Balance on the Current Account**

| Paper (see References) | Sample and Methodology[1] | Result |
|---|---|---|
| **Empirical Contributions** | | |
| Summers, 1986 | US, 1950-1985, single equations | 0.25 |
| Bernheim, 1988 | US, UK, Canada, Germany, single equations | 0.33 for the US |
| Roubini, 1988 | 18 OECD countries, 1961-85, single equations | 0.14 (Canada) to 0.60 (US) |
| Dewald and Ulan, 1990 | Same as Roubini 1988 for the US | 0 |
| Miller and Russek, 1989 | US, Q data, 1971-87, OLS and cointegration | 1 or 0 depending on methodology |
| Enders and Lee, 1990 | US, Q data 1947-87, VAR | 0 |
| Evans, 1990 | G7, Q and annual data, 1973-1988 and other time samples | 0 |
| Normandin, 1994 | US and Canada, Q data 1970-1993 | • Between 0 and 1 for Canada<br>• 0 for the US |
| Chinn and Prasad, 2000 | 18 industrial countries, 1971-1995, Panel regressions | 0.34, 0.13, 0.14, and 0.08 depending on specification |
| Piersanti, 2000 | 17 OECD countries, 1970-1997, GMM | • 0.16 for average of G7 countries<br>• 0.25 for the US |
| Kim and Roubini, 2003 | US, Q data, 1973-2002, VAR | <0 |
| Kennedy and Slok, 2005 | 13 OECD countries, 1982-2003, panel regressions | 0.08 to 0.33 |
| **Theoretical Contributions with Simulations** | | |
| Baxter, 1995 | RBC | 0.5 |
| Kollman, 1998 | RBC | 0 |
| Erceg, Guerrieri and Gust, 2005 | DSGE | 0.2 |

1/ Annual data except where indicated (Q for quarterly data).

**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 | 1963-2001 | 1963-2001 |

*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 used in the estimation (equation 23). 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.*

**Table 3: Regression Results, Current Account Equation**

| Source: | OECD | | | | Solow | |
|---|---|---|---|---|---|---|
| Sample: | G7 | | OECD | | G7 | |
| Primary Balance (t) | 0.01 | | 0.07 | * | 0.05 | |
| | *0.05* | | *0.04* | | *0.05* | |
| Investment (t-1) | -0.02 | | -0.02 | | -0.01 | |
| | *0.02* | | *0.01* | | *0.02* | |
| Productivity: | | | | | | |
| Country Specific (t) | -0.27 | *** | -0.14 | *** | -0.15 | *** |
| | *0.06* | | *0.04* | | *0.03* | |
| Global (t) | -0.11 | | -0.12 | | -0.09 | ** |
| | *0.08* | | *0.07* | | *0.03* | |
| Obs | 209 | | 561 | | 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: Regression Results, Current Account Equation (Country by Country)**

| | CN | | FR | | DE | | IT | | JP | | UK | | US | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Primary Balance (t) | 0.08 | | -0.14 | | 0.23 | | 0.12 | | 0.06 | | -0.04 | | -0.08 | |
| | *0.29* | | *0.20* | | *0.16* | | *0.17* | | *0.14* | | *0.20* | | *0.08* | |
| Investment (t-1) | 0.12 | | -0.10 | | 0.04 | | -0.25 | ** | -0.03 | | -0.01 | | -0.03 | |
| | *0.14* | | *0.11* | | *0.07* | | *0.12* | | *0.03* | | *0.07* | | *0.02* | |
| Productivity: | | | | | | | | | | | | | | |
| Country Specific (t) | 0.49 | | -0.63 | * | -0.30 | | -0.58 | *** | -0.40 | *** | 0.09 | | -0.26 | *** |
| | *0.41* | | *0.33* | | *0.22* | | *0.20* | | *0.14* | | *0.22* | | *0.10* | |
| Global (t) | -0.37 | | -0.16 | | -0.02 | | -0.31 | | 0.07 | | -0.32 | | -0.18 | * |
| | *0.57* | | *0.33* | | *0.23* | | *0.33* | | *0.21* | | *0.34* | | *0.10* | |
| Obs | 42 | | 38 | | 31 | | 43 | | 42 | | 39 | | 42 | |

*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 5: Regression Results, Investment Equation**

| Source: | OECD | | | | Solow | |
|---|---|---|---|---|---|---|
| Sample: | G7 | | OECD | | G7 | |
| Investment (t-1) | -0.08 | *** | -0.09 | *** | -0.06 | *** |
| | *0.02* | | *0.01* | | *0.02* | |
| Productivity: | | | | | | |
| Country Specific (t) | 0.22 | *** | 0.25 | *** | 0.12 | *** |
| | *0.03* | | *0.02* | | *0.02* | |
| Global (t) | 0.28 | *** | 0.30 | *** | 0.19 | *** |
| | *0.04* | | *0.03* | | *0.02* | |
| Obs | 833 | | 833 | | 287 | |

