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

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**Abstract:** This paper uses yearly panel data on OECD countries to analyze the relationship between growth and the cyclicality of government debt. We develop new time-varying estimates of the cyclicality of public debt. Our main findings can be summarized as follows: (i) public debt growth has become increasingly countercyclical in most OECD countries over the past twenty years, but this trend has been less pronounced in the EMU; (ii) more financially developed, less open economies and countries under an inflation targeting regime display more countercyclical public debt growth; (iii) more countercyclical public debt growth can have significantly positive effects on productivity growth, in particular when financial development is lower.

## 1 Introduction

A common view among macroeconomists, is that there is a decoupling between macroeconomic policy (budget deficit, taxation, money supply) which should primarily affect price and income stability<sup>1</sup>, and long-run economic growth which, if anything, should depend

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<sup>&</sup>lt;sup>1</sup>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

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 (2004) and Easterly (2005), which 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 the 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 public debt growth is significant in explaining GDP growth, with a more countercyclical public debt 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 previous work by Aghion, Angeletos, Banerjee and Manova (2006), henceforth AABM. The argument in AABM is that credit constrained firms have a borrowing capacity which 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 is firms' ability to borrow in order to maintain growthenhancing 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'

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.

incentives to engage in such investments. And indeed AABM show on the basis of crosscountry panel regressions that structural investments are more procyclical the lower the country's level of financial development, whereas Berman et al (2007) use a French firmlevel panel dataset to show that R&D investments are more positively correlated with sales performance in firms that are more credit-constrained, and that higher volatility of sales is more detrimental to average R&D and growth in such firms.

More generally, a countercyclical budgetary policy should 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 foster the demand for private firms' products by increasing spending. This could further increase firm's 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 that 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, re-location, etc. The tighter the credit constraints faced by firms and workers, the more growth-enhancing such countercyclical policies should be.<sup>2</sup>

Our contribution in this paper is three-fold. It is first to compute and analyze the cyclicality of government debt on a panel of OECD countries, that is, how government debt responds to fluctuations in the output gap over time. Second, it is to investigate some determinants of the cyclicality of public debt. Third, it is to use these yearly panel data to assess the importance for growth of moving towards more countercyclical budgetary

<sup>&</sup>lt;sup>2</sup>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 can 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.

policies at various levels of financial development. Our main findings can be summarized as follows: (i) public debt growth has become increasingly countercyclical in most OECD countries over the past twenty years, but this trend has been significantly less pronounced in the EMU; (ii) more financially developed, less open economies and countries under an inflation targeting regime display more countercyclical public debt growth; (iii) more countercyclical public debt growth can have significantly positive effects on growth when financial development is lower; in particular our estimates suggest that the eurozone could increase its annual growth rate by 0.57 percentage points per year by making its public debt growth become as countercyclical as that in the US.

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 idea 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 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 et al. (2004) show that emerging market economies with better institutions are more able to conduct a countercyclical fiscal policy<sup>3</sup>. Their empir-

 $<sup>^{3}</sup>$ There is also the paper by Talvi and Vegh (2000), where it is argued that high output volatility is most

ical 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 indexes<sup>4</sup>.

Other papers such as Gali and Perotti (2003) and Lane (2003) focus, as we do, on OECD countries. Gali and Perotti investigate whether fiscal policy in the European Monetary Union (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 towards a more countercyclical fiscal policy over time, the EMU is lagging behind that trend. Lane (2003) is probably the paper that 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, the latter 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 policies and its determinants within OECD countries, and we show that the degree of financial development is an important element to explain both cross-country and within country variations in such policies, while future or present EMU membership explains cross-country variations. Moreover, we show that

likely to generate a procyclical government spending. The idea 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.

<sup>&</sup>lt;sup>4</sup>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.

inflation targeting is associated with a more countercyclical public debt growth.

Most closely related to our second stage analysis of the effect of countercyclical budgetary policy on growth, are Aghion-Angeletos-Banerjee-Manova (2005), henceforth AABM, and Aghion-Bacchetta-Ranciere-Rogoff (2006), henceforth ABRR. AABM develop a model to explain why macroeconomic volatility is more negatively correlated with productivity growth, the lower 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 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 develops the first stage analysis of the cyclicality of public debt growth for each OECD country and each year covered by our panel data set. In Section 3, we uncover some main determinants of the cyclicality of public debt. In Section 4, we regress GDP growth on financial development, the cyclicality coefficients computed in the first-stage regressions, the interaction between the two, and a set of controls. Finally, Section 5 concludes.

# 2 The cyclicality of public spending in the crosscountry panel

### 2.1 Data

Panel data on GDP, the GDP gap (ygap), the GDP deflator, government gross debt (ggfl), and total government disbursements (ypgt) are taken from the OECD Economic Outlook annual series<sup>5</sup>. Total government disbursements include government investment, government consumption, debt repayment, subsidies to the private sector, social security and other related transfers, capital transfers and government consumption of fixed cap-

<sup>&</sup>lt;sup>5</sup>Codes in parenthesis indicate the names of variables in the dataset. Full documentation available at www.oecd.org. Data can be downloaded from sourceoecd.org for subscribers to that service.

ital. 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<sup>6</sup>. 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 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 1. The sample is an unbalanced panel including the following countries: Australia, Austria, Belgium, Canada, Denmark, Spain, Finland, France, United Kingdom, Germany<sup>7</sup>, Greece, Iceland, Italy, Japan, Netherlands, Norway, New Zealand, Portugal, Sweden, USA.

### 2.2 Public debt growth and the output gap

The baseline model for public debt growth as a function of the output gap, comes from the tax-rate-smoothing model by Barro (1979). In this framework, deficits emerge from temporary deviations of government expenditure from "normal" and from temporary deviations of the tax base, assumed to be represented by real GDP, from "normal." Since tax-rate smoothing relates to the ratio of public debt to GDP, an interaction of the level of debt with anticipated growth of GDP also factors into budget deficits. Moreover, given

<sup>&</sup>lt;sup>6</sup>Data downloadable from Ross Levine's homepage.

<sup>&</sup>lt;sup>7</sup>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.

the way real deficits are usually calculated in national accounts (corresponding to changes in nominal debt divided by a price index), it is the growth of nominal GDP that matters. That is, anticipated inflation influences the "real" deficit.

We assume that the relevant tax base is proportional to real GDP,  $y_t$ . We assume further that smoothing of the relevant marginal tax rates (for example, on labor income or consumption or value added) corresponds to smoothing the average tax rates,  $T_t/y_t$ , where  $T_t$  is real taxes collected in year t.

Let  $g_t$  be real government expenditure on purchases and transfers. Suppose that  $log(g_t)$  deviates temporarily from its trend,  $[log(g_t)]^*$ . Formally, the trend should correspond to the expected present value of expenditure. In practice, we use an H-P filter to estimate the trend in  $log(g_t)$ . The deviation,  $log(g_t) - [log(g_t)]^*$ , is the proportionate departure of  $g_t$  from normal. Multiplying by the trend or normal value,  $(g_t)^*$ , gives the amount of real debt issue required to finance temporary expenditure (rather than having temporarily high tax rates).

Suppose that  $log(y_t)$  deviates temporarily from its trend,  $[log(y_t)]^*$ . A positive value corresponds to a boom and a negative one to a recession. We use an OECD measure of potential GDP based on of capacity output to measure  $[log(y_t)]^*$ . Given the behavior of  $g_t$ , tax-rate smoothing implies that a temporary excess of  $log(y_t)$  from  $[log(y_t)]^*$  calls for an equi-proportionate excess of real taxes,  $T_t$ , from normal. Normal real taxes correspond to normal or trend expenditure,  $(g_t)^*$ . Therefore, the product of  $log(y_t) - [log(y_t)]^*$  and  $(g_t)^*$  gives the budget surplus (corresponding to a temporarily high level of real taxes collected) associated with a boom.

Given  $log(g_t) - [log(g_t)]^*$  and  $log(y_t) - [log(y_t)]^*$ , tax-rate smoothing calls for expanding the level of real debt,  $b_t$ , along with expansions of real GDP,  $y_t$ . That is, if  $log(g_t) = [log(g_t)]^*$  and  $log(y_t) = [log(y_t)]^*$ , the debt-GDP ratio should stay constant. Therefore, the change in the real debt,  $b_t - b_{t-1}$ , includes a term  $\gamma b_{t-1}$ , where  $\gamma$  is the (trend) growth rate of real GDP.

The national accounts typically measure the real budget deficit as the real value of the

change in the nominal debt (because nominal government expenditure includes interest payments computed from the nominal interest rate). When measured this way, tax-rate smoothing implies that the real budget deficit includes another term,  $\pi b_{t-1}$ , where  $\pi$  is the (expected) inflation rate. That is, the measured real budget deficit depends on the overall term  $(\gamma + \pi)b_{t-1}$ , where  $\gamma + \pi$  is the growth rate of nominal GDP.

The term  $(\gamma + \pi)b_{t-1}$  should move closely with the real value of nominal interest payments. The difference is that nominal interest payments depend on the real interest rate, r, rather than the growth rate of real GDP,  $\gamma$ . If we generate a dependent variable by subtracting the real value of nominal interest payments from the measured real budget deficit, the coefficient on the variable  $b_{t-1}$  on the right-hand side should be  $\gamma - r$ , which we treat as a constant. This constant would be negative in the standard deterministic model. (However, with uncertainty, the real rate r on government debt could be smaller than  $\gamma$ , the mean growth rate of real GDP.)

The baseline tax-smoothing model has no tendency for the debt-GDP ratio to revert to a stationary mean, such as zero. (More generally, the ratio might revert to something positive, possibly dependent on other assets held by the government.) If there were a tendency for the debt-GDP ratio to revert toward zero, we might pick up this effect from the coefficient on the stock of real debt,  $b_{t-1}$ . Thus, a negative coefficient on  $b_{t-1}$  could represent this mean reversion, along with the effect  $\gamma - r$  already mentioned.

