Session 2

GOVERNMENT BUDGETS AND POTENTIAL GROWTH

DEBT AND GROWTH: NEW EVIDENCE FOR THE EURO AREA

Anja Baum,[*] Cristina Checherita-Westphal[**] and Philipp Rother[***]

Against the background of the euro area sovereign debt crisis, our paper investigates the relationship between public debt and economic growth and adds to the existing literature in the following ways. First, we use a dynamic threshold panel methodology in order to analyse the non-linear impact of public debt on GDP growth. Second, we focus on 12 euro area countries for the period 1990-2010, therefore adding to the current discussion on debt sustainability in the euro area. Our empirical results suggest that the short-run impact of debt on GDP growth is positive and highly statistically significant, but decreases to around zero and loses significance beyond public debt-to-GDP ratios of around 67 per cent. This result is robust throughout most of our specifications, in the dynamic and non-dynamic threshold models alike. For high debt-to-GDP ratios (above 95 per cent), additional debt has a negative impact on economic activity. Furthermore, we can show that the long-term interest rate is subject to increased pressure when the public debt-to-GDP ratio is above 70 per cent, broadly supporting the above findings.

Non-technical summary

The fiscal situation remains challenging in much of the developed world, particularly in the euro area. Market concerns with respect to fiscal sustainability in vulnerable euro area countries have grown and spread to other countries. Against this background, empirical research has started to focus on estimates of the impact of public debt on economic activity.

Looking at the debt-growth nexus literature, two characteristics become apparent. First, only few studies focus on euro area countries. This is insofar surprising as the euro area/EMU offers economic dynamics that are rarely found anywhere else in the world. Moreover, this group of countries is in need of special attention given the current sovereign debt crisis. Second, most of the empirical studies still rely on linear estimation frameworks. Only more recently has the focus been shifting to non-linear threshold analyses, inter alia by employing the threshold panel methodology developed by Hansen (1999). However, all of these studies focus exclusively on non-dynamic panel models, which might lead to inconsistent results due to the persistence of GDP growth rates. To our best knowledge our paper is the first to account for this problem through application of a dynamic threshold framework. Comparing the results from dynamic and non-dynamic threshold estimations provides an idea not only about the robustness of the impact of debt on growth, but also about the robustness of the estimated optimal debt ratios.

Our paper adds to the existing literature in the following ways. First, we use a dynamic threshold panel methodology in order to analyse the non-linear impact of public debt on GDP growth. Second, in comparison to the majority of empirical studies we analyse the short-run relationship between public debt and economic growth using yearly data. Third, our focus on EMU

[*] University of Cambridge, Faculty of Economics, Austin Robinson Building, Sidgwick Avenue Cambridge, CB3 9DD, UK. E-mail: ab862@cam.ac.uk

[**] European Central Bank, Fiscal Policies Division, Kaiserstrasse 29, D-60311 Frankfurt am Main, Germany. E mail: cristina.checherita@ecb.europa.eu

[***] European Central Bank, Fiscal Policies Division, Kaiserstrasse 29, D-60311 Frankfurt am Main, Germany. E-mail: philipp.rother@ecb.europa.eu

We are grateful to participants of an ECB seminar, and in particular to B. Born, G. Callegari, J. Cimadomo, F. Holm-Hadulla, A. Klemm, G. Koester, D. Nautz and D. Tambakis for helpful comments on previous versions of the paper. The views expressed in this paper are those of the authors and do not necessarily reflect those of the European Central Bank.

data provides the opportunity to make specific policy inference, adding to the current discussion on the sustainability of debt dynamics in the euro area.

Our empirical results suggest the following. The short-run impact of debt on GDP growth is positive, but decreases to close to zero beyond public debt-to-GDP ratios of around 67 per cent (*i.e.*, up to this threshold, additional debt has a stimulating impact on growth). This result is robust throughout most of our specifications, in the dynamic and non-dynamic threshold model alike. For really high debt ratios (above 95 per cent), additional debt has a negative impact on economic activity. Confidence intervals for the thresholds are tight, that is (63; 69) for the lower threshold and broader at about (80; 100) for the upper one. Furthermore, we can show that the long-term interest rate is subject to increased pressure when the public debt-to-GDP ratio is above 70 per cent, broadly supporting the above findings.

1 Introduction

The current sovereign debt crisis with its epicenter in the euro area has forcefully revived the academic and policy debate on the economic impact of public debt. Market concerns with respect to fiscal sustainability in vulnerable euro area countries have grown and spread to other countries. Against this background, empirical research has started to focus on estimates of the impact of public debt on economic activity, inter alia by attempting to unveil possible non-linearities.

Nonetheless, the empirical literature on this topic remains scarce (see, for example, Schclarek, 2004; and Reinhart and Rogoff, 2010) and only few studies employ a non-linear impact analysis and are of particular interest for our paper. One of these is a contribution by Kumar and Woo (2010), who use dummy variables for pre-determined ranges of debt to show non-linear effects in a sample of emerging and advanced economies. They find that only very high (above 90 per cent of GDP) levels of debt have a significant and negative impact on growth. Another recent contribution is provided by Checherita and Rother (2010). Expressing growth as a quadratic functional form of debt in a sample of twelve euro area countries over a period starting in 1970, they find significant evidence for a concave (inverted U-shape) relationship. The debt turning point, beyond which debt starts having a negative impact on growth, is found at about 90-100 per cent of GDP.[1]

Papers that relate more closely to the non-linear panel threshold methodology we use in this analysis include the work by Chang and Chiang (2009) and Cecchetti, Mohanty and Zampolli (2011). Both of these papers employ the threshold methodology for non-dynamic panels. Chang and Chiang (2009) analyse a sample of 15 OECD countries and use yearly observations for the period 1990-2004. In a generalisation of the Hansen (1999) multiple regime panel threshold model, they run a regression of GDP per capita growth on the debt-to-GDP ratio and find two debt-to-GDP threshold values, 32.3 per cent and 66.25 per cent. Interestingly, the impact of the debt ratio is positive and significant in all three regimes, higher in the middle regime and lower in the two outer regimes. They thus cannot support the crowding-out view if the debt-to-GDP ratio is more than the threshold value.[2] Cecchetti, Mohanty and Zampolli (2011) use a sample of 18 OECD countries for the period 1980-2010 and obtain a threshold for government debt at 85 per cent of GDP. In contrast to Chang and Chiang (2009), they find a negative impact on growth in the high debt regime.

---

1 Confidence intervals for the debt turning points provided in Checherita and Rother (2010) suggest that the negative growth effect of high debt may start already from levels of around 70-80 per cent of GDP.

2 Chang and Chiang (2009) apply a panel smooth transition regression (PSTR), with a continuous transition function depending on an observable transition variable. In their additive version of this model, the transition function becomes an indicator function, with $I[A] = 1$ when event A occurs, and 0 otherwise. As a consequence, the additive PSTR model is equivalent to the multiple regime threshold model developed by Hansen (1999).

Going through the current empirical debt-growth nexus literature, three characteristics become apparent. First, none of the above mentioned papers uses a dynamic panel threshold approach. Because of the likely persistence in the economic growth rate, the neglect of such a dynamic specification might lead to inconsistent results. Including such dynamics, on the other hand, allows us to capture the effect of debt on growth after controlling for growth persistence, and in this way it is well suited for estimating short-run relationships. To our best knowledge, the current paper is the first to estimate a dynamic threshold model for the debt-growth nexus and then to compare the results of dynamic and static panel estimations. It thus also provides an idea about the robustness of results across different methodologies.

Second, most of the above papers study the long-term impact of debt on growth (Schclarek, 2004; Reinhart and Rogoff, 2010; Kumar and Woo, 2010; Checherita and Rother, 2010).[3] So far, the only exception has been Chang and Chiang (2009), who use exclusively yearly data and thus capture a short-term impact comparable to our focus. On the same note, most of the literature on short-term growth effects analyses fiscal multipliers of shocks to government expenditure or taxes (see Hemming *et al.*, 2002; and van Riet, 2010, for relevant surveys), and if the role of debt is accounted for, its influence is indirect. IMF (2008), for instance, finds that the impact of discretionary fiscal impulses on real GDP growth is contingent on the level of debt, *i.e.*, it is positive and larger at low government debt levels (relative to the sample average). Differently from these studies, the objective of the present paper is to investigate the direct (short-term) impact of debt on growth.

Third, Checherita and Rother (2010) has been so far the only paper focussing exclusively on euro area countries. This is surprising as the EMU offers economic dynamics that are rarely found elsewhere in the world. Moreover, with the current sovereign debt crisis, the euro area would be in need of particular attention, while averaging across OECD countries makes policy inferences difficult.

To summarise, our paper adds to the existing literature in the following ways. First, we use a dynamic threshold panel methodology, inter alia by adapting the methodology proposed in Hansen and Caner (2004), and use it to analyse the non-linear impact of public debt on GDP growth. To our best knowledge, a comparable approach has been applied only once before, in a contribution by Kremer, Bick and Nautz (2009), who analyse the non-linear impact of inflation on growth. Second, we study the short-run relationship between public debt and economic growth using yearly data. Third, our focus on EMU data provides the opportunity to make specific policy inference, adding to the current discussion on the sustainability of debt dynamics in the euro area.

The paper is organised as follows. Section 2 describes the employed methodology and Section 3 presents the data. The estimation results are shown in Section 4. Section 5 employs several robustness exercises, including a broad extension of the explanatory variable set and an analysis of the impact of debt on long-term interest rates. Section 6 concludes.

2 Methodology

In order to account for the persistence of the growth rate, we need a threshold model that allows for endogeneity. Caner and Hansen (2004) develop a threshold methodology for dynamic models, which has to be extended to a panel framework. With several differences as explained

3 Checherita and Rother (2010) use both yearly data for the dependent variable (and one year-lagged debt data), as well as 5-year overlapping and non-overlapping averages (with debt measured at the beginning of the 5-year period and estimates corrected in all cases for time autocorrelation), but do not find radically different results across the various specifications. Cecchetti, Mohanty and Zampolli (2011) use the (less conventional) long-term approach by employing only the 5-year overlapping average growth rates.

below, the extension we apply here has been first suggested by Kremer *et al.* (2009), who analyse the non-linear impact of inflation on growth within an Arellano and Bover (1995) estimation.[4]

The starting point for the threshold analysis is the specification of a linear model, which in the present case is a balanced panel of the form:

$$y_{it} = \mu_i + \chi y_{i,t-1} + \alpha X_{it} + u_{it} \tag{1}$$

$y_{i,t}$ is the dependent variable of country i at time t, $y_{i,t-1}$ is the endogenous regressor, in our case the lagged dependent variable, μ_i are the country specific fixed effects and X is a set of explanatory regressors. The error term μ_{it} is independent and identically distributed with mean zero and finite variance. The linear model can be estimated following the Arellano and Bond (1991) dynamic panel approach.[5]

We estimate the dynamic threshold model following the approach by Caner and Hansen (2004), who develop an estimator and an inference theory for models with endogenous variables and an exogenous threshold variable. Since Caner and Hansen (2004) do not apply their procedure to panel data we first have to make their framework suitable to deal with the country-specific fixed effects. While in a non-dynamic panel model the individual effects μ_i can be removed by mean differencing, in the dynamic panel mean differencing leads to inconsistent estimates due to the fact that the lagged dependent variable will always be correlated with the mean of the individual errors and thus with all of the transformed individual errors (see Arellano, 2003, p. 17). As an alternative we apply a strategy as first suggested in Kremer *et al.* (2009) and use forward orthogonal deviations[6] (1995). The method subtracts the average of all future available observations of a variable and makes it possible to maintain the uncorrelatedness of the error terms.[7]

The dynamic panel threshold model can be represented with:

$$y_{it} = \mu_i + \chi y_{i,t-1} + \alpha' x_{it} + \beta_1 d_{it} I(z_{it} \le z^*) + \beta_2 d_{it} I(z_{it} > z^*) + u_{it} \tag{2}$$

where x is a set of regime independent control variables, d is the set of variables allowed to switch between regimes, and l is an indicator function taking on the value 1 if the value of the threshold series z is below a specific threshold value z^*.

In the estimation of the dynamic panel model, we first run a reduced form regression of the endogenous variable on a set of instruments. For the lagged GDP growth rate we use higher lags of GDP growth as instruments and we can then replace $y_{i,t-1}$ in equation (2) with its predicted values $\hat{y}_{i,t-1}$.

After the reduced form regression the threshold model can be estimated, with the specific threshold value being determined following the strategy by Hansen (1999). The procedure includes three essential steps:

1) first, we conduct a series of least squares (LS) minimisations. That is, we estimate model (2) with 2SLS for each value of the threshold series z. The corresponding LS estimates of the

4 An alternative approach for a dynamic threshold model can be found in Cimadomo (2007). He extends the Hansen (1999) approach by a two stage procedure. In the first step, the autoregressive coefficient is estimated from a linear regression. In the second stage this coefficient is treated asknown and fixed in the non-linear panel regression model.

5 In contrast to our paper, Kremer *et al.* (2009) employ the Arellano and Bover (1995) estimator, as they focus on the central role of initial income for growth convergence. Due to the endogeneity of the lagged level of GDP, the application of Arellano and Bover (1995) is necessary. Since we focus on growth persistence and a short-run impact analysis, the Arellano and Bond (1991) estimation is more appropriate.

6 Programming codes for forward orthogonal deviations can be obtained from http://www.cemfi.es/ arellano.

7 An empirical Monte Carlo proof for the advantage of orthogonal deviations over mean deviations is found in Hayakawa (2009).

parameters and the sum of squared residuals are kept;[8]

2) in a second step the threshold value z^* is selected as the one which minimises the sum of squared residuals;
3) in a third step we test for the significance of the chosen z^*. Since the threshold value is not identified under the null of linearity, the distribution of a standard *F*-statistic is not chi-square. Hansen (2000) therefore proposes a bootstrap procedure with which the asymptotic null distribution of the heteroscedasticity adjusted test statistic can be approximated.[9]

Hence, we test for the threshold significance using the test statistic:

$$F_T = \sup_{z \varepsilon S} F_T(z) \tag{3}$$

where:

$$F_T(z) = T\left(\frac{\tilde{\sigma}_T^2 - \hat{\sigma}_T^2(z)}{\hat{\sigma}_T^2(z)}\right) \tag{4}$$

where $\hat{\sigma}_T^2 = \frac{1}{t}\sum_{t=1}^{T} \hat{u}_t^{\,2}$ is the estimated residual variance of the threshold and $\tilde{\sigma}_T^2$ is the residual variance of the corresponding linear model. Details of the testing procedure are described in the Appendix.

If we find a significant threshold value z^*, the slope coefficients of equation (2) are estimated with GMM.[10] For a more efficient weighting matrix in the coefficient estimation, we prefer the general GMM to the 2SLS estimator, and repeatedly predict the residuals to construct new covariance matrices of the moments after the initial 2SLS estimate.

We also allow for the possibility of more than one threshold and therefore more than two regimes (see Hansen 1999), but since a second threshold value turns out to be insignificant in most of the specifications it will be ignored in the following analysis, unless specified otherwise.

3 Data

3.1 Structural considerations

The model is estimated for 12 euro area countries Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain for yearly data starting with 1990. Using this relatively short time span offers a couple of advantages. First, the shorter period covers more accurately the process of EMU preparation and implementation and is thus less prone to structural changes and more comparable with today's economic conditions. More importantly, the debt-to-GDP ratio is found to be non-stationary upon inclusion of the previous decade (the 1980s). Using the longer time span we would not be able to fully rely on the results of

---

8 This step is repeated for each value of the threshold series on a specified subset of the series, which should be trimmed in order to assure a minimum number of observations in the resulting subsamples. In the non-dynamic model, the 2SLS estimator reduces to the simple LS estimator.

9 We test the null hypothesis of linearity against threshold non-linearity also allowing heteroscedasticity in the error terms. Caner and Hansen (2004) provide evidence that the distribution theory in Hansen (2000) is applicable to the case of 2SLS estimation. However, a full distribution theory for dynamic panels has not yet been provided (we thank Bruce Hansen for his comments). The specific coefficients on the explanatory variables of the dynamic model should thus be considered carefully. Since on the other hand the non-dynamic panel estimation might give inconsistent results due to omitted lagged variables, the direct comparison of both approaches will give an idea about the range in which the coefficients lie.

10 The slope coefficients of non-dynamic model are estimated by OLS.

the threshold testing procedure and, consequently, on the obtained threshold values.[11] Given the above, we base our main estimation models on the period 1990-2007/10 (we do, however, include a discussion on results from the year 1980 onwards in the robustness section).

We are analysing the impact of one-year lagged debt-to-GDP ratios on annual real GDP growth rates. We thus obtain a near contemporaneous effect, which gives us an idea of the short-term debt impact. Hence, a positive impact of debt on growth could be interpreted as a stimulating effect of additional debt. However, the possibility that long-term effects of high debt might be negative cannot be ruled out based on the yearly analysis.

3.2 *Endogenous, regime-dependent variable and other control variables*

The data used originates primarily from the European Commission AMECO database. The endogenous variable is the real GDP growth rate. As the single regime-dependent and threshold variable we use the debt-to-GDP ratio. Since this can be correlated with a range of other factors impacting on growth, we also control for a broad set of other explanatory variables. In the benchmark specification, we include the gross fixed capital formation as a share of GDP, trade openness (defined as imports plus exports as a share of GDP), and a dummy signalling the period of effective EMU membership. Moreover, under the robustness tests we control for other potentially relevant variables as identified in the theoretical and empirical growth literature, such as the initial level of GDP per capita, population growth, secondary education, a measure for the old dependency ratio, the unemployment rate, the budget balance and long- and short-run interest rates.

4 Estimation

4.1 *Benchmark model*

The benchmark model for the 12 EMU countries over the period 1990-2007 (first, excluding the current crisis years) is estimated in the following specification:

$$y_{it} = \mu_i + \chi y_{i,t-1} + \alpha_1 OPEN_{i,t-1} + \alpha_2 GCF_{i,t-1} + \alpha_3 EMU_{it}$$
$$+ \beta_1 d_{i,t-1} I(d_{i,t-1} \leq d^*) + \beta_2 d_{i,t-1} I(d_{i,t-1} > d^*) + u_{it} \quad (5)$$

where y is the GDP growth rate, $OPEN$ is the trade openness measure, GCF is the ratio of gross capital formation to GDP, EMU is the dummy variable which signals the EMU membership, and d is the debt-to-GDP series, with d^* being the debt-to-GDP threshold value. For the dynamic model, $y_{(t-1)}$ is replaced by the predicted values $\hat{y}_{(t-1)}$ obtained from the structural first stage regression of $y_{(t-1)}$ on the lags of $y_{(t-2)}$ to $y_{(t-8)}$. Of course, GDP growth in the structural equation could be dependent on more than one lag. However, we find a second and higher lags to be insignificant in all of our specifications, and therefore they will be ignored in the following analysis.

Table 1 shows the benchmark results for the non-dynamic and the dynamic panel threshold estimation. We can see some differences between the two models, but for both the direction and the significance of the coefficients are comparable. As such, trade openness has a significantly positive effect on GDP growth, the coefficient on investment is positive but insignificant and the EMU dummy is significantly negative. In the dynamic model the strongest impact on current growth comes from the past growth rate itself.

[11] Details on the distribution theory can be found in Hansen (2000).

Table 1

Benchmark Results, 1990-2007

Variable	Non-dynamic Panel		Dynamic Panel	
$y_{(t-1)}$			0.4583^{***}	*(0.1055)*
Openness	0.0148^{**}	*(0.0064)*	0.0172^{**}	*(0.0078)*
GCF	0.0539	*(0.0401)*	0.0184	*(0.0396)*
EMU	-0.0070^{**}	*(0.0034)*	-0.0099^{***}	*(0.0031)*
$d_{(t-1)}$ if $d \leq d^*$	0.0697^{***}	*(0.0209)*	0.0668^{***}	*(0.0148)*
$d_{(t-1)}$ if $d > d^*$	0.0082	*(0.0095)*	0.0124	*(0.0104)*
Threshold Estimate	$d^* = 0.6640$		$d^* = 0.6644$	
Bootstrap p-value	0.0630		0.0780	
Confidence Intervals	$0.6287 < d^* < 0.6831$		$0.6287 < d^* < 0.6908$	

Standard errors in brackets.
$^*/^{**}/^{***}$ indicate significance levels at the 10/5/1 per cent level.

Independent of the specifications, both models find a debt threshold value of around 0.664, which is significant at the 10 per cent level with p-values of 0.063 and 0.078 for the non-dynamic and the dynamic model, respectively. This threshold value splits the observations of the non-dynamic (dynamic) panel into 128 (125) observations in the lower, and 88 (91) observations in the upper regime. When the debt ratio is below 66.4 per cent of GDP, the impact of additional debt is significantly positive in both specifications, with coefficients corresponding to around 0.07 percentage point increase in the annual growth rate after a 1 percentage point increase in the debt-to-GDP ratio. If the debt ratio is above the threshold value, the impact reduces to values around zero, which are therefore insignificant.

This is a very strong result. Additional debt might have a positive impact on GDP growth due to stimulus effects of fiscal policy. However, once a debt threshold is reached this positive effect disappears or becomes insignificant.

4.2 Including the years 2008-10

We re-estimate the model including the crisis years 2008 to 2010. The results for the two threshold models are presented in Table 2. The threshold value of the non-dynamic model increases slightly to 71.7 per cent. At the same time, the regime-independent coefficients change notably compared to the benchmark results, with the GCF being the only positive and significant variable. The impact of debt on GDP growth also changes substantially. For the extended period, it is significantly positive in the lower regime, and significantly negative in the upper regime, while now diverging more in absolute size between the two specifications.

Including the years 2008 to 2010 in the dynamic specification gives the high threshold value of 95.6 per cent, which is significant at the 10 per cent level with a p-value of 0.098, resulting in

Table 2

Benchmark Results, 1990-2010

Variable	Non-dynamic Panel		Dynamic Panel	
$y_{(t-1)}$			0.3218^{***}	*(0.1245)*
Openness	–0.0082	*(0.0072*	0.0014	*(0.0058)*
GCF	0.1126^{**}	*(0.0529)*	0.0147	*(0.0568)*
EMU	–0.0071	*(0.0045)*	-0.0091^{**}	*(0.0036)*
$d_{(t-1)}$ if $d \leq d^*$	0.0470^{***}	*(0.0182)*	0.0351^{***}	*(0.0107)*
$d_{(t-1)}$ if $d > d^*$	-0.0411^{***}	*(0.0144)*	-0.0588^{***}	*(0.0200)*
Threshold Estimate	$d^* = 0.717$		$d^* = 0.956$	
Bootstrap p-value	0.0960		0.0980	
Confidence Intervals	$0.6287 < d^* < 0.7809$		$0.8140 < d^* < 1.0344$	

Standard errors in brackets.
$^*/^{**}/^{***}$ indicate significance levels at the 10/5/1 per cent level.
Threshold of 0.717 splits the sample into 168 observations in the lower and 85 in the upper regime.
Threshold of 0.956 splits the sample into 198 observations in the lower and 55 in the upper regime.

198 observations in the lower, and 55 observations in the upper regime.[12] Except for trade openness the regime-independent coefficients are more robust to changes in the time span than in the non-dynamic model (hence, the lagged GDP is significantly positive, GCF insignificant and the EMU dummy significantly negative). However, the changes for the regime dependent debt variable are comparable to the non-dynamic panel. In the lower regime, the impact of debt is positive at 0.035 per cent, while in the upper regime we obtain a larger negative impact of –0.059 per cent (both values being significant).

With a coefficient of 0.035 the impact in the lower regime decreases strongly compared to the value of 0.067 in the specification without the years 2008-10. However, since the introduction of the higher debt threshold leads to an average estimate over almost the entire original sample (plus a few new observations), we re-estimate the dynamic model with a second threshold, combining the multiple threshold estimation strategy by Hansen (1999) with our framework. We fix the first threshold at 95.6 per cent, and test for a second threshold in the lower sample. We indeed find a second threshold corresponding to the smallest sum of squares again to be 0.664, but it is insignificant with a p-value of 0.147. For illustration purposes the estimation results including the second threshold are shown in Table 3. Compared to the results of the dynamic model presented in Table 2, the debt impact in the lowest sample is now higher (0.0496), while the value of the second regime is insignificant and close to zero up to the threshold of 95.6 per cent of GDP. Afterwards, the debt impact remains negative, highly statistically significant and similar in size.

Hence, our results suggest that debt can have a stimulus effect on growth in the EMU up to a value of between 60 and 70 per cent of GDP. Above that, the growth impact becomes first insignificant, before turning negative for very high debt-to-GDP ratios.

---

[12] The reason for a higher threshold when the years 2008-10 are included is that the point of highest significance of the one break we are looking at shifts upwards. Using a data set up to 2007, we had only few observations with debt higher than 95 per cent of GDP.

Table 3

Second Threshold Value – Dynamic Panel

Variable	Dynamic	
$y_{(t-1)}$	0.3221***	(0.1245)
Openness	–0.0001	(0.0058)
GCF	0.0200	(0.0567)
EMU	–0.0092**	(0.0037)
$d_{(t-1)}$ if $d \leq 0.664$	0.0496***	(0.0137)
$d_{(t-1)}$ if $0.664 \leq d \leq 0.956$	0.0146	(0.0114)
$d_{(t-1)}$ if $d > 0.956$	–0.0591***	(0.0200)

Standard errors in brackets.
*/**/*** indicate significance levels at the 10/5/1 per cent level.
The two thresholds split the sample into 154 observations in the lower regime, 44 in the middle regime, and 55 in the upper regime.

5 Robustness

To make sure that our results are robust throughout a broader range of specifications, we conduct a variety of additional tests. Those include further explanatory variables, an extension of the time frame, further endogeneity tests, an analysis of influential euro area countries, and an analysis employing the real sovereign long term interest rate as the dependent variable. For most of the robustness tests, the results of the benchmark specification can be supported and remain consistent.

5.1 Including further explanatory variables

Next to lagged GDP growth, trade openness, gross capital formation and the dummy for EMU membership, we consecutively include further explanatory variables to test for robustness of the results. These are population growth, the old dependency ratio, the unemployment rate, secondary education, GDP per capita, the general government budget balance and primary budget balance (in ratios to GDP), private gross capital formation (replacing the aggregate variable) and the long and short term interest rates. All variables included are lagged one year compared to the dependent variable in order to avoid further endogeneity. Table 4 shows the results for the threshold dynamic model. Altogether, there are comparatively few changes in the coefficients and their significance, no matter which other variable is included.[13] Furthermore, for all the specifications the estimated threshold associated with the smallest sum of squares is 66.4 per cent, and the threshold value remains significant at the 10 per cent level. The debt coefficients of the two regimes are mostly comparable to the benchmark specification. Only for the last two columns the debt impact is smaller, but it is still significant and positive in the lower, and very close to zero in the upper regime.

[13] This is also true if the explanatory variables are used without or with two lags instead.

