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# Cyclical Budgetary Policy and Economic Growth: What Do We Learn from OECD Panel Data?

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## 1 Introduction

A common view among macroeconomists is that there is a decoupling between macroeconomic policy (e.g., budget deficit, taxation, money supply), which should primarily affect price and income stability[1] and long-run economic growth, which, if anything, should depend only upon structural characteristics of the economy (property right enforcement, market structure, market mobility, and so forth). That macroeconomic policy should not be a key determinant of growth is further hinted at by recent contributions such as Acemoglu et al. (2003) and Easterly (2005), who argue that the correlation between macroeconomic volatility and growth (Acemoglu et al.) or those between growth and macroeconomic variables (Easterly), become insignificant once one controls for institutions.

The question of whether macroeconomic policy does or does not affect (productivity) growth is not purely academic. In particular, it underlies the recent debate on the European Stability and Growth Pact as well as criticisms against the European Central Bank for allegedly pursuing price stability at the expense of employment and growth.

In this paper we question that view by arguing that the cyclicality of the budget deficit is significant in explaining GDP growth, with a more countercyclical budgetary policy being more growth enhancing the lower the country's level of financial development. We also identify economic factors that tend to be associated with more countercyclical policies. These results hold in a sample of OECD countries with comparable institutional environments.

The idea that cyclical macroeconomic policy might affect productivity growth is suggested by Aghion, Angeletos, Banerjee, and Manova

(2006; henceforth AABM). The argument in AABM is that credit-constrained firms have a borrowing capacity that is typically conditioned by current earnings (the factor of proportionality between earning and debt capacity is called credit multiplier, with a higher multiplier reflecting a higher degree of financial development in the economy). In a recession, current earnings are reduced, and so are firms' ability to borrow in order to maintain growth-enhancing investments (e.g., in skills, structural capital, or R&D). To the extent that higher macroeconomic volatility translates into deeper recessions, it should affect firms' incentives to engage in such investments. This prediction finds empirical support, first in cross-country panel regressions by AABM, who show, on the basis of cross-country panel regressions, that structural investments are more procyclical the lower the country's level of financial development; and second, in firm-level evidence by Berman et al. (2007). Using French firm-level panel data on R&D investments and on credit constraints, Berman et al. show that: (a) the share of R&D investment over total investment is countercyclical without credit constraints; (b) the share turns more procyclical when firms are credit constrained; (c) this effect is only observed during down-cycle phases—that is, in the presence of credit constraints, R&D investment share plummets during recessions but doesn't increase proportionally during up-cycle periods.[2]

These findings, in turn, suggest that countercyclical macroeconomic policies, with higher government investment or lower nominal interest rates during recessions, may foster productivity growth by reducing the magnitude of the output loss induced by market failures (in particular, by credit market imperfections) in a recession, which in turn should allow credit-constrained firms to preserve their growth-enhancing investments over the business cycle. For example, the government may decide to stimulate the demand for private firms' products by increasing spending. This could further increase firms' liquidity holdings and thus make it easier for them to face idiosyncratic liquidity shocks without having to sacrifice R&D or other types of longer-term growth-enhancing investments. On the other hand, in a recession, more workers face unemployment, so their earnings are reduced. Government spending could help them overcome credit constraints either directly (social programs, etc.) or indirectly, by fostering labor demand and therefore employment; this relaxation of credit constraints, in turn, would allow workers to make growth-enhancing investments in human capital, relocation, and so on. The tighter the credit constraints faced by firms and workers, the more growth enhancing such countercyclical policies should be.[3]

Our contribution in this paper is three fold. First, we compute and analyze the cyclicality of the budget deficit on a panel of OECD countries—that is, how the budget deficit responds to fluctuations in the output gap over time. Second, we investigate some potential determinants of the countercyclicality of the budget deficit. Third, we use these yearly panel data to assess the relationship between growth and the countercyclicality of budgetary policies at various levels of financial development. Our main findings can be summarized as follows: (a) the budget deficit has become increasingly countercyclical in most OECD countries over the past twenty years, but this trend has been significantly less pronounced in the EMU; (b) within countries, a more countercyclical budgetary policy is positively associated with a higher level of financial development, a lower level of openness, and the adoption of an inflation-targeting regime; (c) a more countercyclical budgetary policy has a greater positive impact on growth when financial development is lower. While we argue that our results likely reflect the causality from budgetary policy to growth, at the very least they document statistical relationships between macroeconomic variables that are consistent with the theory and microevidence on volatility, credit constraints, and growth-enhancing investments.

While we do not know of any previous attempt at analyzing the growth effects of countercyclical budgetary policies, analyses of the determinants of the cyclicality of budgetary policies already exist in the literature. For example, Alesina and Tabellini (2005) argue that more corrupt democracies will tend to run a more procyclical fiscal policy. The hypothesis is that, in good times, voters demand that the government cut taxes or provide more public services instead of reducing debt, because they cannot observe the debt reduction and can suspect the government of appropriating the rents associated with good economic conditions. In equilibrium, this leads to a more procyclical policy as the moral hazard problem worsens, in the sense that governments are more likely to divert public resources in booms. They also show that this mechanism tends to be more powerful in explaining the variation observed in the data than in borrowing constraints alone. While Alesina and Tabellini (2005) are using a large sample of countries and explore cross-sectional variations, in this study we use panel analysis on OECD countries. This makes the use of corruption indices impractical for two reasons. First, there is almost no cross-sectional variation in corruption indices within the OECD. Second, there is even less variation of these indices across time for individual countries.

In a similar vein, Calderon, Duncan, and Schmidt-Hebbel (2004) show that emerging-market economies with more stable institutions are more able to conduct a countercyclical fiscal policy.[4] Their empirical analysis is based on the International Country Risk Guide. Although the variation in this indicator is limited across OECD countries and time, it presents somewhat more variation than corruption indices.[5]

Other papers, such as Galí and Perotti (2003) and Lane (2003) focus, as we do, on OECD countries. Galí and Perotti investigate whether fiscal policy in the EMU has become more procyclical after the Maastricht treaty. They find no evidence for such a development. They do find, however, that while there is a trend in the OECD toward a more countercyclical fiscal policy over time, the EMU is lagging behind that trend. Lane's (2003) paper comes closer to the analysis developed in the third section of our paper. Lane examines the cyclical behavior of fiscal policy within the OECD. He then uses trade openness, output volatility, output per capita, the size of the public sector, and an index for political power dispersion to examine cross-country differences in cyclicality. The reason why power dispersion may play a role is taken from Lane and Tornell (1998): when multiple political groups compete for public spending, they may become more procyclical. No group wants to let any substantial fiscal surplus subsist because they are afraid that this will not lead to debt repayment, but rather to other groups appropriating that surplus. Lane finds, in particular, evidence that GDP growth volatility, trade openness, and political divisions lead to a more procyclical spending pattern, even though the effect of political divisions is not present for all categories of spending. We contribute to this literature by using yearly panel data to analyze the cyclicality of budgetary policy and its determinants within OECD countries, and we show that the degree of financial development is an important element to explain within-country variations in such policies, while future or present EMU membership explains cross-country variations. Moreover, we show that inflation targeting is associated with a more countercyclical budgetary deficit.