Our empirical counterpart of the tax-rate smoothing model of budget deficits is then for each country i:

$$\frac{(b_{it} - b_{i,t-1}) - i_{it}}{y_{it}} = a_{1it}y_{gap,it}\frac{\overline{g_{it}}}{y_{it}} + a_{2it}\{\ln(g_{it}) - \overline{\ln(g_{it})}\}\frac{\overline{g_{it}}}{y_{it}} + a_{3it}\frac{b_{i,t-1}}{y_{it}} + a_{4it} + \varepsilon_{it}$$
where  $\varepsilon_{it} \sim N(0, \sigma_{\varepsilon}^2)$ .
(1)

Empirically, the variables are defined as follows:

- $b_{it}$  : gross government debt in country i at year t
- $i_{it}$ : interest payments made by the government in country i and 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* as computed by the OECD based on a production function approach.
- $g_{it}$ : total government disbursements in country *i* and year *t*
- $\varepsilon_{it}$  : error term

A bar above a variable indicates that one takes the prediction for this variable using the Hodrick-Prescott filter. A lambda parameter of 25 was chosen, following OECD(1995). The prediction was then computed separately for each country.

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 very close to the opposite of the budget balance as a share of GDP.

The *a* coefficients to be estimated are, for the purpose of this paper, assumed to be potentially time-varying, which is why we write  $a_{jit}$  to denote the coefficient on the variable *j* in country *i* at time *t*.

With tax smoothing, the predicted coefficients are  $a_{1it} = -1$  and  $a_{2it} = 1$ . The coefficient  $a_{3it}$  corresponds, as discussed, to  $\gamma - r$  (plus a possible negative effect associated with reversion of the debt-GDP ratio toward zero or some other positive target value).

Even if a government does not precisely pursue tax-rate smoothing, the formulation in equation (1) is useful in the sense that the deviations of the estimated coefficients a from the values prescribed under tax smoothing are informative. For example, if  $a_{1it} < -1$ , the government is pursuing a more counter-cyclical deficit policy than called for by tax smoothing, and vice versa if  $a_{1it} > -1$ . A procyclical deficit policy,  $a_{1it} > 0$ , is very far from tax-rate smoothing; that is,  $a_{1it} = 0$  is not the natural baseline.

We now move on to examine how the coefficients  $a_{jit}$  can be estimated econometrically.

### 2.3 Two econometric methods

Regression based approaches to measure the cyclicality of fiscal policies are 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 observation of cyclicality per country. In order to make full use of the panel structure of our data, we compute instead for each country yearly measures for the cyclicality of debt growth. Our first method uses local Gaussian-weighted ordinary least squares estimates (also called kernel-based nonparametric regression or local smoothing): for each year, points that are closer in time are given more weight than points that are further away. Our second method is to compute time-varying coefficients in the above equation 1 under the assumption that these coefficients follow an AR(1) process. We now describe each of these methods in more detail. <sup>8</sup>

The "local Gaussian-weighted ordinary least squares" method 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*:

$$\frac{(b_{it}-b_{i,t-1})-i_{it}}{y_{it}} = a_{1it}y_{gap,i\tau}\frac{\overline{g_{i\tau}}}{y_{i\tau}} + a_{2it}\{\ln(g_{i\tau})-\overline{\ln(g_{i\tau})}\}\frac{\overline{g_{i\tau}}}{y_{i\tau}} + a_{3it}\frac{b_{i,\tau-1}}{y_{i\tau}} + a_{4it} + \varepsilon_{i\tau},$$
  
for  $\tau \in (t-5,t+4).$ 

that is, one uses a ten year centered rolling window to estimate the pro-cyclicality of public debt growth 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 5 years before and 4 years after.

<sup>&</sup>lt;sup>8</sup>Another method is to compute finite (for example 10-years) rolling window ordinary least squares estimates. This kind of method is straightforward but very noisy and therefore not too reliable.

The ten-year rolling window OLS method simply amounts to estimating the procyclicality of the growth of public debt  $\frac{(b_{it}-b_{i,t-1})-i_{it}}{y_{it}}$  at year t in country i by running the following regression for each country i, and all possible  $\tau$ :

$$\frac{(b_{it} - b_{i,t-1}) - i_{it}}{y_{it}} = a_{1it}y_{gap,i\tau}\frac{\overline{g_{i\tau}}}{y_{i\tau}} + a_{2it}\{\ln(g_{i\tau}) - \overline{\ln(g_{i\tau})}\}\frac{\overline{g_{i\tau}}}{y_{i\tau}} \\
+ a_{3it}\frac{b_{i\tau-1}}{y_{i\tau}} + a_{4it} + \varepsilon_{i\tau},$$
(2)
where  $\varepsilon_{i\tau} \sim N(0, \sigma^2/w_t(\tau))$  and  $w_t(\tau) = \frac{1}{\sigma\sqrt{2\Pi}}\exp\left(-\frac{(\tau-t)^2}{2\sigma^2}\right).$ 

Our second and preferred method, assumes that coefficients follow an AR(1) process, namely, using the notation from equation 1, for each country i and for each coefficient j:

$$a_{jit} = a_{ji,t-1} + \varepsilon_{it}^{a_j}, \varepsilon_{it}^{a_j} \sim N(0, \sigma_{a_j}^2).$$
(3)

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

The optimal estimates for these variance 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<sup>9</sup>. We are thus left with five variances to estimate: four for the coefficient processes ( $\sigma_{a_j}^2$ , j = 1, 2, 3, 4) and one for the variance of the error in the equation ( $\sigma_{\varepsilon}^2$ ). Intuitively, the MCMC method explores randomly (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<sup>10</sup>. An advantage of the MCMC method over maximum likelihood type methods is that it does

<sup>&</sup>lt;sup>9</sup>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 heteroskedasiticty 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.

<sup>&</sup>lt;sup>10</sup>See appendix 1 for more details on the implementation of this method.

not get stuck in local solutions and properly represents uncertainty about the variances<sup>11</sup>. Once we obtain the estimates of these five variances, the  $a_{jit}$  coefficients can be calculated using the Kalman smoother.

AR(1) MCMC is our preferred method for two reasons. First, it reflects a reasonable assumption about policy, i.e. that policy changes slowly and depends on the immediate past. Second, it is econometrically appealing in that it makes policy reflected in the  $a_{jit}$  coefficients depend on the past (because of the AR(1) specification), and not on the future; 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<sup>12</sup>. By contrast, the local Gaussian-weighted ordinary least squares method relies equally on past and future observations, which makes it less appealing as an exogenous explanatory variable. However, it still has the property of making the policy change slowly, as the estimates are smoothed by construction. We therefore also report results using this the local Gaussian-weighted ordinary least squares method, as a robustness check on our preferred estimates.

### 2.4 Results

We now use the Gaussian-weighted OLS and AR(1) methods as described above to characterize the level and time path of the procyclicality of government debt in the OECD countries in our sample. We also report some basic results with the 10 years rolling window method to illustrate the shortcomings of this estimation method.

Table 1 summarizes the descriptive statistics of our main variables of interest. It is worth noting that the three different methods used in the first stage to estimate pro-

<sup>&</sup>lt;sup>11</sup>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  $a_{jit}$  we had obtained using that method are highly correlated with the ones obtained here using MCMC.

<sup>&</sup>lt;sup>12</sup>Strictly speaking, even when using the AR(1) MCMC method, there is some dependency of estimates on future observations of the right-hand side variables. This is because some right-hand side variables are calculated using the HP filter; moreover, we use the Kalman smoother, which yields more precise estimates than the Kalman filter by conditioning the coefficient estimates on all observations, while still maintaining the constraint that the coefficients follow an AR(1) process.

cyclicality give very similar results. We note that gross debt is countercyclical (negative coefficient), which is consistent with Lane's (2003) finding that the primary surplus is procyclical, which in turn is equivalent to saying that government debt is countercyclical. Moreover, the mean of our gross debt procyclicality estimate<sup>13</sup> is very close to -1 for all methods considered, which is in line with the tax smoothing model described above.

#### TABLE 1 HERE

We now look at the evolution of the procyclicality of public debt growth, as measured by the estimated coefficients  $a_{1it}$  from equation 1. Figure 1 shows the evolution of the procyclicality of debt for the US estimated by the three methods described above. We can readily see that, as expected, the 10 years rolling window yields the most volatile results, and the AR(1) method is the smoothest with the Gaussian-weighted OLS method lying in between. Overall, all three methods show a decrease in procyclicality over time, with a recent trend towards increasing procyclicality shown by the 10 years rolling window and Gaussian-weighted OLS methods. Having thus illustrated how noisy the 10 years rolling window estimates are, we only use AR(1) MCMC and Gaussian-weighted OLS in the remainder of the paper.

#### FIGURE 1 HERE

In Figure 2, we then show the procyclicality of public debt estimated through the AR(1) method for a few countries in our sample . In general, and in line with US trends, procyclicality tends to diminish over time, especially since the 1980's. This downward trend in procyclicality is however more pronounced for the UK and the US than for the average of EMU countries. Also, one can observe some divergence between EMU and non-EMU countries: at the beginning of the period, the procyclicality of public debt growth in EMU countries was very similar to that in the US or the UK, however, as of the 1990's, the US and the UK became significantly more countercyclical whereas the EMU did not.

 $<sup>^{13}\</sup>mathrm{See}$  Appendix 2 for detailed results by country and year.

### FIGURE 2 HERE

In Figure 3, 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.

#### FIGURE 3 HERE

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

To summarize our results from first stage regressions, we found that government debt has become more countercyclical in non-EMU countries than in EMU countries since the 1990s. In the next section we investigate possible explanations for these observed differences in the procyclicality of government debt across countries and over time.

### **3** First stage: determinants of public debt cyclicality

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<sup>14</sup>. Instead, we focus on the following candidate variables: financial development, openness, EMU membership<sup>15</sup>, and whether the country has adopted inflation targeting <sup>16</sup>. We also

<sup>&</sup>lt;sup>14</sup>As mentioned above, using ICRG indicators turns out not to be of interest for our analysis.

<sup>&</sup>lt;sup>15</sup>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.