Table 4

Robustness, Dynamic Model – Non-linear, 1990-2007

Variable	(1)	(2)	(3)	(4)	(5)[(a)]	(6)	(7)	(8)	(9)	(10)[(b)]
$y_{(t-1)}$	0.4679***	0.4448***	0.4473***	0.4592***		0.4278***	0.4551***	0.4183***	0.3496***	0.4135***
	(0.1080)	(0.1046)	(0.1414)	(0.1073)		(0.1224)	(0.126)	(0.1115)	(0.1008)	(0.1081)
Openness	0.0176**	0.0176**	0.0188**	0.0176**	0.0326***	0.0153*	0.0141	0.0158*	0.0214***	0.0285***
	(0.0079)	(0.0077)	(0.0088)	(0.0077)	(0.0139)	(0.009)	(0.0090)	(0.0088)	(0.0074)	(0.0098)
GCF	–0.0024	0.0004	–0.0218	0.0193	–0.0182	–0.0408	–0.0411		–0.0144	–0.0318
	(0.0599)	(0.0476)	(0.0492)	(0.0402)	(0.0472)	(0.0468)	(0.0475)		(0.0382)	(0.0362)
EMU	–0.0096***	–0.0095***	–0.0112***	–0.0101**	–0.00001	–0.0052	–0.0046	–0.0053	–0.0117***	–0.0120
	(0.0031)	(0.0032)	(0.0041)	(0.0031)	(0.0042)	(0.0041)	(0.0037)	(0.0035)	(0.0030)	(0.0114)
Population growth	0.2643									
	(0.5179)									
Old ratio		–0.1693								
		(0.2067)								
Unemployment			–0.1024							
			(0.1288)							
Secondary education				0.0000						
				(0.0001)						
GDP per Capita					–1.8948					
					(1.278)					
Budget balance						–0.0153				
						(0.0668)				
Primary budget balance							–0.0409			
							(0.0623)			
GCF Private								–0.0543		
								(0.0544)		
Long run interest rates									–0.4230***	
									(0.1086)	
Short run interest rates										–0.3390***
										(0.0781)
$d_{(t-1)}$ if $d \leq 0.664$	0.0697***	0.0670***	0.075****	0.0669***	0.0626***	0.0718***	0.0707***	0.0730***	0.0491***	0.0396***
	(0.0159)	(0.0144)	(0.0191)	(0.0152)	(0.0142)	(0.0151)	(0.0145)	(0.0145)	(0.0137)	(0.0114)
$d_{(t-1)}$ if $d \leq 0.664$	0.0157	0.0120	0.0211	0.0137	0.0054	0.0125	0.0112	0.0133	0.0048	0.0055
	(0.0122)	(0.0105)	(0.0139)	(0.0115)	(0.015)	(0.0117)	(0.0119)	(0.0115)	(0.0127)	(0.0106)
Bootstrap *p*-value	0.085	0.069	0.10	0.075	0.10	0.084	0.092	0.10	0.070	0.080
Confidence Region	$0.6287<d^*<0.6908$	$0.6287<d^*<0.6908$	$0.6287<d^*<0.6831$	$0.6287<d^*<0.6908$	$0.6287<d^*<0.6698$	$0.6287<d^*<0.6908$	$0.6287<d^*<0.6908$	$0.6287<d^*<0.6908$	$0.6127<d^*<0.6831$	$0.6287<d^*<0.7210$

Standard errors in brackets.
a) Non-dynamic estimation since lagged GDP per capita and lagged GDP growth rate are highly correlated.
b) Estimation excludes Luxembourg due to data limitations.
*/**/*** indicate significance levels at the 10/5/1 per cent level.

Table 5

Alternative Endogenous Variables, Threshold Panel, 1990-2007

Dependent Variable	**Potential GDP Growth**		**GDP Growth**		**GDP Growth**	
Estimation Method	**Dynamic Panel (a)**		**Dynamic Panel (b)**		**IV 2SLS (c)**	
$y_{(t-1)}$	0.8562***	(0.0344)	0.2209**	(0.1008)	0.4234***	(0.1102)
Openness	0.0038**	(0.0018)	0.0310**	(0.0089)	0.0132**	(0.0058)–
GCF	–0.0356***	(0.0096)	–0.0569	(0.0572)	0.0246	(0.0413)
EMU	–0.0020***	(0.0008)	–0.0117***	(0.0043)	–0.0077**	(0.0037)
$d_{(t-1)}$ if $d \leq d^*$	0.0163***	(0.0028)	0.0867***	(0.0177)	0.0583***	(0.0119)
$d_{(t-1)}$ if $d > d^*$	0.0041	(0.0030)	0.0185	(0.0149)	–0.0016	(0.0161)
Threshold Estimate	$d^* = 0.6644$		$d^* = 0.6640$		$d^* = 0.6640$	
Bootstrap *p*-value	0.026		0.085		0.058	
Confidence Intervals	$0.6287 < d^* < 0.7170$		$0.6287 < d^* < 0.6908$		$0.6287 < d^* < 0.6831$	

(a) $y_{(t-1)}$: potential GDP growth; (b) $y_{(t-1)}$: output gap;
(c) $y_{(t-1)}$: GDP growth, debt/GDP as second endogenous variable.
Standard errors in brackets.
*/**/*** indicate significance levels at the 10/5/1 per cent level.

5.2 *Including the period 1980-1989*

As discussed above, the non-stationarity of the debt-to-GDP variable if the years 1980-89 are included causes the resulting threshold estimates to be potentially unreliable. We do, however, re-estimate the model including the foregoing decade to examine whether our implications are generally stable. The estimation suggests that while the obtained linear (regime-independent) coefficients do not change significantly, including the previous decade leads to insignificant threshold estimates.[14] Although insignificant, the two debt-to-GDP ratios associated with the lowest sum of squares lie on average around 0.20 and 0.67, depending on the specification. The lower values can be explained by the lower average debt ratios prevailing in the 80s.

---

[14] This result does not change if dummy variables for the 90s or the years 2008-2010 are included. The results in this subsection are available upon request.

5.3 An alternative endogenous variable / Dealing with endogeneity

In addition to using the GMM estimation[15] to further control for the possibility of endogeneity problems we estimate the dynamic panel with the growth rate of potential GDP instead, where the first lag of the dependent variable, $y_{(t-1)}$, is instrumented with longer lags of the GDP growth rate. The results are shown in the first column of Table 5. The employed endogenous GDP variable has little impact on the significance and size of the threshold value and the debt coefficients, as well as on the direction of the regime-independent variables (the only change is observed in the significance of GCF, which is now significantly negative). The threshold estimate is again 66.4 per cent, being statistically significant at the 5 per cent level. The impact of debt below the threshold decreases, but is still positive and significant, while the impact above 66.4 per cent remains insignificant.

As an alternative, we replace the lagged GDP growth rate in the benchmark specification with the lagged output gap, which is again instrumented with further lags of GDP growth. The results are shown in the second column of Table 5. The coefficient on the output gap series, $y_{(t-1)}$ is positive and significant, while the threshold value and all of the remaining coefficients are comparable to the benchmark specification.

Another endogeneity issue might arise from the debt variable itself. That is, we can expect reverse causation between GDP growth rates and debt levels (low growth rates are likely to result in higher debt-to-GDP ratios). Even though the positive values of the debt coefficients in the benchmark estimation rule out the possibility of reverse causation almost entirely, we still control for endogeneity to check if the results are altered significantly. If this was the case, we could suspect further endogeneity problems. We would like to continue estimating the dynamic panel when debt endogeneity is taken into account. Unfortunately it is impossible to split the instrumented debt-to-GDP series within the construction of the GMM estimator. Therefore we have to limit our estimation to a less efficient (albeit still consistent) 2SLS estimation of the following form:

1) in a first step, the lagged GDP growth rate and the lagged debt-to-GDP series are regressed on higher lags of both variables plus all the exogenous regressors. We then predict the values for both lagged GDP growth and lagged debt-to-GDP;
2) the threshold testing procedure is similar to the benchmark estimation, only with the regime dependent series being the predicted values for debt/GDP;
3) based on the threshold value, the coefficients are estimated using OLS. The resulting coefficients are the 2SLS estimators.

The third column of Table 5 shows the results from the described regression approach. As can be seen, the coefficients differ only negligibly from the benchmark results.

5.4 Influential countries

Based on the benchmark specification, we first exclude two sets of countries, those with the highest and those with the lowest debt-to-GDP ratios over time. Excluding Luxembourg – the country with the lowest debt-to-GDP ratios – has no significant impact on the results. The same is true if we exclude Belgium or Italy, the two countries with the highest average debt ratios. Even if the two countries are excluded together (resulting in a sample with only 10 countries) the

[15] See Caselli *et al.* (1996) who proposed to use GMM as a way to deal with endogeneity problems in the context of panel growth regressions and Durlauf *et al.* (2005) for a related discussion.

coefficients change only marginally and the significant debt-to-GDP threshold value is again 66.4 per cent.

Next to the outliers of high and low debt ratios, we conduct the exclusion exercise for all the remaining countries (excluding one country at a time). Only two countries seem to have an impact on the debt threshold: Greece and Ireland. Excluding Greece or/and Ireland results in a debt threshold of 45 per cent.[16] The coefficients of debt on GDP growth in the two regimes are comparable to the benchmark results, positive and significant for debt ratios below, insignificant and close to zero above the threshold value.

However, we would like to mention that the exclusion of countries is conducted only as an econometric exercise and is of limited value to our analysis. Not only could we lose significant spillover effects, but we are also specifically interested in the most significant values for the (old) euro area as a whole over the period of our analysis and not only for a subset of countries.

5.5 *Influence on the interest rate*

Finding a significant debt threshold gives rise to the question why its impact on growth becomes smaller once a certain threshold value is reached. Among other channels, higher public debt is likely to be associated by investors with higher sovereign risk premia, which could be translated into higher long-term interest rates. In turn, this may lead to an increase in private interest rates and a decrease in private spending growth, both by households and firms (see Elmendorf and Mankiw 1999), which is likely to dampen output growth. While the empirical findings on the relationship between public debt and long-term interest rates are diverse, a significant number of recent studies suggest that high debt may contribute to rising sovereign yield spreads (see Codogno *et al.* 2003; Schuknecht *et al.* 2010 and Attinasi *et al.* 2009, among others) and ultimately sovereign long-term interest rates (Ardagna *et al.* 2007, Laubach 2009).

In order to examine this hypothesis, we run a non-dynamic threshold estimation of the form:

$$INT_{it} = \mu_i + \alpha_1 INT^s_{i,t-1} + \alpha_2 GDP_{i,t-1} + \alpha_3 OPEN_{i,t-1} + \alpha_4 EMU_{it}$$
$$+ \beta_1 d_{i,t-1} I(d_{i,t-1} \leq d^*) + \beta_2 d_{i,t-1} I(d_{i,t-1} > d^*) + u_{it} \,, \tag{6}$$

INT is the sovereign long-term real interest rate, INT^S is the short-term real interest rate, which is included to capture monetary policy effects, GDP is the growth rate of GDP, and as before $OPEN$ is the trade openness measure, EMU is the dummy variable which signals the EMU membership, and d is the debt-to-GDP series, with d^* being the threshold value. The explanatory variables are broadly in line with Ardagna *et al.* (2007).[17]

Both interest rate series are de-trended, applying linear trend filtering from 1990. The resulting coefficients for the two periods 1990-2007 and 1990-2010 are presented in Table 6. For both time periods we find a threshold value of 73.8 per cent, significant at 10 per cent, and respectively, at 1 per cent level. Below this threshold, the impact of additional debt decreases the long-run interest rates.[18] Once the threshold is reached, we observe an increasing pressure on the

---

16 The results of estimations with Greece and Ireland excluded one at a time are comparable with those resulting from a combined exclusion.

17 Ardagna *et al.* (2007) estimate the response of long-term interest rates in a panel of 16 OECD countries, over the years 1975-2002. Comparable to our specification, they use the nominal interest rate on 10-year government bonds as the dependent variable, and GDP growth, interest rates on 3-month Treasury bills, inflation and deficit as explanatory variables, a baseline specification which is close to the one employed in our paper.

18 For a detailed discussion on reasons for the negative impact of debt on interest rates below a threshold value, we refer to Section 3, specifically 3.2 in Ardagna *et al.* (2007).

Table 6

Interest Rates, Non-dynamic Threshold Model

Years	**1990-2007**		**1990-2010**	
INT^S	0.2860***	(0.0551)	0.3881***	(0.0442)
GDP	–0.0801	(0.0509)	–0.0491	(0.0452)
Openness	–0.0172**	(0.0073)	–0.0087	(0.0059)
EMU	0.0077**	(0.0030)	0.0062**	(0.0028)
$d_{(t-1)}$ if $d \leq d^*$	–0.0406***	(0.0089)	–0.0288***	(0.0077)
$d_{(t-1)}$ if $d > d^*$	0.0079	(0.0122)	0.0283***	(0.0086)
Threshold Estimate	$d^* = 0.7380$		$d^* = 0.7380$	
Bootstrap *p*-value	0.078		0.009	
Confidence Intervals	$0.6287 < d^* < 0.7709$		$07220 < d^* < 0.8180$	

Dependent variable: long-term real sovereign interest rates.
Standard errors in brackets.
*/**/*** indicate significance levels at the 10/5/1 per cent level.

interest rate. This is true especially for the longer period, for which the coefficient on the upper regime debt ratio is highly statistically significant and positive. These results are broadly in line with Ardagna *et al.* (2007): using debt in a quadratic functional form, they find a non-linear effect of public debt on long-term interest rates, with a negative impact when the debt-to-GDP ratio is below 65 per cent and a positive impact when the ratio is above this threshold.[19] The resulting crowding-out of economic activity helps explaining why the impact of additional debt on the economy decreases with the size of debt, and might even become negative above certain threshold values.

6 Conclusion

Our paper analyses the short-run impact of debt-to-GDP ratios on GDP growth, using one year lagged debt ratios in a non-linear threshold panel model. The empirical results suggest the following. The short-run impact of debt on GDP growth is positive, but decreases to close to zero and loses significance beyond public debt-to-GDP ratios of around 67 per cent. This result is robust throughout most of our specifications, in the dynamic and non-dynamic threshold models alike. For high debt ratios (above 95 per cent) the impact of additional debt has a negative impact on economic activity. The confidence intervals for the thresholds are generally tight, at about (63; 69) for the lower threshold and broader at about (80; 100) for the upper threshold.

[19] Ardagna *et al.* (2007) further include a panel VAR estimation, which does not account for any form of non-linearity. Clearly, applying the threshold methodology to a VAR specification would be an interesting extension. It is, however, beyond the scope of this paper.

Various robustness tests show that the lower threshold value reacts only marginally to changes in the number of control variables and countries included. The only departure from 67 per cent as the most significant debt threshold value occurs when we include the years before 1990 and the crisis years 2008-10. However, in both cases tests for further thresholds reveal that 67 per cent is associated with the value resulting in the (second) smallest SSR. We further show that the long-term interest rate is subject to increased pressure when the public debt-to-GDP ratio is above 70 per cent, broadly supporting the above findings.

Our results suggest that the positive short term economic stimulus from additional debt decreases drastically when the initial debt level is high, and might even become negative. The reverse would imply that when the debt ratio is very high, reducing it would have beneficial effects for annual growth. On the other hand, in case of low debt levels, reducing the debt further would tend to reduce growth in the short run, in line with conventional Keynesian multipliers (while the long-term effect may differ). Hence, in light of the attempt to defend increasing debt with economic stimulus reasons, our results are supportive only if the initial debt level is below a certain threshold.

APPENDIX
THRESHOLD TESTING

The pointwise *F*-statistic is:

$$F_T = \sup_{z \varepsilon S} F_T(z) \tag{7}$$

where:

$$F_T(z) = T\left(\frac{\tilde{\sigma}_T^2 - \hat{\sigma}_T^2(z)}{\hat{\sigma}_T^2(z)}\right) \tag{8}$$

with $\tilde{\sigma}_T^2$ being the estimated residual variance of the corresponding linear model. The threshold value is not identified under the null of linearity and consequently the distribution of the standard *F*-statistic is not chi-square (Hansen 2000). We can approximate the asymptotic distribution with the following bootstrap procedure:

Compute y_t^* *iid* $N(0,1)$ random draws and regress y_t^* on X_t and on $X_t(z)$ to obtain the residual variances $\tilde{\sigma}_T^{*2}$ and $\tilde{\sigma}_T^{*2}(z)$, respectively. Repeated bootstrap draws from the test statistic:

$$F_T^* = \sup_{z \varepsilon S} F_T^*(z) \tag{9}$$

with:

$$F_T^*(z) = T\left(\frac{\tilde{\sigma}_T^{*2} - \hat{\sigma}_T^{*2}(z)}{\hat{\sigma}_T^{*2}(z)}\right) \tag{10}$$

can then be used to approximate the asymptotic null distribution of F_T. The distribution of F_T^* converges weakly in probability to the null distribution of F_T under the alternatives for Γ_2 and the asymptotic bootstrap *p*-value is obtained by counting the percentage of bootstrap samples for which the bootstrap statistic F_T^* exceeds the statistic F_T.

Accounting for possible heteroscedasticity in the error terms, the standard *F*-statistic is replaced by a heteroscedasticity-consistent Wald or Lagrange Multiplier test:

$$L_T = \sup_{z \varepsilon S} L_T(z) \tag{11}$$

with:

$$L_T(z) = (R\hat{\delta}(z))'[R(M_T(z)^{-1}V_T(z)M_T(z)^{-1})R']^{-1} R\,\hat{\delta}(z) \tag{12}$$

where $R = (1\ I)$ is the selector matrix, $M_T(z) = \sum X_t(z)X_t(z)'$ and $V_T(z) = \sum X_t(z)X_t(z)'\hat{u}_t^2$.

REFERENCES

Arellano, M. and S. Bond (1991), "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations", *The Review of Economic Studies*, No. 58, pp. 277-97.

Arellano, M. and O. Bover (1995), "Another Look at the Instrumental Variable Estimation of Error-components Models", *Journal of Econometrics*, Vol. 68, No. 1, pp. 29-51.

Arellano, M. (2003), *Panel Data Economics*, Oxford University Press.

Ardagna, S., F. Caselli and T. Lane (2007), "Fiscal Discipline and the Cost of Public Debt Service: Some Estimates for OECD Countries", *The B.E. Journal of Macroeconomics*, Vol. 7, No. 1, Article 28.

Attinasi, M.G., C. Checherita and C. Nickel (2009), "What Explains the Surge in Euro Area Sovereign Spreads During the Financial Crisis of 2007-09?", ECB, Working Paper, No. 1131, also published in *Public Finance and Management*, Vol. 10, No. 4, pp. 595-645, 2010.

Caner, M. and B.E. Hansen (2004), "Instrumental Variable Estimation of a Threshold Model", *Econometric Theory*, No. 20, pp. 813-43.

Caselli, F., G. Esquivel and F. Lefort (1996), "Reopening the Convergence Debate: A New Look at Cross Country Growth Empirics", *Journal of Economic Growth*, Vol. 1, No. 3, pp. 363-89.

Cecchetti, S.G., M.S. Mohanty and F. Zampolli (2011), "The Real Effects of Debt", BIS, Working Paper, No. 352.

Chang, T. and G. Chiang (2009), "The Behavior of OECD Public Debt: A Panel Smooth Transition Regression Approach", *The Empirical Economics Letters*, Vol. 8, No. 1.

Checherita, C. and P. Rother (2010), "The Impact of High and Growing Government Debt on Economic Growth – An Empirical Investigation for the Euro Area", ECB, Working Paper, No. 1237, forthcoming in *European Economic Review*.

Cimadomo, J. (2007), "Fiscal Policy in Real Time", Centre D'Etudes Prospectives et D'Informations International (CEPII), Working Paper, No. 2007-10.

Codogno, L., C. Favero and A. Missale (2003), "Yield Spreads on EMU Government Bonds", *Economic Policy*, No. 18, pp. 505-32.

Durlauf, S., P. Johnson and J. Temple (2005), "Growth Econometrics", in P. Aghion and S.N. Durlauf (eds.), *Handbook of Economic Growth*, 1A, Amsterdam, North-Holland.

Elmendorf, D. and N. Mankiw (1999), "Government Debt", in J. Taylor and M. Woodford (eds.), *Handbook of Macroeconomics*, 1C, pp. 1615-69, Amsterdam, North-Holland.

Hansen, B.E. (1999), "Threshold Effects in Non-dynamic Panels: Estimation, Testing and Inference", *Journal of Econometrics*, Vol. 93, No. 2, pp. 345-68.

—————(2000), "Sample Splitting and Threshold Estimation", *Econometrica*, Vol. 68, No. 3, pp. 575-603.

Hayakawa, K. (2009), "First Difference or Forward Orthogonal Deviation – Which Transformation Should be Used in Dynamic Panel Data Models? A Simulation Study", *Economics Bulletin*, Vol. 29, No. 3, pp. 2008-17.

Hemming, R., M. Kell and S. Mahfouz (2002), "The Effectiveness of Fiscal Policy in Stimulating the Economic Activity – A Review of the Literature", IMF, Working Paper, No. WP/02/2008.

IMF (2008), "Fiscal Policy as a Countercyclical Tool", IMF, World Economic Outlook, Chapter 5, October.

Kremer, S., A. Bick and D. Nautz (2009), "Inflation and Growth: New Evidence From a Dynamic Panel Threshold Analysis", SFB 649, Discussion Paper, No. 2009-036.

Kumar, M.S. and J. Woo (2010), "Public Debt and Growth", IMF, Working Paper, No. WP/10/174.

Laubach, T. (2009), "New Evidence on the Interest Rate Effects of Budget Deficits and Debt", *Journal of the European Economic Association*, Vol. 7, No. 4, pp. 858-85.

Reinhart, C.M. and K.S. Rogoff (2010), "Growth in a Time of Debt", NBER, Working Paper, No. 15639.

Schclarek, A. (2004), "Debt and Economic Growth in Developing Industrial Countries", mimeo.

Schuknecht, L., J. von Hagen and G. Wolswijk (2010), "Government Bond Risk Premiums in the EU Revisited: The Impact of the Financial Crisis", ECB, Working Paper, No. 1152.

van Riet, A. (ed.) (2010), "Euro Area Fiscal Policies and the Crisis", ECB, Occasional Paper, No. 109.

PUBLIC DEBT AND GROWTH

Manmohan S. Kumar[*] *and Jaejoon Woo*[*]

This paper examines the impact of high public debt on long-run economic growth in a panel of advanced and emerging economies over four decades, while taking into account various estimation issues including reverse causality and endogeneity. Threshold effects, non-linearities, and differences between advanced and emerging market economies are also explored. High initial public debt is found to be significantly and consistently associated with slower subsequent growth, controlling for other determinants of growth. The adverse effect largely reflects a slowdown in labor productivity growth mainly due to reduced investment and slower growth of capital stock. Extensive robustness checks confirm the results.

1 Introduction

The recent global economic and financial crisis has led to an unprecedented increase in public debt across the world. By the end of 2012, public debt is expected to reach about 107 per cent of GDP in advanced economies – its highest level in 50 years. This has raised serious concerns about fiscal sustainability and their economic impact for many advanced economies amid the current European sovereign debt crisis. What are the effects on longer-term growth of high public debt? This is an important policy question. Surprisingly, however, there has been little systematic empirical analysis in the literature, despite the existence of a very large empirical growth literature (see, for example, Aghion and Durlauf, 2005).[1]

Public debt has important influence over the economy both in the short- and the long run. The conventional view is that debt can stimulate aggregate demand and output in the short run, but crowds out capital and reduces output in the long run (see Elmendorf and Mankiw, 1999 for a literature survey). This paper concerns the long-run effects of public debt. Standard growth theory predicts that an increase in government debt leads to slower growth: a temporary decline in growth along the transition path to a new steady state in the neoclassical model, such as the Solow model, and a permanent decline in growth in the endogenous growth model (Saint-Paul, 1992). Building on Barro's (1990) endogenous growth model with public good services, Aizenman *et al.* (2007) also show that with effective upper bound on tax revenue due to distortions and imperfect tax

* International Monetary Fund, Washington, D.C. 20431.

The authors would like to thank Emanuele Baldacci, John Berdell, Carlos Caceres, Giovanni Calligari, Yongsung Chang, Cristina Checherita, Carlo Cottarelli, Rafael Domenech, Balazs Egert, Julio Escolano, Phil Gerson, Atish Ghosh, Alfred Greiner, Fuad Hasanov, William Hauk, Gerhard Illing, John Janssen, Julian Di Giovanni, George Karras, Jun Il Kim, Jun-Kyung Kim, Daniel Leigh, Paolo Mauro, Sandro Modigliano, Carmen Reinhart, Helmut Reisen, Andre Sapir, Jeffrey Wooldridge, Zheng Zhang, and seminar participants at the IMF, European Commission Conference on Public Debt and Economic Growth, Banca d'Italia Public Finance Workshop, World Bank-KDI School International Conference on Fiscal Policy and Management, Beijing Forum, Yonsei University, Korea Development Institute (KDI), and Korea Institute of Public Finance (KIPF) for helpful comments and discussions. Julia Guerreiro provided excellent research assistance. The opinions expressed in the paper are those of the authors and should not be held to represent those of the IMF or its Member countries. Correspondence: jwoo@imf.org or mkumar@imf.org

[1] A notable partial exception is Reinhart and Rogoff (2010) who examine economic growth and inflation at different levels of government debt in advanced and emerging economies based on long historical data series. However, their study only considers correlations between debt and growth, and does not take into account other determinants of growth via econometric analysis as well as issues such as reverse causality (*i.e.*, low growth can lead to large public debt). After the publication of the working paper version of our paper (Kumar and Woo, 2010), subsequent studies by others examined much smaller samples of countries and obtained the results that are quantitatively similar to ours: Checherita and Rother (2010) in 12 Euro economies for 1970-2008 and Cecchetti *et al.* (2011) in 18 OECD countries for 1980-2006. However, they mostly focus on identifying the threshold level of debt above which debt becomes harmful to growth. They do not explore the channels through which debt can affect growth nor consider the interaction between growth, debt, and a country's economic and financial position *vis-à-vis* the rest of the world (or currency composition of debt), not to mention the lack of rigorous discussion on related econometric issues.

enforcement, an increase in (initial) debt lowers the productive government spending, which reduces the return to capital and growth subsequently.

High debt may adversely affect medium- and long-run growth via several channels: high public debt can adversely affect capital accumulation and growth via higher long-term interest rates (Gale and Orzag, 2003; Baldacci and Kumar, 2010), higher future distortionary taxation (Barro, 1979; Dotsey, 1994) and lower future public infrastructure spending (Aizenmann *et al.*, 2007), higher inflation (Sargent and Wallace 1981; Barro 1995; Cochrane 2011), and greater uncertainty about prospects and policies. In more extreme cases of a debt crisis, by triggering a banking or currency crisis, these effects can be magnified (Burnside *et al.*, 2001; Hemming *et al.*, 2003). Also, high debt is likely to constrain the scope for countercyclical fiscal policies, which may result in higher volatility and further lower growth (Aghion and Kharroubi, 2007; Woo, 2009).