Most closely related to our second-stage analysis of the effect of countercyclical budgetary policy on growth are Aghion, Angeletos, Banerjee, Manova (2005; AABM), and Aghion, Bacchetta, Ranciere, Rogoff (2006; ABRR). AABM develop a model to explain why macroeconomic volatility is more negatively correlated with productivity growth, the lower the financial development, and they test this prediction using cross-country panel data. ABRR move from a closed real to an open monetary economy and show that a fixed nominal exchange rate regime or lower real exchange rate volatility are more positively associated with productivity growth, the lower the financial development and the lower the ratio of real shocks to financial shocks.

The remaining part of the paper is organized as follows. Section 2 discusses the estimation of the countercyclicality of the budget deficit for each OECD country and each year covered by our panel data set. Section 3 uncovers some main determinants of the countercyclicality of the budget deficit. Section 4 regresses GDP per capita growth on financial development, the countercyclicality coefficients computed in section 2, the interaction between the two, and a set of controls. Finally, section 5 concludes.

## 2 The Countercyclicality of the Budget Deficit in the Cross-Country Panel

In this section we compute time-varying measures of the cyclicality of budgetary policy in our cross-country panel and compare the extent to which budgetary policy became more countercyclical over time in some countries than in others. A main finding is that budgetary policy in the United States and the United Kingdom have become significantly more countercyclical over the past twenty years, whereas it has not in the EMU area.

### *2.1 Data*

Panel data on GDP, the GDP gap (ygap), the GDP deflator, and government gross debt (ggfl) are taken from the OECD Economic Outlook annual series.[6] Our measure of budgetary policy is the first difference of debt divided by the GDP, which is the same as the budget deficit over GDP. Note that debt and other government data refer to general government. Financial development is measured by the ratio of private credit to GDP, and annual cross-country data for this measure of financial development can be drawn from the Levine database.[7] In this latter measure, private credit is all credit to private agents, and therefore includes credit to households. The "average years of education in the population over 25 years old" series is directly borrowed from the Barro-Lee dataset; this measure is only available every five years and has been linearly interpolated to obtain a yearly series. The openness variable is defined as exports and imports over GDP, and data on it come from the Penn World Tables 6.1. The population growth, government share of

**Table 4.1**
Summary Statistics

| | Obs. | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| GDP gap | 756 | 0.000 | 0.019 | –0.070 | 0.071 |
| Gross government debt/GDP | 756 | 0.548 | 0.295 | 0.046 | 1.686 |
| Budget deficit/GDP | 756 | 0.048 | 0.046 | –0.065 | 0.321 |
| Countercyclicality of budget deficit (AR[1]) | 641 | 0.511 | 0.563 | 2.686 | –0.342 |
| Countercyclicality of budget deficit (Gaussian weighted rolling window) | 756 | 0.578 | 0.752 | 3.337 | –1.112 |
| Countercyclicality of budget deficit (10-years rolling window) | 532 | 0.608 | 1.065 | 8.972 | –3.011 |
| Growth of GDP per capita | 689 | 0.025 | 0.026 | –0.092 | 0.116 |
| Private credit/GDP | 585 | 0.801 | 0.392 | 0.128 | 2.240 |
| Average years of schooling for the population over 25 years old | 585 | 8.236 | 1.989 | 2.510 | 12.250 |
| Openness | 605 | 53.633 | 35.641 | 8.705 | 266.883 |
| Inflation | 756 | 0.061 | 0.066 | –0.025 | 0.762 |
| Population growth | 689 | 0.006 | 0.005 | –0.018 | 0.047 |
| Government share of GDP (in %) | 605 | 12.440 | 5.709 | 3.008 | 27.848 |
| Investment/GDP (in %) | 605 | 24.106 | 4.983 | 12.867 | 41.635 |
| Inflation-targeting dummy | 756 | 0.112 | 0.316 | 0 | 1 |

*Note:* Sample restricted to observations where the Countercyclicality of budget deficit computed using Gaussian weighted rolling windows is not missing.
*Sources: OECD Economic Outlook,* Levine dataset, Barro Lee dataset, and Penn World Tables 6.1.

GDP, and investment share of GDP also come from the Penn World Tables 6.1. The inflation targeting dummy is defined using the dates when countries adopted inflation targeting, as summarized in Vega and Winkelried (2005). All nominal variables are deflated using the GDP deflator. Summary statistics can be found in table 4.1. The sample is an unbalanced panel including the following countries: Australia, Austria, Belgium, Canada, Denmark, Spain, Finland, France, United Kingdom, Germany,[8] Iceland, Italy, Japan, Netherlands, Norway, New Zealand, Portugal, Sweden, and the United States.

## 2.2 *Public Deficit and Growth: The Empirical Challenge*

We are interested in evaluating the impact of the cyclicality of the budget deficit on the growth of GDP per capita, and how this effect may depend on the degree of financial development. Our expectation is that a

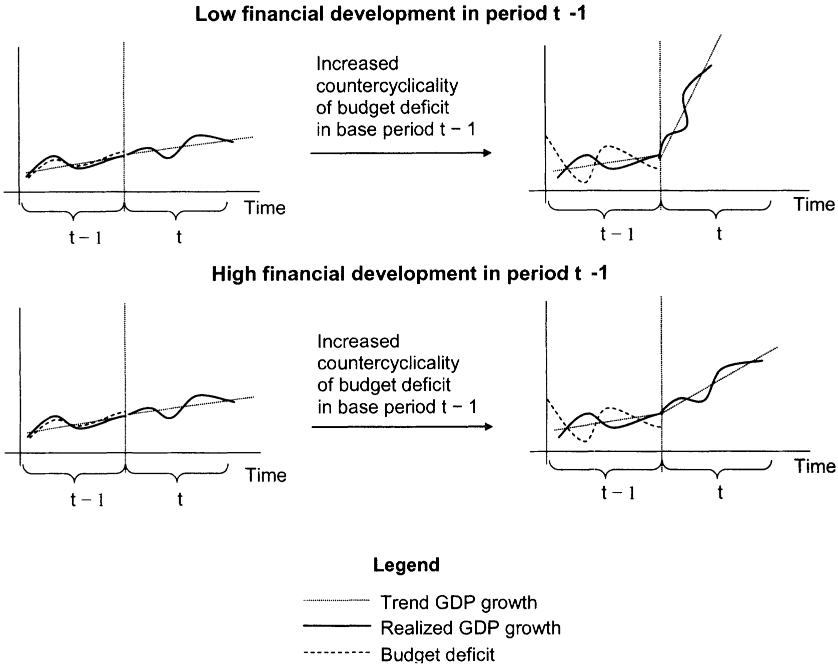


**Figure 4.1**
The Impact of an Increase in the Countercyclicality of the Budget Deficit on Growth

more countercyclical budget deficit is more likely to enhance growth when financial development is lower. Empirically, we wish to identify this effect from time variation of budgetary policy within countries. Figure 4.1 illustrates this idea for a hypothetical case: we distinguish between the situation where, in the base period $t - 1$, financial development is low (upper panels), and the situation where financial development is high (lower panels). We start with a baseline depicted in the left-hand side panels of figure 4.1: the budget deficit is thus initially assumed to be procyclical. The right-hand side panels of figure 4.1 illustrate the growth response in period 2 after an increase in the countercyclicality of the budget deficit in period 1, such that the budget deficit becomes strongly countercyclical. If financial development is low, then trend growth in period 2 increases substantially (upper left panel in figure 4.1). If, on the other hand, financial development is high, then trend growth increases by a smaller amount (lower left panel of figure 4.1).[9]

Looking at figure 4.1, the most obvious method one can think of to compute cyclicality is to regress the public deficit on the GDP growth using ordinary least squares (OLS) on the observations in period $t$. In practice, it seems more reasonable to regress the public deficit on the GDP gap (defined as $[GDP - GDP^*]/GDP^*$, where $GDP^*$ is the trend GDP) rather than the GDP growth. Indeed, the GDP gap is very much like a detrended measure of the GDP growth, and a forward-looking government's budgetary policy should respond to shortfalls from trend rather than to GDP growth per se (for a theory of why fiscal policy should depend on the GDP gap, see Barro [1979]).