<sup>&</sup>lt;sup>16</sup>In Table 1 of Appendix 3, we perform the same regression but adding budgetary rule indicators (See Van Hagen et al (2004).) which reflect the agenda-setting power of the finance minister or the extent to which budgets can be renegotiated in cabinet or in parliament. In particular, having multiannual budgetary constraints on cabinet negotiations and/or on parliamentary discussions should reduce the countercyclicality of public debt growth, as this should reduce a country's ability to renegotiate its public debt upward in recessions. Having finance ministers with strong agenda-setting power first in cabinet negotiations with other ministers and then in parliamentary debates, should also affect the cyclicality of public debt.

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 in recessions. Lower financial development should thus translate into lower countercyclicality of public debt growth. While OECD countries are arguably less subject to borrowing constraints than other countries in the world, there is still a fair amount of cross-country variation in financial development among 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 than during booms. This in turn tends to increase the long-run cost of financing countercyclical public debt policies while maintaining the overall debt constant on average over the long run. The EMU dummy is also a plausible candidate, given: (i) our observation in Figures 2 and 3 that public debt growth is less countercyclical in the eurozone than in the US or the UK; (ii) 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 unreasonable.

Table 2, where the procyclicality measures are derived using the AR(1) MCMC and Gaussian-weighted OLS methods, shows results that are consistent with these conjectures, namely: (i) in all specifications, higher financial development is positively and significantly correlated with the countercyclicality of government debt (the table shows a negative coefficient of public debt procyclicality); using the results from column 3, our estimates imply that a one standard deviation increase in private credit over GDP is associated with 37% of a standard deviation decrease in procyclicality of public debt growth; in other words, it is precisely when the countercyclicality of public debt is more positively correlated with growth, namely when financial development is low, that public debt countercyclicality seems hardest to achieve; (ii) in most specifications, more trade openness is negatively and significantly correlated with public debt countercyclicality (the table shows a positive coefficient on openness); (iii) according to the OLS estimates using the Gaussian-weighted OLS method, EMU countries appear to have a harder time achieving public debt countercyclicality<sup>17</sup>; 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<sup>18</sup>; further investigation of this question is however beyond the scope of this paper; (iv) a higher share of government in the GDP are associated with a more countercyclical debt policy; (v) pursuing inflation targeting is associated with more countercyclical public debt growth; using the results from column 3, our estimates imply that moving to inflation targeting would result in a 57% of a standard deviation decrease in the procyclicality of public debt, a very large effect.<sup>19</sup>

### TABLE 2 HERE

Hence, a lower level of financial development, a higher degree of openness, belonging

<sup>&</sup>lt;sup>17</sup>When using AR(1) MCMC, the coefficient on EMU is also positive and significant IF we do not control for inflation targeting. This suggests that the positive effect on procyclicality of being in the EMU group may be partially explained by the fact that these countries, by and large, did not adopt inflation targeting. Therefore, if the EMU adopted inflation targeting, it would probably close at least some of the gap with such non-EMU countries as the UK.

<sup>&</sup>lt;sup>18</sup>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.

<sup>&</sup>lt;sup>19</sup>In Table 1 of Appendix 3 we also find that more powerful finance ministers in countries where the finance minister negotiates bilaterally with other cabinet members (Van Hagen et al (2004) refer to those countries as "delegation states")) is associated with more procyclical public debt growth. Similarly, more stringent budgetary rules in countries where the executive has limited agenda-setting power (the so-called "contracts states" in Van Hagen et al) are also typically associated with more procyclical public debt growth.

to the EMU group, and the absence of inflation targeting, are all associated with a lower degree of countercyclicality in government debt. In the next section we move to second stage analysis of the effect of public debt cyclicality on growth.

## 4 Second stage: cyclical public debt and growth

In this section we regress growth on the cyclicality coefficients derived for public debt growth in the first stage regressions of the previous section, financial development, the interaction between the two variables, and a set of controls. Our conjecture is that the more firms and workers are credit constrained, that is, the lower financial development, the more growth-enhancing countercyclical budgetary policies should be to the extent that they reduce the costs that negative liquidity shocks impose on credit-constrained agents.

### 4.1 Empirical specifications

In all the specifications we use for our second-stage regressions, we measure productivity growth by the first difference of the log of real GDP per capita. We then regress productivity growth on the lagged cyclicality of public debt growth as derived in the first stage regressions, the lagged private credit measure captured by the ratio of private credit to GDP and borrowed from Levine (2001), and the interaction between those two variables. As control variables, we typically use the lag of log real GDP per capita, the level of schooling, openness to trade, inflation, population growth, the government share of total GDP, and inflation targeting. Moreover, in all specifications we weigh each observation by the inverse of the variance of the estimated cyclicality coefficient (aweights in Stata), thus giving higher weight to coefficients that are more precisely estimated in the first stage.

Using the set of cyclicality measures derived in the first stage respectively from the Gaussian-weighted least squares and AR(1) methods, we perform country fixed effects

estimates, and then move on to country and year fixed effects estimates. In each case, 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, schooling, population growth and investment over GDP. We then add more controls, namely trade openness, inflation, government share of GDP and inflation targeting.

This empirical strategy raises however the question of whether our procyclicality variables are causal for growth. One simple step we took towards identifying a causal effect is to use the lagged procyclicality to explain growth, thus reducing the possibility of reverse causation. Second, we use GMM estimation to further probe the robustness of our results. In those GMM estimations, we instrument both the procyclicality variable and the lagged GDP per capita. For the latter, we use the classic instruments second and third lag of GDP per capita. For the procyclicality variable, we use inflation targeting as an instrument. Indeed, we have shown in Table 2 that inflation targeting is significant in predicting procyclicality; on the other hand, we find that inflation targeting has typically no independent effect on growth. This makes inflation targeting a good candidate instrument for procyclicality<sup>20</sup>. Excluded instruments in our GMM regressions are thus second and third lag of GDP per capita and the inflation targeting dummy.

Another source of concern for our estimation strategy is autocorrelation of residuals. Indeed, as is typical in panel growth regressions and can be confirmed by the Wooldridge test implemented in Stata's xtserial command, the errors are serially correlated (AR(1)) in first differences (this is true whether or not we include the lagged dependent variable, i.e. lag of log real GDP per capita). This implies that country fixed effect estimates may be biased. To correct for this potential bias, our GMM estimates allow for Newey errors (Bartlett kernel) of lag  $1^{21}$ .

We perform the GMM estimates for both the AR(1) and Gaussian-weighted measures

 $<sup>^{20}</sup>$ We also experimented with adding the budgetary institutions variables from Hallerberg et al. (2004) as instruments, but those tend to have an independent effect on growth and therefore non-surprisingly failed the C test for validity of instruments.

 $<sup>^{21}</sup>$ Varying the bandwidth of the Bartlett kernel (for autocorrelation) up to 5 does not affect results found with a bandwidth of 1.

of procyclicality, using both country and country year fixed effects. In the case of AR(1) estimates, the model fails the J test for over-identification, and we cannot reject that procyclicality is exogenous. We therefore do not report GMM results for AR(1) estimates. The fact that AR(1) estimates of procyclicality are plausibly exogenous may be explained by the already pointed out fact that these estimates depend on the past and not on the future, while Gaussian-weighted estimates depend on both past and future. Even in the case of AR(1) estimates, one may still be concerned about autocorrelation of residuals. As a robustness check, we have used Stata's xtregar command, which implements the method described in Batalgi (2001) to estimate the coefficient of correlation between the errors and give unbiased estimates; since the coefficients on the variables of interests using this method were not statistically different from the ones found with simple fixed effects, we do not report these results.

### 4.2 Results

Table 3 shows the results of regressing the first difference of the log of real GDP per capita over the lagged cyclicality of government debt, measured by the coefficients obtained in the first stage regression using the AR(1) method. The prediction is that of a negative coefficient for the effect on growth of the procyclicality of public debt when private credit over GDP is 0, and of a positive coefficient on procyclicality interacted with financial development. In the first column of Table 3, using country fixed effects and a limited set of controls, we see that the corresponding coefficients have the anticipated signs and are statistically significant: a more procyclical government debt is negatively correlated with growth, but the interaction term between public debt procyclicality and financial development is positive. Including a richer set of controls in column 2 does not change the results; if anything, the point estimates are larger. Moving on to country and year fixed effects in columns 3 and 4, the results are very similar and still statistically significant.

Table 3 is thus consistent with the prediction of a negative effect of procyclicality

in public debt on growth, whereas we see a positive and significant interaction effect between private credit and the procyclicality variable. Thus the less financially developed a country is, the more growth-enhancing it is for the government to be countercyclical in its debt policy.

#### TABLE 3 HERE

To get a better sense of the magnitude of the effects of public debt cyclicality on growth and the interaction of these effects with financial development, we can ask the following question: according to our estimates, what would happen if public debt in the EMU became as countercyclical as that in the US? Table 4 summarizes the answer to this question, which is based on the estimates in column 4 of Table 3, that is on the most demanding specification with both country and year fixed effects. Thus, if the EMU's government debt was to become as countercyclical as that in the US, which corresponds to a reduction in procyclicality equal to 1.18 units, then the EMU would gain 0.57 percentage points of growth. By contrast, if the US was to reduce its procyclicality by the same 1.18 units, it would grow *less* by 1 percentage point. While these figures should be taken with caution since we extrapolate well outside the range of average observed values for the EMU, they still point at significant growth effects of changes in the cyclicality of budgetary policy.

### TABLE 4 HERE

Thus, paradoxically, EMU countries have public debt policies that are less countercyclical than in the US, even though the US are more financially developed than EMU: thus, the ratio of private credit to GDP in 2000 in the EMU is equal 0.92 against 2.17 in the US.