The purpose of this paper is to examine empirically the effects of high public debt on economic growth. To our knowledge, this paper presents the first econometric evidence on the impact of *initial* high public debt on *subsequent* growth of real GDP per capita in a panel of advanced and emerging economies for the period of 1970-2008 by carefully applying various econometric techniques. Here it is worth emphasizing that the paper uses *initial* level of government debt to examine the impact on *subsequent* growth over the next five to twenty years (or longer) so that it avoids reverse causality. Evidence strongly suggests an inverse relationship between initial debt and subsequent growth, controlling for other determinants of growth: on average, a 10 percentage point increase in the initial debt-to-GDP ratio is associated with a slowdown in real per capita GDP growth of around 0.2 percentage points per year, with the impact being somewhat smaller in advanced economies. This order of magnitude is robust to various specifications, estimation methods, samples and periods. There is some evidence of non-linearity with higher levels of initial debt (above around 90 per cent of GDP) having more significantly negative effects on subsequent growth.

Moreover, we find that the impact on growth of initial debt is conditional on a country's economic and financial position *vis-à-vis* the rest of the world and that the currency composition of public debt matters. The adverse impact of debt on growth is larger when the net foreign asset (NFA) position is low or the portion of foreign-currency denominated debt as a share of total public debt is high. Growth accounting exercises imply that the adverse effect largely reflects a slowdown in labor productivity growth mainly due to reduced investment and slower growth of capital stock, rather than through slower growth of TFP or human capital. Additional evidence on the impact of initial debt on subsequent investment renders strong support to this conclusion. We conduct extensive robustness checks. The results are robust to a number of alternative specifications, which control for the variables usually identified as the main determinants of economic growth (Sala-i-Martín *et al.*, 2004), as well as to different samples and periods. In particular, we carefully address a variety of econometric issues including reverse causality, endogeneity, and outliers.

Our paper is related to a few studies that have looked at the impact of *external* (public and private) debt on economic growth *exclusively* in the context of *low income economies*. Most of these studies were motivated by the "debt overhang" hypothesis – a situation where a country's debt service burden is so heavy that a large portion of output accrues to foreign lenders and consequently creates disincentives to invest (Krugman, 1988; Sachs, 1989). Imbs and Rancière (2009) and Pattillo *et al.* (2002, 2004) find a non-linear effect of external debt on growth: that is, a negative and significant impact on growth at high debt levels (typically, over 60 per cent of GDP), but an insignificant impact at low debt levels. Besides the differences in estimation strategies, however, we examine the growth impact of *public debt* in the context of *advanced (and emerging)* *economies* that is largely domestic and denominated in domestic currency,[2] which may have different implications for the magnitude of growth impact and the operating channel(s), compared to those of external debt in the context of low income countries.

The rest of the paper is organized as follows: Section 2 briefly describes data and some stylized facts relating to public debt and growth; Section 3 discusses a number of methodological issues and estimation strategy, and then presents the main panel regression results on the relationship between debt and growth, followed by Section 4 Growth Accounting. Section 5 concludes. Appendixes 1-3 provide additional discussion regarding country sample, data sources and growth accounting.

2 Data and stylized facts

Data for the key variables such as GDP, population, investment, and government size are obtained primarily from the latest version 7.0 of Penn World Table (Heston *et al.*, 2011). Fiscal data including government debt are primarily from the IMF's World Economic Outlook database, and other variables are from World Bank's World Development Indicators, Barro and Lee (2011). The availability of data on public debt and other variables included in the regression dictated the sample size: the main analysis is based on a panel of 38 advanced and emerging economies with a population of over 5 million for the period 1970-2008, while we also present the results using the full sample of 79 countries (including advanced, emerging, and developing countries) without imposing a population size restriction (see Appendices 1-2 for the country list and data sources).

Some stylized facts: First, data on government debt and growth clearly show that there is a negative correlation between *initial* government debt and *subsequent* growth of real per capita GDP. Figure 1 shows a scatter plot of initial debt against subsequent growth of real per capita GDP over five-year periods in the sample of countries with population of over 5 million. According to the OLS fitted line, the coefficient of initial debt is –0.024. Taken at face value (*i.e.*, ignoring the potential endogeneity problem, and not controlling for other growth determinants), it suggests that a 10 percentage point increase in initial debt-to-GDP ratio is associated with a subsequent slowdown in per capita GDP growth of 0.24 percentage points. At shown below, this magnitude turns out to be surprisingly consistent with that obtained using robust econometric analysis. Similarly, *initial* debt is negatively associated with both *subsequent* growth of capital per worker (Figure 2) and domestic investment over 5-year periods (Figure 3).

Second, the *subsequent* growth rate of per capita GDP over five-year periods during high *initial* debt episodes (above 90 per cent of GDP) is on average lower than that during low *initial* debt episodes (below 30 per cent of GDP) across various groups of countries (Figure 4). In advanced economies, the difference in the average growth rates between low initial debt and high initial debt episodes is 0.9 percentage points; in emerging economies, it is more than twice that (1.7 percentage points). This pattern is consistent with econometric results discussed later. Similarly, the average growth differential in G7 countries between low and high initial debt periods is 1.7 percentage points. In the full sample (including developing countries), the growth differential is 2.8 percentage points. (See Appendix Table 10 for summary statistics on average growth rates of real GDP per capita, output per worker, TFP, capital stock per worker, and average levels of domestic investment at different levels of initial government debt for various country groupings).[3]

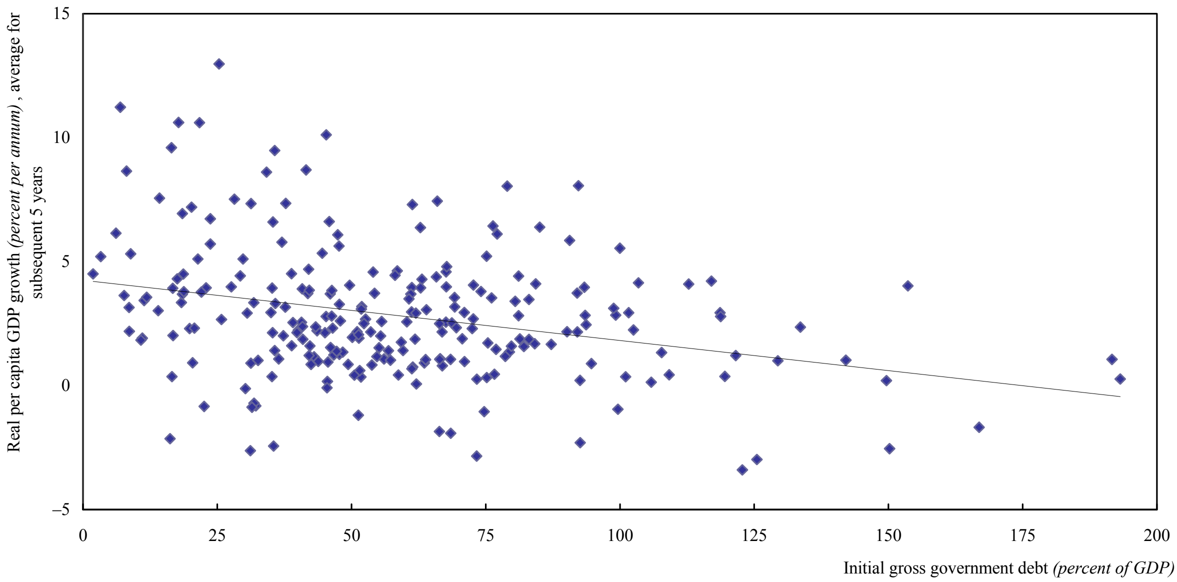
---

2 This is not only true of advanced economies throughout the sample period, but also of emerging economies in the recent decades during which the portion of domestic-currency denominated debt has been increasing sharply.

3 Also, high *initial* government debt levels at the start of recession are associated with a slower *subsequent* recovery and longer duration of recovery. See Woo *et al.* (2012) for details.

Figure 1

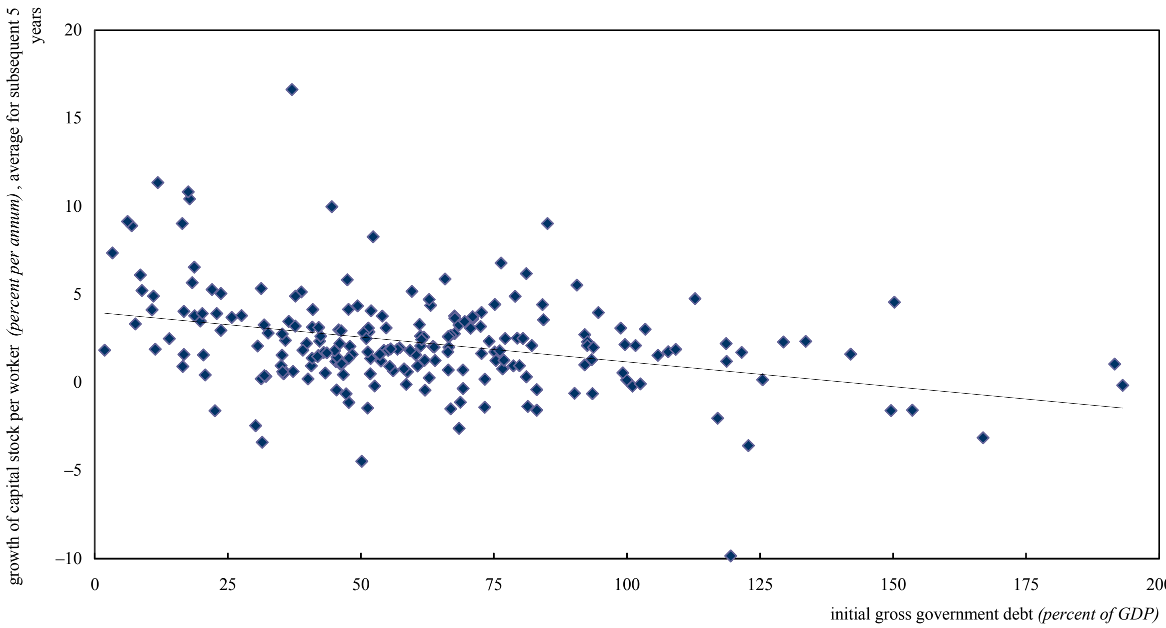
Initial Government Debt and Subsequent Growth of per Capita Real GDP Over Five-year Periods



Fitted line: Growth =4.24–0.024*Initial debt, where the initial debt coefficient is significant at 1 per cent.
Source: Authors' calculation.

Figure 2

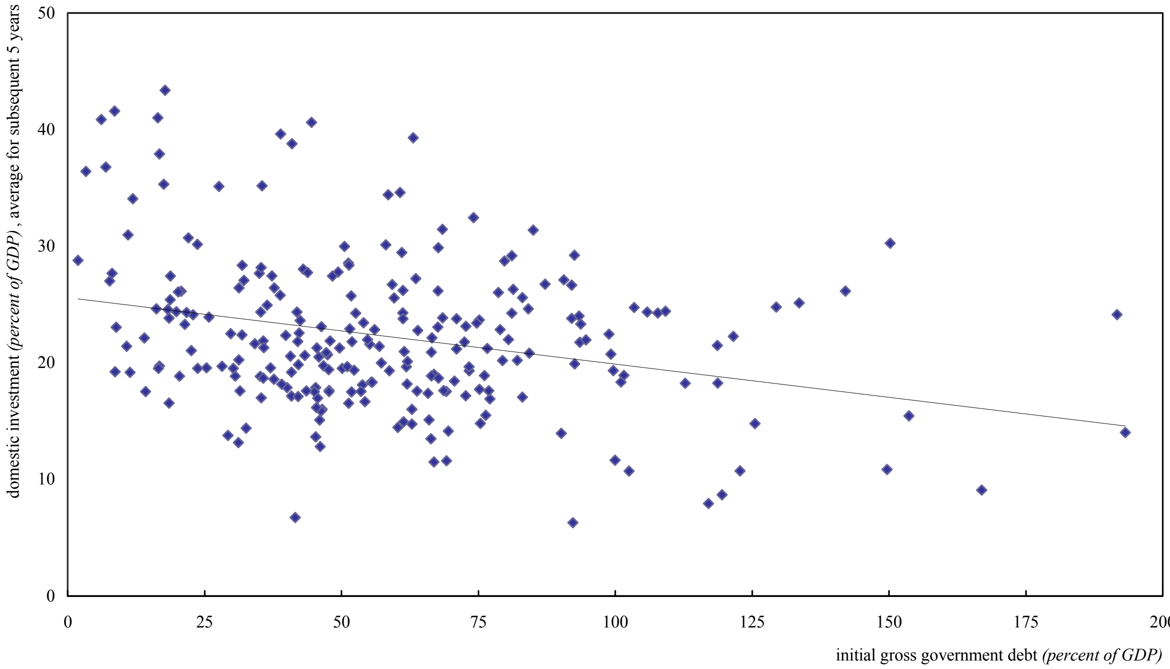
Initial Government Debt and Subsequent Growth of Capital Stock per Worker Over Five-Year Periods



Fitted line: Growth of capital per worker=3.99–0.028*Initial debt, where the debt coefficient is significant at 1 per cent.
Source: Authors' calculation.

Figure 3

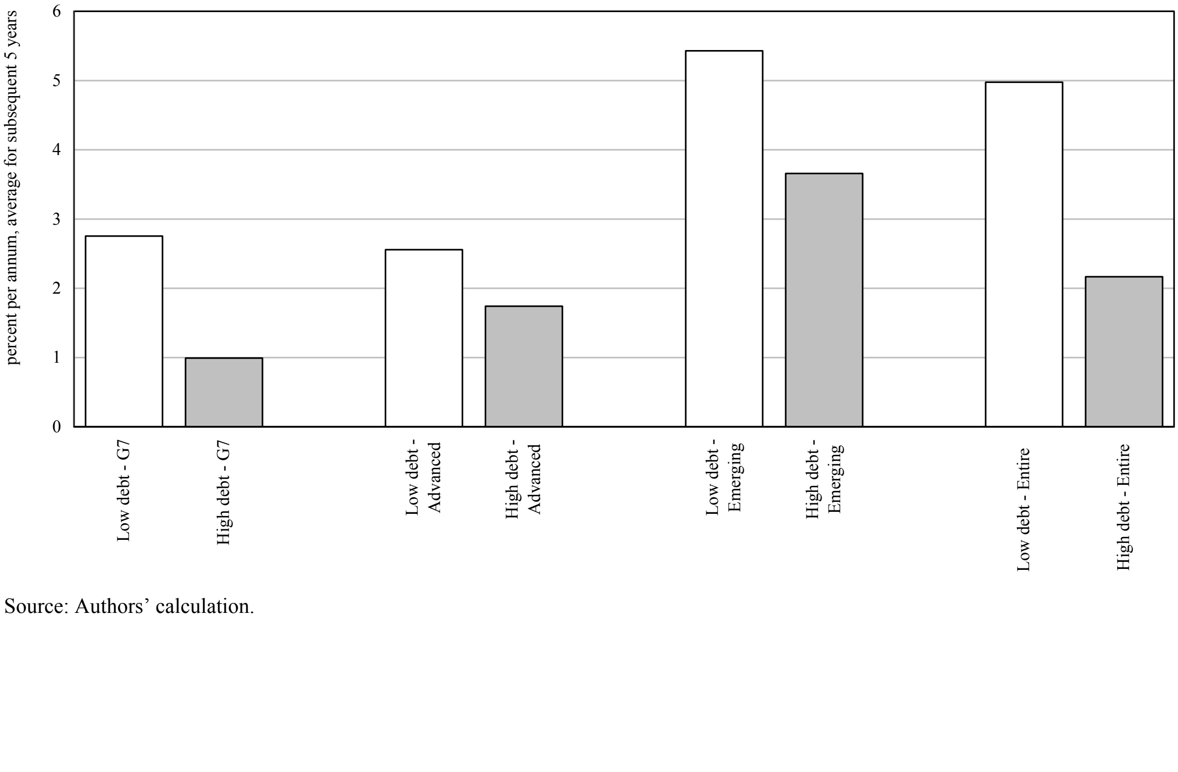
Initial Government Debt and Subsequent Domestic Investment over Five-Year Periods



Fitted line: Investment=25.6–0.057*Initial debt, where the debt coefficient is significant at 1 per cent.
Source: Authors' calculation.

Figure 4

Subsequent Growth of Real GDP per capita
Between High and Low Initial Government Debt Episodes
(low debt <30% of GDP and high debt>90% of GDP)



Source: Authors' calculation.

3 Econometric analysis

3.1 Model specification

The formal analysis focuses on the medium/longer-run relationship between initial government debt and subsequent economic growth, while exploiting both cross-sectional and time-series dimensions of the data. Our panel spans 39 years from 1970 to 2008, and comprises eight non-overlapping five-year periods (1970-74, 1975-79, … , 2000-04, 2005-08), except for the last period spanning four years. In addition, cross-country OLS regressions are estimated for longer time periods – for example, two or three decades (see Appendix Tables 11-12 for the results).

The baseline panel regression specification is as follows:

$$y_{i,t} - y_{i,t-\tau} = \alpha y_{i,t-\tau} + \boldsymbol{X}_{i,t-\tau}\beta + \gamma Z_{i,t-\tau} + \eta t + \nu_i + \varepsilon_{i,t} \quad (1)$$

where a period is a five-year time interval (*i.e.*, τ=4); t denotes the end of a period and $t-\tau$ denotes the beginning of that period; i denotes country; y is the logarithm of real per capita GDP; ν_i is the country-specific fixed effect; ηt is the time-fixed effect; $\varepsilon_{i,t}$ is an unobservable error term; $\boldsymbol{X}_{i,t-\tau}$ is a vector of economic and financial variables; $Z_{i,t-\tau}$ is the initial government debt (in percent of GDP).[4]

A core set of explanatory variables that have been shown to be consistently associated with growth in the literature is fully taken into account.[5] The variables X in the baseline specification are as follows: (i) initial level of real GDP per capita, to capture the catching-up process; (ii) human capital, to reflect the notion that countries with an abundance of it are more likely to have a greater ability to attract investors, absorb ideas from the rest of the world, and engage in innovation activities (Grossman and Helpman, 1991). As a proxy for human capital, we use the log of average years of secondary schooling in the population over age 15 in the initial year, taken from Barro and Lee (2011); (iii) initial government size (as measured by government consumption share of GDP) is also included, in the light of the robust results obtained by Sala-i-Martín *et al.* (2004);[6] (iv) initial trade openness (sum of export and import as a percent of GDP); (v) initial financial market depth (liquid liabilities as a percent of GDP); (vi) initial inflation as measured by CPI inflation (to be precise, logarithm of (1+inflation rate)); (vii) terms of trade growth rates (averaged over each time period); (viii) a measure of banking crisis incidence is also included (based on Reinhart and Reinhart, 2008), reflecting Reinhart and Rogoff's (2009) finding that banking crises are typically accompanied by large increases in government debt. At the same time, banking crises typically result in slow growth; (ix) fiscal deficit is included to take into account the finding that fiscal deficits are negatively associated with longer-run growth (see Fischer, 1993; Baldacci *et al.*, 2004).

To check the robustness of results, parsimonious specifications are tried and additional variables also considered, such as population (a proxy of country size), aged-dependency ratio (a

---

4 To be precise, the average growth rate of real per capita GDP per year over the period $t-\tau$ and t is $(y_{i,t} - y_{i,t-\tau})/\tau$, which is actually used in the empirical application of equation (1). All the explanatory variables in $\mathbf{X}_{i,t-\tau}$ are measured at the beginning of period, except for the terms of trade growth, incidences of banking crisis, and fiscal deficit that are measured over the period $t-\tau$ and t.

5 In particular, the findings of Sala-i-Martín *et al.* (2004) and Sala-i-Martín (1997) are closely followed in selecting the core set of growth determinants.

6 Also, it can be motivated by a consideration of fiscal sustainability. Huang and Xie (2008) derive a fiscal sustainability frontier in an endogenous growth framework, and show that higher levels of government spending reduce the sustainable level of government debt. This implies that estimating a threshold effect on growth based on a widely used single-dimensional perspective of fiscal sustainability such as debt in excess of a particular level may be difficult. What matters is the ability to finance any given level of debt, which in part depends on the availability of savings and the preferences of the savers. Related, Woo (2003) finds that financial market depth is one of the robust determinants of public deficits for various estimation techniques and extensive robustness checks including an extreme-bounds analysis. Thus, a measure of financial depth is included in the baseline regression.

proxy for population aging), investment,[7] fiscal spending volatility, urbanization, private saving, and checks and balances or constraints on executive decision-making (as a proxy of durable institutionalized constraints; see Glaeser *et al.*, 2004).

In addition to taking into account the "core set" of growth determinants which are mostly embodied in the initial conditions, it is worth emphasizing that our estimation uses *initial* level of debt to examine the impact on *subsequent* growth over the next five to two decades (or longer) and thereby avoid the reverse causality problem. Reverse causality may not be a trivial issue as slower economic growth can lead to high debt buildup, rather than high debt lowering growth.[8] However, most of other studies (for example, Checherita and Rother, 2010; Patillo *et al.*, 2002, 2004) have run regressions of growth on the contemporaneous debt ratios, compounding the potential reverse causality problem.

3.2 Sources of bias and estimation strategies

There are a number of sources of biases that can cause inconsistent estimates of the coefficients in panel growth regressions.[9] Yet, each of the estimators involves some trade-off: estimators that may seem attractive to address a specific econometric problem can lead to a different type of bias. For example, when an omitted variables bias coexists with measurement errors that are likely in the cross-country data, dealing with the first problem may exacerbate the second. With this in mind, we employ a variety of estimation techniques, such as pooled OLS, robust regression, between estimator (BE), fixed effects (FE) panel regression, and system GMM (SGMM) dynamic panel regression (Blundell and Bond, 1998). Speaking of the important sources of biases, the first is the omitted-variables bias (so-called heterogeneity bias) resulting from possible correlation between country-specific fixed effects (ν_i) and the regressors, affecting the consistency of pooled OLS and BE (between estimator) estimates. The second is the endogeneity problem due to potential correlation between the regressors and the error term, which would affect the consistency of pooled OLS, BE and FE. Specific to dynamic panels, there is a dynamic panel bias which will make FE estimates inconsistent.[10] The third is classical measurement errors (errors in variables) in the independent variables, which affects the consistency of pooled OLS, BE, and FE estimator, although the bias tends to be exacerbated in FE and moderated in BE.

Specifically, the BE estimator (which applies the OLS to a single cross-section of variables averaged across time periods) tends to reduce the extent of measurement error via time averaging of the regressors, but does not deal with the omitted-variables bias; pooled OLS and BE suffer from both heterogeneity bias and measurement errors but will reduce the heterogeneity bias because other things equal, measurement errors tend to reduce the correlation between the regressors and the country fixed effects; FE addresses the problem of the omitted-variables bias via controlling for

---

7 The *proximate* causes of growth, such as investment or capital per worker, are not included in the core set of growth determinants, but are examined in the growth accounting exercises instead. Nonetheless, we check whether including investment in the regression changes the estimated coefficients of initial government debt.

8 Easterly (2001) argues that slow growth contributed to debt explosion in the developing countries in 1980s. However, Imbs and Rancière's (2009) findings contradict Easterly's argument in an event study of external debt: investment actually builds up *prior to* the onset of debt overhang, which argues against the possibility that an investment slump predates the overhang and explains the debt build-up. Related, Reinhart *et al.* (2012) find that public debt overhang episodes are lasting long (typically for more than a decade), and thus refute the view that the negative association between public debt and growth is caused mainly by debt buildups during recessions.

9 See Durlauf *et al.* (2005) for more details on econometric issues in the empirical growth literature.

10 To see this more clearly, one can rewrite the equation (1) as $y_{i,t} = (1+\alpha)y_{i,t-\tau} + \mathbf{X}_{i,t-\tau}\beta + \gamma Z_{i,t-\tau} + \eta_t + \nu_i + \varepsilon_{i,t}$. The endogeneity bias (often called dynamic panel bias) arises due to inevitable correlation between $y_{i,t-\tau}$ and ν_i in the presence of lagged dependent variable because $y_{i,t-\tau}$ is endogenous to the fixed effects (ν_i) in the error term. In the FE, the fixed effects (ν_i) are eliminated via within-transformation, but there is now a correlation between the transformed lagged dependent variable and the transformed error term, causing the FE to be inconsistent and biased downward.

fixed-effects, but tends to exacerbate the measurement error problem, relative to BE and OLS. This measurement error bias under FE tends to get even worse when the explanatory variables are more time-persistent than the errors in the measurement (Hauk and Wacziarg, 2009).[11] Furthermore, in the dynamic panel setting, the within-transformation in the estimation process of FE introduces a correlation between transformed lagged dependent variable and transformed error, which also makes FE inconsistent. Theoretically, the dynamic panel GMM estimator addresses a variety of biases such as the omitted-variables bias, endogeneity, and measurement errors (as long as instruments are uncorrelated with the errors in measurement, for example, if they are white noise as in the classical case), but it may be subject to a weak instruments problem (Roodman, 2009; Bazzi and Clemens, 2009). While the SGMM that is used in this paper is generally more robust to weak instruments than the difference GMM, it can still suffer from weak instrument biases.[12] In sum, it is difficult to see which estimator yields the smaller *total bias* in the presence of various sources of bias a priori.

However, an important conclusion from the Monte Carlo study of growth regressions by Hauk and Wacziarg (2009) is that the BE performs the best among the four estimators (pooled OLS, BE, FE, and difference GMM) in terms of the extent of *total bias* on each of the estimated coefficients in the presence of both potential heterogeneity bias and a variety of measurement errors.[13] Therefore, the BE and SGMM estimators are the preferred estimation techniques in this paper, while we utilize the other techniques also.

As further robustness checks, we also run a single cross-country regression of the type that is most commonly used in the empirical growth literature for longer time periods. This helps address the issue that the five-year time interval in the panel may not be long enough to smooth out short-term business cycle fluctuations. The cross-country regression results (including the order of magnitude of the coefficients) however turn out to be broadly similar to those from panel regressions. On the other hand, the least squares estimates tend to be sensitive to outliers, either observations with unusually large errors or influential observations with unusual values of explanatory variables (often called leverage points). In an extensive evaluation of growth regressions in relation to macroeconomic policy variables, Easterly (2005) argues that some of the large effects on growth of a policy variable in the earlier empirical studies are often caused by outliers that represent "extremely bad" policies. Thus, to ensure that our results are not unduly driven by outliers, robust regression is also implemented.[14]

---

11 Intuitively, the within-transformation (*i.e.*, demeaning) under FE may exacerbate the measurement error bias by decreasing the signal-to-noise ratio (Grilliches and Hausman, 1986).

12 A standard test of weak instruments in dynamic panel GMM regressions does not currently exist (Bazzi and Clemens, 2009). See Stock *et al.* (2002) on why the weak instrument diagnostics for linear IV regression do not carry over to the more general setting of GMM.

13 The BE estimator applies the OLS to perform estimating of the following equation:

$$\overline{y_{i,} - y_{i,-1}} = \alpha \overline{y_{i,-1}} + \overline{X_{i,-1}}\beta + \gamma \overline{Z_{i,-1}} + v_i + \bar{\varepsilon}_i$$

where the upper bar indicates the average of each variable across time periods (up to eight periods), for example, $\overline{X_{i,-1}} = \sum_t X_{i,t-\tau} / T_i$. Thus, time-fixed effects are not appropriate and suppressed by the BE. As one can see, the BE estimator does not correspond to the cross-sectional estimator most commonly used in the literature in which in which the dependent and explanatory variables are averaged, say, over 1970-2008, except for the initial income level in 1970.