This type of regression-based approach to measure the cyclicality of fiscal policies is now common in the literature and can be found, for example, in Lane (2003) and Alesina and Tabellini (2005). However, the methods used in these papers give rise to only one (or a few) observation of cyclicality per country. Since we want to investigate the impact of time variation in cyclicality, we need to compute, for each country, time-varying measures for the countercyclicality of budget deficit. Specifically, as we wish to use a yearly panel of countries, we need a measure of countercyclicality that varies yearly. This means that period $t - 1$ and period $t$ in figure 4.1 are reduced to one single year each! A regression is not defined for a single observation, so we must use observations from a few years in order to compute countercyclicality. The next subsection discusses what methods can be used to compute countercyclicality.

## 2.3 *Econometric Methods to Compute Countercyclicality*

Generally, one would like estimate the following equation for each country $i$:

$$\frac{b_{it} - b_{i,t-1}}{y_{it}} = a_{1it} y_{gap,it} + a_{2it} + \varepsilon_{it}, \text{ where } \varepsilon_{it} \sim N(0, \sigma_\varepsilon^2), \tag{1}$$

where $a_{1it}$ measures the countercyclicality of budgetary policy. Note that there is a minus sign in front of $y_{gap,it}$: when the economy is in a recession and the GDP gap is negative, the opposite of the GDP gap is positive, and so a positive $a_{1it}$ means that the budget deficit increases when the economy is in a recession; that is, the budget deficit is countercyclical. Both $a_{1it}$ and the constant $a_{2it}$[10] are time-varying, which is why we write $a_{jit}$ to denote the coefficient on the variable $j$ in country $i$ at year $t$.

The variables in equation 1 are defined as follows:

- $b_{it}$: Gross government debt in country $i$ at year $t$
- $y_{it}$: The GDP in country $i$ and year $t$, in value

- $y_{gap,it}$: The GDP gap in country $i$ and year $t$. It is computed as $(y_{it} - y^*_{it})/y^*_{it}$, where $y^*_{it}$ is the prediction of $y_{it}$ using the Hodrick-Prescott filter. A lambda parameter of 25 was chosen, following OECD (1995). Note that the GDP gap computed by the OECD using a production function approach is also smoothed by a Hodrick-Prescott technique, so that in practice the difference between the OECD measure of the GDP gap and the measure used here is very limited: the correlation between the two variables is 77%. Our measure of the GDP gap is, as expected, positively correlated with the GDP per capita growth: the correlation is, however, not so strong, at 36%.

Note that $b_{it} - b_{i,t-1}$ is exactly equal to the opposite of the budget balance, so that our left-hand side variable is equal to the budget deficit as a share of GDP, which we will simply refer to as *budget deficit*. We now examine how the coefficients $a_{jit}$ can be estimated econometrically.

One way to implement this is to compute finite (for example, ten-years) rolling-window ordinary least squares (OLS) estimates. The ten-year rolling window OLS method simply amounts to estimating the countercyclicality of the budget deficit $(b_{it} - b_{i,t-1}/y_{it})$ at year $t$ in country $i$ by running the following regression for each country $i$, and all possible years $\tau$:

$$\frac{b_{it} - b_{i,t-1}}{y_{it}} = -a_{1it} y_{gap,i\tau} + a_{2it} + \varepsilon_{i\tau}, \text{ for } \tau \in (t-5, t+4). \tag{2}$$

That is, one uses a ten-year centered rolling window to estimate the countercyclicality of budget deficit at any date $t$. This method suffers, however, from serious shortcomings. First, by definition, we lose the first five years and the last four years of data for each country. Second, because the method involves estimating a coefficient by discarding at each time period one old observation and taking into account a new one, the coefficient can vary substantially when the new observation is very different from the one it replaces. This implies that the series may be jagged and affected by noise and transitory changes; moreover, a sudden jump in the series would not be coming from changes in the immediate neighborhood of date $t$, but from changes five years before and four years after.

To deal with the shortcomings of the ten-years rolling window method, one can use smoothing such that all observations are used for each year, but those observations closest to the reference year are given greater weight. The local Gaussian-weighted ordinary least squares method is one way of achieving this. It consists in computing the $a_{jit}$ coefficients by using all the observations available for each country $i$ and then performing one regression for each date $t$, where the observations are weighted by a Gaussian centered at date $t$.[11]

$$\frac{b_{it} - b_{i,t-1}}{y_{it}} = -a_{1it} y_{gap,i\tau} + a_{2it} + \varepsilon_{i\tau}, \tag{3}$$

where $\varepsilon_{i\tau} \sim N[0, \sigma^2/w_t(\tau)]$ and $w_t(\tau) = \frac{1}{\sigma\sqrt{2\Pi}} \exp\left[-\frac{(\tau - t)^2}{2\sigma^2}\right]$

While the local Gaussian-weighted OLS method is less noisy than the ten-years rolling window method, it suffers from a similar shortcoming when it comes to testing the idea illustrated in figure 4.1. Indeed, these two methods use observations from both the past and the future (previous years and future years) to calculate yearly countercyclicality. Ultimately, we want to look at the impact of year $t - 1$ changes in countercyclicality on year $t$ growth, but if countercyclicality is computed using some future observations, then in practice we are examining the impact of both past and (some) future countercyclicality on growth. Thus, it is hard to be certain that year $t - 1$ countercyclicality causes year $t$ growth, and reverse causality becomes a problem. One way to address this issue is to use longer lags of countercyclicality ($t - 2$ or $t - 3$ or $t - 4$, etc.), but this requires us to assume that the effects of countercyclicality on growth at year $t$ are delayed for a specific number of years.

An alternative method, which gets around this problem by making current countercyclicality depend essentially upon past observations, is to assume that coefficients follow an AR(1) process. Namely, using the notation from equation 1, for each country $i$ and for each coefficient $j$:

$$a_{jit} = a_{jt,t-1} + \varepsilon_{it}^{a_j}, \ \varepsilon_{it}^{a_j} \sim N(0, \sigma_{a_j}^2). \tag{4}$$

The main challenge in implementing this method is to estimate $\sigma_{a_j}^2$ (the variance of the coefficients) at the same time as the variance of the observation, that is, the variance $\sigma_\varepsilon^2$ in the formulation of equation 1. Once these variances are estimated, applying the Kalman filter gives the best estimates for $a_{jit}$.

The optimal estimates for these variances are extremely hard to compute. While finding analytical closed-form solutions turns out to be virtually impossible, Markov Chain Monte Carlo (MCMC) methods provide a feasible numerical approximation. We implement the method in Matlab, assuming that the variances of the coefficients and equation are the same for all countries.[12] We are thus left with three variances to estimate: two for the coefficient processes ($\sigma^2_{a_j}, j = 1, 2$) and one for the variance of the error in the equation ($\sigma^2_{\varepsilon}$). Intuitively, the MCMC method randomly explores (using a Markov chain, hence the name) a wide spectrum of possible values for the variances, and one then retains a set of values that is representative of probable values, given the data.[13] An advantage of the MCMC method over maximum likelihood type methods is that it does not get stuck in local solutions and thus properly represents uncertainty about the variances.[14] Once we obtain the estimates of these three variances, the $a_{jit}$ coefficients can be calculated using the Kalman filter.