Table 5 performs the same second-stage exercise as in Table 3, but with the cyclicality coefficients on the right-hand side being computed using the Gaussian-weighted method. Overall, the results are similar to those found in Table 3. Thus, country fixed effects

estimates (columns 1 and 2) yield significant effects of the procyclicality of debt growth and procyclicality interacted with private credit; moreover, the coefficients are of similar magnitudes. However, when also including country year fixed effects (columns 3 and 4) results are less significant than in the AR(1) case. Thus, the coefficient on the procyclicality of public debt growth is not significant with a reduced set of controls in column 3, but is significant with a few more controls in column 4. The coefficient on the interaction of procyclicality of public debt growth and private credit becomes insignificant irrespective of the set of controls used.

### TABLE 5 HERE

Finally, Table 6 repeats the regressions in Table 5 using GMM estimates. In all specifications, first stage estimates are significant (see F test and Shea's partial R squared), but the explanatory power of inflation targeting for procyclicality is limited (Shea's partial R squared for procyclicality is around 1%). With country fixed effects (columns 1) and 2), overidentifying restrictions are not rejected by the J test, and we reject that procyclicality and its interaction with private credit are exogenous. In columns 1 and 2, the point estimates on procycality and its interaction with private credit remain significant, and are larger than in the simple country fixed effects case. With country and year fixed effects (columns 3 and 4), the models still pass the overidentification test. With the limited set of controls (column 3), we cannot reject at conventional levels that the procyclicality variable and its interaction with private credit are exogenous; however, when using a richer set of controls in column 4, the exogeneity test makes us reject that these variables are exogenous. With country year effects and a limited set of controls (column 3), the coefficients on procyclicality and the interaction of procyclicality with private credit are significant and of the usual sign. However, adding a few more controls in column 4 makes these coefficients become insignificant. Overall, we take these GMM results to be encouraging. Indeed, with country fixed effects, GMM estimates still yield significant effects of our variables of interest, and since inflation targeting is a relatively weak instrument for procyclicality, it is not surprising that significance can be sometimes lost, as is the case in column 4.

### TABLE 6 HERE

# 5 Conclusion

In this paper we have analyzed the dynamics and determinants of the cyclicality of public debt on a yearly panel of OECD countries, and the relationship between public debt countercyclicality, financial development, and productivity growth. Our findings can be summarized as follows: first, countercyclicality has increased over time across all countries in our sample, however to a lower extent in EMU countries than in the US or the UK. Second, countercyclicality of government debt 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 public debt policy is more growth enhancing 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 productivity growth in EMU countries would be fostered if public debt growth 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 to inflation targeting, e.g following the UK lead in this respect, and also by improving the coordination among finance ministers in the eurozone on fiscal policy over the cycle. One may alternatively argue that financial development is increasing in the EMU area over time, boosted by the monetary union itself, and that higher financial development reduces the need for countercyclical public debt growth. However, based on the historical growth trend of financial development, the EMU will not reach the current level of financial development of the USA until year 2084<sup>22</sup>.

 $<sup>^{22}</sup>$ Even based on the faster growth trend of financial development of the 1990's, the EMU will only

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, e.g 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 which extent allowing for higher procyclicality of short term nominal interest rates, can help firms maintain R&D investments in recessions and/or improve governments' ability to implement growth-enhancing countercyclical budgetary policies? Third, one could analyze in more detail which types of countercyclical public spending (consumption, investment) are most growth-enhancing, and on which sectors. Finally, one could investigate the possible interactions in growth regressions between countercyclical budgetary policy and structural reforms in the product and labor markets.

reach the USA level of financial development in 2068. In order for more countercyclicality to be no longer growth enhancing for the EMU, and based on growth trend of financial development of the 1990's, the EMU would still have to wait for several decades (at least until between 2020 and 2030, depending on which specification we base our estimates on).

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[21] Vega M. and Winkelried D. (2005), "Inflation targeting and inflation behavior: a successful story?", International Journal of Central Banking, Vol. 1, No. 3, December 2005, 153-175. **Table 1: Summary statistics** 

	Obs.	Mean	Std. Dev.	Min	Max
GDP gap	622	-0.003	0.029	-0.109	0.160
Gross government debt/GDP	622	0.553	0.274	0.073	1.608
(d.Gross government debt-					
interests)/GDP	622	0.007	0.044	-0.113	0.195
Procyclicality of gross government debt					
(AR(1))	612	-0.925	1.042	-4.206	1.447
Procyclicality of gross government debt					
(Gaussian weighted rolling window)	643	-1.072	1.169	-4.004	1.951
Procyclicality of gross government debt					
(10-years rolling window)	454	-1.179	1.923	-9.259	3.466
Growth of GDP per capita	565	0.022	0.023	-0.092	0.107
Private credit/GDP	515	0.831	0.388	0.132	2.240
Average years of schooling for the					
population over 25 years old	485	8.325	1.996	2.580	12.250
Openness	495	52.074	26.493	9.228	155.568
Inflation	622	0.058	0.065	-0.025	0.762
Population growth	565	0.005	0.005	-0.018	0.047
Government share of GDP (in %)	495	12.483	5.796	3.008	26.638
Investment/GDP (in%)	495	23.535	4.357	12.867	41.022
Inflation targeting dummy	643	0.142	0.349	0	1

Note: sample restricted to observations where the procyclicality of gross government consumption computed using Gaussian weighted rolling windows is not missing. Source: OECD Economic Outlook, Levine dataset, Barro Lee dataset, Penn World Tables 6.1.



Figure 1: the procyclicality of public debt in the USA

Note: the graph plots the  $a_{1ii}$  coefficients, i.e. the coefficients on the output gap composite variable (see equation 1), using various estimation techniques. Source: OECD Economic Outlook.



Figure 2: The procyclicality of public debt using the AR(1) MCMC method

Note: the graph plots the  $a_{1ii}$  coefficients, i.e. the coefficients on the output gap composite variable (see 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 non-missing observations. Source: OECD Economic Outlook.



Figure 3: The procyclicality of public debt using the Gaussian-weighted OLS method

Note: the graph plots the  $a_{1it}$  coefficients, i.e. the coefficients on the output gap composite variable (see 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 non-missing observations. Source: OECD Economic Outlook.

Table 2: The determinants of government debt procyclicality

		AR(1)			WRW	
	OLS	Country	Country	OLS	Country	Country
		f.e.	year f.e.		f.e.	year f.e.
Private credit/GDP	-0.630	-0.982	-1.013	-0.487	-1.074	-0.977
	(0.118)***	(0.129)***	(0.140)***	(0.163)***	(0.123)***	(0.130)***
EMU country	-0.023			0.220		
	(0.085)			(0.101)**		
Standard error	-9.183			-4.737		
of GDP growth	(1.479)***			(1.555)***		
Lag(log (real GDP	-0.012	0.081	-0.202	-0.033	-0.719	-0.206
per capita))	(0.045)	(0.267)	(0.499)	(0.038)	(0.249)***	(0.568)
Openness	0.000	0.003	0.021	0.008	0.016	0.024
	(0.001)	(0.004)	(0.005)***	(0.002)***	(0.003)***	(0.005)***
Government share	-0.008	-0.009	-0.016	-0.031	-0.015	-0.024
of GDP (in %)	(0.008)	(0.006)	(0.007)**	(0.010)***	(0.005)***	(0.005)***
Inflation targeting	-1.249	-0.620	-0.593	-1.060	-0.429	-0.329
	(0.119)***	(0.100)***	(0.113)***	(0.130)***	(0.081)***	(0.091)***
Observations	515	515	515	489	489	489
R-squared	0.27	0.79	0.80	0.18	0.87	0.88
Robust standard errors in	parenthese	s				
* significant at 10%; ** sig	nificant at {	5%; *** sigr	nificant at 1%			

Note: The explained variable is the coefficient on the GDP gap composite variable from equation 1, estimated using the AR(1) MCMC method for columns 1-3, and the Gaussian-weighted rolling window method for columns 4-6. EMU country is a dummy variable equal to 1 for all countries that are part of the EMU as of 2006.

Source: OECD Economic Outlook, Levine dataset, Barro Lee dataset, Penn World Tables 6.1.

	Сс	ountry f.e.	Cour	ntry year f.e.
lag(Procyclicality of government	-0.016	-0.023	-0.013	-0.015
debt)	(0.005)***	(0.005)***	(0.004)***	(0.005)***
lag(Private credit/GDP)	0.014	-0.003	-0.011	-0.012
	(0.008)	(0.009)	(0.008)	(0.009)
lag(Procyclicality of government	0.016	0.017	0.011	0.011
debt*Private credit/GDP)	(0.005)***	(0.005)***	(0.004)***	(0.005)**
lag(log (real GDP per	-0.063	-0.101	-0.156	-0.135
capita))	(0.014)***	(0.015)***	(0.022)***	(0.023)***
Average years of schooling for	0.013	0.007	0.005	0.005
the population over 25 years old	(0.003)***	(0.003)**	(0.003)**	(0.003)**
Population growth	-1.994	-2.090	-1.362	-1.481
	(0.308)***	(0.317)***	(0.257)***	(0.283)***
Investment/GDP (in%)	0.003	0.003	0.003	0.002
	(0.000)***	(0.000)***	(0.000)***	(0.000)***
Openness		0.001		0.001
		(0.000)***		(0.000)**
Inflation		-0.071		-0.043
		(0.021)***		(0.022)*
Government share of GDP (in %)		-0.001		-0.001
		(0.000)**		(0.000)*
Inflation targeting		-0.003		-0.001
		(0.005)		(0.004)
Observations	460	460	460	460
R-squared	0.29	0.40	0.59	0.61
Robust standard errors in parenthese	es			
* significant at 10%; ** significant at	5%; *** significa	int at 1%		

Table 3: The effect of public debt procyclicality on growth, AR(1) MCMC method

Note: The explained variable is the first difference of the log of real GDP per capita. Source: OECD Economic Outlook, Levine dataset, Barro Lee dataset, Penn World Tables 6.1. Table 4: Implied effect on growth of a change in the procyclicality of public debt such that the EMU would have the same level of procyclicality as the US in 2000

	Estimated				Estimated coef.				Average(		
coef. on lag				lag(Procyclicality				lag			
(Procyclicality				of government				(private		Implied	
	of government		Difference US-		debt*private	I	Difference US-		credit/		effect on
debt)			EMU		credit/GDP)	E	EMU		GDP))		growth
EMU in 2000	-0.0150	*	-1.1840	+	0.0110	*	-1.1840	*	0.9242	=	0.0057
US in 2000	-0.0150	*	-1.1840	+	0.0110	*	-1.1840	*	2.1696	=	-0.0105

Note: The estimated coefficients are taken from estimates column 4 of Table 3. The difference US-EMU is defined as: (procyclicality of government debt in the US in 2000)- (procyclicality of government debt in the EMU in 2000). The averages of variables are calculated using the same sample on which regressions were estimated.