*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: Regression Results, Investment Equation (Country by Country)**

| | CN | | FR | | DE | | IT | | JP | | UK | | US | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Investment (t-1) | -0.24 | * | -0.03 | | -0.29 | | -0.13 | | 0.00 | | -0.06 | | -0.14 | * |
| | *0.12* | | *0.07* | | *0.14* | | *0.10* | | *0.07* | | *0.09* | | *0.08* | |
| Productivity: | | | | | | | | | | | | | | |
| Country Specific (t) | -0.01 | | 0.76 | *** | 0.27 | | 0.25 | *** | 0.45 | *** | 0.06 | | 0.20 | ** |
| | *0.15* | | *0.13* | | *0.18* | | *0.09* | | *0.09* | | *0.09* | | *0.10* | |
| Global (t) | 0.01 | | 0.65 | *** | 0.49 | *** | 0.29 | *** | 0.48 | *** | 0.11 | | 0.33 | *** |
| | *0.16* | | *0.14* | | *0.18* | | *0.10* | | *0.15* | | *0.12* | | *0.11* | |
| Obs | 22 | | 27 | | 31 | | 32 | | 30 | | 30 | | 37 | |

*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 7: Robustness Tests, Using Principal Components**

| Sample: | G7 | | | |
|---|---|---|---|---|
| Source: | OECD | | Solow | |
| Primary Balance (t) | 0.03 | | 0.05 | |
| | *0.06* | | *0.05* | |
| Investment (t-1) | -0.02 | | -0.01 | |
| | *0.02* | | *0.02* | |
| Productivity: | | | | |
| Country Specific (t) | -0.19 | *** | -0.13 | *** |
| | *0.06* | | *0.03* | |
| Global (t) | -0.66 | | -0.08 | |
| | *0.42* | | *0.05* | |
| Obs | 207 | | 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 8: Robustness Tests: Checking the Assumptions.**

| | Benchmark | | Benchmark Specification Excluding | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (1) | | (2) | | (3) | | (4) | | (5) | | (6) | |
| Primary Balance (t) | 0.07 | * | 0.10 | ** | 0.08 | ** | 0.06 | * | 0.07 | * | 0.07 | * | 0.08 | * |
| | *0.04* | | *0.04* | | *0.04* | | *0.04* | | *0.04* | | *0.04* | | *0.04* | |
| Investment (t-1) | -0.02 | * | -0.02 | | -0.02 | | -0.02 | | -0.02 | | -0.02 | | -0.02 | |
| | *0.01* | | *0.02* | | *0.01* | | *0.01* | | *0.01* | | *0.01* | | *0.01* | |
| Productivity: Country Specific (t) | -0.14 | *** | -0.12 | *** | -0.11 | *** | -0.13 | *** | -0.12 | *** | -0.14 | *** | -0.14 | *** |
| | *0.04* | | *0.05* | | *0.05* | | *0.05* | | *0.05* | | *0.05* | | *0.05* | |
| Global (t) | -0.12 | | -0.08 | | -0.13 | * | -0.12 | | -0.11 | | -0.13 | | -0.12 | |
| | *0.07* | | *0.09* | | *0.08* | | *0.08* | | *0.08* | | *0.08* | | *0.07* | |
| Obs | 561 | | 524 | | 531 | | 530 | | 529 | | 534 | | 533 | |

*(1) US, (2) Japan, (3) Germany, (4) Italy, (5) Belgium.*
*(6) 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 9: Additional Robustness Tests, Current Account Equation (cyclically adjusted v. non-adjusted fiscal balance)**

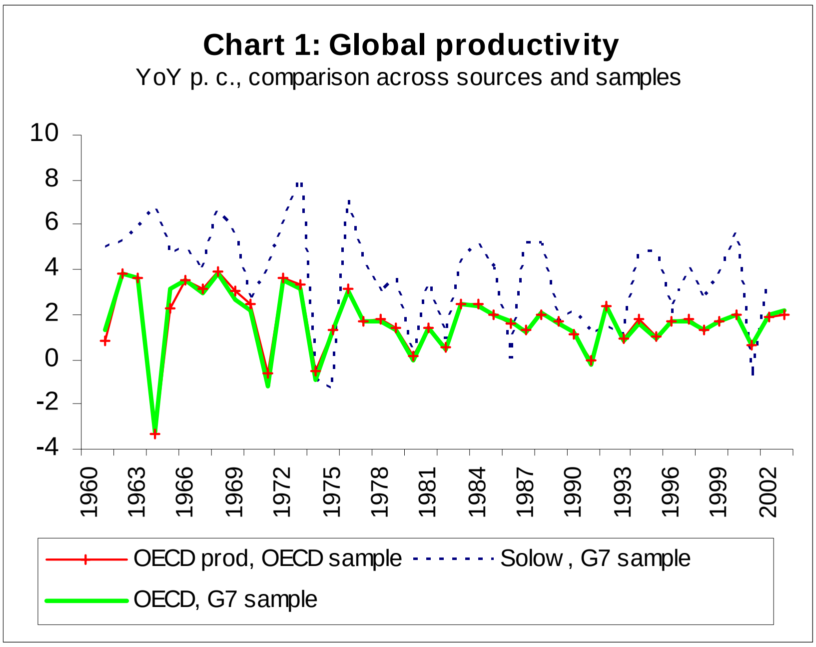
| | Benchmark (cycl. adj.) | | Alternative (non-adj.) | |
|---|---|---|---|---|
| Primary Balance (t) | 0.07 | * | -0.35 | |
| | *0.04* | | *0.31* | |
| Investment (t-1) | -0.02 | | -0.02 | |
| | *0.01* | | *0.01* | |
| Productivity: Country Specific (t) | -0.14 | *** | -0.14 | *** |
| | *0.04* | | *0.05* | |
| Global (t) | -0.12 | | -0.07 | |
| | *0.07* | | *0.07* | |
| Obs | 561 | | 561 | |