14 It is essentially an iterated re-weighted least squares regression in which the outliers are dropped (if Cook's distance is greater than 1) and the observations with large absolute residuals are down-weighted.

3.3 *Basic results*

The main results for advanced and emerging economies are presented in Table 1. Columns 1-4 show that the coefficients of initial debt are negative and are significant at the 1-5 per cent levels, with their values ranging from –0.015 to –0.030 across the various estimation techniques.[15] The BE regression in column 1 suggests that a 10 percentage points of GDP increase in initial debt is associated with a slowdown in subsequent growth in real GDP per capita of around 0.25 percentage points per year. The pooled OLS and FE in columns 2 and 3 yield results similar to that of the BE regression, although their estimates of initial debt coefficient become somewhat smaller (around –0.02). The SGMM estimate of initial debt coefficient is also in a similar range (–0.03) and significant at the 1 per cent level.

The coefficients on other explanatory variables (initial income per capita, average years of schooling, financial market development, inflation, banking crisis, and fiscal deficit) are of the expected sign and mostly significant at conventional levels across various estimation techniques. The OLS and FE estimators are likely to be biased in the opposite direction in the context of lagged dependent variables in short panels, with OLS biased upwards, and FE downwards. The *consistent* GMM estimator should lie between the two (Bond 2002). In the growth regressions, this means that the OLS understates the convergence rate (reflected by the coefficient of initial income per capita), while the FE estimator overstates it. Consistent with this reasoning, the OLS coefficient of initial real per capita GDP is –1.88, whereas the FE coefficient is –3.92. The SGMM coefficient of the initial income per capita (–2.34) is between those two estimates, indicating that the reported SGMM estimate in column 4 is likely to be a *consistent* parameter estimate of the convergence rate.

Consistency of the SGMM estimator depends on the validity of the instruments. We consider two specification tests, suggested by Arellano and Bover (1995) and Blunedell and Bond (1998). The first is a Hansen J-test of over-identifying restrictions, which tests the overall validity of the instruments by analyzing the sample analog of the moment conditions used in the estimation process. This indicates that we cannot reject the null hypothesis that the full set of orthogonality conditions are valid (*p*-value=0.65).[16] The second test examines the hypothesis that the error term $\varepsilon_{i,t}$ is not serially correlated. We use an Arellano-Bond test for autocorrelation, and find that we cannot reject the null hypothesis of no second-order serial correlation in the first-differenced error terms (*p*-value=0.24).[17]

The regressions in columns 2-4 do not include the time-fixed effects. It is possible that global factors can simultaneously affect both domestic growth and public debt which may bias the results toward finding a stronger relationship between debt and growth. At the same time, however, as global factors can be correlated with domestic fiscal or economic variables, one can expect that the inclusion of time-fixed effects may understate the estimated effects of these variables. Columns 5-7 include time-fixed effects in the regression to allow for global factors. The pooled OLS and SGMM coefficients of initial debt remain significant at 5-10 per cent, and the size of

---

15 In the OLS and robust regressions, dummies for OECD, Asia, Latin America, and sub-Saharan Africa are included. Results for robust regressions are similar to those of pooled OLS, so they are not reported to save space.

16 Importantly, the difference-in-Hansen tests of exogeneity of instrument subsets do not reject the null hypothesis that the instrument subsets for the level equations are orthogonal to the error (*p*-value=0.34), that is, the assumption that lagged differences of endogenous explanatory variables that are being used as instruments in levels is uncorrelated with the errors. This is the additional restriction that needs to be satisfied for the SGMM estimator.

17 The dynamic panel GMM can generate too many instruments, which may overfit endogenous variables and run a risk of a weak-instruments bias (Roodman, 2009; Bazzi and Clemens, 2009). Given that, one recommendation when faced with a weak-instrument problem is to be parsimonious in the choice of instruments. Roodman (2009) suggests restricting the number of lagged levels used in the instrument matrix or collapsing the instrument matrix or combining the two. Some studies including Beck and Levine (2004) use the technique of collapsing instrument matrix. The reported SGMM results in our paper are obtained by combining the "collapsed" instrument matrix with lag limits.

Table 1

Baseline Panel Regression – Growth and Initial Government Debt, 1970-2008 (Five-year Period Panel)
Sample: Advanced and Emerging Economies (with Population of Over 5 Million)

(dependent variable: real per capita GDP growth)

Explanatory Variables	(1) BE	(2) Pooled OLS	(3) FE	(4) SGMM	(5) Pooled OLS	(6) FE	(7) SGMM
Initial real GDP per capita	–2.123***	–1.877**	–3.924***	–2.336***	–1.707**	–4.744**	–2.229***
	(–5.02)	*(–2.54)*	*(–2.74)*	*(–3.47)*	*(–2.14)*	*(–2.36)*	*(–2.95)*
Initial years of schooling	4.813***	3.143**	3.388	4.508*	3.136**	2.394	3.161
	(3.94)	*(2.57)*	*(1.64)*	*(1.93)*	*(2.55)*	*(1.07)*	*(1.55)*
Initial inflation rate	2.151	–2.100***	–2.630***	–2.666**	–2.457***	–2.454***	–2.678**
	(0.82)	*(–3.32)*	*(–5.38)*	*(–2.49)*	*(–3.21)*	*(–5.81)*	*(–2.05)*
Initial government size	0.109**	0.109**	0.147	0.162	0.111**	0.055	0.138
	(2.06)	*(2.43)*	*(1.68)*	*(1.36)*	*(2.38)*	*(0.70)*	*(1.23)*
Initial trade openness	–0.002	–0.004	0.023*	–0.013**	–0.005	0.023	–0.004
	(–0.43)	*(–0.78)*	*(1.73)*	*(–2.03)*	*(–1.11)*	*(1.57)*	*(–0.57)*
Initial financial depth	0.022**	0.020**	0.001	0.035***	0.023**	0.006	0.027**
	(2.15)	*(2.13)*	*(0.07)*	*(3.18)*	*(2.50)*	*(0.64)*	*(2.31)*
Terms of trade growth	0.204**	–0.013	0.009	–0.032	–0.017	–0.003	–0.044*
	(2.33)	*(–0.52)*	*(0.33)*	*(–1.14)*	*(–0.70)*	*(–0.13)*	*(–1.97)*
Banking crisis	–1.077	–0.617	–0.638***	–1.033	–0.612*	–0.513*	–1.838
	(–0.61)	*(–1.58)*	*(–2.96)*	*(–1.55)*	*(–1.75)*	*(–1.98)*	*(–1.24)*
Fiscal deficit	0.028	–0.044***	–0.047***	–0.046***	–0.045***	–0.035***	–0.062***
	(0.80)	*(–4.27)*	*(–4.07)*	*(–2.96)*	*(–4.72)*	*(–3.50)*	*(–3.10)*
Initial government debt	–0.025**	–0.022***	–0.015**	–0.030***	–0.018**	–0.004	–0.019*
	(–2.28)	*(–3.29)*	*(–2.17)*	*(–4.14)*	*(–2.34)*	*(–0.67)*	*(–1.89)*
Arellano-Bond AR(2) test *p*-value[1]				0.65			0.45
Hansen *J*-statistics (*p*-value)[2]				0.24			0.29
Number of observations	166	166	166	166	166	166	166
R^2	0.68	0.51	0.39		0.58	0.51	
Time-fixed effects	N/A	No	No	No	Yes	Yes	Yes

Note: Heteroskedasticity and country-specific autocorrelation consistent *t*-statistics are in parentheses. Time dummies are not reported. Levels of significance: *** 1%, ** 5%, * 10%. In the OLS regressions, dummies for OECD, Asia, Latin America, and Sub-Saharan Africa are also included in each regression (not reported to save space). FE refers to the fixed-effects panel regressions and BE is the between estimator. For the dynamic panel estimation, a two-step system GMM (SGMM) with the Windmeijer's finite-sample correction for the two-step covariance matrix.

1) The null hypothesis is that the first-differenced errors exhibit no second-order serial correlation.

2) The null hypothesis is that the instruments used are not correlated with the residuals.

those coefficients is reduced as expected. The estimated effects suggest that a 10 percentage point increase in the initial debt-to-GDP ratio is associated with a slowdown in growth of per capita GDP around 0.2 per cent per year.

In contrast, the FE results on initial debt turn out to be particularly sensitive to whether time-fixed effects are included or not in the regression (compare column 6 with column 3). The FE coefficient of initial debt is now insignificant and reduced to –0.004. It is well known in the literature that the FE can bias toward zero the slope estimates on the determinants of the steady-state level of income – the accumulation and depreciation variables in the Solow model (Islam, 1995). Given that the FE estimator tends to identify parameters on the basis of within-country variation, compared to cross-sectional alternatives such as pooled OLS and BE, it is not surprising that the within-country variation in each of regressors (especially time-persistent variables) is further reduced once time-fixed effects are accounted for.[18] Moreover, the measurement error bias can also be exacerbated under FE. With these caveats, time-fixed effects are included in the remaining regressions.

3.4 *Robustness of results*

A variety of robustness checks were conducted: First, to account for the possibility that there may have been structural changes over the sample period, including changes in global trend growth or global risk factors, time-fixed effects were included. In addition, we restricted the sample to the second half of the period to check whether there are significant changes in the estimated coefficients. Thus columns 1-4 in Table 2 repeat the same sets of regressions (BE, pooled OLS, FE, and SGMM) for the period of 1990-2008. The results are quite similar to those for the entire period. Except for the FE estimate, the impact of initial debt is significant, ranging from –0.020 to –0.024, indicating that a 10 percentage point increase in initial debt-to-GDP ratio is associated with decline in per capita GDP growth of around 0.2-0.24 per cent per year.

Second, columns 5-8 and 9-12 of Table 2 replicate the regression exercises for 46 advanced and emerging economies and the full sample of 79 countries (46 advanced and emerging economies and 33 developing countries) regardless of the population size for the entire period, respectively. Again, the results are broadly the same as those from the 38 advanced and emerging economies with a population of over 5 million, although the size of the debt coefficients becomes slightly smaller.

Third, Table 3 presents the results based on a parsimonious specification that excludes the fiscal deficit term.[19] The coefficients of initial debt are negative and significant at 1-5 per cent, ranging from –0.014 to –0.026, except for the FE result in which the coefficient of initial debt loses statistical significance (columns 1-4). It is noteworthy that the BE estimates of initial debt coefficient are stable around 0.21 to 0.26 across different samples, periods, and specifications. Using average debt instead of initial debt also yields a similar range of –0.019 to –0.030 for the debt coefficients under BE, OLS and SGMM, which are all significant at 1-10 per cent (columns 5, 6 and 8), except for the FE in column 7.

Fourth, additional variables are considered, such as population size (a proxy of country size), aged-dependency ratio (a proxy of population aging), investment, fiscal volatility, urbanization, and checks and balances or constraints on executive decision-making (as a proxy of durable

[18] With the time-fixed effects included, the coefficients of years of schooling and initial debt are often insignificant under FE in contrast to those under SGMM, as one can see throughout this paper.

[19] Qualitatively similar results are obtained in various parsimonious specifications, such as also dropping a measure of banking crisis and/or financial market depth.

Table 2

Robustness Checks—Time Period and Sample

(dependent variable: real per capita GDP growth)

Explanatory Variables	(1) BE	(2) Pooled	(3) FE	(4) SGMM	(5) BE	(6) Pooled	(7) FE	(8) SGMM	(9) BE	(10) Pooled	(11) FE	(12) SGMM
	Period: 1990-2008 Sample: OECD and Emerging Economies				Period: 1970-2008 Sample: OECD and Emerging Economies Without Population Size Restriction				Period: 1970-2008 Sample: Full Sample (Including Developing Countries) Without Population Size Restriction			
Initial real GDP per capita	–1.794***	–1.711**	–3.325*	–2.376**	–1.796***	–1.074*	–5.843***	–2.072*	–0.962***	–1.021**	–4.495**	–1.566**
	(–4.67)	*(–2.22)*	*(–1.99)*	*(–2.21)*	*(–4.37)*	*(–1.80)*	*(–3.09)*	*(–1.96)*	*(–2.79)*	*(–2.09)*	*(–2.13)*	*(–2.12)*
Initial years of schooling	3.815***	3.491***	–0.784	3.903	3.768***	1.809*	4.629**	2.956	1.550*	0.887	2.624	2.346*
	(3.35)	*(2.78)*	*(–0.17)*	*(0.92)*	*(3.10)*	*(1.68)*	*(2.56)*	*(0.87)*	*(1.79)*	*(0.98)*	*(1.11)*	*(1.79)*
Initial inflation rate	1.258	–2.918***	–2.308***	–1.717	2.227	–1.201**	–2.262***	–1.112	2.727	0.324	–0.899	–0.251
	(0.51)	*(–3.19)*	*(–4.33)*	*(–1.14)*	*(0.92)*	*(–2.14)*	*(–5.37)*	*(–0.93)*	*(1.14)*	*(0.46)*	*(–1.12)*	*(–0.33)*
Initial government size	0.120**	0.119**	0.074	0.205*	0.030	–0.018	–0.039	–0.180*	–0.020	–0.026	–0.023	–0.092
	(2.41)	*(2.45)*	*(0.68)*	*(1.73)*	*(0.77)*	*(–0.44)*	*(–0.56)*	*(–1.75)*	*(–0.63)*	*(–1.00)*	*(–0.41)*	*(–1.23)*
Initial trade openness	0.001	–0.007	0.030*	–0.006	0.009**	0.003	0.015	0.003	0.003	0.004	0.002	0.000
	(0.19)	*(–1.55)*	*(1.76)*	*(–0.72)*	*(2.38)*	*(0.78)*	*(1.63)*	*(0.24)*	*(0.83)*	*(1.29)*	*(0.15)*	*(0.03)*
Initial financial depth	0.016*	0.027**	0.002	0.032	0.002	0.001	0.007	–0.001	–0.000	–0.004	–0.006	0.006
	(1.71)	*(2.68)*	*(0.13)*	*(1.66)*	*(0.27)*	*(0.07)*	*(0.76)*	*(–0.06)*	*(–0.05)*	*(–0.60)*	*(–0.54)*	*(0.39)*
Terms of trade growth	0.223***	–0.016	–0.018	–0.049	0.187**	–0.001	0.008	–0.046	–0.033	0.028	0.062**	0.024
	(2.79)	*(–0.29)*	*(–0.36)*	*(–0.94)*	*(2.14)*	*(–0.04)*	*(0.31)*	*(–1.03)*	*(–0.64)*	*(0.92)*	*(2.05)*	*(0.74)*
Banking crisis	0.632	–0.358	–0.576	–1.233	–1.445	–0.867**	–0.837***	–1.003	–3.566**	–1.357***	–1.026***	–1.861***
	(0.38)	*(–0.68)*	*(–1.15)*	*(–0.90)*	*(–0.80)*	*(–2.23)*	*(–2.80)*	*(–1.16)*	*(–2.32)*	*(–3.85)*	*(–3.53)*	*(–3.21)*
Fiscal deficit	0.009	–0.055***	–0.046***	–0.057*	0.050*	–0.037***	–0.045***	–0.045**	–0.028**	–0.034***	–0.041***	–0.035**
	(0.27)	*(–4.18)*	*(–2.92)*	*(–1.71)*	*(1.72)*	*(–3.40)*	*(–4.25)*	*(–2.46)*	*(–2.17)*	*(–3.80)*	*(–5.50)*	*(–2.13)*
Initial government debt	–0.024***	–0.020**	–0.008	–0.023*	–0.019*	–0.020**	–0.011*	–0.021*	–0.021***	–0.017***	–0.011*	–0.016*
	(–2.85)	*(–2.26)*	*(–0.65)*	*(–2.02)*	*(–1.94)*	*(–2.62)*	*(–1.78)*	*(–1.74)*	*(–3.22)*	*(–3.31)*	*(–1.66)*	*(–1.83)*
Arellano-Bond AR(2) test p-value[1]				0.42				0.59				0.59
Hansen J-statistics (p-value)[2]				0.13				0.98				0.36
Number of observations	124	124	124	124	208	208	208	208	297	297	297	297
R^2	0.72	0.61	0.44		0.56	0.44	0.51		0.37	0.36	0.43	
Time-fixed effects	N/A	Yes	Yes	Yes	N/A	Yes	Yes	Yes	N/A	Yes	Yes	Yes

Note: Heteroskedasticity and country-specific autocorrelation consistent t-statistics are in parentheses. Time dummies are not reported. Levels of significance: *** 1%, ** 5%, * 10%. In the OLS regressions, dummies for OECD, Asia, Latin America, and Sub-Saharan Africa are also included in each regression (not reported to save space). FE refers to the fixed-effects panel regressions and BE is the between estimator. For the dynamic panel estimation, a two-step system GMM (SGMM) with the Windmeijer's finite-sample correction for the two-step covariance matrix.

1) The null hypothesis is that the first-differenced errors exhibit no second-order serial correlation.

2) The null hypothesis is that the instruments used are not correlated with the residuals.

Table 3

Robustness Checks – Parsimonious Specification: Advanced and Emerging Economies

(dependent variable: real per capita GDP growth)

Explanatory Variables	(1) BE	(2) Pooled OLS	(3) FE	(4) SGMM	(5) BE	(6) Pooled OLS	(7) FE	(8) SGMM
Initial real GDP per capita	–2.007***	–2.068**	–5.835**	–2.545***	–1.722***	–1.786**	–6.157***	–2.014**
	(–5.08)	*(–2.41)*	*(–2.59)*	*(–3.37)*	*(–4.45)*	*(–2.17)*	*(–3.25)*	*(–2.36)*
Initial years of schooling	4.576***	3.486**	1.404	6.493**	3.393***	2.749**	1.057	3.654*
	(3.89)	*(2.68)*	*(0.51)*	*(2.42)*	*(2.93)*	*(2.25)*	*(0.38)*	*(1.91)*
Initial inflation rate	1.469	–1.276*	–1.692***	–0.683	2.467	–1.376	–2.318*	–4.405
	(0.60)	*(–1.73)*	*(–5.52)*	*(–0.97)*	*(1.20)*	*(–1.30)*	*(–1.79)*	*(–1.49)*
Initial government size	0.117**	0.093**	0.001	0.011	0.094*	0.084*	0.009	0.264
	(2.26)	*(2.03)*	*(0.01)*	*(0.08)*	*(1.88)*	*(2.01)*	*(0.12)*	*(1.14)*
Initial trade openness	–0.004	–0.001	0.038***	0.000	–0.005	–0.002	0.030**	–0.005
	(–0.79)	*(–0.15)*	*(2.83)*	*(0.04)*	*(–1.16)*	*(–0.58)*	*(2.59)*	*(–0.45)*
Initial financial depth	0.024**	0.017*	0.002	0.005	0.024**	0.020**	0.002	0.026
	(2.47)	*(1.98)*	*(0.32)*	*(0.51)*	*(2.61)*	*(2.21)*	*(0.30)*	*(1.38)*
Terms of trade growth	0.169**	0.005	0.003	–0.014	0.006	–0.007	0.021	–0.031
	(2.24)	*(0.15)*	*(0.11)*	*(–0.46)*	*(0.07)*	*(–0.25)*	*(0.67)*	*(–1.06)*
Banking crisis	–0.880	–0.483	–0.402	–1.311	–2.004	–1.199***	–1.208***	–0.614
	(–0.50)	*(–1.21)*	*(–1.48)*	*(–0.85)*	*(–1.35)*	*(–2.74)*	*(–2.97)*	*(–0.42)*
Initial government debt	–0.026**	–0.014**	0.010	–0.014*				
	(–2.39)	*(–2.12)*	*(1.36)*	*(–1.95)*				
Government debt, average					–0.030***	–0.019**	–0.004	–0.023*
					(–2.87)	*(–2.36)*	*(–0.56)*	*(–1.86)*
Arellano-Bond AR(2) test *p*-value[1]				0.08				0.14
Hansen *J*-statistics (*p*-value)[2]				0.33				0.27
Number of observations	166	166	166	166	181	181	181	181
R^2	0.67	0.52	0.45		0.59	0.49	0.47	
Time-fixed effects	N/A	Yes	Yes	Yes	N/A	Yes	Yes	Yes

Note: Heteroskedasticity and country-specific autocorrelation consistent *t*-statistics are in parentheses. Time dummies are not reported. Levels of significance: *** 1%, ** 5%, * 10%. In the OLS regressions, dummies for OECD, Asia, Latin America, and Sub-Saharan Africa are also included in each regression (not reported to save space). FE refers to the fixed-effects panel regressions and BE is the between estimator. For the dynamic panel estimation, a two-step system GMM (SGMM) with the Windmeijer's finite-sample correction for the two-step covariance matrix.

1) The null hypothesis is that the first-differenced errors exhibit no second-order serial correlation.

2) The null hypothesis is that the instruments used are not correlated with the residuals.

institutional quality; see Glaeser *et al.*, 2004). The results do not change appreciably (Table 4). Columns 1-4 add the log of initial population to the baseline specification: the coefficients of initial debt are negative and significant at 5 per cent level except for the FE in column 3 in which it is insignificant. According to the BE, OLS, and SGMM, the estimated effects of initial debt suggest that a 10 percentage point increase of initial debt-to-GDP ratio is associated with slowdown in growth of per capita GDP of around 0.18 to 0.25 per cent per year. In contrast, the coefficients of population size are insignificant except for FE in which it becomes significant.

The results when initial domestic investment (as a percent of GDP) is added to the baseline specification are shown in columns 5-8 of Table 4. Under OLS and SGMM, the coefficients of initial debt ratio are significant at 5 per cent level, whereas the coefficients of investment are of the expected positive sign and significant at 5 per cent under BE and OLS. Under SGMM, the investment coefficient becomes insignificant, and its coefficient size is slightly smaller than that under BE. However, the FE estimates of the coefficients of initial debt and initial investment are not only insignificant, but the coefficient of initial investment even changes its sign to negative.

In columns 9-12 of Table 4, we include a measure of fiscal spending volatility (as measured by a logarithm of standard deviations of annual growth in real general government expenditures) in the regressions. Recently, Fatás and Mihov (2003) have argued that excessive discretionary fiscal policies that are not related to dealing with business cycle fluctuations can lead to higher output volatility and lower growth.[20] At the same time, this excessive fiscal activism may lead to a large debt buildup. According to this view, excessive fiscal discretion may be an underlying force behind the negative relation between government debt and growth. If this is so, one may expect the coefficient of initial debt in the growth regression to become weaken or at least to get smaller in its absolute value, once the fiscal volatility term is included in the regression. However, our analysis does not find evidence in support of this view.[21] The coefficients of fiscal volatility are insignificant, and even change sign across different estimations. By contrast, the coefficients of initial debt remain largely significant, and the size of estimated coefficients is quite similar to that in the baseline regressions.

Finally, we run a single cross-country regression of the type that is most commonly used in the empirical growth literature for longer time periods. The cross-country regression results are presented in Appendix Tables 11 and 12. They are remarkably similar to the above panel regression results. In particular, the size of estimated initial debt coefficients which is around –0.02~–0.03 is remarkably similar to that found in the baseline panel regression.

3.5 Non-linearities and differences between advanced and emerging economies

To explore potential non-linearities, Table 5 (columns 1-4) shows regressions that include the interaction terms between initial debt and dummy variables for three ranges of initial debt: Dum_30 for low debt (below 30 per cent of GDP); Dum_30-90 for medium debt (30-90 per cent of GDP); and Dum_90 for high debt (over 90 per cent of GDP). The coefficients of low initial debt (*i.e.*, initial debt*Dum_30) are all insignificant and of the positive sign, which seems to suggest that

20 Ideally, the measure of fiscal policy volatility (that is, excessive discretionary policy changes undertaken for reasons other than smoothing out business cycle fluctuations) can be constructed in a more sophisticated manner. For example, it can be obtained as a standard deviation of the residuals from time-series regression of government spending growth on macroeconomic variables such as output growth and inflation. Given such a short time duration of each period, it is impossible to run a meaningful time-series regression for each five-year period. However, the qualitative behavior of such a measure of fiscal volatility is very similar to that of a crude measure of fiscal volatility as used in this paper (Woo, 2009).

21 While there is significant evidence that fiscal volatility is positively correlated with output volatility and that output volatility is negatively associated with growth (Fatás and Mihov, 2003; Ramey and Ramey, 1995), there is little analysis in the literature regarding the relationship between government debt and fiscal behavior such as fiscal volatility or fiscal cyclicality.