Source: OECD Economic Outlook, Levine dataset, Barro Lee dataset, Penn World Tables 6.1.

	C	ountry f.e.	Cou	ntry year f.e.
lag(Procyclicality of government	-0.020	-0.029	-0.006	-0.010
debt)	(0.006)***	(0.005)***	(0.004)	(0.004)**
lag(Private credit/GDP)	0.019	-0.002	-0.018	-0.027
	(0.011)*	(0.010)	(0.009)**	(0.009)***
lag(Procyclicality of government	0.012	0.019	0.004	0.003
debt*Private credit/GDP)	(0.006)**	(0.005)***	(0.004)	(0.004)
lag(log (real GDP per	-0.044	-0.114	-0.159	-0.153
capita))	(0.018)**	(0.020)***	(0.029)***	(0.028)***
Average years of schooling for	0.005	0.005	-0.002	0.002
the population over 25 years old	(0.005)	(0.005)	(0.003)	(0.004)
Population growth	-2.105	-1.979	-0.916	-1.022
	(0.507)***	(0.498)***	(0.349)***	(0.374)***
Investment/GDP (in%)	0.004	0.004	0.003	0.003
	(0.001)***	(0.001)***	(0.001)***	(0.001)***
Openness		0.001		0.001
		(0.000)***		(0.000)**
Inflation		-0.077		-0.031
		(0.023)***		(0.033)
Government share of GDP (in %)		-0.001		-0.001
		(0.000)**		(0.000)**
Inflation targeting		-0.008		-0.003
		(0.006)		(0.005)
Observations	485	465	465	465
R-squared	0.24	0.37	0.61	0.64
Robust standard errors in parenthese	es			
* significant at 10%; ** significant at	5%; *** significa	ant at 1%		

Table 5: The effect of public debt procyclicality on growth, Gaussian-weighted OLS method

Note: The explained variable is the first difference of the log of real GDP per capita. Source: OECD Economic Outlook, Levine dataset, Barro Lee dataset, Penn World Tables 6.1.

	Country f.e., G	MM+Newey errors	Country year f.e.,	GMM+Newey errors
lag(Procyclicality of government	-0.204	-0.112	-0.062	-0.077
debt)	(0.091)**	(0.059)*	(0.034)*	(0.052)
lag(Private credit/GDP)	0.145	0.086	0.034	0.045
	(0.080)*	(0.047)*	(0.036)	(0.044)
lag(Procyclicality of government	0.164	0.108	0.060	0.075
debt*Private credit/GDP)	(0.083)**	(0.052)**	(0.033)*	(0.047)
lag(log (real GDP per	-0.068	-0.140	-0.192	-0.169
capita))	(0.033)**	(0.026)***	(0.026)***	(0.032)***
Average years of schooling for	0.008	0.007	-0.000	0.003
the population over 25 years old	(0.006)	(0.005)	(0.004)	(0.004)
Population growth	-3.930	0.001	-1.553	0.001
	(1.083)***	(0.000)***	(0.528)***	(0.000)
Investment/GDP (in%)	0.008	-0.115	0.004	-0.040
	(0.002)***	(0.040)***	(0.001)***	(0.045)
Openness		-2.480		-1.778
		(0.849)***		(0.822)**
Inflation		-0.001		-0.001
		(0.001)*		(0.001)
Government share of GDP (in %)		0.005		0.004
		(0.001)***		(0.001)***
Observations	485	485	485	485
R-squared				
GMM diagnostic statistics				
<u>(P-values in parentheses)</u>				
F test of excluded instruments				
lag(Proc. of gov. debt)	11.94 (0.000)	9.65 (0.000)	8.13 (0.000)	8.03 (0.000)
lag(Proc. of gov. debt* P. c.)	17.84 (0.000)	14.09 (0.000)	9.12 (0.000)	8.51 (0.000)
lag(log (r. GDP per cap.))	1173.38 (0.000)	962.05 (0.000)	328.62 (0.000)	328.39 (0.000)
Shea's partial R squared				
lag(Proc. of gov. debt)	0.0143	0.0143	0.0173	0.0088
lag(Proc. of gov. debt* P. c.)	0.0168	0.0167	0.0175	0.0102
lag(log (r. GDP per cap.))	0.8350	0.7371	0.8291	0.4854
Hansen J statistic	1.064 (0.302)	0.275 (0.600)	0.197 (0.6573)	0.039 (0.843)
Exogeneity test				
lag(Proc. of gov. debt) and	10.363 (0.006)	7.243 (0.027)	3.507 (0.173)	5.712 (0.058)
lag(Proc. of gov. debt* P. c.)				
lag(log (r. GDP per cap.))	1.275 (0.0259)	2.530 (0.112)	10.086 (0.002)	9.426 (0.002)
Robust standard errors in parenthese	es			
* significant at 10%; ** significant at	5%; *** significant	at 1%		

 Table 6: The effect of public debt procyclicality on growth, Gaussian-weighted OLS method, GMM estimates

Note: The explained variable is the first difference of the log of real GDP per capita. GMM estimation with fixed effects is performed using Stata's xtivreg2; estimation is robust to heteroskedasticity and autocorrelation (Bartlett kernel, bandwidth=1); endogenous variables are the lag of procyclicality, the interaction of procyclicality with private credit, and the lagged GDP per capita; excluded instruments are inflation targeting, the interaction of inflation targeting and private credit, and the second and third lag of GDP per capita.

Source: OECD Economic Outlook, Levine dataset, Barro Lee dataset, Penn World Tables 6.1.

# 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 smoother 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 desribed by equation 2. The implementation was carried out in Matlab.

Estimating the means and variances of the coefficients of interest - that is  $a_{jit}$  in equation 2 - involves two procedures: Kalman smoothing<sup>1</sup> and MCMC.

To compute the coefficients with the Kalman smoother for each country, we need to know the values of five variances :

- $\sigma_{a_j}^2$  in equation 2, for j = 1, 2, 3, 4, i.e. the process variances in the terminology of the Kalman smoother
- the variance  $\sigma_{\varepsilon}^2$  of the error term  $\varepsilon_t$  in equation 1, i.e. the measurement error variance in the terminology of the Kalman smoother.

Moreover, to use the Kalman smoother, 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 negligeable 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 10 years of data for each country, and the value of the initial variance is set to be 100000 times the estimated variance of these coefficients.

<sup>&</sup>lt;sup>1</sup>For an excellent overview of the Kalman filter and smoother, see the notes by Max Welling "Kalman Filters", available on the web at http://www.ics.uci.edu/~welling/classnotes/classnotes.html. The difference between the Kalman filter and smoother is that the latter uses future values as well as past values to estimate the coefficients of interest. We use the Kalman smoother here rather than the filter for two reasons. First, we want to make maximum use of a limited data and the smoother uses more information. Second, given the nature of the problem at hand, the government has to rely on beliefs about future states in order to set policy, so that the future should matter as well as the present in defining policy cyclicality.

However, the process variances  $\sigma_{a_j}^2$  and the measurement error variance  $\sigma_{\varepsilon}^2$  are unknown and we do not have any meaninful prior over them. We therefore need a method to find reasonable values for these five 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:

$$p_{accept} = min\left(1, \frac{p(data|new\_parameters)}{p(data|previous\_parameters)}\right)$$
(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. Afterwards, the MCMC algorithm is exploring the space of relevant parameters. Over 3 runs, we took 10000 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 3 runs, we thus get a total of 300 essentially uncorrelated samples for each of the five 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 5 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 smoother that stems from the finite number of noisy observations. The other source of uncertainty is uncertainty about the 5 parameters of the AR(1) processes 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 smoother runs using the 300 samples that we retained from the MCMC estimates of the 5 variances. This approximation becomes correct if the variance as estimated by the Kalman smoother is similar over different runs of the Markov chain, which was a good appriximation for our data.

Finally, a full general statistical description of the methods used here can be found in Kording-Marinescu(2006).

	Procyclicality of public debt				Procyclicali	ty of public debt
Year Country	WRW	AR(1)	Year	Country	WRW	AR(1)
			1972	Austria	-0.849	-0.345
			1973	Austria	-0.797	-0.362
			1974	Austria	-0.746	-0.342
			1975	Austria	-0.698	-0.332
			1976	Austria	-0.652	-0.290
			1977	Austria	-0.608	-0.247
			1978	Austria	-0.568	-0.253
			1979	Austria	-0.535	-0.259
			1980	Austria	-0.512	-0.250
			1981	Austria	-0.500	-0.233
			1982	Austria	-0.497	-0.224
			1983	Austria	-0.501	-0.215
			1984	Austria	-0.508	-0.188
			1985	Austria	-0.514	-0.117
			1986	Austria	-0.515	-0.115
			1987	Austria	-0.508	-0.079
			1988	Austria	-0.487	-0.034
1989 Australia	-0.337	-0.693	1989	Austria	-0.449	-0.006
1990 Australia	-0.542	-0.700	1990	Austria	-0.395	0.008
1991 Australia	-0.780	-0.724	1991	Austria	-0.329	-0.048
1992 Australia	-1.032	-0.786	1992	Austria	-0.262	-0.093
1993 Australia	-1.278	-0.929	1993	Austria	-0.199	-0.063
1994 Australia	-1.503	-1.154	1994	Austria	-0.142	-0.034
1995 Australia	-1.700	-1.222	1995	Austria	-0.086	-0.005
1996 Australia	-1.872	-1.292	1996	Austria	-0.031	0.034
1997 Australia	-2.025	-1.363	1997	Austria	0.021	0.064
1998 Australia	-2.172	-1.436	1998	Austria	0.063	0.090
1999 Australia	-2.322	-1.451	1999	Austria	0.091	0.130
2000 Australia	-2.485	-1.438	2000	Austria	0.104	0.083
2001 Australia	-2.665	-1.460	2001	Austria	0.106	0.090
2002 Australia	-2.864	-1.447	2002	Austria	0.102	0.087
2003 Australia	-3.078	-1.452	2003	Austria	0.100	0.081
2004 Australia	-3.297	-1.444	2004	Austria	0.102	0.024
2005 Australia	-3.509	-1.443	2005	Austria	0.112	0.017