AR(1) MCMC is to be preferred over the previous methods for two reasons. First, it reflects a reasonable assumption about policy—that is, that policy changes slowly and depends on the immediate past. Second, and most importantly, it is econometrically appealing in that it makes policy reflected in the $a_{jit}$ coefficients mainly depend on the past (because of the AR(1) specification);[15] thus, when the $a_{jit}$ coefficients are used as explanatory variables in panel regressions, it is less likely that there should be a reverse causation problem.

## 2.4 *Results*

We now use the AR(1) method as previously described to characterize the level and time path of the countercyclicality of budget deficits in the OECD countries in our sample. We also report some basic results with the ten-year rolling window and Gaussian-weighted OLS methods.

Table 4.1 summarizes the descriptive statistics of our main variables of interest. For all three measures, the budget deficit is countercyclical (positive coefficient), which is consistent with Lane's (2003) finding that the primary surplus is procyclical. It is worth noting that the three different methods used in the first stage to estimate countercyclicality give very similar results in terms of the mean: a mean of about .5 means that, on average, in our sample a 1 percentage point increase in the opposite of the GDP gap (i.e., a worse recession) leads to about .5 percentage points increase in the budget deficit as a share of the GDP. In terms of the variance of these measures, we can see that the standard error is largest for the ten-years rolling window method, as expected; it is smaller for the Gaussian method, and even smaller for the AR(1) MCMC method.

We now look at the evolution of the countercyclicality of budget deficit, as measured by the estimated coefficients $a_{1it}$ from equation 1. Figure 4.2 shows the evolution of the countercyclicality of the budget

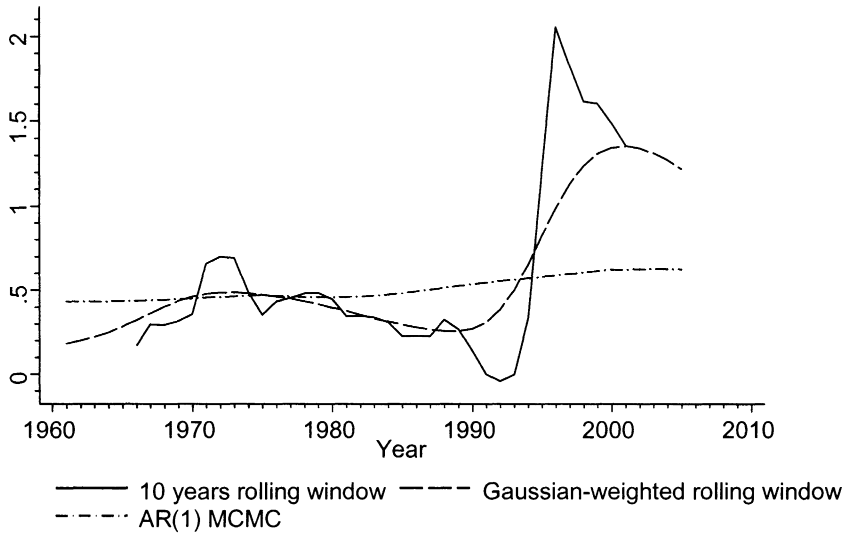


**Figure 4.2**
The Countercyclicality of the Budget Deficit in the United States
*Note:* The graph plots the $a_{1it}$ coefficients, i.e., the coefficients on the opposite of the output gap in equation 1, using various estimation techniques.
*Source: OECD Economic Outlook.*

deficit for the United States, estimated by the three methods described previously. We can readily see that, as expected, given the construction of these measures and their empirical standard errors, the ten-years rolling window yields the most volatile results, and the AR(1) method is the smoothest, with the Gaussian-weighted OLS method in between. Overall, all three methods show an increase in countercyclicality over time, with a recent trend toward decreasing countercyclicality, shown by the ten-years rolling window and Gaussian-weighted OLS methods.

In figure 4.3, we show the countercyclicality of the budget deficit estimated through the AR(1) method for a few countries in our sample. United States and United Kingdom countercyclicality tend to increase over time, especially since the 1980s. On the other hand, the average countercyclicality of budgetary policy in EMU countries slightly decreases over time. Also, one can observe some divergence between EMU and non-EMU countries: at the beginning of the period, the countercyclicality of the budget deficit in EMU countries was very similar to that in the United States: however, as of the 1990s, the United States

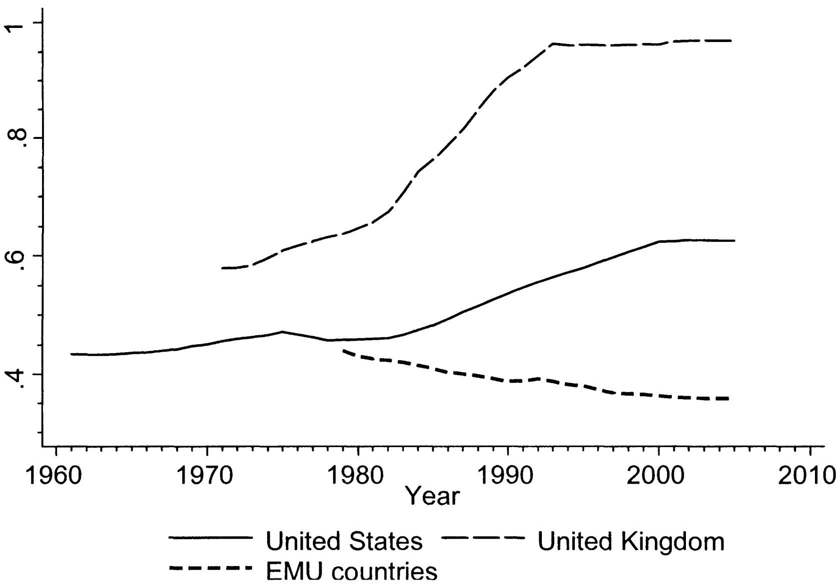


**Figure 4.3**
The Countercyclicality of Budget Deficits Using the AR(1) MCMC Method

*Note:* The graph plots the $a_{1it}$ coefficients, i.e. the coefficients on the opposite of the output gap in equation 1, using the AR(1) MCMC method. For EMU countries (i.e., countries who are or will be part of the EMU), the line represents the average of the estimated coefficients for the EMU countries present in the sample; the average is only computed for those years where all EMU countries have nonmissing observations.

*Source: OECD Economic Outlook.*

and the United Kingdom became significantly more countercyclical, whereas the European Monetary Union did not.

In figure 4.4, we plot the same evolution, this time based on coefficients that are estimated using the Gaussian-weighted OLS. Trends in estimates are very similar to those obtained using the AR(1) method.

These results are consistent with Galí and Perotti (2003), who show, splitting their sample by decades, that in general, fiscal deficits in the OECD have become more countercyclical, although less so in EMU countries. Here we confirm these results, using a full-fledged time-series measure of countercyclicality.