Table 4

Robustness Checks – Additional Variables: Advanced and Emerging Economies

(dependent variable: real per capita GDP growth)

Explanatory Variables	(1) BE	(2) Pooled OLS	(3) FE	(4) SGMM	(5) BE	(6) Pooled OLS	(7) FE	(8) SGMM	(9) BE	(10) Pooled OLS	(11) FE	(12) SGMM
Initial real GDP per capita	–1.798***	–1.581**	–4.361***	–2.478**	–2.412***	–2.506***	–3.832	–2.909***	–2.110***	–1.737**	–4.762**	–1.830**
	(–3.39)	*(–2.14)*	*(–2.76)*	*(–2.43)*	*(–6.07)*	*(–2.82)*	*(–1.64)*	*(–2.74)*	*(–4.32)*	*(–2.17)*	*(–2.36)*	*(–2.53)*
Initial years of schooling	4.611***	2.994**	–1.364	6.483*	4.385***	3.729***	2.057	5.403	4.818***	3.037**	2.358	3.173
	(3.73)	*(2.52)*	*(–0.48)*	*(1.68)*	*(3.93)*	*(3.08)*	*(0.94)*	*(1.60)*	*(3.86)*	*(2.49)*	*(1.08)*	*(1.14)*
Initial inflation rate	2.481	–2.313***	–2.642***	–5.741	2.099	–2.659***	–2.484***	–5.742	2.140	–2.351***	–2.444***	–3.296*
	(0.94)	*(–3.15)*	*(–5.48)*	*(–0.90)*	*(0.89)*	*(–3.53)*	*(–5.54)*	*(–0.94)*	*(0.80)*	*(–2.94)*	*(–5.15)*	*(–1.68)*
Initial government size	0.094*	0.109**	0.079	0.251	0.128**	0.119**	–0.010	0.174	0.110*	0.108**	0.055	0.245**
	(1.72)	*(2.44)*	*(0.91)*	*(0.95)*	*(2.64)*	*(2.71)*	*(–0.14)*	*(1.08)*	*(1.98)*	*(2.31)*	*(0.70)*	*(2.17)*
Initial trade openness	0.002	–0.001	0.042***	–0.009	0.001	–0.003	0.020	–0.012	–0.003	–0.004	0.023	0.002
	(0.34)	*(–0.21)*	*(3.08)*	*(–0.75)*	*(0.15)*	*(–0.95)*	*(1.18)*	*(–1.06)*	*(–0.39)*	*(–0.87)*	*(1.49)*	*(0.27)*
Initial financial depth	0.015	0.021**	0.007	0.019	0.021**	0.024***	0.005	0.025	0.022*	0.022**	0.005	0.019
	(1.20)	*(2.38)*	*(0.88)*	*(0.89)*	*(2.32)*	*(3.12)*	*(0.53)*	*(1.48)*	*(1.97)*	*(2.38)*	*(0.64)*	*(1.46)*
Terms of trade growth	0.219**	–0.014	–0.012	–0.028	0.300***	–0.011	–0.005	–0.026	0.205**	–0.017	–0.003	–0.048**
	(2.47)	*(–0.56)*	*(–0.50)*	*(–0.63)*	*(3.45)*	*(–0.47)*	*(–0.20)*	*(–0.45)*	*(2.24)*	*(–0.65)*	*(–0.13)*	*(–2.35)*
Fiscal deficit	0.039	–0.043***	–0.032***	–0.041*	0.015	–0.047***	–0.038***	–0.064	0.028	–0.044***	–0.035***	–0.043***
	(1.07)	*(–4.68)*	*(–3.83)*	*(–1.71)*	*(0.45)*	*(–5.21)*	*(–3.68)*	*(–1.58)*	*(0.76)*	*(–4.54)*	*(–3.45)*	*(–2.84)*
Banking crisis	–1.506	–0.687*	–0.298	–0.747	–0.434	–0.543	–0.391	–2.481	–1.059	–0.597*	–0.510*	–1.523
	(–0.83)	*(–2.02)*	*(–1.07)*	*(–0.55)*	*(–0.27)*	*(–1.38)*	*(–1.34)*	*(–0.99)*	*(–0.58)*	*(–1.73)*	*(–1.98)*	*(–1.12)*
Initial government debt	–0.025**	–0.018**	0.003	–0.018**	–0.015	–0.014**	–0.008	–0.025*	–0.025**	–0.017**	–0.004	–0.014
	(–2.24)	*(–2.49)*	*(0.50)*	*(–2.29)*	*(–1.40)*	*(–2.59)*	*(–1.17)*	*(–1.74)*	*(–2.24)*	*(–2.36)*	*(–0.66)*	*(–1.28)*
Initial population size (log)	0.275	0.200	9.096***	0.094								
	(1.01)	*(1.02)*	*(2.81)*	*(0.09)*								
Initial investment					0.106**	0.076**	–0.079	0.080				
					(2.65)	*(2.50)*	*(–1.42)*	*(0.78)*				
Fiscal volatility									0.031	–0.194	–0.016	0.133
									(0.06)	*(–0.76)*	*(–0.07)*	*(0.28)*
Arellano-Bond AR(2) test *p*-value[1]				0.12				0.25				0.27
Hansen *J*-statistics (*p*-value)[2]				0.88				0.24				0.99
Number of observations	166	166	166	166	166	166	166	166	166	166	166	166
R^2	0.69	0.59	0.56		0.75	0.61	0.53		0.68	0.59	0.51	
Time-fixed effects	N/A	Yes	Yes	Yes	N/A	Yes	Yes	Yes	N/A	Yes	Yes	Yes

Note: Heteroskedasticity and country-specific autocorrelation consistent *t*-statistics are in parentheses. Time dummies are not reported. Levels of significance: *** 1%, ** 5%, * 10%. In the OLS regressions, dummies for OECD, Asia, Latin America, and Sub-Saharan Africa are also included in each regression (not reported to save space). FE refers to the fixed-effects panel regressions and BE is the between estimator. For the dynamic panel estimation, a two-step system GMM (SGMM) with the Windmeijer's finite-sample correction for the two-step covariance matrix.

1) The null hypothesis is that the first-differenced errors exhibit no second-order serial correlation.

2) The null hypothesis is that the instruments used are not correlated with the residuals.

Table 5

Panel Regression – Different Levels of Initial Debt and Advanced vs. Emerging Economies

(dependent variable: real per capita GDP growth)

Explanatory Variables	(1) BE	(2) Pooled OLS	(3) FE	(4) SGMM	(5) BE	(6) Pooled OLS	(7) FE	(8) SGMM
Initial real GDP per capita	–2.014***	–1.875***	–4.912**	–2.227***	–2.796***	–2.539***	–4.705**	–2.897***
	(–5.13)	*(–2.79)*	*(–2.65)*	*(–3.14)*	*(–4.51)*	*(–2.96)*	*(–2.35)*	*(–4.07)*
Initial years of schooling	4.377***	3.185***	2.260	3.988	4.691***	3.127***	2.232	2.074
	(3.77)	*(3.10)*	*(1.00)*	*(1.42)*	*(3.91)*	*(2.79)*	*(1.03)*	*(1.06)*
Initial inflation rate	1.551	–2.773***	–2.329***	–2.352**	0.503	–3.213***	–2.390***	–9.852**
	(0.59)	*(–3.67)*	*(–5.06)*	*(–2.65)*	*(0.18)*	*(–3.17)*	*(–5.17)*	*(–2.31)*
Initial government size	0.135**	0.127***	0.033	0.199**	0.096*	0.086*	0.056	0.293**
	(2.65)	*(3.06)*	*(0.40)*	*(2.03)*	*(1.82)*	*(2.02)*	*(0.70)*	*(2.65)*
Initial trade openness	–0.003	–0.005	0.026*	–0.007	–0.002	–0.005	0.023	–0.005
	(–0.65)	*(–1.37)*	*(1.77)*	*(–1.02)*	*(–0.30)*	*(–1.18)*	*(1.56)*	*(–0.76)*
Initial financial depth	0.023**	0.023***	0.006	0.026***	0.022**	0.024***	0.005	0.032***
	(2.18)	*(3.02)*	*(0.68)*	*(2.84)*	*(2.24)*	*(2.87)*	*(0.57)*	*(3.06)*
Terms of trade growth	0.183*	–0.018	–0.003	–0.038	0.235**	–0.008	–0.002	–0.050**
	(1.93)	*(–0.65)*	*(–0.18)*	*(–1.23)*	*(2.66)*	*(–0.32)*	*(–0.10)*	*(–2.26)*
Fiscal deficit	0.011	–0.046***	–0.033***	–0.045**	0.019	–0.050***	–0.034***	–0.059***
	(0.32)	*(–4.75)*	*(–3.14)*	*(–2.23)*	*(0.53)*	*(–4.94)*	*(–3.24)*	*(–3.69)*
Banking crisis	–1.270	–0.563	–0.468	–0.612	–0.992	–0.588*	–0.506*	–1.163
	(–0.72)	*(–1.60)*	*(–1.61)*	*(–0.83)*	*(–0.57)*	*(–1.75)*	*(–1.94)*	*(–1.13)*
Initial debt*Dum below30	0.016	0.0002	0.017	0.030				
	(0.17)	*(0.01)*	*(0.65)*	*(1.25)*				
Initial debt*Dum 30 90	–0.037	–0.028**	0.007	–0.015				
	(–1.43)	*(–2.66)*	*(0.79)*	*(–1.26)*				
Initial debt*Dum above90	–0.010	–0.015***	–0.001	–0.015***				
	(–0.79)	*(–2.79)*	*(–0.08)*	*(–2.91)*				
Initial debt*Dum advanced					–0.017	–0.012**	–0.005	–0.014*
					(–1.35)	*(–2.19)*	*(–0.75)*	*(–1.95)*
Initial debt*Dum emerging					–0.044**	–0.042***	0.001	–0.038*
					(–2.62)	*(–2.97)*	*(0.08)*	*(–1.95)*
Arellano-Bond AR(2) test *p*-value[1]				0.34				0.14
Hansen *J*-statistics (*p*-value)[2]				0.86				0.85
Number of observations	166	166	166	166	166	166	166	166
R^2	0.75	0.62	0.52		0.7	0.61	0.51	
Time-fixed effects	N/A	Yes	Yes	Yes	N/A	Yes	Yes	Yes

Note: Heteroskedasticity and country-specific autocorrelation consistent *t*-statistics are in parentheses. Time dummies are not reported. Levels of significance: *** 1%, ** 5%, * 10%. In the OLS regressions, dummies for OECD, Asia, Latin America, and Sub-Saharan Africa are also included in each regression (not reported to save space). FE refers to the fixed-effects panel regressions and BE is the between estimator. For the dynamic panel estimation, a two-step system GMM (SGMM) with the Windmeijer's finite-sample correction for the two-step covariance matrix.

1) The null hypothesis is that the first-differenced errors exhibit no second-order serial correlation.

2) The null hypothesis is that the instruments used are not correlated with the residuals.

relatively low levels of public debt is not significantly harmful to growth. In the OLS, the coefficient of medium level of debt (initial debt*Dum_30-90) is significant at 5 per cent, and its estimated coefficient is –0.028. But they are all insignificant in other estimations (BE, FE and SGMM). By contrast, the coefficients of high debt (initial debt*Dum_90) are negative and significant at 1 per cent under OLS, and SGMM.

Interestingly, the negative effect of initial debt on growth in advanced economies tends to be smaller than that in emerging economies. Columns 5-8 in Table 5 use the interaction terms between initial debt and dummy variables for advanced and emerging economies.[22] The coefficients of both interaction terms are negative and significant at various levels, except for the FE results and the coefficient of the initial debt*Dum_advanced term in BE. Under BE, OLS, and SGMM, the coefficients of initial debt in advanced economies range from –0.012 to –0.017, whose absolute size is smaller than that of emerging economies (–0.038 to –0.044): a 10 percentage point increase in initial debt-to-GDP ratio is associated with growth slowdown around 0.12-0.17 per cent in advanced economies, compared to 0.38-0.4 per cent in emerging economies.[23] This may reflect limited borrowing capacity of emerging economies due to less-developed domestic financial markets or fragile access to international capital markets.

3.6 *Net foreign asset position, foreign liabilities, and domestic vs. foreign currency-denominated portion of public debt*

An important question that arises is whether and the extent to which the impact on growth of initial debt is conditional on a country's economic and financial position *vis-à-vis* the rest of the world. For example, does the NFA (net foreign asset) position of a country or aggregate foreign liabilities matter for the magnitude of the relationship between public debt and growth?[24] Is it the case that the adverse impact of high debt on growth would be smaller if at the same time the aggregate foreign liabilities of a country are relatively low? This could be related to the fact that high public debt is being financed by private domestic savings rather than from abroad. Conversely, excessive foreign liabilities may compound the fiscal vulnerability arising from public debt *per se*, to the extent that foreign creditors may be more sensitive to changes in global risk appetite, or they may have shorter time horizons. Another channel could be in terms of signaling: high public debt when foreign liabilities are also high may indicate that the imbalances facing a country are broader than just the public sector. Similar arguments could be used with regard to the NFA, rather than only foreign liabilities *per se*.

In order to investigate this issue, we considered the NFA and foreign liabilities (as percent of GDP) as an additional variable, as well as an interactive term. It is the case that the bilateral correlation between government debt and the NFA or foreign liabilities is low (correlation coefficients are –0.10 and 0.11, respectively), and neither the NFA nor foreign liabilities are not significant in growth regressions, as shown in columns 1-4 of Table 6 (the results on foreign liabilities are not reported). However, the logic of the above argument would suggest that the interaction of initial public debt with NFA or liabilities might be more important. This was assessed by examining the interaction of debt with a dummy that took a value of 1 if the NFA exceeded the

---

22 See Appendix 1 for the list of advanced and emerging economies.

23 The same pattern is also found in the regressions on components of output per worker growth that the negative effects on growth of high debt are greater in emerging economies than in advanced economies.

24 The current sovereign debt crisis in Europe suggests that there is a strong correlation between the NFA positions and sovereign yields, indicating the market perceptions of fiscal risks associated with high debt (such as debt default and fiscal unsustainability) may depend on the NFA position. Conversely, some commentators observe that the currently very low yields on Japanese government bonds despite the very high level of debt (about 230 per cent of GDP) are possibly due to its high level of NFA in addition to Japan's haven status.

Table 6

Panel Regression – Different Levels of Initial NFA and Foreign Liabilities

(dependent variable: real per capita GDP growth)

Explanatory Variables	(1) BE	(2) Pooled	(3) FE	(4) SGMM	(5) BE	(6) Pooled	(7) FE	(8) SGMM	(9) BE	(10) Pooled	(11) FE	(12) SGMM
Initial real GDP per capita	–2.127***	–1.698**	–4.772**	–1.852**	–2.273***	–1.863**	–4.754**	–2.182***	–1.909***	–1.816**	–4.949**	–1.881***
	(–4.95)	*(–2.23)*	*(–2.29)*	*(–2.51)*	*(–5.43)*	*(–2.66)*	*(–2.38)*	*(–3.86)*	*(–4.40)*	*(–2.35)*	*(–2.46)*	*(–2.78)*
Initial years of schooling	4.760***	3.044**	2.345	2.580	4.458***	3.076***	2.396	3.749***	5.066***	3.308***	2.250	1.592
	(3.81)	*(2.51)*	*(1.04)*	*(1.11)*	*(3.72)*	*(2.92)*	*(1.08)*	*(2.77)*	*(4.22)*	*(2.76)*	*(1.04)*	*(0.67)*
Initial inflation rate	2.019	–2.397***	–2.483***	–1.402	2.874	–2.098***	–2.418***	–1.905	–0.277	–2.621***	–2.527***	–2.514**
	(0.75)	*(–3.20)*	*(–5.82)*	*(–1.21)*	*(1.12)*	*(–3.06)*	*(–5.53)*	*(–1.58)*	*(–0.09)*	*(–3.57)*	*(–5.84)*	*(–2.15)*
Initial government size	0.108*	0.115**	0.057	0.142	0.096*	0.115**	0.059	0.114	0.117**	0.117**	0.053	0.111
	(2.00)	*(2.44)*	*(0.73)*	*(1.50)*	*(1.86)*	*(2.70)*	*(0.74)*	*(0.68)*	*(2.26)*	*(2.61)*	*(0.67)*	*(1.32)*
Initial trade openness	–0.003	–0.006	0.023	0.008	0.0003	–0.004	0.024	–0.007	–0.001	–0.002	0.026*	0.003
	(–0.50)	*(–1.28)*	*(1.51)*	*(1.07)*	*(0.06)*	*(–1.17)*	*(1.58)*	*(–1.40)*	*(–0.13)*	*(–0.39)*	*(1.90)*	*(0.28)*
Initial financial depth	0.019	0.021**	0.006	0.018	0.014	0.021**	0.006	0.027**	0.020*	0.022**	0.006	0.021*
	(1.47)	*(2.18)*	*(0.66)*	*(1.24)*	*(1.29)*	*(2.62)*	*(0.66)*	*(2.33)*	*(1.98)*	*(2.26)*	*(0.64)*	*(1.66)*
Terms of trade growth	0.199**	–0.016	–0.003	–0.034	0.167*	–0.021	–0.004	–0.034	0.161*	–0.022	–0.007	–0.051***
	(2.22)	*(–0.62)*	*(–0.13)*	*(–0.77)*	*(1.92)*	*(–0.90)*	*(–0.17)*	*(–0.99)*	*(1.81)*	*(–0.95)*	*(–0.28)*	*(–2.75)*
Fiscal deficit	0.028	–0.044***	–0.035***	–0.034	0.021	–0.045***	–0.035***	–0.044	–0.0002	–0.050***	–0.039***	–0.067***
	(0.79)	*(–4.80)*	*(–3.59)*	*(–1.44)*	*(0.62)*	*(–5.40)*	*(–3.52)*	*(–1.59)*	*(–0.00)*	*(–5.03)*	*(–3.55)*	*(–2.78)*
Banking crisis	–0.943	–0.570	–0.525*	–2.219*	–1.468	–0.510	–0.489*	–1.077	–0.672	–0.550	–0.485*	–0.427
	(–0.52)	*(–1.66)*	*(–1.88)*	*(–1.96)*	*(–0.85)*	*(–1.46)*	*(–1.83)*	*(–1.19)*	*(–0.38)*	*(–1.56)*	*(–1.81)*	*(–0.54)*
Initial government debt	–0.024**	–0.017**	–0.004	–0.015*								
	(–2.14)	*(–2.40)*	*(–0.72)*	*(–1.81)*								
Initial NFA (net foreign assets)	0.003	0.005	–0.002	–0.013								
	(0.39)	*(0.84)*	*(–0.21)*	*(–1.26)*								
*Initial debt*Dum NFA above median*[3]					*–0.020**	*–0.015***	*–0.004*	*–0.023**				
					(–1.80)	(–2.64)	(–0.60)	(–1.84)				
Initial debt*Dum NFA below median					–0.042***	–0.029***	–0.006	–0.029*				
					(–2.88)	*(–3.17)*	*(–0.70)*	*(–1.95)*				
Initial debt*Dum Foreign Liabilities below_75percentile[4]									–0.013	–0.015*	–0.003	–0.017*
									(–0.99)	*(–1.98)*	*(–0.38)*	*(–1.85)*
Initial debt*Dum Foreign Liabilities above_75percentile									–0.036***	–0.025***	–0.010	–0.025*
									(–2.81)	*(–2.74)*	*(–1.19)*	*(–1.71)*
Arellano-Bond AR(2) test *p*-value[1]				0.16				0.28				0.36
Hansen J-statistics (*p*-value)[2]				0.47				0.16				0.90
Number of observations	166	166	166	166	166	166	166	166	166	166	166	166
R^2	0.68	0.59	0.51		0.71	0.61	0.51		0.7	0.59	0.52	
Time-fixed effects	N/A	Yes	Yes	Yes	N/A	Yes	Yes	Yes	N/A	Yes	Yes	Yes

Note: Heteroskedasticity and country-specific autocorrelation consistent *t*-statistics are in parentheses. Time dummies are not reported. Levels of significance: *** 1%, ** 5%, * 10%. In the OLS regressions, dummies for OECD, Asia, Latin America, and Sub-Saharan Africa are also included in each regression (not reported to save space). FE refers to the fixed-effects panel regressions and BE is the between estimator. For the dynamic panel estimation, a two-step system GMM (SGMM) with the Windmeijer's finite-sample correction for the two-step covariance matrix.

1) The null hypothesis is that the first-differenced errors exhibit no second-order serial correlation.

2) The null hypothesis is that the instruments used are not correlated with the residuals.

3) The median value of NFA in the sample of 36 advanced and emerging economies is –17 per cent of GDP.

4) The 75 percentile level of foreign liabilities in the sample of 36 advanced and emerging economies is 89 per cent of GDP.

sample median value (–17 per cent of GDP), or if foreign liabilities were greater than the 75th percentile (89 per cent of GDP), and 0 otherwise. The results are shown in columns 5-8 and 8-12 of Table 6, respectively. The results bear out the basic hypothesis: when foreign liabilities are high or NFA low, the adverse impact of public debt on growth is about *one and a half to two* times as large as is the case otherwise. These results are striking from an economic perspective, and statistically significant. Perhaps what they are really implying is the notion that if the economy as a whole is operating essentially outside its means, the impact of high public debt on growth is substantially worse than when it is operating within it.

Next, we turn to the question of whether the currency composition of public debt also matters. The larger the portion of foreign-currency denominated debt as a share of total public debt, the larger the extent of exposure to foreign currency risk. This is related to the "Original Sin" problem highlighted by Eichengreen and Hausmann (1999), which could have adverse macroeconomic consequences. If a country affected by original sin has net foreign debt, then this country is likely to have a currency mismatch in its national balance sheet and large swings in the real exchange rate will have an effect on aggregate wealth and affect a country's ability to service its debt. As a consequence, original sin tends to make debt riskier, increase volatility, and affect a country's ability to conduct an independent monetary policy. Table 7 shows the results when we included the interaction of debt with a dummy that took a value of 1 if the domestic-currency portion exceeded the sample median value (89 per cent of total debt), or if it is greater than the 25th percentile (59 per cent of total debt), and 0 otherwise. The regression coefficients of the interaction terms are mostly significant and of the expected sign. They suggest that when the foreign-currency debt portion is large, the negative impact of public debt on growth can be more than twice as large as is the case otherwise.

4 Growth accounting

A detailed growth accounting exercise was also undertaken to explore channels (factor accumulation versus total factor productivity) through which government debt influences growth.[25] Taking a standard neoclassical framework, we consider a Cobb-Douglas production function $Y=AK^{\alpha}(HL)^{1-\alpha}$, where α is capital income share; K is physical capital; L is labor input; H is human capital; and A is TFP (total factor productivity). In terms of per worker, the production function can be written as $y=Ak^{\alpha}H^{1-\alpha}$, where $y=Y/L$ (output per worker) and $k=K/L$ (capital per worker). Then, growth of output per worker ($\dot{y}/y$) can be decomposed to TFP growth ($\dot{A}/A$) and contributions from growth of capital per worker ($\dot{k}/k$) and growth of human capital ($\dot{H}/H$).

$$\dot{y}/y = \dot{A}/A + \alpha(\dot{k}/k) + (1-\alpha)(\dot{H}/H) \tag{2}$$

Table 8 presents results from panel regression on output per worker growth and its components (TFP growth ($\dot{A}/A$) and growth of capital per worker ($\dot{k}/k$)), using the same baseline specification (Equation 1).[26] First, the coefficients of initial debt in the regressions of output per worker growth are significant at 5-10 per cent under BE, OLS, and SGMM, ranging from –0.012 to –0.022, whereas it becomes insignificant under FE (columns 1-4). The estimated

[25] See Appendix 3 for details about the growth accounting. The relation between labor force participation and initial debt is also examined, but the results are not significant (not reported).

[26] In terms of regression specification, y now denotes the logarithm of output per worker (Y/L) in the regressions on growth of output per worker (columns 1-4 of Table 8); y is the logarithm of level of TFP in the TFP growth regressions (columns 5-8); y is the logarithm of capital stock per worker (K/L) in the regressions on growth of capital stock per worker (columns 9-12). In the investment regressions of Table 9, the dependent variable is the average level of domestic investment (percent of GDP) over the period t and $t-\tau$.

Table 7

Panel Regression – Domestic vs. Foreign Currency-Denominated Portion of Public Debt

(dependent variable: real per capita GDP growth)

Explanatory Variables	(1) BE	(2) Pooled OLS	(3) FE	(4) SGMM	(5) BE	(6) Pooled OLS	(7) FE	(8) SGMM
Initial real GDP per capita	–2.531***	–2.092***	–4.927**	–2.337**	–2.178***	–1.856**	–4.818**	–2.688**
	(–4.79)	*(–2.96)*	*(–2.32)*	*(–2.29)*	*(–4.40)*	*(–2.44)*	*(–2.35)*	*(–2.37)*
Initial years of schooling	5.311***	3.293***	3.195	4.209	5.054***	3.110**	3.030	2.578
	(4.01)	*(3.10)*	*(1.32)*	*(1.54)*	*(3.63)*	*(2.52)*	*(1.22)*	*(0.74)*
Initial inflation rate	0.946	–2.471***	–2.393***	–3.002**	2.136	–2.652***	–2.401***	–2.521*
	(0.30)	*(–3.53)*	*(–5.90)*	*(–2.28)*	*(0.69)*	*(–2.98)*	*(–4.73)*	*(–1.67)*
Initial government size	0.081	0.091*	0.086	0.182	0.111*	0.112**	0.095	0.118
	(1.30)	*(2.01)*	*(1.19)*	*(1.64)*	*(1.80)*	*(2.32)*	*(1.24)*	*(1.05)*
Initial trade openness	–0.002	–0.005	0.025	–0.012*	–0.001	–0.004	0.026	0.001
	(–0.32)	*(–0.93)*	*(1.51)*	*(–1.72)*	*(–0.18)*	*(–0.90)*	*(1.48)*	*(0.12)*
Initial financial depth	0.018	0.017**	0.005	0.026*	0.022	0.023**	0.004	0.024*
	(1.40)	*(2.08)*	*(0.50)*	*(1.84)*	*(1.54)*	*(2.36)*	*(0.41)*	*(1.97)*
Terms of trade growth	0.211**	0.004	0.003	–0.032	0.212**	–0.018	–0.000	–0.040*
	(2.27)	*(0.14)*	*(0.10)*	*(–0.99)*	*(2.18)*	*(–0.72)*	*(–0.00)*	*(–1.70)*
Banking crisis	–1.613	–0.832*	–0.588*	–0.501	–0.547	–0.612	–0.577*	–2.577
	(–0.67)	*(–2.03)*	*(–2.00)*	*(–0.34)*	*(–0.23)*	*(–1.33)*	*(–1.98)*	*(–1.48)*
Fiscal deficit	0.008	–0.051***	–0.036***	–0.074***	0.028	–0.047***	–0.035***	–0.063***
	(0.19)	*(–4.36)*	*(–3.24)*	*(–4.01)*	*(0.66)*	*(–4.61)*	*(–3.11)*	*(–4.43)*
Initial debt*Dum_domdebt_below25pctile[3]	–0.047**	–0.054***	–0.039***	–0.060*				
	(–2.35)	*(–2.86)*	*(–2.79)*	*(–1.94)*				
Initial debt*Dum_domdebt_above25pctile	–0.021*	–0.017**	–0.004	–0.023*				
	(–1.72)	*(–2.50)*	*(–0.77)*	*(–1.74)*				
Initial debt*Dum_domdebt_belowMedian[4]					–0.025	–0.028**	–0.011	–0.033**
					(–1.63)	*(–2.71)*	*(–1.04)*	*(–2.24)*
Initial debt*Dum_domdebt_aboveMedian					–0.025*	–0.018**	–0.006	–0.019**
					(–1.90)	*(–2.40)*	*(–0.87)*	*(–2.20)*
Arellano-Bond AR(2) test *p*-value[1]				0.68				0.89
Hansen J-statistics (*p*-value)[2]				0.41				0.55
Number of observations	151	151	151	151	151	151	151	151
R^2	0.7	0.63	0.51		0.67	0.6	0.51	
Time-fixed effects	N/A	Yes	Yes	Yes	N/A	Yes	Yes	Yes

Note: Heteroskedasticity and country-specific autocorrelation consistent *t*-statistics are in parentheses. Time dummies are not reported. Levels of significance: *** 1%, ** 5%, * 10%. In the OLS regressions, dummies for OECD, Asia, Latin America, and Sub-Saharan Africa are also included in each regression (not reported to save space). FE refers to the fixed-effects panel regressions and BE is the between estimator. For the dynamic panel estimation, a two-step system GMM (SGMM) with the Windmeijer's finite-sample correction for the two-step covariance matrix.

1) The null hypothesis is that the first-differenced errors exhibit no second-order serial correlation.
2) The null hypothesis is that the instruments used are not correlated with the residuals.
3) The 25 percentile level of domestic currency-denominated public debt portion in the sample 36 advanced and emerging economies is 59 per cent of total public debt.
4) The median level of domestic currency-denominated public debt portion in the sample 36 advanced and emerging economies is 89 per cent of total public debt.