## **Appendix 2: Procyclicality estimates**

		Procyclicality of public debt				Procyclicality of public del	
Year	Country	WRW	AR(1)	Year	Country	WRW	AR(1)
1972	Belgium	0.371	0.145	-			
1973	Belgium	0.377	0.119				
1974	Belgium	0.374	0.154				
1975	Belgium	0.355	0.204				
1976	Belgium	0.307	0.255				
1977	Belgium	0.224	0.317				
1978	Belgium	0.106	0.374				
1979	Belgium	-0.037	0.431				
1980	Belgium	-0.186	0.526				
1981	Belgium	-0.324	0.423	1981	Canada	-0.318	-0.436
1982	Belgium	-0.438	0.334	1982	Canada	-0.355	-0.439
1983	Belgium	-0.524	0.314	1983	Canada	-0.395	-0.541
1984	Belgium	-0.579	0.325	1984	Canada	-0.435	-0.524
1985	Belgium	-0.603	0.345	1985	Canada	-0.473	-0.538
1986	Belgium	-0.597	0.334	1986	Canada	-0.506	-0.546
1987	Belgium	-0.564	0.269	1987	Canada	-0.536	-0.554
1988	Belgium	-0.506	0.243	1988	Canada	-0.562	-0.561
1989	Belgium	-0.431	0.212	1989	Canada	-0.589	-0.620
1990	Belgium	-0.352	0.253	1990	Canada	-0.624	-0.740
1991	Belgium	-0.277	0.232	1991	Canada	-0.673	-0.795
1992	Belgium	-0.206	0.351	1992	Canada	-0.745	-0.881
1993	Belgium	-0.119	0.409	1993	Canada	-0.842	-0.970
1994	Belgium	0.025	0.495	1994	Canada	-0.960	-0.929
1995	Belgium	0.245	0.573	1995	Canada	-1.088	-0.884
1996	Belgium	0.497	0.636	1996	Canada	-1.207	-0.802
1997	Belgium	0.691	0.634	1997	Canada	-1.303	-0.780
1998	Belgium	0.768	0.635	1998	Canada	-1.371	-0.767
1999	Belgium	0.736	0.629	1999	Canada	-1.420	-0.793
2000	Belgium	0.634	0.613	2000	Canada	-1.461	-0.829
2001	Belgium	0.505	0.647	2001	Canada	-1.496	-0.840
2002	Belgium	0.384	0.665	2002	Canada	-1.525	-0.852
2003	Belgium	0.293	0.685	2003	Canada	-1.540	-0.856
2004	Belgium	0.239	0.631	2004	Canada	-1.539	-0.856
2005	Belgium	0.224	0.617	2005	Canada	-1.519	-0.856

		Procyclicality	of public debt			Procyclicality	of public debt
Year	Country	WRW	AR(1)	Year	Country	WRW	AR(1)
1973	Germany	-0.153	-0.165				
1974	Germany	-0.116	-0.202				
1975	Germany	-0.091	-0.215				
1976	Germany	-0.077	-0.197				
1977	Germany	-0.072	-0.167				
1978	Germany	-0.078	-0.101				
1979	Germany	-0.093	-0.134				
1980	Germany	-0.115	-0.198				
1981	Germany	-0.144	-0.251	1981	Denmark	-2.526	-3.854
1982	Germany	-0.182	-0.314	1982	Denmark	-2.583	-4.098
1983	Germany	-0.234	-0.377	1983	Denmark	-2.642	-4.061
1984	Germany	-0.307	-0.430	1984	Denmark	-2.713	-3.863
1985	Germany	-0.405	-0.496	1985	Denmark	-2.806	-3.694
1986	Germany	-0.523	-0.567	1986	Denmark	-2.928	-3.476
1987	Germany	-0.653	-0.640	1987	Denmark	-3.082	-3.587
1988	Germany	-0.790	-0.710	1988	Denmark	-3.264	-3.664
1989	Germany	-0.933	-0.779	1989	Denmark	-3.464	-3.725
1990	Germany	-1.079	-0.810	1990	Denmark	-3.661	-3.800
1991	Germany	-1.217	-0.840	1991	Denmark	-3.830	-3.884
1992	Germany	-1.336	-0.818	1992	Denmark	-3.948	-4.032
1993	Germany	-1.430	-0.835	1993	Denmark	-4.004	-4.206
1994	Germany	-1.501	-0.801	1994	Denmark	-4.001	-3.980
1995	Germany	-1.558	-0.858	1995	Denmark	-3.946	-3.768
1996	Germany	-1.610	-0.783	1996	Denmark	-3.846	-3.556
1997	Germany	-1.665	-0.758	1997	Denmark	-3.704	-3.351
1998	Germany	-1.726	-0.764	1998	Denmark	-3.522	-3.200
1999	Germany	-1.793	-0.746	1999	Denmark	-3.297	-3.112
2000	Germany	-1.862	-0.772	2000	Denmark	-3.022	-2.856
2001	Germany	-1.927	-0.811	2001	Denmark	-2.688	-2.580
2002	Germany	-1.985	-0.851	2002	Denmark	-2.286	-2.404
2003	Germany	-2.032	-0.860	2003	Denmark	-1.816	-2.255
2004	Germany	-2.070	-0.881	2004	Denmark	-1.288	-2.259
2005	Germany	-2.100	-0.899	2005	Denmark	-0.724	-2.274

		Procyclical	ity of public deb	t		Procyclicali	ty of public debt
Year	Country	WRW	AR(1)	Year	Country	WRW	AR(1)
				1976	Finland	-1.609	-1.340
				1977	Finland	-1.559	-1.354
1978	Spain	-3.334	-2.535	1978	Finland	-1.509	-1.374
1979	Spain	-3.121	-2.566	1979	Finland	-1.464	-1.384
1980	Spain	-2.892	-2.596	1980	Finland	-1.427	-1.394
1981	Spain	-2.655	-2.577	1981	Finland	-1.402	-1.408
1982	Spain	-2.419	-2.653	1982	Finland	-1.396	-1.417
1983	Spain	-2.194	-2.680	1983	Finland	-1.415	-1.424
1984	Spain	-1.993	-2.606	1984	Finland	-1.462	-1.422
1985	Spain	-1.829	-2.332	1985	Finland	-1.538	-1.448
1986	Spain	-1.711	-2.096	1986	Finland	-1.635	-1.474
1987	Spain	-1.642	-1.976	1987	Finland	-1.739	-1.505
1988	Spain	-1.616	-1.860	1988	Finland	-1.830	-1.547
1989	Spain	-1.625	-1.697	1989	Finland	-1.892	-1.642
1990	Spain	-1.666	-1.668	1990	Finland	-1.920	-1.819
1991	Spain	-1.738	-1.771	1991	Finland	-1.918	-1.967
1992	Spain	-1.847	-1.859	1992	Finland	-1.893	-2.284
1993	Spain	-1.992	-1.941	1993	Finland	-1.854	-1.738
1994	Spain	-2.164	-1.983	1994	Finland	-1.804	-1.411
1995	Spain	-2.348	-2.207	1995	Finland	-1.748	-1.610
1996	Spain	-2.522	-2.350	1996	Finland	-1.684	-1.389
1997	Spain	-2.674	-2.254	1997	Finland	-1.613	-1.367
1998	Spain	-2.796	-2.284	1998	Finland	-1.534	-1.221
1999	Spain	-2.890	-2.259	1999	Finland	-1.447	-1.026
2000	Spain	-2.962	-2.255	2000	Finland	-1.355	-0.942
2001	Spain	-3.018	-2.261	2001	Finland	-1.261	-0.907
2002	Spain	-3.064	-2.257	2002	Finland	-1.168	-0.887
2003	Spain	-3.104	-2.253	2003	Finland	-1.077	-0.876
2004	Spain	-3.140	-2.249	2004	Finland	-0.988	-0.859
2005	Spain	-3.172	-2.244	2005	Finland	-0.897	-0.843