To summarize our descriptive results, we found that the budget deficit has become more countercyclical in the United States and the United Kingdom than in EMU countries since the 1990s. In the next section we investigate possible explanations for these observed differences

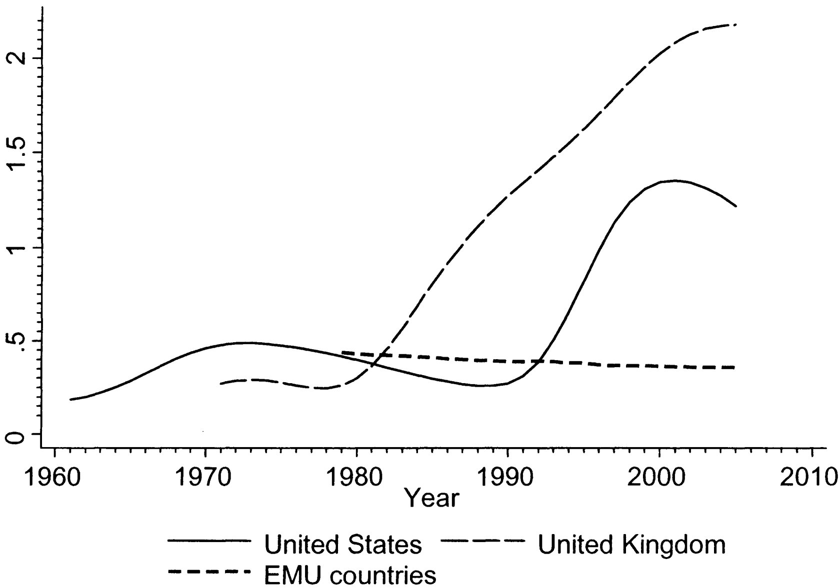


**Figure 4.4**
The Countercyclicality of Budget Deficits using the Gaussian-Weighted OLS Method
*Note:* The graph plots the $a_{1it}$ coefficients, i.e., the coefficients on the opposite of the output gap in equation 1, using the Gaussian-weighted rolling window OLS method. For EMU countries (i.e., countries who are or will be part of the EMU), the line represents the average of the estimated coefficients for the EMU countries present in the sample; the average is only computed for those years where all EMU countries have nonmissing observations.
*Source: OECD Economic Outlook.*

in the countercyclicality of budgetary deficit across countries and over time.

## 3 First Stage: Determinants of the Countercyclicality of Budgetary Policy

In this section, we use the series of cyclicality coefficients derived using the AR(1) MCMC method and regress the countercyclicality of budgetary policy over a set of macroeconomic variables. Since our sample is restricted to OECD countries, little variation should be expected from the corruption or other institutional variables considered by the literature so far.[16] Instead, we focus on the following candidate variables: financial development, openness, EMU membership,[17] and whether the country has adopted inflation targeting. We also include GDP growth volatility as measured by the standard error of GDP growth, lag of log-real GDP per capita, and the government share of GDP as control variables.

Financial development is a plausible suspect, as it influences both the ability and the willingness of governments to borrow during recessions in order to finance a budget deficit. Lower financial development should thus translate into lower countercyclicality of budget deficit. While OECD countries are arguably less subject to borrowing constraints, there is still a fair amount of cross-country variation in financial development between OECD countries. Openness is also a plausible candidate, as one can expect foreign capital to flow in during booms and flow out during recessions, implying that the cost of capital is higher during recessions rather than booms. This, in turn, tends to increase the long-run cost of financing countercyclical budget deficit policies while maintaining the overall debt constant, on average, over the long run. The EMU dummy is also a plausible candidate, given: (a) our observation in figures 4.2 and 4.3, that the budget deficit is less countercyclical in the eurozone than in the United States or the United Kingdom; (b) the deficit and debt restrictions imposed by the Stability and Growth Pact and also the restrictions that individual countries imposed on themselves in order to qualify for EMU membership.

Inflation targeting should also improve a country's willingness or ability to conduct countercyclical budgetary policy. In particular, one potential factor that might discourage governments to borrow in recessions is people's expectation that such borrowing might result in higher inflation in the future—for example, as a way for the government to partially default on its debt obligations. This, in turn, would reduce the impact of current government borrowing on private (long-term) investment. Inflation targeting increases the effectiveness of government borrowing in recession by making such expectations less reasonable.

Table 4.2, where the countercyclicality measures are derived using the AR(1) MCMC method, shows results that are consistent with these conjectures, namely: (a) while countries that are more financially developed tend to have a less countercyclical budgetary policy (column 1), as a country gets more financially developed, it exhibits a significantly more countercyclical budget deficit (column 2); using the results from column 2, our estimates imply that a 10 percentage points increase in private credit over GDP is associated with an increase of about 0.0196 in the countercyclicality of the budget deficit; in other words, it is precisely when the countercyclicality of the budget deficit is more positively correlated with growth, namely when financial development is low, that

**Table 4.2**
The Determinants of the Countercyclicality of Budget Deficits

| | (1) | (2) |
|---|---|---|
| | Year f.e. | Country year f.e. |
| Private credit/GDP | –0.453 | 0.196 |
| | (0.115)*** | (0.018)*** |
| EMU country | –0.127 | |
| | (0.038)*** | |
| Standard error of GDP growth | –3.364 | |
| | (0.818)*** | |
| Lag(log [real GDP per capita]) | 0.011 | 0.072 |
| | (0.017) | (0.071) |
| Government share of GDP (in %) | 0.000 | 0.004 |
| | (0.005) | (0.001)*** |
| Inflation targeting | 0.292 | 0.112 |
| | (0.081)*** | (0.015)*** |
| Openness | –0.007 | –0.002 |
| | (0.001)*** | (0.001)*** |
| Observations | 515 | 515 |
| *R*-squared | 0.21 | 0.99 |

*Note:* The explained variable is the coefficient on the opposite of the GDP gap in equation 1, estimated using the AR(1) MCMC method. EMU country is a dummy variable equal to 1 for all countries that are part of the EMU as of 2006.
Robust standard errors in parentheses.
*Significant at 10%
**Significant at 5%
***Significant at 1%
*Sources: OECD Economic Outlook,* Levine dataset, Barro Lee dataset, and Penn World Tables 6.1.

budgetary deficit countercyclicality seems hardest to achieve; (b) when using country- and year-fixed effects (column 2) more trade openness is positively and significantly associated with budgetary deficit countercyclicality (the table shows a positive coefficient on openness); (c) EMU countries and countries with a larger standard error of GDP growth appear to have a harder time achieving budgetary deficit countercyclicality (column 1); the EMU dummy implies that, on average, EMU countries' budgetary policy countercyclicality is lower by 0.127, which is about a fourth of a standard deviation; the effect of the EMU dummy is more likely to be explained by rigidities already imposed by the precursor EMS regime and then reinforced by the Maastricht Treaty, rather than the 1999 implementation of the EMU itself;[18] further investigation of this question is, however, beyond the scope of this paper; (d) a higher share of government in the GDP is associated with a more countercyclical budgetary policy; (e) pursuing inflation targeting is associated with a more countercyclical budget deficit. Note that the coefficient on the inflation targeting dummy in column 2 is of the same magnitude as the coefficient on the EMU dummy in column 1, but of opposite sign.

Hence, a lower level of financial development, a higher degree of openness, belonging to the EMU group, and the absence of inflation targeting are all associated with a lower degree of countercyclicality in the budget deficit. In the next section we move to a second-stage analysis of the effect of budget deficit cyclicality on growth.