Table 8

Growth Accounts and Panel Regression: Advanced and Emerging Economies

Explanatory Variables	(1) BE	(2) Pooled OLS	(3) FE	(4) SGMM	(5) BE	(6) Pooled OLS	(7) FE	(8) SGMM	(9) BE	(10) Pooled OLS	(11) FE	(12) SGMM
	dependent variable: growth of output per worker				*dependent variable: growth of TFP*				*dependent variable: growth of capital stock per worker*			
Lagged dependent variable[1]	–1.728**	–2.034**	–6.198**	–2.338**	–2.851***	–3.783***	–9.309***	–2.768**	–0.425	–0.515	–3.698*	–2.547
	(–2.25)	*(–2.40)*	*(–2.47)*	*(–2.71)*	*(–3.33)*	*(–4.62)*	*(–3.95)*	*(–2.61)*	*(–0.50)*	*(–0.79)*	*(–1.88)*	*(–1.57)*
Initial years of schooling	3.669***	2.649*	–1.829	3.894	2.507***	1.858**	–3.418	2.016	2.089	1.240	–1.809	10.654**
	(3.09)	*(2.01)*	*(–0.63)*	*(1.40)*	*(3.29)*	*(2.62)*	*(–1.33)*	*(1.12)*	*(1.26)*	*(0.91)*	*(–0.40)*	*(2.58)*
Initial inflation rate	1.443	–1.830**	–2.928***	–4.783	1.565	–1.241**	–2.260***	–4.515	0.190	–2.450***	–2.824***	–8.658
	(0.44)	*(–2.34)*	*(–5.72)*	*(–1.35)*	*(0.72)*	*(–2.04)*	*(–5.06)*	*(–1.64)*	*(0.04)*	*(–3.18)*	*(–4.73)*	*(–1.03)*
Initial government size	0.134**	0.104**	–0.076	0.102	0.070*	0.052	–0.031	0.143*	0.182**	0.114*	–0.330***	0.388
	(2.32)	*(2.28)*	*(–0.69)*	*(1.08)*	*(1.80)*	*(1.60)*	*(–0.27)*	*(1.73)*	*(2.31)*	*(1.96)*	*(–3.20)*	*(1.62)*
Initial trade openness	–0.009	–0.005	0.006	–0.009	–0.003	–0.001	0.016	–0.004	–0.016	–0.011	–0.015	–0.026
	(–1.14)	*(–1.06)*	*(0.47)*	*(–1.14)*	*(–0.56)*	*(–0.37)*	*(1.23)*	*(–0.28)*	*(–1.48)*	*(–1.52)*	*(–1.30)*	*(–0.93)*
Initial financial depth	0.030**	0.023**	0.012	0.026**	0.021**	0.017***	0.010	0.023*	0.025	0.015	0.003	0.027
	(2.33)	*(2.27)*	*(1.39)*	*(2.13)*	*(2.39)*	*(2.81)*	*(1.22)*	*(2.03)*	*(1.43)*	*(1.29)*	*(0.49)*	*(1.12)*
Terms of trade growth	0.342**	–0.038	–0.023	–0.059	0.237**	–0.021	–0.011	–0.048**	0.305*	–0.019	–0.007	–0.022
	(2.69)	*(–1.24)*	*(–0.82)*	*(–1.52)*	*(2.73)*	*(–0.89)*	*(–0.45)*	*(–2.19)*	*(1.79)*	*(–0.32)*	*(–0.15)*	*(–0.16)*
Banking crisis	–0.484	–0.033**	–0.027**	–0.010	–0.165	–0.032***	–0.022**	–0.033	–0.271	–0.010	–0.014	0.068
	(–0.26)	*(–2.55)*	*(–2.30)*	*(–0.28)*	*(–0.13)*	*(–3.53)*	*(–2.61)*	*(–1.00)*	*(–0.11)*	*(–0.77)*	*(–1.42)*	*(0.66)*
Fiscal deficit	0.061	–0.430	–0.539	–0.273	0.020	–0.327	–0.466	0.108	0.091	–0.128	–0.118	0.612
	(1.48)	*(–0.88)*	*(–1.29)*	*(–0.43)*	*(0.74)*	*(–0.77)*	*(–1.37)*	*(0.11)*	*(1.59)*	*(–0.28)*	*(–0.31)*	*(0.68)*
Initial government debt	–0.022*	–0.012*	0.005	–0.020**	–0.009	–0.004	0.009	–0.008	–0.034*	–0.023**	–0.014*	–0.045**
	(–1.78)	*(–1.75)*	*(0.69)*	*(–2.45)*	*(–1.11)*	*(–1.16)*	*(1.33)*	*(–0.60)*	*(–2.06)*	*(–2.13)*	*(–1.79)*	*(–2.04)*
Arellano-Bond AR(2) test *p*-value[2]				0.16				0.9				0.14
Hansen J-statistics (*p*-value)[3]				0.25				0.42				0.28
Number of observations	159	159	159	159	159	159	159	159	159	159	159	159
R^2	0.75	0.5	0.45		0.79	0.51	0.44		0.58	0.41	0.55	
Time-fixed effects	N/A	Yes	Yes	Yes	N/A	Yes	Yes	Yes	N/A	Yes	Yes	Yes

Note: Heteroskedasticity and country-specific autocorrelation consistent *t*-statistics are in parentheses. Time dummies are not reported. Levels of significance: *** 1%, ** 5%, * 10%. In the OLS regressions, dummies for OECD, Asia, Latin America, and Sub-Saharan Africa are also included in each regression (not reported to save space). FE refers to the fixed-effects panel regressions and BE is the between estimator. For the dynamic panel estimation, a two-step system GMM (SGMM) with the Windmeijer's finite-sample correction for the two-step covariance matrix.

1) The log of initial level of output per worker for columns 1-4; the log of initial level of TFP for Columns 5-8; and the log of initial level of capital stock per worker for columns 9-12, respectively.

2) The null hypothesis is that the first-differenced errors exhibit no second-order serial correlation.

3) The null hypothesis is that the instruments used are not correlated with the residuals.

coefficients of initial debt from the preferred estimators (BE and SGMM) indicate that a 10 percentage point increase in initial debt-to-GDP ratio is associated with a slowdown in growth of labor productivity (output per worker) of around 0.2 per cent per year.

Columns 5-8 show the regression results for TFP growth. There seems to be significant (conditional) convergence in the level of TFP, as indicated by the significant and negative coefficients of the log of initial level of TFP (in the first row). However, the coefficients of initial debt are insignificant across all four regressions, while they have a negative sign (except for FE). The estimated coefficients of initial debt under BE and SGMM are around –0.01.

The regression results for growth of capital per worker are stronger (columns 9-12). The initial debt coefficients are all significant at the conventional levels across estimation techniques, ranging from –0.014 to –0.045. Since the capital income share (α) is assumed to be 0.35 in the growth accounting exercise, the estimated coefficients of initial debt under BE and SGMM suggest that a 10 percentage point increase in initial debt-to-GDP ratio induces slowdown in growth of output per worker around 0.1-0.2 per cent per year via the channel of reduced growth in capital per worker. Taken together, the individual effects of initial debt on TFP growth and capital per worker growth roughly add up to 0.2-0.3 per cent per year, which is approximately in line with the regression outcomes for growth of output per worker shown in columns 1-4. However, there are no significant effects on human capital growth from debt and are not reported.

Table 9 presents panel regressions for domestic investment (percent of GDP, averaged over each five-year time period). Columns 1-3 show the regression results using the baseline specification except for the dependent variable which is the average domestic investment. The coefficients of initial debt are all significant at 1-10 per cent, ranging from –0.06 to –0.1. Columns 4 and 5 present the dynamic panel SGMM regressions in which the lagged term of the average investment is included instead of initial income per capita. The coefficient of initial debt in column 4 is significant at 5 per cent, and its estimate suggests that a 10 percentage point increase in initial debt-to-GDP ratio is associated with decline in domestic investment by about 0.4 percentage points of GDP. Column 5 includes interaction terms between initial debt and dummy variables for advanced and emerging economies. The coefficients of both interaction terms are significant at 5-10 per cent, and the estimated effects suggest that the adverse impact on domestic investment from debt in emerging economies is almost twice as large as that in advanced economies.

In addition, we considered the potential relationship between high debt and macroeconomic volatility. Intuitively, high debt may not only increase uncertainty about economic prospects and policies but also raise vulnerability to crises, leading to greater macroeconomic volatility. A simple scatter plot of macroeconomic volatility against initial government debt suggests a mild positive correlation. We ran regressions on macroeconomic volatility as measured by the log of standard deviation of annual real GDP growth rates using the baseline specification. The coefficient of initial debt in the regressions for volatility is only significant and of expected positive sign under FE when time-fixed effects are not included. However, they are all insignificant in all other estimations (with or without time dummies). Similarly, the coefficient of high debt (as captured by the interaction term, initial debt*Dum_90) is only significant under FE with no time-fixed effects included, as is the coefficient of initial debt for advanced economies (*i.e.*, initial debt*Dum_advance) in a separate FE regression (not reported to save space).

From the growth accounting perspective, therefore, the adverse effects on growth of initial debt largely reflect a slowdown in labor productivity growth mainly due to reduced investment and slower growth of capital per worker.

Table 9

Panel Regression on Investment: Advanced and Emerging Economies

Explanatory Variables	(1) BE	(2) Pooled OLS	(3) FE	(4) SGMM	(5) SGMM
Lagged dependent variable				0.763***	0.773***
				(8.35)	*(5.62)*
Initial real GDP per capita	–3.028*	2.645	8.700***		
	(–1.90)	*(0.89)*	*(3.76)*		
Initial years of schooling	3.361	–3.261	–2.197	5.029	–0.682
	(0.73)	*(–0.74)*	*(–0.34)*	*(1.56)*	*(–0.27)*
Initial inflation rate	–10.390	–1.632	–2.371***	–3.305*	–4.949***
	(–1.05)	*(–0.81)*	*(–3.15)*	*(–1.71)*	*(–3.27)*
Initial government size	–0.027	–0.056	–0.429**	0.367*	0.147
	(–0.14)	*(–0.32)*	*(–2.31)*	*(1.75)*	*(0.73)*
Initial trade openness	–0.011	0.000	–0.051*	–0.043***	–0.027***
	(–0.54)	*(0.02)*	*(–1.88)*	*(–2.94)*	*(–3.08)*
Initial financial depth	0.046	0.010	–0.009	0.031	0.022
	(1.19)	*(0.27)*	*(–1.00)*	*(1.56)*	*(1.43)*
Terms of trade growth	–0.157	0.062	0.069	0.200**	0.144*
	(–0.48)	*(0.70)*	*(0.91)*	*(2.42)*	*(1.81)*
Fiscal deficit	0.161	–0.002	–0.058***	–0.017	–0.069
	(1.21)	*(–0.07)*	*(–4.67)*	*(–0.31)*	*(–1.36)*
Banking crisis	1.178	–0.488	0.663	–1.519	–1.240
	(0.18)	*(–0.32)*	*(0.71)*	*(–1.06)*	*(–0.38)*
Initial government debt	–0.110**	–0.057*	–0.055***	–0.041**	
	(–2.64)	*(–1.67)*	*(–5.12)*	*(–2.48)*	
Initial debt*Dum_advanced					–0.032***
					(–2.94)
Initial debt*Dum_emerging					–0.077**
					(–2.61)
Arellano-Bond AR(2) test *p*-value[1]				0.54	0.79
Hansen *J*-statistics (*p*-value)[2]				0.59	0.40
Number of observations	166	166	166	159	159
R^2	0.45	0.48	0.53		
Time-fixed effects	N/A	Yes	Yes	Yes	Yes

Note: Heteroskedasticity and country-specific autocorrelation consistent *t*-statistics are in parentheses. Time dummies are not reported. Levels of significance: *** 1%, ** 5%, * 10%. In the OLS regressions, dummies for OECD, Asia, Latin America, and Sub-Saharan Africa are also included in each regression (not reported to save space). FE refers to the fixed-effects panel regressions and BE is the between estimator. For the dynamic panel estimation, a two-step system GMM (SGMM) with the Windmeijer's finite-sample correction for the two-step covariance matrix.

1) The null hypothesis is that the first-differenced errors exhibit no second-order serial correlation.

2) The null hypothesis is that the instruments used are not correlated with the residuals.

5 Concluding Remarks

Given the sharp increase in advanced country sovereign debt as a result of the global economic and financial crisis, there have begun to be serious concerns about its broader economic and financial market impact including an acute sovereign debt crisis in Europe. In particular, a number of observers have alluded to the risk that large debts may discourage capital accumulation and reduce economic growth. This could occur through higher long-term interest rates, higher future distortionary taxation, higher inflation, greater vulnerability to a debt crisis, and reduced scope for future counter-cyclical fiscal policy. If growth is indeed reduced, fiscal sustainability issues are likely to be exacerbated, with further adverse consequences.

Empirical evidence, based on a range of econometric techniques, strongly suggests an inverse relationship between initial debt and subsequent growth, controlling for other determinants of growth: on average, a 10 percentage point increase in the initial debt-to-GDP ratio is associated with a slowdown in real per capita GDP growth of around 0.2 percentage points per year, with the impact being smaller (around 0.15) in advanced economies and/or smaller when (net) foreign liabilities are relatively high. Also, the currency composition of public debt matters. There is some evidence of non-linearity, with only high (above 90 per cent of GDP) levels of debt having a significant negative effect on growth. This adverse effect largely reflects a slowdown in labor productivity growth, mainly due to reduced investment and slower growth of the capital stock per worker. On average, a 10 percentage point increase in initial debt ratio is associated with a decline of investment by about 0.4 percentage points of GDP, with a larger impact in emerging economies. Various robustness checks yield largely similar results. They underline the need to take measures to not just stabilize public debt but to place them on a downward trajectory in the medium and long term.

APPENDIX 1
COUNTRY LIST

The sample of countries is dictated by the availability of data. The following 38 advanced and emerging economies with a population of over 5 million are included in the baseline panel regressions.

Country	Country
Australia	Japan
Austria	Korea
Belgium	Malaysia
Brazil	Mexico
Canada	Netherlands
Chile	Pakistan
China	Peru
Colombia	Philippines
Czech Republic*	Poland
Denmark	Portugal
Egypt	Russian Federation*
France	Slovak Republic*
Germany	South Africa
Greece	Spain
Hong Kong	Sweden
Hungary	Switzerland
India	Turkey
Indonesia	United Kingdom
Italy	United States

Note:
1. Three countries with the asterisk mark (*) in the above list are not included in the growth accounting exercise because necessary data in computing TFP are not available.
2. Eight additional countries are also available in the panel regressions for all available 46 advanced and emerging economies without the over-5-million-population size restriction: Finland, Iceland, Ireland, Israel, Jordan, Norway, New Zealand, and Singapore.

3 Thirty three developing countries that are included in the full sample of 79 countries are: Barbados, Bolivia, Bulgaria, Costa Rica, Croatia, Cyprus, Ecuador, Gambia, Guinea-Bissau, Guyana, Honduras, Iran, Jamaica, Kuwait, Lesotho, Mauritania, Mauritius, Mozambique, Nicaragua, Panama, Romania, Rwanda, Senegal, Slovenia, Sri Lanka, Sudan, Swaziland, Syria, Togo, Trinidad & Tobago, Tunisia, Uganda, and Uruguay.

4 The list of advanced economies includes Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Netherlands, New Zealand, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States, which were the OECD member nations as of 1990, except for Turkey which is classified as an emerging market economy.

APPENDIX 2
DESCRIPTION OF DATA

A. Dependent variables

The following dependent variables are measured over the five-year period in the panel (or the relevant time period in the cross-country regression).

1) Growth of real per capita GDP, PWT7.0 (2011)
2) Growth of output per worker, PWT7.0 (2011)
3) TFP growth, constructed using PWT7.0 (2011) and Barro and Lee (2011)
4) Growth of capital per worker PWT7.0 (2011)
5) Domestic investment (percent of GDP), PWT7.0 (2011)
6) Volatility of output (log of standard deviation of annual real GDP growth rates over the five-year period), PWT7.0 (2011)

B. Explanatory variables

Initial values of explanatory variables – for example, initial real GDP per capita or initial government size – are measured at the measured at the beginning of each five-year period in the panel (or the relevant time period in the cross-country regression). Otherwise, the variables, such as terms of trade growth or average government debt, are averaged over the five-year period.

1) Initial real GDP per capita (in log), PWT7.0 (2011)
2) Initial average years of schooling of population of age over 15 (in log), Barro and Lee (2011)
3) Initial government size (percent of GDP), PWT7.0 (2011)
4) Initial trade openness (percent of GDP), PWT7.0 (2011)
5) Initial inflation rate (log of $(1+\pi)$), WDI (2011)
6) Initial financial market depth (liquid liabilities, percent of GDP), WDI (2011)
7) Terms of trade growth (in percent), IMF, WEO (2011)
8) Banking crisis (total number of incidences over five-year period), Reinhart and Reinhart (2008)
9) Initial population size (in log), PWT7.0 (2011)
10) Fiscal deficit (percent of GDP), IMF, WEO (2011)
11) Population growth (in percent), PWT7.0 (2011)
12) Initial domestic investment (percent of GDP), PWT7.0 (2011)
13) Fiscal volatility (log of standard deviation of annual growth rates of real general government expenditures over the five-year period), WDI (2011)
14) Aged-dependency ratio (ratio of population of age over 65 to working population), WDI (2011)
15) Urbanization, WDI (2011)
16) Checks and balances, Database of Political Institutions (2009)
17) Constraints on executive decision-making, Polity IV (2009)
18) Initial gross government debt (percent of GDP), IMF, WEO (2011)
19) Average gross government debt (percent of GDP), IMF, WEO (2011)

APPENDIX 3
GROWTH ACCOUNTING

Taking a standard neoclassical approach, let us consider a Cobb-Douglas production function $Y=AK^{\alpha}(HL)^{1-\alpha}$, where α=capital income share; K=physical capital; L=labor input; H=human capital; and A= TFP (total factor productivity). In terms of per worker, the production function can be written as $y=Ak^{\alpha}H^{1-\alpha}$, where $y=Y/L$ (output per worker) and $k=K/L$ (capital per worker). Then, growth of output per worker ($\dot{y}/y$) can be decomposed to TFP growth ($\dot{A}/A$) and contributions from growth of capital per worker ($\dot{k}/k$) and growth of human capital ($\dot{H}/H$):

$$\dot{y}/y = \dot{A}/A + \alpha(\dot{k}/k) + (1-\alpha)(\dot{H}/H).$$

The growth accounting is consistent with a wide range of alternative production functional forms linking the factor inputs and output. It is only necessary to assume a degree of competition sufficient so that the earnings of the factors are proportionate to their factor productivity. Then we can measure TFP growth rates, using the shares of income paid to the factors to measure their importance in the production process as described above (see Caselli, 2005 for details about TFP). Since consistent measures of factor income shares are often difficult to obtain for individual countries, most studies assume that income shares are identical across time and space. Yet, Gollin (2002) provides strong evidence in support of such an assumption of constant income shares across time and space, which is consistent with the Cobb-Douglas function approach. Also, Bernanke and Gürkaynak (2001) find no systematic tendency for labor shares to vary with real GDP per capita or the capital-labor ratio nor systematic tendency to rise or fall over time, and most estimated labor income shares lie between 0.6 and 0.8, the average being 0.65. In this paper, we tried both a fixed labor share of 0.65 and actual income shares from Gollin (2002) and Bernanke and Gürkaynak (2001). The results using alternative income share measures are very similar, suggesting that using a fixed labor income share is not a serious problem.

We construct a new data set on TFP for a large number of developed and developing countries in the period 1970-2008. National income and product account data and labor force data are obtained from the latest version 7.0 of the Penn World Table (Heston *et al.*, 2011). To construct the labor quality index for human capital (H), we take average years of schooling in the population over 15 years old from the international data on educational attainment by Barro and Lee (2011). We follow Hall and Jones (1999) to give larger weight to more educated workers as follows: $H = e^{\phi(E)}$, where E is average years of schooling; the function $\phi(E)$ is piece linear with slope of 0.134 for $E \leq 4$, 0.101 for $4 < E \leq 8$; and 0.068 for $8 < E$. The rationale behind this functional form for human capital is as follows. The wage of a worker with E years of education is proportional to her human capital. Since the wage-schooling relationship is widely believed to be log-linear, this would imply that human capital (H) and education (E) would have a log-linear relation as well, such as H=exp($const \times E$). However, international data on education-wage profiles (Psacharopulos, 1994) suggests that in sub-Saharan Africa (which has the lowest levels of education), the return to one extra year of education is about 13.4 per cent, the world average is 10.1 per cent, and the OECD average is 6.8 per cent.

We estimate the capital stock, K, using the perpetual inventory method: $K_t = I_t + (1-\delta)K_{t-1}$, where I_t is the investment and δ is the depreciation rate. Data on I_t are from PWT 7.0 as real aggregate investment in PPP. For many countries in our sample, investment data go back to as early as 1950-55. We estimate the initial value of the capital stock, say, in year 1950 as I1950/(g+ δ) where g is the average compound growth rate between 1950 and 1960, and δ is the depreciation rate (δ =0.06 is assumed). We further adjust these capital stocks for the portion of residential capital stock that is not directly related to production activity.[27] Batteries of consistency checks suggest that our estimates of TFP growth are reasonable.

[27] PWT 5.6 provides data on residential capital per worker as a fraction of nonresidential capital per worker for 63 countries. For these countries, we use the average ratio of nonresidential capital to total capital to impute the nonresidential capital stock in our data set. For the remaining countries, we assume that nonresidential capital is two-thirds of the total capital, which is about the average value of 0.69 for the countries for which the data are available.

APPENDIX

Table 10

Level of Initial Government Debt, Growth, and Investment, 1970-2008: Countries with a Population of Over 5 Million

Group of Countries	Initial Debt below 30 per cent of GDP	Initial Debt between 30 and 60 per cent of GDP	Initial Debt between 60 and 90 per cent of GDP	Initial Debt above 90 per cent of GDP
Average: Real per capita GDP Growth Rate *(annualized over the subsequent 5 years)*				
Entire	5.0	2.7	2.6	2.2
Advanced[1]	2.6	1.8	2.1	1.7
Emerging	5.4	3.1	2.9	3.7
Developing	6.6	4.4	3.1	2.2
Average: Output per worker Growth Rate *(annualized over the subsequent 5 years)*				
Entire	4.4	1.9	2.0	1.7
Advanced	2.3	1.2	1.6	1.5
Emerging	4.7	2.3	2.3	3.4
Developing	5.9	3.3	2.4	1.6
Average: TFP Growth Rate *(annualized over the subsequent 5 years)*				
Entire	1.3	0.3	0.7	1.1
Advanced	0.3	0.1	0.5	0.4
Emerging	2.0	0.8	0.7	2.4
Developing	2.1	-0.3	1.1	1.4
Average: Capital stock per worker Growth Rate *(annualized over the subsequent 5 years)*				
Entire	4.6	2.4	2.2	1.5
Advanced	4.2	1.8	2.2	2.1
Emerging	5.8	1.8	1.9	0.9
Developing	2.5	5.7	2.3	1.2
Average: Domestic Investment *(percent of GDP over the subsequent 5 years)*				
Entire	25.8	21.7	21.6	18.5
Advanced	25.2	20.7	21.9	23.9
Emerging	30.5	22.1	21.8	16.4
Developing	21.0	23.7	21.0	15.8

Note: Initial debts are the government gross debt to GDP (percent) in the first year of each five-year sub-period (*i.e.*, 1970, 1975, 1980, 1985, 1990, 1995, 2000, 2005). Average growth rates (percent per annum) are over each five-year sub-period (*i.e.*, 1970-74, 1975-79, 1980-84, 1985-89, 1990-94, 1995-99, 2000-04, 2005-08).

1) Advanced economies are defined as the OECD Members as of 1990, excluding Turkey, which is classified as an emerging economy.

Table 11

Cross-country Regression – Government Debt and Real per Capita GDP Growth: Advanced and Emerging Economies (Without Restriction on Population Size)

(dependent variable: real per capita GDP growth)

Explanatory Variables	(1) OLS 1975-2008	(2) OLS 1985-2008	(3) OLS 1990-2008	(4) OLS 1995-2008	(5) OLS 2000-2008	(6) OLS 1990-2008	(7) OLS 1995-2008	(8) OLS 2000-2008
Initial real GDP per capita	1.862	–2.928*	–2.464***	–1.726**	–0.480	–1.353	–1.121*	–0.494
	(1.91)	*(–2.00)*	*(–4.44)*	*(–2.37)*	*(–0.58)*	*(–1.63)*	*(–1.84)*	*(–0.61)*
Initial years of schooling	0.393	0.576	2.462**	2.944**	1.021	1.419	2.204**	1.286
	(0.38)	*(0.50)*	*(2.66)*	*(2.08)*	*(0.63)*	*(1.15)*	*(2.09)*	*(0.82)*
Initial inflation rate	8.395**	–1.578	0.400	8.932**	1.628	–0.059	2.831**	1.300
	(4.37)	*(–0.77)*	*(0.99)*	*(2.12)*	*(0.43)*	*(–0.38)*	*(2.19)*	*(0.38)*
Initial government size	–0.127*	–0.024	–0.027	0.021	0.114**	–0.020	0.020	0.101*
	(–2.86)	*(–0.40)*	*(–0.85)*	*(0.58)*	*(2.25)*	*(–0.72)*	*(0.57)*	*(1.96)*
Initial trade openness	0.012*	0.016	0.010**	0.014***	0.001	0.008	0.004	–0.0002
	(3.93)	*(1.39)*	*(2.18)*	*(3.04)*	*(0.21)*	*(1.43)*	*(0.81)*	*(–0.04)*
Terms of trade growth	0.039	–0.036	–0.192	–0.189*	0.071	–0.195	–0.124	0.049
	(0.54)	*(–0.20)*	*(–1.13)*	*(–1.97)*	*(0.78)*	*(–1.31)*	*(–1.60)*	*(0.61)*
Banking crisis			–0.428	–0.728	0.061	0.082	–0.825	–0.044
			(–1.26)	*(–1.33)*	*(0.11)*	*(0.22)*	*(–1.60)*	*(–0.08)*
Initial government debt	–0.020**	–0.009	–0.018***	–0.029***	–0.020			
	(–4.49)	*(–1.07)*	*(–3.29)*	*(–3.73)*	*(–1.65)*			
Government debt, average						–0.021**	–0.022**	–0.018*
						(–2.21)	*(–2.68)*	*(–1.83)*
Number of observations	10	20	30	37	44	42	46	46
R^2	0.99	0.60	0.85	0.67	0.63	0.53	0.51	0.62

Note: Heteroskedasticity-consistent t-statistics are in parentheses. Levels of significance: *** 1%, ** 5%, * 10%. An intercept term and dummies for OECD, Asia, Latin America, and Sub-Saharan Africa are included in each regression, except for column (1) in which the number of observations is small relative to the number of covariates (not reported to save space).