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

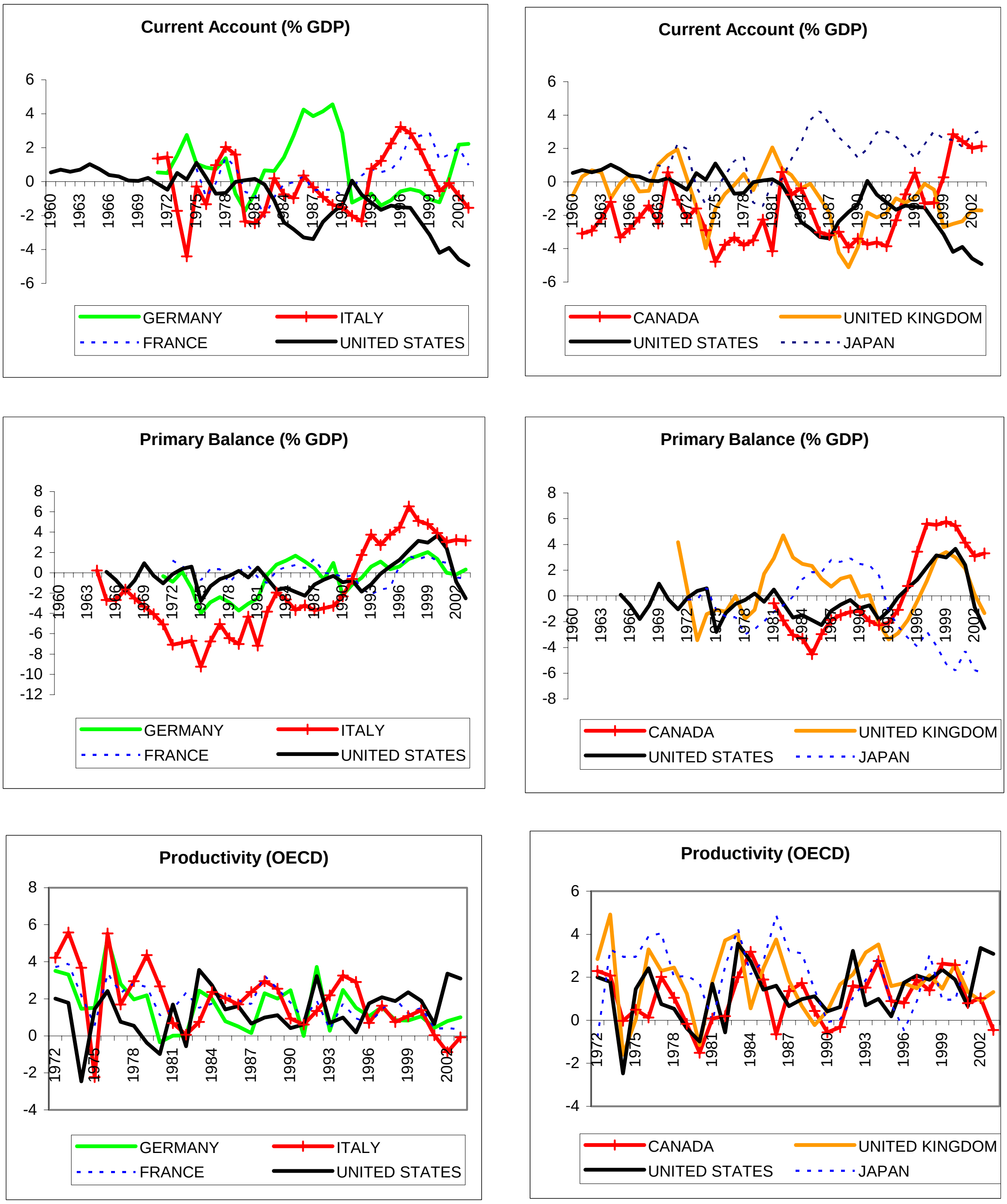
# Appendix II: Country List

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

# Appendix III: Charts



## Chart 2: Selected Variables, G7 economies



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