## 4 Second Stage: Cyclical Budget Deficit and Growth

In this section we regress growth on the cyclicality coefficients for budgetary policy derived in section 2, financial development, the interaction between the two variables, and a set of controls. Our discussion of the theory and microeconomic evidence on volatility, credit constraints, and R&D/growth in the introduction suggests that the lower financial development, the greater the correlation should be between growth and the countercyclicality of budgetary policy: the idea is that a more countercyclical budgetary policy can help reduce the negative effect that negative liquidity shocks impose on credit-constrained firms that invest in R&D and innovation.

### 4.1 *Empirical Specification and Results*

Our empirical specification is:

$$\Delta y_{it} = \beta_1 a_{1i,t\text{-}1} + \beta_2 p_{i,t-1} + \beta_3 a_{i,t-1} p_{i,t-1} + X_{it}\beta_4 + \gamma_i + \delta_t + \varepsilon_{it}, \tag{5}$$

where $\Delta y_{it}$ is the first difference of the log of real GDP per capita in country $i$ and year $t$; $a_{1i,t-1}$ is the countercyclicality of the budget deficit as estimated by the AR(1) MCMC method. Since $a_{i,t-1}$ is an estimated coefficient, we weigh each observation by the inverse of the variance of this coefficient (aweights in Stata), thus giving higher weight to coefficients that are more precisely estimated in the first stage. The ratio of private credit, $p_{i,t-1}$ to GDP is borrowed from Levine and Demirguc-Kunt (2001); $X_{it}$ is a vector of control variables that vary with the specification considered, $\gamma_i$ is a country-fixed effect, $\delta_t$ is a year-fixed effect, and $\varepsilon_{it}$ is the error term.

In table 4.3, we first report results with a limited set of controls, representing the most widely accepted determinants of growth: lag of log real GDP per capita, population growth, and investment over GDP (column 1). We then add more controls, namely schooling, trade openness, inflation, government share of GDP, and inflation targeting (column 2). Note that since we control for inflation, we indirectly control for the impact of monetary policy on growth.

The prediction is that of a positive $\beta_1$ coefficient for the effect on growth of the countercyclicality of the budget deficit when private credit over GDP is 0, and of a negative $\beta_3$ coefficient on countercyclicality interacted with financial development. In the first column of table 4.3, using a limited set of controls, we see that the corresponding coefficients have the anticipated signs and are statistically significant: a more countercyclical budget deficit is positively correlated with growth, but the interaction term between countercyclicality and financial development is negative. Including a richer set of controls in column 2 does not change the results. If anything, the point estimates are larger: a coefficient of 0.11 of the lagged countercyclicality of budget deficit means that if private credit over GDP is 0, then increasing the countercyclicality of the budget deficit by one percentage point increases growth by 0.11 percentage points. For each percentage point increase in private credit over GDP, this positive effect of countercyclicality diminishes by 0.0004. The effect of the interaction is thus small: private credit over GDP would need to be larger than 2.75 for a countercyclical budgetary policy to become growth reducing. Such a high value of private credit over GDP is not observed in our sample: the United States in 2000, at 2.24, has the highest value of this variable in our sample.

Then, in columns 3 and 4, we repeat the same specifications as in columns 1 and 2, but allow the impact of the interaction between the countercyclicality of the budget deficit and private credit over GDP to differ by quartiles of the private credit over GDP (the first quartile is then the excluded category). For example, the dummy "2ndq (Private Credit/GDP)" is equal to 1 if the Private Credit/GDP ratio lies in the second quartile, and is equal to zero otherwise. As the results in these columns show, the interaction between cyclicality and financial development is nonlinear, with a significant jump occurring when the private credit ratio moves from the second to the third quartile. In other terms, it is only at fairly high levels of financial development that countercyclical budgetary policy becomes noticeably less growth enhancing.

Table 4.3 is thus consistent with the prediction of a positive effect of a

**Table 4.3**
The Effect of the Countercyclicality of Budget Deficits on Growth, AR(1) MCMC Method

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| lag(Countercyclicality of budget deficit) | 0.075 | 0.110 | 0.058 | 0.081 |
| | (0.021)*** | (0.024)*** | (0.016)*** | (0.018)*** |
| lag(Private credit/GDP) | −0.010 | −0.005 | −0.014 | −0.008 |
| | (0.008) | (0.008) | (0.007)** | (0.007) |
| lag(Countercyclicality of budget deficit*Private credit/GDP) | −0.030<br>(0.012)*** | −0.040<br>(0.014)*** | | |
| lag(Countercyclicality of budget deficit*2ndq[Private credit/GDP]) | | | −0.006<br>(0.003)** | −0.009<br>(0.003)*** |
| lag(Countercyclicality of budget deficit*3rdq[Private credit/GDP]) | | | −0.022<br>(0.007)*** | −0.024<br>(0.008)*** |
| lag(Countercyclicality of budget deficit*4thq[Private credit/GDP]) | | | −0.023<br>(0.008)*** | −0.030<br>(0.010)*** |
| lag(log [real GDP per capita]) | −0.140 | −0.132 | −0.142 | −0.131 |
| | (0.022)*** | (0.022)*** | (0.022)*** | (0.022)*** |
| Investment/GDP (in %) | 0.002 | 0.002 | 0.002 | 0.002 |
| | (0.000)*** | (0.000)*** | (0.000)*** | (0.000)*** |
| Population growth | −1.490 | −1.702 | −1.484 | −1.635 |
| | (0.268)*** | (0.284)*** | (0.272)*** | (0.290)*** |
| Average years of schooling for the population over 25 years old | | 0.002<br>(0.003) | | 0.003<br>(0.003) |
| Government share of GDP (in %) | | −0.001 | | −0.001 |
| | | (0.000)*** | | (0.000)** |
| Inflation | | −0.049 | | −0.053 |
| | | (0.022)** | | (0.021)** |
| Inflation targeting | | −0.004 | | −0.001 |
| | | (0.005) | | (0.005) |
| Openness | | 0.001 | | 0.001 |
| | | (0.000)** | | (0.000)*** |
| Observations | 477 | 467 | 477 | 467 |
| *R*-squared | 0.60 | 0.64 | 0.62 | 0.65 |

*Note:* The explained variable is the first difference of the log of real GDP per capita. All specifications include country and year fixed effects. Columns 3 and 4 allow for the effects of countercyclicality of the budget deficit to differ with quartiles of private credit/GDP. Robust standard errors in parentheses.
*Significant at 10%
**Significant at 5%
***Significant at 1%
*Sources: OECD Economic Outlook,* Levine dataset, Barro Lee dataset, and Penn World Tables 6.1.

countercyclical budget deficit on growth, whereas we see a negative and significant interaction effect between private credit and the countercyclicality variable. Thus, the less financially developed a country is, the more growth-enhancing it is for the government to be countercyclical in its budgetary policy. In particular, we observe that EMU countries have budgetary policies that are, on average, far less countercyclical than in the United States (0.37 vs 0.61), even though the United States is more financially developed than the EMU: thus, the ratio of private credit to GDP in 2000 in the EMU is equal to 1.02, against 2.24 in the United States. Then, to the extent that it reflects the causality from cyclical budgetary policy to growth, the regression in table 4.3 suggests that increasing the countercyclicality of the budgetary policy would be more growth enhancing for the EMU than for the United States.

### 4.2 *Robustness Tests*

This section discusses various potential issues with our table 4.3 estimates. We take as the reference specification for this discussion the specification shown in table 4.3, column 2. Therefore, when we report on alternative specifications, they are all based on this reference specification.