Table 12

Growth Accounting and Cross-Country Growth Regression: Advanced and Emerging Economies

(without restriction on population size)

Explanatory Variables	(1) OLS 1990-2008	(2) OLS 1995-2008	(3) OLS 1990-2008	(4) OLS 1995-2008	(5) OLS 1990-2008	(6) OLS 1995-2008	(7) OLS 1990-2008	(8) OLS 1995-2008	(9) OLS 1990-2008	(10) OLS 1995-2008	(11) OLS 1990-2008	(12) OLS 1995-2008
	dependent variable: growth of real output per worker				*dependent variable: growth of TFP*				*dependent variable: growth of capital stock per worker*			
Initial real GDP per capita	–2.278***	–1.490**	–1.219	–1.033	–1.810***	–1.070**	–1.276**	–1.001***	–1.438*	–1.080	–0.041	–0.119
	(–4.35)	*(–2.19)*	*(–1.44)*	*(–1.68)*	*(–5.14)*	*(–2.57)*	*(–2.52)*	*(–2.87)*	*(–1.89)*	*(–1.21)*	*(–0.04)*	*(–0.16)*
Initial years of schooling	2.653***	3.076**	1.692	2.620**	2.972***	2.810***	2.352***	2.790***	1.350	2.387	0.004	1.300
	(2.90)	*(2.10)*	*(1.40)*	*(2.17)*	*(4.37)*	*(3.04)*	*(3.12)*	*(3.79)*	*(0.86)*	*(1.24)*	*(0.00)*	*(0.85)*
Initial inflation rate	0.739*	11.195**	0.079	3.680*	0.762**	7.907***	0.239	2.529**	0.029	8.876	–0.440	2.710
	(1.89)	*(2.54)*	*(0.33)*	*(1.91)*	*(2.84)*	*(3.08)*	*(1.41)*	*(2.04)*	*(0.05)*	*(1.23)*	*(–1.39)*	*(0.98)*
Initial government size	–0.030	0.038	–0.033	0.015	–0.026	0.038*	–0.026	0.019	–0.037	0.006	–0.038	–0.012
	(–0.87)	*(1.10)*	*(–1.01)*	*(0.40)*	*(–1.51)*	*(1.86)*	*(–1.24)*	*(0.84)*	*(–0.68)*	*(0.13)*	*(–0.99)*	*(–0.25)*
Initial trade openness	0.010**	0.013**	0.007	0.002	0.011***	0.011***	0.009**	0.005	–0.002	0.004	–0.006	–0.008
	(2.35)	*(2.64)*	*(1.14)*	*(0.35)*	*(3.47)*	*(4.05)*	*(2.30)*	*(1.54)*	*(–0.32)*	*(0.60)*	*(–0.94)*	*(–1.27)*
Terms of trade growth	–0.063	–0.187*	–0.089	–0.171**	–0.054	–0.165**	–0.031	–0.138**	–0.082	–0.071	–0.176	–0.098
	(–0.43)	*(–1.80)*	*(–0.64)*	*(–2.29)*	*(–0.59)*	*(–2.64)*	*(–0.38)*	*(–2.66)*	*(–0.33)*	*(–0.44)*	*(–1.07)*	*(–1.00)*
Banking crisis	–0.014	–0.628	0.432	–0.837	0.030	–0.467	0.372	–0.299	–0.345	–0.204	0.092	–1.295*
	(–0.04)	*(–1.01)*	*(1.15)*	*(–1.55)*	*(0.14)*	*(–1.28)*	*(1.59)*	*(–0.93)*	*(–0.62)*	*(–0.23)*	*(0.18)*	*(–1.75)*
Initial government debt	–0.021***	–0.029***			–0.012***	–0.018***			–0.020*	–0.027*		
	(–3.33)	*(–2.86)*			*(–3.93)*	*(–3.21)*			*(–1.77)*	*(–1.80)*		
Government debt, average			–0.020**	–0.017**			–0.010	–0.008			–0.026**	–0.026**
			(–2.08)	*(–2.20)*			*(–1.68)*	*(–1.68)*			*(–2.33)*	(–2.69)
Number of observations	30	36	44	45	30	36	44	45	30	36	44	45
R^2	0.85	0.64	0.48	0.46	0.87	0.69	0.56	0.51	0.65	0.42	0.45	0.38

Note: Heteroskedasticity-consistent t-statistics are in parentheses. Levels of significance: *** 1%, ** 5%, * 10%. An intercept term and dummies for OECD, Asia, Latin America, and Sub-Saharan Africa are included in each regression (not reported to save space).

REFERENCES

Aghion, P., and S. Durlauf (2005), *Handbook of Economic Growth*, Vol. 1A and 1B, Amsterdam, North-Holland.

Aghion, P. and E. Kharroubi (2007), "Cyclical Macro Policy and Industry Growth: The Effect of Countercyclical Fiscal Policy", Harvard University, Working Paper.

Aizenman, J., K. Kletzer and B. Pinto (2007), "Economic Growth with Constraints on Tax Revenues and Public Debt: Implications for Fiscal Policy and Cross-country Differences", NBER, Working Paper, No. 12750, Cambridge (MA).

Arellano, M. and S. Bond (1991), "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations", *Review of Economic Studies*, Vol. 58, No. 2, pp. 277-97, April.

Arellano, M. and O. Bover (1995), "Another Look at the Instrumental Variables Estimation of Error-Components Models", *Journal of Econometrics*, No. 68, pp. 29-51.

Baldacci, E., A. Hillman and N. Kojo (2004), "Growth, Governance and Fiscal Policy Transmission Channels in Low-income Countries", *European Journal of Political Economy*, Vol. 20, pp. 517-49.

Baldacci, E. and M. Kumar (2010), "Fiscal Deficits, Public Debt and Sovereign Bond Yields", IMF, Working Paper, No. 10/184, Washington (D.C.).

Barro, R. (1979), "On the Determinants of the Public Debt", *Journal of Political Economy*, Vol. 85, No. 5, pp. 940-71.

——————(1990), "Government Spending in a Simple Model of Endogenous Growth", *Journal of Political Economy*, Vol. 98, No. 5, pp. S103-125.

——————(1995), "Inflation and Economic Growth", NBER, Working Paper, No. 5326, Cambridge (MA).

Barro, R. and J. Lee (2011), "A New Data Set of Educational Attainment in the World, 1950-2010", NBER, Working Paper, No. 15902.

Bazzi, S. and M. Clemens (2009), "Blunt Instruments: On Establishing the Causes of Economic Growth", Center for Global Development, Working Paper, No. 171, Washington (D.C.).

Beck, T. and R. Levine (2004), "Stock Markets, Banks, and Growth: Panel Evidence", *Journal of Banking and Finance*, Vol. 28, No. 3, pp. 423-42.

Bernanke, B. and R. Gürkaynak (2001), "Is Growth Exogenous? Taking Mankiw, Romer, and Weil Seriously?", in B. Bernanke and K. Rogoff (eds.), *NBER Macroeconomics Annual 2001*, pp. 11-57, Cambridge (MA), NBER.

Blundell, R. and S. Bond (1998), "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models", *Journal of Econometrics*, Vol. 87, No. 1, pp. 115-43.

Bond, S. (2002), "Dynamic Panel Data Models: A Guide to Micro Data Methods and Practice", Institute for Fiscal Studies, Working Paper, No. 09/02, London.

Burnside, C., M. Eichenbaum and S. Rebelo (2001), "Prospective Deficits and the Asian Currency Crisis", *Journal of Political Economy*, Vol. 109, No. 6, pp. 1155-97.

Caselli, F. (2005), "Accounting for Cross-country Income Differences", in P. Aghion and S. Durlauf (eds.), *Handbook of Economic Growth*, Amsterdam, North-Holland.

Cecchetti, S., M. Mohanty and F. Zampolli (2011), "The Real Effects of Debt", Bank for International Settlements, Working Paper, No. 352, August.

Checherita, C. and P. Rother (2010), "The Impact of High and Growing Government Debt on Economic Growth: An Empirical Investigation for the Euro Area", European Central Bank, Working Paper, No. 1237, August.

Cochrane, J. (2011), "Understanding Policy in the Great Recession: Some Unpleasant Fiscal Arithmetic", *European Economic Review*, No. 55, pp. 2-30.

Dotsey, M. (1994), "Some Unpleasant Supply Side Arithmetic", *Journal of Monetary Economics*, pp. 507-24.

Durlauf, S., P. Johnson and J. Temple (2005), "Growth Econometrics", in P. Aghion and S. Durlauf (eds.), *Handbook of Economic Growth*, Amsterdam, North-Holland.

Easterly, W. (2005), "National Policies and Economic Growth", in P. Aghion and S. Durlauf (eds.), *Handbook of Economic Growth*, Amsterdam, North-Holland.

Eichengreen, B. and R. Hausmann (1999), "Exchange Rates and Financial Fragility", paper presented at the symposium *New Challenges for Monetary Policy*, 26-28 August, Jackson Hole (WY).

Elmendorf, D. and N.G. Mankiw (1999), "Government Debt", in J.B. Taylor and M. Woodford (eds.), *Handbook of Macroeconomics*, Vol. 1C, Amsterdam, North-Holland.

Fatás, A. and I. Mihov (2003), "The Case for Restricting Fiscal Policy Discretion", *Quarterly Journal of Economics*, Vol. 118, No. 4, pp.1419-47.

Fischer, S. (1993), "The Role of Macroeconomic Factors in Growth", *Journal of Monetary Economics*, Vol. 32, No. 3, pp. 485-512.

Gale, W. and P. Orszag (2003), "The Economic Effects of Long-term Fiscal Discipline", Urban-Brookings Tax Policy Center, Discussion Paper, No. 8, Washington (D.C.), Brookings Institution.

Glaeser, E., R. La Porta, F. López-de-Silanes and A. Shleifer (2004), "Do Institutions Cause Growth?", *Journal of Economic Growth*, Vol. 9, pp. 271-303.

Gollin, D. (2002), "Getting Income Shares Right", *Journal of Political Economy*, Vol. 110, No. 2, pp. 458-74.

Grilliches, Z. and J. Hausman (1987), "Errors in Variables in Panel Data", *Journal of Econometrics*, Vol. 31, No. 1, pp. 93-118.

Grossman, G. and E. Helpman (1991), *Innovation and Growth in the Global Economy*, Cambridge (MA), MIT Press.

Hall, R. and C.I. Jones (1999), "Why Do Some Countries Produce So Much More Output per Worker than Others?", *Quarterly Journal of Economics*, Vol. 114, pp. 83-116.

Hauk, W. and R. Wacziarg (2009), "A Monte Carlo Study of Growth Regressions", *Journal of Economic Growth*, Vol. 14, No. 2, pp. 103-47.

Hemming, R., M. Kell and A. Schimmelpfennig (2003), "Fiscal Vulnerability and Financial Crises in Emerging Market Economies", IMF, Occasional Paper, No. 218, Washington (D.C.).

Heston, A., R. Summers and B. Aten (2011), *Penn World Table Version 7.0*, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, June.

Huang, H. and D. Xie (2008), "Fiscal Sustainability and Fiscal Soundness", *Annals of Economics and Finance*, Vol. 9, No. 2, pp. 239-51.

Imbs, J. and R. Rancière (2005), "The Overhang Hangover", World Bank, Policy Research, Working Paper, No. 3673, Washington (D.C.).

Islam, N. (1995), "Growth Empirics: A Panel Data Approach", *Quarterly Journal of Economics*, Vol. 110, No. 4, pp.1127-70.

Krugman, P. (1988), "Financing Versus Forgiving a Debt Overhang", *Journal of Development Economics*, Vol. 29, pp. 253-68.

Kumar, M. and J. Woo (2010), "Public Debt and Growth", IMF, Working Paper, No. 10/174, Washington (D.C.).

Pattilo, C., H. Poirson and L. Ricci (2002), "External Debt and Growth", IMF, Working Paper, No. 02/69, Washington (D.C.).

―――――(2004), "What Are the Channels through which External Debt Affects Growth?", IMF, Working Paper, No. 04/15, Washington (D.C.).

Ramey, G. and V. Ramey (1995), "Cross-country Evidence on the Link between Volatility and Growth", *American Economic Review*, Vol. 85, pp. 1138-51.

Reinhart, C. and V. Reinhart (2008), "Capital Flow Bonanzas: An Encompassing View of the Past and Present", in J. Frankel and F. Giavazzi (eds.) *NBER International Seminar in Macroeconomics 2008*, Chicago, Chicago University Press.

Reinhart, C., V. Reinhart and K. Rogoff (2012), "Debt Overhang: Past and Present", NBER, Working Paper, No. 18015.

Reinhart, C. and K. Rogoff (2009), "The Aftermath of Financial Crises", *American Economic Review*, Vol. 99, No. 2, pp. 466-72, May.

―――――(2010), "Growth in a Time of Debt", *American Economic Association Papers and Proceedings*, Vol. 100, No. 2, pp. 1-9, May.

Roodman, D. (2009), "A Note on the Theme of Too Many Instruments", *Oxford Bulletin of Economics and Statistics*, Vol. 71, No. 1, pp. 135-58.

Sachs, J. (1989), "The Debt Overhang of Developing Countries", in G.A. Calvo, R. Findlay, P. Kouri and J.B. de Macedo (eds.), *Debt Stabilization and Development*, pp. 80-102, Oxford and Cambridge (MA), Basil Blackwell.

Sala-i-Martín, X. (1997), "I Just Ran Two Million Regressions", *American Economic Review*, Papers and Proceedings, pp. 178-83, May.

Sala-i-Martín, X., G. Doppelhofer and R. Miller (2004), "Determinants of Long-Term Growth: A Bayesian Averaging of Classical Estimates (BACE) Approach", *American Economic Review*, Vol. 94, No. 4, pp. 813-35.

Saint-Paul, G. (1992), "Fiscal Policy in an Endogenous Growth Model", *Quarterly Journal of Economics*, Vol. 107, No. 4, pp. 1243-59.

Sargent, T. and N. Wallace (1981), "Some Unpleasant Monetarist Arithmetic", *Quarterly Review*, Federal Reserve Bank of Minneapolis, Fall.

Stock, J.H., J.H. Wright and M. Yogo (2002), "A Survey of Weak Instruments and Weak Identification in Generalized Method of Moments" *Journal of Business and Economic Statistics*, Vol. 20, No. 4, pp. 518-29.

Woo, J. (2003), "Economic, Political and Institutional Determinants of Public Deficits", *Journal of Public Economics*, Vol. 87, No. 3, pp. 387-426, March.

——————(2009), "Why Do More Polarized Countries Run More Procyclical Fiscal Policy?", *Review of Economics and Statistics*, Vol. 91, No. 4, pp. 850-70, November.

Woo, J., T. Kinda and M. Poplawski-Ribeiro (2012), "Economic Recovery from Recessions, Fiscal Policy, and Structural Reforms", IMF, work in progress.

World Bank (2011), *World Development Indicators CD-ROM*, Washington (D.C.).

DYNAMIC LABOR SUPPLY WITH TAXES: THE CASE OF ITALIAN COUPLES

Maria Rosaria Marino,[*] *Marzia Romanelli*[*] *and Martino Tasso*[*]

Labor force participation rate among married women in Italy is particularly low. In order to better understand the role played by the tax and benefit system on this phenomenon, we build and estimate a structural dynamic life-cycle model of household labor supply, saving, and consumption behavior. The model features several sources of heterogeneity in the characteristics of the members of the couple and it incorporates most of the fiscal rules which have an effect on the net incomes of the agents. The parameters of the model are estimated using cross-sectional and longitudinal data for the 2004-10 period. We use the estimated model to simulate a few counterfactual policies and study their effect on labor supply and poverty. In this version of our work we present some preliminary estimates and simulations.

1 Introduction

Government decisions about how to raise revenue have obviously a large impact on households' choices. The design of these policies can foster economic growth through the labor supply channel. Interventions in this area face a trade-off between the desire to increase the welfare in the poorest strata of the population and the need to avoid negative effects on the labor supply. In many developed countries these interventions take the form of special provision of the tax scheme or work-related cash benefits. Because the fixed cost of working is likely to be related to the number of children in the family these instruments vary accordingly. Moreover, a long series of studies have found that the margin which is more likely to be affected by these policies is the participation one for single and married women.

The role of taxes and family benefits on household labor supply and consumption decisions has been a topic of deep research interest for a long time. The works of Eckstein and Wolpin (1989), Sheran (2007), and Eckstein and Lifshitz (2011) are examples of contributions to the modelling of female labor supply in a dynamic framework. On the other hand, relatively few studies which estimate such complex models allow for a full specification of taxes and welfare benefits: the works of Haan and Prowse (2010) on joint retirement decisions of German workers, and Keane and Wolpin (2010) on labor supply effects of the Earned Income Tax Credit in the United States are exemplary of this strand of the literature. Other scholars decided to calibrate, rather than estimate, their models (see, for example, the recent contribution of Blundell *et al.*, 2011).

The introduction or the extension of cash benefits in several countries over the last twenty years created the opportunity for the study of the various effects of these policy tools. The works by Eissa and Liebman (1995) and Meyer (2002) deal with the effects of different extensions of the

---

[*] Bank of Italy.

E-mails: mariarosaria.marino@bancaditalia.it, marzia.romanelli@bancaditalia.it, martino.tasso@esterni.bancaditalia.it

Martino Tasso acknowledges the funding of the Bank's research fellowship.

We are indebted to Sandro Momigliano and Maura Francese. We also thank Roberto Bonsignore, Fabrizio Colonna, Domenico Depalo, Valentina Michelangeli, Cecilia Moretti, Gilles Mourre, Pietro Rizza, Stefania Zotteri, the participants to the Bank of Italy 14th Public Finance Workshop, and all our colleagues at the Public Finance Division of the Research Department for a series of useful comments. We acknowledge the use of the computing facilities at the Bank of Italy and we are indebted to Giarcarlo Marra for technical assistance. The views expressed in this study are our own and do not necessarily reflect those of the Bank of Italy. Of course we are responsible for any error. Comments on this very preliminary and incomplete draft are very welcome.

Earned Income Tax Credits in the United States; Blundell *et al.* (2000) studies the English Working Families Tax Credits instead.

The Italian labor market is characterized by a particularly low participation rate among women. According to data collected by Eurostat, this rate among women between the age of 15 and 64 was just 51.1 per cent in 2010 (up from 46.3 per cent ten years earlier). The same figure was between 64.4 and 70.8 per cent in the EU, United Kingdom, Germany, France, and Spain. The average degree of labor market attachment by married women is even lower. A few studies have dealt with the effects of the Italian tax system on this outcome. A series of simulations of alternative tax systems are presented in Colombino and Del Boca (1990), Aaberge *et al.* (1999), and Aaberge *et al.* (2004). More recently, Marcassa and Colonna (2011) present some extremely interesting evidence of the high implicit tax rates imposed by the Italian tax system on the second earners. All these studies, while accounting for the main features of the tax scheme and simulating the likely effects of hypothetical reforms, model the labor supply decisions of the households in a static framework.

We contribute to this strand of literature by building and estimating a dynamic life-cycle model of household labor supply and saving decisions. Our model incorporates fiscal rules in place in the period 2005-11, as well as the main features of the family allowances. The agents in the model are heterogeneous in terms of human capital (education and on-the-job experience), and the families differ also by the number of children. We use a two-step approach to estimate the parameters of our model; like in French (2005), we recover the estimates of the parameters in the wage equations separately from the preferences. We use the method of simulated moments (or indirect inference) to estimate the values of the parameters in the agents' utility function. In this, our approach is similar to that of the study by Van der Klaauw and Wolpin (2008) on the effect of social security reforms on retirement and savings decisions by elderly in the United States.

Dynamics enters our model in several ways. First of all, agents accumulate human capital while working (like in Imai and Keane (2004)): when comparing the costs and the benefits of participation, married women take into account the fact that each additional year in the market has long-lived effects. Secondly, households are allowed to accumulate and decumulate assets, thus providing a mechanism through which they can ensure against adverse shocks on the labor market. Finally, like in all life-cycle models, agents are forward looking, and they react not only to the implementation of policies, but also to their announcement. That is, they are allowed to intertemporally adjust both consumption and labor supply.

The goal of our research is to build a model which can be used to assess the effect of changes in the tax-benefit system on female participation to the labor market. In this version of our model we present the results of a set of highly preliminary experiments. In particular, we simulate the effects of policies which could be used to increase the female participation rate directly via an increase in the household net labor income or, indirectly, giving support to the low income households which are the ones where the female participation rate is particularly low (Marcassa and Colonna, 2011). Our results are consistent with the prediction of the economic theory. In general, an increase in households' non-labor income decreases the overall poverty (in terms of head-count ratio) but lowers the incentives of married women to participate in the labor market. On the contrary, policies aimed at increasing the return of the hours worked have positive effects on both dimensions.

The rest of the paper is organized as follows. Section 2 deals with the main features of the Italian labor market, while section 3 introduces the model, explaining our solution method as well. In section 4 we illustrate the main features of the Italian fiscal system, as well as those of the family allowances. Sections 5 and 6 provide respectively an illustration of the econometric technique and

Table 1

Activity and Employment Rates (15 to 64 Years)

Country	Activity Rate					Employment Rate				
	1997	2007	2008	2009	2010	1997	2007	2008	2009	2010
European Union (EU)	67.9	70.4	70.8	70.9	71.0	60.7	65.3	65.8	64.5	64.1
Euro area (EA)	66.2	70.9	71.3	71.3	71.4	58.6	65.6	65.9	64.5	64.2
Germany (DE)	70.6	75.6	75.9	76.3	76.6	63.7	69	70.1	70.3	71.1
Spain (ES)	62.4	71.6	72.6	73.0	73.4	49.5	65.6	64.3	59.8	58.6
France (FR)	68.1	69.9	70.0	70.5	70.5	59.6	64.3	64.8	64.0	63.8
Italy (IT)	*58.2*	*62.5*	*63*	*62.4*	*62.2*	*51.3*	*58.7*	*58.7*	*57.5*	*56.9*
United Kingdom (UK)	75.4	75.5	75.8	75.7	75.5	69.9	71.5	71.5	69.9	69.5

Source: Eurostat.

the data sources we use. Some preliminary results are presented in Sections 7 and 8, while Section 9 concludes, providing a guideline for our ongoing and future work.

2 The Italian labor market

The Italian labour market is characterized by participation and employment rates considerably lower than those of the other major European economies (Table 1) and well below the objective set by the Europe 2020 strategy. Although the decade preceding the 2008 financial crisis has seen a substantial improvement in both dimensions, the gap is still far from closing. The economic crisis has further deteriorated the picture. In particular in the years 2008-10, differently from the other largest EU countries, Italy has shown a decline not only in the employment rate but also in the participation to the market.

The positive dynamics in employment observed up to the pre-crisis period was determined mainly by the expansion in part-time and temporary contracts, whose shares increased by 6.8 and 5.3 percentage points respectively in the period 1997-2007 (more than 2 and 4 times the EU average). Moreover, unemployment in Italy was and still is more likely to be of long term duration with respect to the other EU countries: in 2007 the unemployment spell was at least 12 months for more than 47.4 per cent of the Italian unemployed workers while the EU average was 42.7 per cent; in 2010 the incidence of long term unemployment increased in Italy up to 48.4 per cent, while an opposite trend was observed on average in the other EU countries (39.9 per cent).

The aggregate data hide the large disparities that affect different groups of workers and that have led to an increasing dualism of the labour market. In particular, the poor performance of the labour market partly reflects its segmentation which tends to segregate the young and the women. Indeed, these are the dimensions along which Italy records some of the largest gaps. Differences by gender and age are well reflected in activity and employment rates (Table 2).

With respect to the other European countries, the young and the female workers are particularly distressed. The participation rate registered on average in Italy in 2010 in the age group 15-24 is lower than the corresponding value for the EU economies by almost 15 p.p. (23 percentage points with respect to Germany and more than 30 percentage points compared to UK). For what concerns employment the picture is analogous, with rates largely below the other major EU countries.

Table 2

Activity and Employment Rates by Sex and Age Groups, 2010
(percent)

Age Group	Activity Rate							Employment Rate						
	EU	**EA**	**DE**	**ES**	**FR**	**Italy**	**UK**	**EU**	**EA**	**DE**	**ES**	**FR**	**Italy**	**UK**
Males														
15-24	46.1	45.5	53.7	45.1	42.9	**33.2**	61.8	36.2	35.9	47.9	25.6	33.4	**24.3**	48.5
25-49	92.4	92.9	93.6	93.2	94.8	**89.5**	92.1	84.3	84.3	86.9	75.7	87.3	**83.3**	85.9
50-54	88.0	89.8	90.9	88.4	91.5	**88.9**	87.7	81.7	83.5	84.8	75.6	86.3	**85.1**	82.4
55-64	58.9	58.2	70.8	63.9	45.2	**49.6**	69.1	54.6	53.8	65.0	54.7	42.1	**47.6**	65.0
15-64	77.6	78.2	82.3	80.7	74.9	**73.3**	81.7	70.1	70.4	76	64.7	68.1	**67.7**	74.5
Females														
15-24	39.7	39.5	48.9	40.1	35.6	**23.4**	56.4	31.8	31.6	44.6	24.2	27.2	**16.5**	46.6
25-49	79.0	78.9	81.4	80.3	84.2	**65.7**	78.7	71.7	71.0	76.4	64.4	76.7	**59.3**	74.1
50-54	73.9	73	80.9	66.7	81.2	**57.8**	78.3	68.9	67.8	76.1	56.6	75.8	**55.1**	75.5
55-64	41.2	40.9	54.5	38.5	40.0	**27.0**	51.1	38.6	38.0	50.5	33.2	37.4	**26.2**	49.5
15-64	64.4	64.5	70.8	65.9	66.1	**51.1**	69.4	58.2	57.9	66.1	52.3	59.7	**46.1**	64.6

Source: Eurostat.

Particularly affected are the women, whose participation and employment rates in 2010 were the lowest within the EU (with the exception of Malta). The gap between men and women is also impressive: it is almost double than what can be observed on average in the EU, both in terms of participation and employment rates (respectively 22.2 and 21.6 percentage points in Italy vs. 13.2 and 11.9 on average in the EU in 2010). Moreover, the gender gap enlarges sensibly in case of married workers with children and in correspondence of lower levels of education attainment (Table 3).

3 Setup of the model

We model the household's problem in a standard dynamic framework. We also assume that the decision maker is the household. The agent chooses how much to consume and how many hours to work to maximize her lifetime utility. A series of state variables affect the decision process: the agent takes into account the level of accumulated assets, and the realized labor incomes of all the components of the household, as well as the cost related to raising children under different labor market participation scenarios. Clearly, expectations about the future play a role too. Moreover, the agent knows the structure of the tax-and-transfer system and its effect of the family net income under different circumstances.

For the sake of simplicity, for the moment being, we assume that the husband is always employed in a full time-job (except when he is retired). This assumption greatly simplifies the treatment of the problem, is broadly in line with empirical data, and is not unusual in this kind of literature (see for example Eckstein and Wolpin (1989)). On the other hand, the wife can be in one of the following three states: out of the labor force, employed in a part-time job, or employed in a full-time occupation. Both husband and wife receive a new job offer at the beginning of each period. The log hourly wages follow a Mincer-type structure:

$$\log(e_{jt}^h) = \alpha_0^h + \alpha_1^h age_{jt}^h + \alpha_2^h agesq_{jt}^h + \alpha_3^h edu_{jt}^h + \varepsilon_{jt}^h \tag{1}$$

$$\log(e_{jt}^w) = \alpha_0^w + \alpha_1^w edu_{jt}^w + \alpha_2^w \exp_{jt}^w + \alpha_3^w \exp sq_{jt}^w + \alpha_4^w pt_{jt} + \varepsilon_{jt}^w \tag{2}$$

$$\varepsilon_{jt}^i \sim N(0,\sigma^{2,i}), \quad \forall i \in \{h,w\} \tag{3}$$

The fact that women's wage equation depends on the accumulated experience allows us to incorporate in the model a new channel through which labor supply decisions (and therefore tax policy ones) may have long-lasting effects. The coefficient α_4^w captures the penalty in the hourly wage that a woman incurs when she works in a part-time occupation.