	Procyclicalit	y of public of	debt		Procyclicali	ty of public debt
Year Country	ŴRW	AR(1)	Year	Country	WRW	AR(1)
			1971	United Kingdom	-0.321	-0.749
			1972	United Kingdom	-0.174	-0.730
			1973	United Kingdom	-0.023	-0.720
			1974	United Kingdom	0.123	-0.737
			1975	United Kingdom	0.254	-0.752
			1976	United Kingdom	0.357	-0.687
			1977	United Kingdom	0.421	-0.610
1978 France	0.708	0.491	1978	United Kingdom	0.438	-0.509
1979 France	0.615	0.477	1979	United Kingdom	0.402	-0.407
1980 France	0.536	0.453	1980	United Kingdom	0.313	-0.309
1981 France	0.466	0.424	1981	United Kingdom	0.182	-0.076
1982 France	0.400	0.317	1982	United Kingdom	0.028	0.003
1983 France	0.328	0.291	1983	United Kingdom	-0.125	-0.226
1984 France	0.244	0.220	1984	United Kingdom	-0.262	-0.617
1985 France	0.147	0.123	1985	United Kingdom	-0.373	-0.617
1986 France	0.043	-0.047	1986	United Kingdom	-0.463	-0.781
1987 France	-0.060	-0.237	1987	United Kingdom	-0.548	-0.987
1988 France	-0.153	-0.357	1988	United Kingdom	-0.653	-1.319
1989 France	-0.236	-0.484	1989	United Kingdom	-0.805	-1.627
1990 France	-0.316	-0.631	1990	United Kingdom	-1.020	-1.882
1991 France	-0.402	-0.725	1991	United Kingdom	-1.291	-2.080
1992 France	-0.504	-0.794	1992	United Kingdom	-1.591	-2.343
1993 France	-0.624	-0.870	1993	United Kingdom	-1.887	-2.608
1994 France	-0.758	-0.942	1994	United Kingdom	-2.153	-2.453
1995 France	-0.893	-1.067	1995	United Kingdom	-2.377	-2.541
1996 France	-1.016	-1.017	1996	United Kingdom	-2.553	-2.507
1997 France	-1.121	-1.032	1997	United Kingdom	-2.681	-2.531
1998 France	-1.207	-1.116	1998	United Kingdom	-2.767	-2.536
1999 France	-1.281	-1.054	1999	United Kingdom	-2.826	-2.536
2000 France	-1.349	-1.107	2000	United Kingdom	-2.876	-2.538
2001 France	-1.417	-1.170	2001	United Kingdom	-2.932	-2.598
2002 France	-1.488	-1.221	2002	United Kingdom	-3.000	-2.613
2003 France	-1.559	-1.271	2003	United Kingdom	-3.073	-2.627
2004 France	-1.625	-1.338	2004	United Kingdom	-3.136	-2.625
2005 France	-1.679	-1.374	2005	United Kingdom	-3.167	-2.622

		Procyclicalit	ality of public debt			Procyclicality of public de	
Year	Country	WRW	AR(1)	Year	Country	WRW	AR(1)
1975	Greece	-0.109					
1976	Greece	-0.186					
1977	Greece	-0.269					
1978	Greece	-0.353		1978	Ireland	-3.113	-0.142
1979	Greece	-0.434		1979	Ireland	-3.136	-0.128
1980	Greece	-0.505		1980	Ireland	-3.135	-0.358
1981	Greece	-0.563		1981	Ireland	-3.104	-0.462
1982	Greece	-0.601		1982	Ireland	-3.038	-0.763
1983	Greece	-0.615		1983	Ireland	-2.927	-1.073
1984	Greece	-0.598		1984	Ireland	-2.764	-1.059
1985	Greece	-0.547		1985	Ireland	-2.545	-1.115
1986	Greece	-0.464		1986	Ireland	-2.277	-1.279
1987	Greece	-0.365		1987	Ireland	-1.982	-1.043
1988	Greece	-0.277		1988	Ireland	-1.702	-0.971
1989	Greece	-0.232		1989	Ireland	-1.475	-0.959
1990	Greece	-0.256		1990	Ireland	-1.311	-0.947
1991	Greece	-0.354		1991	Ireland	-1.183	-0.917
1992	Greece	-0.507		1992	Ireland	-1.059	-0.894
1993	Greece	-0.675		1993	Ireland	-0.925	-0.967
1994	Greece	-0.815		1994	Ireland	-0.784	-0.633
1995	Greece	-0.891		1995	Ireland	-0.649	-0.575
1996	Greece	-0.892		1996	Ireland	-0.531	-0.482
1997	Greece	-0.828		1997	Ireland	-0.439	-0.449
1998	Greece	-0.721		1998	Ireland	-0.378	-0.439
1999	Greece	-0.591		1999	Ireland	-0.348	-0.418
2000	Greece	-0.458		2000	Ireland	-0.343	-0.510
2001	Greece	-0.333		2001	Ireland	-0.354	-0.407
2002	Greece	-0.225		2002	Ireland	-0.373	-0.408
2003	Greece	-0.140		2003	Ireland	-0.396	-0.414
2004	Greece	-0.077		2004	Ireland	-0.419	-0.416
2005	Greece	-0.035		2005	Ireland	-0.440	-0.411

	Procyclicality of public debt		ebt		Procyclica	Procyclicality of public debt	
Year Country	WRW	AR(1)	Year	Country	WRW	AR(1)	
			1965	Italy	1.193	0.280	
			1966	Italy	1.162	0.289	
			1967	Italy	1.141	0.233	
			1968	Italy	1.125	0.176	
			1969	Italy	1.107	0.104	
			1970	Italy	1.078	0.062	
			1971	Italy	1.026	0.165	
			1972	Italy	0.940	0.251	
			1973	Italy	0.814	0.337	
			1974	Italy	0.647	0.368	
			1975	Italy	0.451	0.282	
			1976	Italy	0.243	0.215	
			1977	Italy	0.049	0.152	
			1978	Italy	-0.111	0.092	
			1979	Italy	-0.224	0.027	
			1980	Italy	-0.291	0.018	
1981 Iceland	-1.908	-1.588	1981	Italy	-0.317	0.037	
1982 Iceland	-1.864	-1.442	1982	Italy	-0.309	0.084	
1983 Iceland	-1.815	-1.479	1983	Italy	-0.268	0.140	
1984 Iceland	-1.759	-1.445	1984	Italy	-0.191	0.162	
1985 Iceland	-1.697	-1.364	1985	Italy	-0.073	0.183	
1986 Iceland	-1.630	-1.309	1986	Italy	0.084	0.295	
1987 Iceland	-1.565	-1.234	1987	Italy	0.273	0.365	
1988 Iceland	-1.507	-1.207	1988	Italy	0.476	0.462	
1989 Iceland	-1.464	-1.181	1989	Italy	0.666	0.566	
1990 Iceland	-1.437	-1.161	1990	Italy	0.818	0.753	
1991 Iceland	-1.428	-1.146	1991	Italy	0.910	0.814	
1992 Iceland	-1.433	-1.248	1992	Italy	0.929	0.897	
1993 Iceland	-1.444	-1.406	1993	Italy	0.866	1.017	
1994 Iceland	-1.454	-1.425	1994	Italy	0.722	0.758	
1995 Iceland	-1.457	-1.336	1995	Italy	0.501	0.725	
1996 Iceland	-1.448	-1.169	1996	Italy	0.220	0.676	
1997 Iceland	-1.424	-1.001	1997	Italy	-0.093	0.679	
1998 Iceland	-1.385	-0.828	1998	Italy	-0.399	0.624	
1999 Iceland	-1.332	-0.655	1999	Italy	-0.661	0.620	
2000 Iceland	-1.260	-0.377	2000	Italy	-0.861	0.555	
2001 Iceland	-1.162	-0.005	2001	Italy	-1.001	0.489	
2002 Iceland	-1.026	-0.045	2002	Italy	-1.100	0.430	
2003 Iceland	-0.844	-0.081	2003	Italy	-1.171	0.374	
2004 Iceland	-0.612	-0.092	2004	Italy	-1.224	0.322	
2005 Iceland	-0.334	-0.086	2005	Italy	-1.262	0.296	

	Procyclicality of public debt		ot		Procyclicali	ty of public debt
Year Country	WRW	AR(1)	Year	Country	WRW	AR(1)
1971 Japan	-1.564	-1.220				
1972 Japan	-1.552	-1.242	1972	Netherlands	-0.486	-0.469
1973 Japan	-1.539	-1.280	1973	Netherlands	-0.528	-0.471
1974 Japan	-1.524	-1.287	1974	Netherlands	-0.570	-0.480
1975 Japan	-1.502	-1.336	1975	Netherlands	-0.610	-0.490
1976 Japan	-1.475	-1.427	1976	Netherlands	-0.647	-0.497
1977 Japan	-1.451	-1.449	1977	Netherlands	-0.678	-0.506
1978 Japan	-1.448	-1.466	1978	Netherlands	-0.705	-0.522
1979 Japan	-1.487	-1.452	1979	Netherlands	-0.725	-0.537
1980 Japan	-1.589	-1.435	1980	Netherlands	-0.737	-0.553
1981 Japan	-1.760	-1.436	1981	Netherlands	-0.739	-0.563
1982 Japan	-1.982	-1.439	1982	Netherlands	-0.728	-0.590
1983 Japan	-2.232	-1.444	1983	Netherlands	-0.702	-0.638
1984 Japan	-2.490	-1.444	1984	Netherlands	-0.662	-0.616
1985 Japan	-2.747	-1.458	1985	Netherlands	-0.611	-0.601
1986 Japan	-2.984	-1.486	1986	Netherlands	-0.552	-0.522
1987 Japan	-3.158	-1.464	1987	Netherlands	-0.494	-0.454
1988 Japan	-3.212	-1.506	1988	Netherlands	-0.450	-0.440
1989 Japan	-3.127	-1.544	1989	Netherlands	-0.439	-0.408
1990 Japan	-2.939	-1.572	1990	Netherlands	-0.476	-0.378
1991 Japan	-2.713	-1.603	1991	Netherlands	-0.559	-0.469
1992 Japan	-2.496	-1.490	1992	Netherlands	-0.666	-0.560
1993 Japan	-2.304	-1.412	1993	Netherlands	-0.771	-0.654
1994 Japan	-2.131	-1.332	1994	Netherlands	-0.879	-0.753
1995 Japan	-1.958	-1.270	1995	Netherlands	-1.010	-0.862
1996 Japan	-1.763	-1.201	1996	Netherlands	-1.170	-0.984
1997 Japan	-1.536	-1.140	1997	Netherlands	-1.341	-1.102
1998 Japan	-1.277	-1.090	1998	Netherlands	-1.498	-1.174
1999 Japan	-0.998	-1.015	1999	Netherlands	-1.627	-1.283
2000 Japan	-0.714	-0.872	2000	Netherlands	-1.725	-1.408
2001 Japan	-0.440	-0.731	2001	Netherlands	-1.796	-1.416
2002 Japan	-0.186	-0.618	2002	Netherlands	-1.847	-1.454
2003 Japan	0.044	-0.637	2003	Netherlands	-1.881	-1.492
2004 Japan	0.247	-0.634	2004	Netherlands	-1.904	-1.535
2005 Japan	0.425	-0.631	2005	Netherlands	-1.918	-1.554