A potential first source of concern for our estimation strategy is autocorrelation of residuals, which is typical in panel growth regressions. This implies that the standard errors may be biased. To correct for this plea of the potential bias, we used Newey errors to adjust the standard errors in the reference specification. Allowing for autocorrelation of errors up to lag 1 increased the standard errors very slightly and left the coefficients significant at the 1% level. Allowing for autocorrelation up to 5 lags leaves the effect of the countercyclicality of the budget deficit at the same level of statistical significance, but makes the interaction between the countercyclicality of the budget deficit and private credit be only significant at the 2% instead of the 1% level. Globally, it does not seem that autocorrelation of residuals substantially affects the standard errors of our estimates.

Second, the reader may wonder about what components of the budget deficit increase growth when they are more countercyclical. For example, is it the countercyclicality of total government spending that ultimately matters for growth? What about transfers and social security spending? We have run the same analysis for these variables as for the budget deficit,[19] and found that their countercyclicality was not significant in explaining economic growth. This indicates that the cyclical behavior of automatic stabilizers is unlikely to fully account for our results: namely, it is not the case that just increasing transfers and social security spending in recessions increases economic growth. What matters for growth is not the countercyclicality of spending per se (be it discretionary or not) but rather the degree to which this spending is financed by debt—that is, the degree to which the government injects extra liquidity into the economy.

Third, the reader may be interested in knowing what happens if we replace the AR(1) MCMC estimate of countercyclicality by the Gaussian-weighted or the ten-years rolling window OLS. In the case of the Gaussian, the coefficients on the countercyclicality of the budget deficit and on its interaction with private credit have the same sign as in the reference specification and are significant at the 1% level. The only difference is that the value of the coefficient on the countercyclicality of the budget deficit is lower. In the case of the ten-years rolling window method, the coefficients of interest are of the same sign, but are not statistically significant, which is not surprising, since these estimates are much noisier.

Fourth, one may still be skeptical about the causal interpretation of our estimates. As mentioned in section 2, our AR(1) MCMC estimate of countercyclicality should, in principle, be mostly uncorrelated with the future, reducing the endogeneity problem. First, to check whether, indeed, future countercyclicality is independent of growth, we include both the lag and the lead of the countercyclicality measure in the reference specification. Doing so does not significantly change the coefficient on the lagged countercyclicality but yields an insignificant and positive coefficient on the lead of procyclicality. These results are consistent with countercyclicality causing growth, not the reverse. Second, we noticed that inflation targeting is associated with a less countercyclical budget deficit (table 4.2) but is insignificant in explaining growth (table 4.3). This raises the possibility of using inflation targeting as an instrument for countercyclicality in a GMM framework. In the GMM estimation, we instrument both the countercyclicality variable and the lagged GDP per capita. For the latter, we use the classic instruments' second and third lag of GDP per capita. Excluded instruments in our GMM regression are thus second and third lag of GDP per capita and the inflation targeting dummy. Moreover, our GMM estimates allow for Newey errors of lag 1. We have thus re-estimated the reference specification using GMM. First-stage estimates are significant, but the explanatory power of inflation targeting for countercyclicality is limited. Overidentifying restrictions are not rejected by the J test. However, we do not reject the countercyclicality and its interaction with private credit are exogenous, which means that GMM is not more appropriate than OLS. The coefficients on countercyclicality and its interaction with private credit are of similar magnitudes as in the reference specification, but they are not significant ($P$-values around 30%). This exercise thus confirms that our countercyclicality measure is unlikely to be endogenous.

Finally, one may be interested in the time horizon of our effects: when the countercyclicality of the budget deficit changes in a given year, how far in the future does the effect on growth persist? One way to answer this question is to modify the reference specification by replacing the lag of the countercyclicality of the budget deficit, private credit over GDP, and the interaction of the two by further lags. When using the second lag of these variables, the coefficients of interest ($\beta_1$ and $\beta_3$) are still significant and of the same sign, but the $R^2$ diminishes slightly. When using the third lag of these variables, the coefficient on the countercyclicality of the deficit is still significant, but the interaction with private credit is no longer significant. Using even further lags makes the coefficients of interest become insignificant. Thus, it seems that an increase in the countercyclicality of budgetary policy affects GDP growth up to two or three years later.

## 5 Conclusion

In this paper we have analyzed the dynamics and determinants of the cyclicality of budgetary policy on a yearly panel of OECD countries, and the relationship between this cyclicality, financial development, and economic growth. Our findings can be summarized as follows: first, countercyclicality of budget deficits has generally increased over time. However, in EMU countries, the budget deficit became slightly less countercyclical. Second, countercyclicality of budgetary policy appears to be facilitated by a higher level of financial development, a lower degree of openness to trade, and a monetary policy committed to inflation targeting. Third, we found that countercyclical budget deficits are more positively associated with growth the lower the country's level of financial development.

The line of research pursued in this paper bears potentially interesting growth policy implications. In particular, our second-stage regressions suggest that growth in EMU countries could be fostered if the budget deficit in the eurozone became more countercyclical. Our first-stage regression suggests that this, in turn, could be partly achieved by having the EMU area move toward inflation targeting; for example, following the UK lead in this respect, and also by improving the coordination between finance ministers in the eurozone on fiscal policy over the cycle so as to make it become more countercyclical.[20]

The analysis in this paper should be seen as one step in a broader research program. First, one could try to perform the same kind of analysis for other groups of countries; for example, middle-income countries in Latin America or in Central and Eastern Europe. Second, one could take a similar AABM-type of approach to volatility, financial development, and growth to further explore the relationship between growth and the conduct of monetary policy. For example, to what extent, allowing for higher procyclicality of short-term nominal interest rates, can firms maintain R&D investments in recessions and/or improve governments' ability to implement growth-enhancing countercyclical budgetary policies? Finally, one could investigate the possible interactions in growth regressions between countercyclical budgetary policy and structural reforms in the product and labor markets.

## Appendix

### 1 The AR(1) MCMC Method for Calculating Cyclicality in the First Stage

The aim of this section is to give a brief description of how we used the Kalman filter together with Markov Chain Monte Carlo methods (MCMC) in order to estimate the coefficients $a_{jit}$ from equation 1, under the assumption that they follow an AR(1) process as described by equation 4. The implementation was carried out in Matlab. Estimating the means and variances of the coefficients of interest—that is $a_{jit}$ in equation 4—involves two procedures: Kalman filtering and MCMC. To compute the coefficients with the Kalman filter for each country, we need to know the values of three variances:

- $\sigma^2_{a_j}$ in equation 4, for $j = 1, 2$; that is, the process variances in the terminology of the Kalman filter
- the variance $\sigma^2_\varepsilon$ of the error term $\varepsilon_t$ in equation 1; that is, the measurement error variance in the terminology of the Kalman filter.

Moreover, to use the Kalman filter, we need a prior for the first period of observation for each country—that is, a specification of our expectation over the values $a_{jit}$ at the first time step. As we do not have any meaningful prior information about cyclicality at the first observed period, we use a very high variance around the prior mean, so that this prior has a negligible effect on the estimates. Specifically, the set of initial values for the coefficients were chosen to be the OLS estimates of the coefficients using the first ten years of data for each country, and the value of the initial variance is set to be 100,000 times the estimated variance of these coefficients. However, the process variances $\sigma^2_{a_j}$ and the measurement error variance $\sigma^2_\varepsilon$ are unknown and we do not have any meaningful prior over them. We therefore need a method to find reasonable values for these three unknown variances. This is where MCMC methods are useful. One can think of MCMC as the opposite of simulating: in the case of simulation, we know the parameters of our process—for example, the variances, and every time we run a simulation program, it gives us a set of possible observed data. More specifically, the probability of getting any set of observed data is the probability defined by the model that we have and the parameters. MCMC is the opposite: we assume that we have a given dataset, and we are producing a set of possible parameters. This is done in such a fashion that the probability of accepting a parameter value is identical to the probability that this parameter value has actually produced the data. Specifically, in our implementation, we use the classic Metropolis-Hastings (MH) sampler to do MCMC (for an introduction to MCMC and Metropolis-Hastings, see for example Chib and Greenberg [1995]). In MH, one starts with arbitrary parameters values. Every iteration one proposes a random change (in our case a small Gaussian change) of the parameters. This is what is called the *proposal distribution.* Subsequently, this change is either accepted or rejected. The probability of acceptance is:

$$p_{\text{accept}} = \min\left[1, \frac{p(\text{data} \mid \text{new\_parameters})}{p(\text{data} \mid \text{previous\_parameters})}\right] \tag{1}$$

It is easy to prove that this procedure is actually sampling from the correct posterior distribution over the parameter values. MCMC algorithms go through two different stages. In the first stage, the sampler converges to a probable interpretation of the data in terms of the parameters. This stage is called *burn-in,* and took about 500 iterations in our case. Within these 500 iterations, probabilities increased dramatically and then converged to a stable high level. Afterward, the MCMC algorithm explores the space of relevant parameters. Over three runs, we took 10,000 samples per run after the end of burn-in. To avoid the autocorrelation that typically characterizes a Markov chain, we only retain samples every 100 iterations in order to compute the final estimates. From these three runs, we thus get a total of 300 essentially uncorrelated samples for each of the three parameters we wish to estimate. Convergence of the Markov chain was assessed comparing the within-chain correlation with the across-chain correlation. From these 300 samples, we can then directly estimate means and variances of the three parameters of interest. In order to correctly infer the effect of cyclicality on growth in our second-stage regressions, we need to determine not only the value of the cyclicality ($a_{1it}$), but also the uncertainty we have about it. To estimate this uncertainty—or in other words, the standard deviation of the cyclicality estimates—it is necessary to consider the relevant sources of uncertainty. Two sources are relevant in our case. One is the uncertainty that is represented by the Kalman filter that stems from the finite number of noisy observations. The other source of uncertainty is uncertainty about the three parameters that are modeled by the MCMC process. To combine them, we use the approximation $variance_{total} = variance_{MCMC} + \overline{variance_{Kalman}}$, where $\overline{variance_{Kalman}}$ denotes the average variance over the 300 Kalman filter runs using the 300 samples that we retained from the MCMC estimates of the three variances. This approximation becomes correct if the variance, as estimated by the Kalman filter, is similar over different runs of the Markov chain, which was a good approximation for our data. Finally, a full general statistical description of the methods used here can be found in Kording-Marinescu (2006).

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## Endnotes

1. For example, Lucas (1987) analyzes the welfare costs of income volatility in an economy with complete markets for individual insurance, taking the growth rate as given. Atkeson and Phelan (1994) analyze the welfare gains from countercyclical policy in an economy with incomplete insurance markets but no growth. Both find very small effects of volatility (or of countercyclical policies aimed at reducing it) on welfare.

2. As pointed out by several authors, some of these results may be biased because of an endogeneity problem that may come from the potential simultaneous determination of sales and investment. Berman, Eymard, Aghion, Askenazy, and Cette (BEAAC) check the robustness of their results by instrumenting the variation in sales by an exchange rate exposure variable, which depends on exchange rate variations and firms' export status. This variable is strongly correlated with sales variation without being affected by investment decisions. Their results are robust to this instrumentation.

3. That government intervention might increase aggregate efficiency in an economy subject to credit constraints and aggregate shocks has already been pointed out by Holmstrom and Tirole (1998). Our analysis in this section may be seen as a first attempt to explore potential empirical implications of this idea for the relationship between growth and public spending over the cycle.

4. There is also the paper by Talvi and Vegh (2000), who argue that high output volatility is most likely to generate procyclical government spending. The hypothesis is that running a budget surplus generates political pressures to spend more: the government therefore minimizes that surplus and becomes procyclical. This movement is then accentuated by a volatile output, and therefore a volatile tax base.

5. We have also used these indicators in our analysis. However, they typically have no significant effect on GDP growth over time in our sample. Moreover, as they are less widely available than our main variables of interest, their use considerably restricts the available sample, leading to less precise estimates. We have therefore decided not to use these indicators in the results reported here.

6. Codes in parentheses indicate the names of variables in the dataset. Full documentation is available at www.oecd.org. Data can be downloaded from sourceoecd.org for subscribers to that service.

7. Data downloadable from Ross Levine's home page, http//: www.econ.brow.edu/fac/Ross_Levine/Publications.htm.

8. All level variables are adjusted for the German reunification. The adjustment involves regressing each variable of interest on time and a constant in the ten years before 1991 (data based on West Germany only). We then use the estimated coefficients to predict the values for 1991 to 2000. We take the average ratio between actual and predicted values in the years 1991 to 2000. We use this ratio to proportionally adjust values before 1991.

9. The effect of a decrease in the countercyclicality of public deficit could become negative at high enough levels of financial development, if the government's deficit crowds out more efficient private borrowing and spending.

10. The constant $\alpha_{2it}$ can be interpreted as a measure of structural budgetary deficit: indeed, by construction it corresponds to the part of budget deficit that does not depend upon the business cycle.

11. In practice, we chose a value of 5 for $\sigma$. While this choice is somewhat arbitrary, changing this smoothing value slightly does not qualitatively affect the results.

12. This assumption is reasonable, since the OECD countries in our sample share similar institutions and degrees of economic development. Moreover, this assumption is similar to assuming no heteroskedasticity across panels when estimating a panel regression, which is the standard assumption. Finally, assuming country-specific variances would make estimates much more imprecise, due to the fact that our relatively small number of observations would have to be used to identify many more parameters.

13. See appendix 1 for more details on the implementation of this method.

14. It is indeed also possible to use maximum likelihood-type methods to estimate the variances, but these are precisely liable to get stuck in local solutions. In a previous version of this paper, we used such a method, amended so that it does not systematically get stuck in a local solution. In practice, the estimates of the coefficients $\alpha_{jit}$ we had obtained using that method are highly correlated with the ones obtained here using MCMC.

15. The coefficients also depend on the future, inasmuch as their variance is calculated using the full sample of available observations. Moreover, because the GDP gap is constructed using trend GDP as computed by an HP filter, future GDP is also partially reflected in the GDP gap and hence in the coefficients on the GDP gap.

16. As mentioned earlier, using ICRG indicators turns out not to be of interest for our analysis.

17. This dummy variable takes a value of 1 for all countries that currently belong to the EMU, and 0 for all the other countries. This is because the EMU has been prepared for many years, so that the countries that would eventually join might be different even before the EMU is fully effective.

18. We have experimented with an interaction between the EMU dummy and a post-1999 dummy, but this interaction was typically insignificant, indicating that there is no substantial change occurring with the full implementation of the EMU in 1999.

19. Specifically, in equation 1, we replaced the first difference of debt by the first difference of each of these variables.

20. The Sapir report (Sapir et al. [2003]) recommended the setting-up of "rainy day" funds, supervised by the European Commission.

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