		Procyclicality of public debt				Procyclicality of public debt	
Year	Country	WRW	AR(1)	Year	Country	WRW	AR(1)
1971	Norway	1.080	1.346				
1972	Norway	1.244	1.266				
1973	Norway	1.396	1.275				
1974	Norway	1.531	1.193				
1975	Norway	1.645	1.207				
1976	Norway	1.738	1.056				
1977	Norway	1.812	1.447				
1978	Norway	1.869	1.391				
1979	Norway	1.913	1.094				
1980	Norway	1.941	1.062				
1981	Norway	1.951	1.083				
1982	Norway	1.937	1.129				
1983	Norway	1.893	1.168				
1984	Norway	1.813	1.154				
1985	Norway	1.700	1.153				
1986	Norway	1.555	1.125				
1987	Norway	1.384	0.830				
1988	Norway	1.189	0.698				
1989	Norway	0.975	0.539				
1990	Norway	0.749	0.589				
1991	Norway	0.524	0.450				
1992	Norway	0.313	-0.061				
1993	Norway	0.121	-0.635				
1994	Norway	-0.053	-0.830				
1995	Norway	-0.218	-1.019	1995	New Zealand	-0.303	-0.252
1996	Norway	-0.384	-1.201	1996	New Zealand	-0.396	-0.252
1997	Norway	-0.558	-1.374	1997	New Zealand	-0.494	-0.208
1998	Norway	-0.749	-1.478	1998	New Zealand	-0.592	-0.172
1999	Norway	-0.966	-1.458	1999	New Zealand	-0.687	-0.150
2000	Norway	-1.215	-1.384	2000	New Zealand	-0.771	-0.136
2001	Norway	-1.501	-1.375	2001	New Zealand	-0.838	-0.127
2002	Norway	-1.817	-1.327	2002	New Zealand	-0.884	-0.135
2003	Norway	-2.146	-1.270	2003	New Zealand	-0.905	-0.143
2004	Norway	-2.456	-1.254	2004	New Zealand	-0.898	-0.145
2005	Norway	-2.703	-1.238	2005	New Zealand	-0.866	-0.145

	Procyclicality of public debt				Procyclicality	/ of public debt
Year Country	WRW	AR(1)	Year	Country	WRW	AR(1)
1971 Portugal	-2.163	-1.696	1971	Sweden	-0.856	-0.936
1972 Portugal	-2.226	-1.632	1972	Sweden	-1.016	-0.929
1973 Portugal	-2.278	-1.508	1973	Sweden	-1.181	-0.913
1974 Portugal	-2.310	-1.616	1974	Sweden	-1.348	-0.936
1975 Portugal	-2.308	-1.670	1975	Sweden	-1.513	-1.021
1976 Portugal	-2.259	-1.689	1976	Sweden	-1.670	-1.180
1977 Portugal	-2.162	-1.710	1977	Sweden	-1.814	-1.210
1978 Portugal	-2.027	-1.759	1978	Sweden	-1.940	-1.408
1979 Portugal	-1.873	-1.809	1979	Sweden	-2.048	-1.644
1980 Portugal	-1.718	-1.618	1980	Sweden	-2.138	-1.882
1981 Portugal	-1.568	-1.560	1981	Sweden	-2.216	-2.070
1982 Portugal	-1.421	-1.502	1982	Sweden	-2.286	-2.253
1983 Portugal	-1.274	-1.489	1983	Sweden	-2.353	-2.326
1984 Portugal	-1.122	-1.364	1984	Sweden	-2.416	-2.463
1985 Portugal	-0.971	-1.103	1985	Sweden	-2.480	-2.593
1986 Portugal	-0.826	-0.752	1986	Sweden	-2.546	-2.701
1987 Portugal	-0.693	-1.002	1987	Sweden	-2.621	-2.897
1988 Portugal	-0.576	-0.948	1988	Sweden	-2.708	-2.965
1989 Portugal	-0.479	-0.874	1989	Sweden	-2.805	-3.025
1990 Portugal	-0.404	-0.830	1990	Sweden	-2.906	-3.171
1991 Portugal	-0.358	-0.765	1991	Sweden	-3.000	-3.062
1992 Portugal	-0.346	-1.029	1992	Sweden	-3.079	-2.940
1993 Portugal	-0.375	-1.039	1993	Sweden	-3.138	-2.208
1994 Portugal	-0.444	-1.046	1994	Sweden	-3.177	-2.430
1995 Portugal	-0.548	-1.062	1995	Sweden	-3.199	-2.425
1996 Portugal	-0.677	-1.028	1996	Sweden	-3.211	-2.394
1997 Portugal	-0.821	-0.994	1997	Sweden	-3.216	-2.365
1998 Portugal	-0.969	-0.952	1998	Sweden	-3.220	-2.477
1999 Portugal	-1.111	-0.862	1999	Sweden	-3.224	-2.536
2000 Portugal	-1.240	-0.805	2000	Sweden	-3.228	-2.552
2001 Portugal	-1.350	-0.702	2001	Sweden	-3.231	-2.550
2002 Portugal	-1.440	-0.641	2002	Sweden	-3.235	-2.551
2003 Portugal	-1.512	-0.562	2003	Sweden	-3.238	-2.552
2004 Portugal	-1.571	-0.531	2004	Sweden	-3.241	-2.553
2005 Portugal	-1.624	-0.549	2005	Sweden	-3.241	-2.551

		Procyclicality of public debt		
Year	Country	WRW	AR(1)	
1964	United States	-1.093	-0.962	
1965	United States	-1.144	-0.964	
1966	United States	-1.187	-0.981	
1967	United States	-1.219	-1.016	
1968	United States	-1.233	-1.045	
1969	United States	-1.226	-1.066	
1970	United States	-1.196	-1.056	
1971	United States	-1.141	-1.054	
1972	United States	-1.064	-1.029	
1973	United States	-0.970	-1.002	
1974	United States	-0.869	-0.981	
1975	United States	-0.771	-0.972	
1976	United States	-0.679	-0.900	
1977	United States	-0.596	-0.827	
1978	United States	-0.529	-0.753	
1979	United States	-0.479	-0.728	
1980	United States	-0.448	-0.720	
1981	United States	-0.432	-0.721	
1982	United States	-0.428	-0.763	
1983	United States	-0.433	-0.822	
1984	United States	-0.445	-0.904	
1985	United States	-0.466	-0.973	
1986	United States	-0.498	-1.023	
1987	United States	-0.550	-1.078	
1988	United States	-0.631	-1.139	
1989	United States	-0.752	-1.208	
1990	United States	-0.920	-1.288	
1991	United States	-1.139	-1.366	
1992	United States	-1.398	-1.412	
1993	United States	-1.674	-1.464	
1994	United States	-1.934	-1.516	
1995	United States	-2.145	-1.567	
1996	United States	-2.286	-1.630	
1997	United States	-2.352	-1.694	
1998	United States	-2.346	-1.759	
1999	United States	-2.275	-1.822	
2000	United States	-2.148	-1.911	
2001	United States	-1.984	-1.923	
2002	United States	-1.807	-1.958	
2003	United States	-1.637	-1.979	
2004	United States	-1.487	-1.987	
2005	United States	-1.363	-1.986	

### **Appendix 3: the impact of budgetary institutions**

		AR(1)			WRW		
	OLS	Country	Country	OLS	Country	Country	
		f.e.	year f.e.		f.e.	year f.e.	
Private credit/GDP	-0.869	-1.555	-1.631	-0.612	-1.282	-1.448	
	(0.127)***	(0.133)***	(0.136)***	(0.097)***	(0.137)***	(0.109)***	
EMU country	1.448			0.794			
	(0.170)***			(0.146)***			
Standard error	-0.422			0.345			
of GDP growth	(5.013)			(2.732)			
Lag(log (real GDP	-0.183	-0.454	-0.306	-0.323	0.003	0.778	
per capita))	(0.093)*	(0.335)	(0.635)	(0.068)***	(0.349)	(0.503)	
Openness	0.017	0.009	0.021	0.010	0.002	0.042	
	(0.002)***	(0.004)**	(0.005)***	(0.002)***	(0.004)	(0.006)***	
Government share	0.014	-0.026	-0.029	0.024	-0.019	-0.014	
of GDP (in %)	(0.010)	(0.006)***	(0.006)***	(0.005)***	(0.005)***	(0.005)**	
Inflation targeting	-0.179	-0.294	-0.250	-0.666	-0.486	-0.395	
	(0.158)	(0.102)***	(0.112)**	(0.105)***	(0.104)***	(0.125)***	
Delegation state	0.417			0.086			
	(0.174)**			(0.147)			
Contracts index*	-0.569	0.761	0.846	-0.237	0.236	0.551	
(1-Delegation state)	(0.292)*	(0.218)***	(0.227)***	(0.162)	(0.238)	(0.243)**	
Delegation index*	0.970	0.709	0.864	1.373	1.684	2.415	
Delegation state	(0.239)***	(0.699)	(0.694)	(0.232)***	(0.691)**	(0.509)***	
Observations	230	230	230	251	251	251	
R-squared	0.67	0.94	0.95	0.68	0.87	0.91	
Robust standard errors in parentheses							
* significant at 10%; ** sig	nificant at {	5%; *** sigr	ificant at 1%				

Table 1: The determinants of government debt procyclicality, including budgetary institutions

Note: The explained variable is the coefficient on the GDP gap composite variable from equation 1, estimated using the AR(1) MCMC method for columns 1-3, and the Gaussian-weighted rolling window method for columns 4-6. EMU country is a dummy variable equal to 1 for all countries that are part of the EMU as of 2006. The delegation dummy is 1 for delegation states, i.e. states where the management of the budget is in the main delegated to the finance minister; the dummy is 0 for contract states, i.e. states where the budget is decided through multi-annual targets and fiscal procedures. The contracts index measures how strict the implementation of the multi-annual targets is; the delegation index measures how much power the finance minister has. Source: OECD Economic Outlook, Levine dataset, Barro Lee dataset, Penn World Tables 6.1. The delegation state dummy, contracts and delegation indices are from data kindly provided by Juergen von Hagen.