Once a member of the family reaches the age of 65, he or she retires and gets a pension which is a deterministic function of her income in the last year of employment. Every individual dies with certainty at age 85. Since wives and husbands are not necessarily the same age, the model accounts for possible periods of widowhood too.

The recursive problem can be written as follows:

$$V_t\,(X_t^h, X_t^w, A_t) = \max_{\{l^w, A_{t+1}\}}\left\{U_t + \beta E[V_{t+1}(X_{t+1}^h, X_{t+1}^w, A_{t+1})]\right\}$$

subject to:

$$\frac{A_{t+1}}{(1+r)} = A_t + \tau_t[e^h l^h + e^w l^w] - c_t - K_t$$

Table 3

Gender Employment Rate Gap by Highest Level of Education Attained and Household Composition, 2010
(percent)

Country	Single Adult with Children	Single Adult without Children	Adult Living in a Couple with Children	Adult Living in a Couple without Children
Total				
EA	–13.1	–5.0	–22.6	–11.8
DE	–11.6	0.7	–23.3	–10.3
ES	–9.7	–8.7	–22.6	–14.2
FR	–15.6	–5.8	–15.6	–5.8
Italy	*–11.2*	*–11.7*	*–34.2*	*–21.4*
UK	–17.7	–0.9	–18.3	–12.6
Pre-primary, primary and lower secondary education				
EA	–18.7	–12	–35.1	–18.6
DE	na	–1.9	–35.3	–19.6
ES	–18.6	–15.3	–32.0	–22.9
FR	–23.4	–7.0	–24.8	–6.0
Italy	*–19.6*	*–20.7*	*–49.0*	*–28.9*
UK	–18.3	–3.2	–26.6	–22.2
Upper secondary and post-secondary non-tertiary education				
EA	–11.3	–4.8	–22.1	–7.6
DE	–7.3	–0.1	–20.9	–7.3
ES	3.5	–10.8	–22.4	–10.4
FR	–16.2	–8.6	–17.3	–3.1
Italy	*–10.2*	*–8.3*	*–30.9*	*–14.2*
UK	–14	0.8	–17.9	–9.9
First and second stage of tertiary education				
EA	–7.8	–1.1	–13.8	–5.6
DE	–14.4	3.1	–17.8	–5.5
ES	–9.3	–4.2	–15.7	–2.7
FR	–2.7	–2.5	–10.7	–6.3
Italy	*–6.8*	*–6.2*	*–17.6*	*–10.2*
UK	–11.1	0.1	–14.4	–5.1

Souce: Eurostat.

where A_t is the household's net wealth at the beginning of period t, l^h and l^w are the number of hours supplied on the labor market by husband and wife respectively, and τ_t a function which replicates the main features of the tax-and-benefit system in year t. c_t is household consumption, while K_t is the cost of childcare in period t: it depends on whether there are children in the household in that period, and on the mother's labor market participation.

For the moment being, a quite simple specification is chosen for the utility function:

$$U_t = \frac{\left(\frac{c_t}{n_t}\right)^{1+\eta}}{1+\eta} - \phi \cdot \frac{l_t^{1+\gamma}}{1+\gamma} \tag{4}$$

The household cares about both the level of consumption and the number of hours worked. In particular, η is the coefficient of relative risk aversion, while φ and γ measure the extent of the disutility of working. This specification of the preferences has been used often by the literature on dynamic labor supply (see Imai and Keane, 2004 and Keane, 2011).

One of the main drawbacks of the standard life-cycle model is its inability to replicate well the shape of consumption pattern over time. Adjusting for the demographic characteristics of the household can help to solve this problem: consumption is hump-shaped, it tracks income, and peaks when the head of the household is in her late thirties (Fernandez-Villaverde and Krueger, 2002). To accommodate for demographics, we rescale consumption in the utility function by dividing it by the equivalent number of household members, n_t, like in Laibson *et al.* (2007) and in Attanasio and Wakefield (2010).[1]

3.1 *Solution of the model*

As explained above, the dynamic programming involves several continuous and discrete state variables, making a full solution infeasible in this case. Therefore, we follow an approximation method which has become customary in this kind of large estimable dynamic models (Keane and Wolpin, 1994). In a nutshell, this approach is based on choosing a random subset of the points in the state space at each point in time and solve for the optimal value function there, while approximating the same function elsewhere on the basis of a flexible function of the state variables. The solution of the model is then obtained through value function iteration, starting from the last period and working backwards. The shocks are approximated numerically through Monte Carlo integration.

The solution of the dynamic programming allows us to obtain the optimal choices of the agents in each possible situation. Because of that, we can simulate the life of our households from the first period in which we observe them in the data onwards. For each household we simulate 20 realizations of the wage shocks for both members of the couple in each period. Our simulations involve about 20,000 wage offers in each period. For each of them, and for each possible labor supply choice, we compute the income of the members of the family, net of taxes and social security contributions and the implied level of family allowances. These simulations are at the basis of our econometric strategy to recover the preference parameters.[2]

---

1 We divide total household consumption by the square root of the number of household members.

2 In order to deal with the computational burden implied by the very high number of computations, we choose Fortran 90 as programming language and we parallelize both the value function iteration and the simulation with the OpenMP libraries. Our program runs in parallel on as many as 32 processors.

Table 4

Income Brackets and Tax Rates

2005-06		2007-11	
Income Brackets (euros)	**Tax Rates**	**Income Brackets (euros)**	**Tax Rates**
0-26,000	23%	0-15,000	23%
26,000-33,500	33%	15,000-28,000	27%
33,500-100,000	39%	28,000-55,000	38%
Above 100,000	43%	55,000-75,000	41%
		Above 75,000	43%

4 The Italian tax and benefit system

The model incorporates the main features of the Italian tax-benefit system: the personal income tax (so-called Irpef) and family allowances.

Irpef is a "personal" and progressive tax. Its amount depends on specific characteristics of the taxpayer (occupation, household composition, specific expenses of a personal nature, and so on) and it is calculated applying increasing tax rates to specified income brackets (see Table 4). Horizontal and vertical equity are granted through deductions from taxable income (as for the period 2005-06) or tax credits (as for the years 2007-11) for work-related expenses and dependent people (Tables 5, 6, and 7). The amount of both instruments is inversely related and linearly dependent from income, ensuring different degrees of progressivity for different sources of income and family structures.

On the basis of these characteristics Irpef has become, since its introduction, the main tool for income redistribution policies in Italy, *i.e.*, policies aimed at alleviating the tax burden on households with low income and a large number of components. This is especially true since the Italian tax system lacks more appropriate redistribution tools, such as subsidies or a negative tax programs able to support people with tax liabilities smaller than tax credits (so-called "incapienti").

Family allowances are tax exempt public cash transfers to families with incomes below certain levels. To be eligible for these cash transfers, the sum of taxable salaries and pension incomes of the components of the household has to be at least 70 per cent of the gross family income. The amount of family allowances increases with the size of the household but it is inversely related to gross household income. Family income brackets are established by law every July and revalued each year by the percentage change in average annual index of consumer prices for the families of workers and employees, while the amount of the allowances remain unchanged. Family income limits are higher for lone parents and those with disabled persons.

The model contains the main characteristics of the Italian tax-benefit system in force in the period 2005-11 and allows the simulation of alternative schemes related to different features of Irpef and family allowances.

Table 5

Tax Deductions, 2005-06

Income Source	**Maximum Amount (DEDB) (euros)**	**Dependent People**	**Maximum Amount (DEDF) (euros)**
Dependent worker	7,500	Spouse	3,200
Pensioner	7,000	Child	2,900
Self-employed	4,500	Child younger than 3 years	3,450
Other	3,000	Child with handicap	3,700
Using: $x_i = \frac{26{,}000 + DEDB - y}{26{,}000}$		Using: $x_i = \frac{78{,}000 + DEDF - y}{78{,}000}$	

Amount: $\begin{cases} 0, & if\ x_i \leq 0 \\ x_i * DED, & if\ 0 < x_i < 1 \\ DED, & if\ x_i \geq 1 \end{cases}$

5 Econometric strategy

The goal of our econometric exercise is to estimate the parameters in the utility function of the agents. In this preliminary version of our work we focus only on the coefficient of relative risk aversion and the parameters of the disutility of working. Possible extensions, including heterogeneity in the preferences are left for the future version of this work. We identify these parameters by searching for the vector of values which minimizes a weighted distance between our observed data and the behavior of the agents simulated by our model. The strategy is that of the so-called Method of Simulated Moments (or Indirect Inference), as in McFadden (1989). More formally, the econometric problem can be explained as follows:

$$\hat{\theta} = \arg\min\{g(\theta)' W g(\theta)\}$$

and:

$$g(\theta)' = \left[m_1^D - m_1^S(\theta), \ldots, m_J^D - m_J^S(\theta)\right]$$

where m_j^D be the j^{th} moment in the data and m_j^S the j^{th} simulated moment. The latter is found as an average across all the simulated individual observations, that is as $m_j^S = \frac{1}{NS} \sum m_j^s(\theta)$ where θ is the vector of parameters to be estimated.

The weighting matrix W is a diagonal matrix whose entries on the main diagonal are the inverse of the variances on the sample moments.

For the moment being, the moments used include the proportion of families in which wives participate to the labor force, work full-time, as well as the mean value of net worth. The pattern in the accumulation of the assets by the households is used to identify the coefficient of relative risk aversion, as in previous studies, such as those by Cagetti (2003) and Gourinchas and Parker (2002). The parameters governing the scale and the shape of the disutility from working are identified by the share of observations in each labor market status.

Table 6

Tax Credits for Work-related Expenses, 2007-11

Income Source	**Income Brackets** *(euro)*	**Tax Credit** *(euro)*
Dependent worker	0-8,000	1,840
	8,000-15,000	1,338+502*[(15,000–y)/7,000]
	15,000-55,000	1,338*[(55,000–y)/40,000]
	Above 55,000	0
	Plus:	
	23,000-24,000	10
	24,000-25,000	20
	25,000-26,000	30
	26,000-27,700	40
	27,700-28,000	25
Pensioner aged less than 76	0-7,750	1,725
	7,750-15,000	1,255+470*[(15,000–y)/7,500]
	15,000-55,000	1,255*[(55,000–y)/40,000]
	Above 55,000	0
Pensioner aged 76 and more	0-7,750	1,783
	7,750-15,000	1,297+486*[(15,000–y)/7,250]
	15,000-55,000	1,297*[55,000–y)/40,000]
	Above 55,000	0
Self-employed	0-4,800	1,104
	4,800-55,000	1,104*[(55,000–y)/50,200]
	Above 55,000	0

In order to obtain the optimal value of the parameters, our algorithm has to iterate between the solution of the model (and the simulation of the optimal behavior of our agents) and the minimization of the objective function. Because the objective function is likely to be discontinuous, we adopt a minimization algorithm which is based on the function values only, namely the Nelder and Mead (1965) method.

In order to alleviate the computational burden of the estimation, we choose to proceed in two steps, estimating the wage equations separately from the preference parameters. This approach is similar to that of French (2005), among others. This strategy is dictated mostly by the fact that a single dataset cannot provide all the needed information: in particular we use a different data source to estimate the wage offers, gross of any tax and social security contribution.

Table 7

Tax Credits for Dependent People, 2007-11

Dependent People	Income Brackets *(euro)*	Tax Credit *(euro)*
Spouse	0-15,000	800–110*[y/15,000]
	15,000-40,000	690
	40,000-80,000	690*[(80,000–y)/40,000]
	Above 80,000	0
	Plus:	
	29,000-29,200	10
	29,200-34,700	20
	34,700-35,000	30
	35,000-35,100	20
	35,100-35,200	10
Child	Aged 3 or more	$(800 \cdot nchild) \cdot \frac{((95{,}000 + 15{,}000 \cdot (nchild - 1)) - y)}{(95{,}000 + 15{,}000 \cdot (nchild - 1))}$
	Younger than 3	$(900 \cdot nchild) \cdot \frac{((95{,}000 + 15{,}000 \cdot (nchild - 1)) - y)}{(95{,}000 + 15{,}000 \cdot (nchild - 1))}$
	With handicap	(1)
	More than 3 children	(2)
Other dependent people		$(750 \cdot nother) \cdot \frac{(80{,}000 + 15{,}000 \cdot (nother - 1) - y)}{(80{,}000 + 15{,}000 \cdot (nother - 1))}$

(1) Previous formulas but 800 and 900 euros are increased by 200 euros.
(2) Maximum amount augmented by 200 euros for each child after the first one.

6 Data

We use two main sources of data. Data about family composition and asset accumulation come from the Bank of Italy Survey on Household Income and Wealth (SHIW). Data about gross labor incomes come from several waves of the EU Community Statistics on Income and Living Conditions (EU-SILC) survey. Observations are matched on the basis of comparable background information about both members of the couple. All monetary values are expressed in 2010 euros using the official price indexes computed by the Italian National Statistical Office (ISTAT).

Bank of Italy has been collecting a nationally representative household survey since the 1960s. The SHIW collects information about sources of income and wealth allocation for about 8,000 households. Since 1989, it features a longitudinal component. About half of the families are

Table 8

Descriptive Statistics

	Average	S.D.	Observations
Family-level data:			
Net worth	159,854	139,014	559
Number of kids	1.62	0.93	559
Individual-level data:			
Wife partecipation	0.51	0.5	559
Wife full-time work	0.39	0.49	559
Wife years of education	9.45	2.22	559
Husband years of education	9.33	2.15	559
Wife age	40.36	6.21	559
Husband age	43.58	6.21	559

Source: our calculations on the SHIW 2004 sample. Data in 2010 euros.

interviewed in up to five waves. Given its detailed information on assets, this dataset has been used widely in previous studies[3] and it is well suited for our research goal.

We use four continuous waves of the SHIW dataset: from 2004 to 2010, the most recent one. We focus only on married individuals, who are out of the labor force or dependent workers in each wave. Our selection decision is dictated by the fact that the rules for the determination of taxable income and some features of the tax structure are different for self-employed with respect to employees. We plan on extending our analysis to single individuals in future versions of this study. We drop very few observed households who accumulated an extremely high or extremely low level of assets. Since the SHIW is a rotating panel, our resulting sample is unbalanced. We observe 559 households in 2004: almost 70 percent of them are followed until 2010, more than 80 per cent until 2008. Overall, our resulting sample is composed of 2,792 individuals-years observations.

Table 8 reports some simple unweighted descriptive statistics about our sample in 2004. The average net worth is slightly lower than 160,000 euros. Only one every two married women is employed, while only about two fifths of them works full-time. The number of children per family is about two and it is about constant in our sampled families across the six observed years.

The EU-SILC survey is released annually within the European Statistical System. The survey aims at collecting cross-country comparable micro-data on income, poverty and social exclusion at European level. Starting in 2003 in six member states, it currently covers all EU countries. The database has both a cross-sectional and a longitudinal dimension. Concerning Italy, the survey started in 2004. The reference population is made of private households residing in the country and their current members. The sample design is a rotational one articulated in four groups

---

3 See, for example, Jappelli and Pistaferri (2000).

drawn according to a stratified two-stage selection (where in the first stage municipalities are selected and in the second one households). The design attaches to each household (and to each member in the same household) a sample weight adjusted for non-response and external sources (such as the population distribution by age and sex). Over the period 2004-09 the average number of households interviewed each year is about 21,700, corresponding to 54,800 individuals (46,700 aged 15 or above). The Italian section of the EU-SILC survey includes some methodological peculiarities regarding in particular some sources of personal income, including earnings. The recorded data are indeed controlled and integrated with administrative data, via an exact match at individual level based on taxpayer identification numbers (ISTAT, 2008). This process allows for minimizing the under-reporting of the income data, making them more reliable.

In the estimation of the employee income generating process, we pool the 2004-09 waves together and select individuals aged between 25 and 55. We further restrict our sample by considering only employees and non-working women, ending up with 41,761 observations. Income is defined as the gross monthly earnings for employees, which includes only monetary earnings in the main job, gross of tax and social contributions.[4] We build hourly wages dividing these amounts by the reported number of hours worked.

Some parameters are kept constant during the estimation; this is the case of the discount rate β, which is set to 0.98, and of the annual return rate on financial investments r, which is set to 1.5 per cent, in line with other studies. Data from the 2009 survey on consumption conducted by ISTAT is used to parametrize the childcare costs, which vary according to the labor market status of the mother.

7 Preliminary results

As explained above, we estimate the parameters of the models in two separate steps. First, we estimate the wage functions separately for men and women, then we use these results to parametrize the model and estimate the preference parameters.

The log wage equations are estimated using standard techniques: ordinary least squares for men, maximum likelihood, with sample selection correction, for women. The results are shown in Table 9. As expected, the wage profile is hump-shaped. The return of an additional year of education is about 3.3 per cent for men and 4.4 per cent for women. Experience has a positive and significative effect on offered wages for women (one additional year on the job increases offered hourly wage by about 3 per cent). Part-time jobs come with a significative penalty: *ceteris paribus*, hourly wages are about 6 per cent lower than in full-time occupations.

As regards the preliminary estimates of the preference parameters (see Table 10), we find a coefficient of relative risk aversion of –2.76, which is within the range of the existing estimates. Moreover, working is associated with a sizable disutility, which varies with the number of hours worked. The standard errors around our estimates of the preference parameters are quite low.

The fit of the model to the observed data is quite good. The main features are reported in Table 11. Even though the model slightly underpredicts the average level of net worth in each wave, the asset distribution mirrors quite closely that observed in the data (Table 12). The model predicts very closely the average proportion of wives who are participating to the labor market, and the average proportion of full-time employees. In terms of net wages, the unconditional net income in 2006 is around 20,000 euros for men, while it is around 8,000 euros for women.

---

[4] We use the variable PY200G.

Table 9

First Stage Estimates

	Men Coeff	(se)	Women Coeff	(se)
Age	0.0374	(0.0028)	-	
*Age*2	–0.0003	(0.0000)	-	
Experience	-		0.0343	(0.0014)
*Experience*2	-		–0.0005	(0.0000)
Part-time	-		–0.0637	(0.0066)
Education	0.0334	(0.0006)	0.0441	(0.0007)
Married	0.0751	(0.0050)	0.0693	(0.0050)
Constant	1.087	(0.0545)	1.472	(0.0179)
Observations:	42,343		41,761	
Method:	OLS		Heckit	

Table 10

Preference Parameters

η	φ	γ
–2.757	3.046	–0.078
(0.009)	(0.026)	(0.007)

8 Policy experiments (preliminary)

The model is used to simulate the effects of four main changes to the tax-benefit system on the female participation rate and on the overall poverty.[5] The policy exercises can be divided in two main groups: changes aimed at increasing the non-labor income of the households in the lowest part of the income distribution and changes which directly influence labor income. In particular, the policy experiments belonging to the first group include: i) a 20 per cent increase in family allowances; ii) a possible refund of at most 400 euros to households whose net tax liabilities are negative (so-called *incapienti*); iii) a 35 per cent rise in child-related tax credits. The fourth simulation which consists of a 30 per cent increase in work-related tax credits affects directly labor income.

[5] We define as poor a household whose net income is below the relative poverty line reported by the National Statistical Office (Istat). It should be noticed that such poverty line is calculated in terms of consumption expenditure. However in general in the lowest part of the income distribution consumption and net income tend to be of the same magnitude. As measure of poverty we consider the head-count ratio.

Table 11

Fit of the Model

	Year	Data	Model
Female participation:			
	2006	51.6	52.5
	2008	54.4	53.5
	2010	52.5	54.2
Female full-time employment:			
	2006	37.6	37.6
	2008	39.9	40.4
	2010	40.1	42
Family net wealth:			
	2006	185,113	153,996
	2008	194,900	141,849
	2010	202,386	133,026

Table 12

Distribution of the Assets in 2006
(thousands of 2010 euros)

Percentile	Data	Model
5%	3	5
10%	8	10
25%	59	40
50%	165	128
75%	278	227
90%	394	348
95%	479	435

All the experiments are announced in 2004 and implemented in 2007 (except the one concerning family allowances which is applied since 2005). This is because in 2005 and 2006 tax credits were replaced by tax deductions. The time lag allows us to also test to which extent these policies would create some inter-temporal shift in labor supply.

With respect to the baseline scenario (which simulate the actual tax-benefit system) all policy alternatives produce a reduction in net revenue amounting to around 4 per cent (defined as the algebraic sum of tax revenue, net of tax credits, of social security contributions and tax expenses for family allowances).

The model is used to simulate the optimal choices of about 10,000 families over their life-cycle, starting from the end of 2004. These optimal choices are obtained solving the dynamic programming using the optimal parameters estimated in section 7.

The main results are summarized in Table 13, which illustrate the effects of the simulated policies on the female participation rates, full-time jobs and poverty head-count ratio.

It is important to bear in mind that the treatment of unemployment in the current version of the model may play a crucial role. In particular, our model assumes that there are no frictions in the labor market. Being aware of the relevance of such assumption, it will be relaxed in the next version of the model.

As far as results as concerned, the policy experiments reduce, as expected, the overall head-count ratio. They however differ for the magnitude of the effect. In particular, it goes from a minimum of –0.4 percentage points, in the case of partially refundable tax credits, to –1.7 percentage points when an increase in child-related tax credits is implemented. Generally, the two alternatives involving tax credits produce effects which are almost twice that of the other designed policies.

Concerning the impact on the female participation rate, the policy experiments aimed at increasing the households' non-labor income are not effective, and sometimes even detrimental. In particular, an increase in the family allowances, which are not dependent from the active position of the second earner but only from the household overall income, would negatively affect both labor supply and full-time employment. This is due to the inverse relation between the amount of family allowances and household income. The same effect is obtained increasing proportionally child-related tax credits or making all tax credits (including those for the spouse) partially refundable. On the other hand, when only the work-related tax credits are increased wives' labor supply in general rises (both in terms of part-time and full-time employment). The initial decrease we observe in 2006 is exclusively due to inter-temporal shifts in labor supply related to the time lag between the announcement of the policy and its implementation. Therefore, overall, this policy experiment is the only one successful in reaching both higher female participation rates and lower headcount ratios.

9 Conclusions and agenda for ongoing work

In this work, we build and estimate a large dynamic life-cycle model of labor supply, consumption, and asset accumulation for a sample of Italian families, which were observed between 2004 and 2010. The model allows for heterogeneity across agents, and incorporates the main features of the tax-and-benefit schemes in place at that time. The goal of our research is to build a tool that could be used in the future to run a series of policy experiments in the area of taxation and labor supply. The Italian labor market is characterized by a low participation rate of married women. As highlighted by a series of previous works, the tax code may play an important role. In a set of highly preliminary results, we show the possible effect on labor supply of a short

Table 13

Policy Simulations
(preliminary)

	Year	Female Participation	Female Full-time Employment
Baseline:			
	2006	52.46	37.65
	2008	53.46	40.35
	2010	54.24	42.01
Head-count ratio in 2010: 7.24 per cent			
Increasing family allowances by 20 per cent:			
	2006	48.45	35.64
	2008	49.55	38.10
	2010	50.54	40.17
Change in net revenue in 2010: –4.10 per cent			
Change in head-count ratio in 2010: –0.84 per cent			
Making all tax credits refundable up to 400 euros:			
	2006	51.39	37.23
	2008	49.72	36.98
	2010	50.33	39.27
Change in net revenue in 2010: –4.50 per cent			
Change in head-count ratio in 2010: –0.38 per cent			
Increasing child-related tax credits by 35 per cent:			
	2006	51.40	36.73
	2008	52.76	39.14
	2010	53.32	41.19
Change in net revenue in 2010: –4.27 per cent			
Change in head-count ratio in 2010: –1.65 per cent			
Increasing work-related tax credits by 30 per cent:			
	2006	50.97	36.35
	2008	54.06	41.69
	2010	54.63	43.18
Change in net revenue in 2010: –4.35 per cent			
Change in head-count ratio in 2010: –1.34 per cent			

We compute net revenue as the algebraic sum of tax revenue, net of tax credits, of social security contributions and tax expenses for family allowances.

list of partial reforms to the system. This work can be extended in different directions. First of all, we plan to enrich the specification of the utility function, so that some forms of both observed and unobserved heterogeneity could be accounted for. This would give us the opportunity to study the differential effects of hypothetical reforms on different sectors of the population. Moreover, allowing for different *types* in the population would allow for a better treatment of the initial conditions.

The estimation of the risk aversion coefficient requires that our model captures the main aspects of the risks to which Italian families are exposed. This is unlikely to be the case in the present form of our study: in particular, we are working to incorporate a better treatment of unemployment into the setup of the model.

Both the introduction of unobserved permanent heterogeneity, and the introduction of labor market rationing through unemployment shocks are likely to increase the degree of persistence in the observed behavior of the simulated agents. We expect these features to lower the magnitude of our simulated responses to reforms to the tax and benefit system.

Finally, extending the study to a sample of single adults could allow us to investigate the role of preferences in the distribution of resources inside the household and the potential effects of taxation schemes, including those family based, on different sectors of the population.

REFERENCES

Aaberge, R., U. Colombino and S. Strøm (1999), "Labour Supply in Italy: An Empirical Analysis of Joint Household Decisions, with Taxes and Quantity Constraints", *Journal of Applied Econometrics*, Vol. 14, No. 4, pp. 403-22.

—————(2004), "Do More Equal Slices Shrink the Cake? An Empirical Investigation of Tax-transfer Reform Proposals in Italy", *Journal of Population Economics*, Vol. 17, No. 4, pp. 767-85.

Attanasio, O. and M. Wakefield (2010), "The Effects on Consumption and Saving of Taxing Asset Returns", in J. Mirrlees (ed.), *Dimensions of Tax Design: The Mirrlees Review*, pp. 675-736, Oxford University Press, Oxford and New York.

Blundell, R., M. Dias, C. Meghir and J. Shaw (2011), "The Long-term Effects of In-work Benefits in a Life-cycle Model for Policy Evaluation", CeMMAP, Working Paper.

Blundell, R., A. Duncan, J. McCrae and C. Meghir (2000), "The Labour Market Impact of the Working Families' Tax Credit", *Fiscal Studies*, Vol. 21, No. 1, pp. 75-104.

Cagetti, M. (2003), "Wealth Accumulation Over the Life Cycle and Precautionary Savings", *Journal of Business and Economic Statistics*, Vol. 21, No. 3, pp. 339-53.

Colombino, U. and D. Del Boca (1990), "The Effect of Taxes on Labor Supply in Italy", *Journal of Human Resources*, pp. 390-414.

Eckstein, Z. and O. Lifshitz (2011), "Dynamic Female Labor Supply", *Econometrica*, Vol. 79, No. 6, pp. 1675-726.

Eckstein, Z. and K.I. Wolpin (1989), "Dynamic Labour Force Participation of Married Women and Endogenous Work Experience", *Review of Economic Studies*, pp. 375-90.

Eissa, N. and J. Liebman (1995), "Labor Supply Response to the Earned Income Tax Credit", National Bureau of Economic Research, Working Paper.

Fernandez-Villaverde, J. and D. Krueger (2002), "Consumption Over the Life Cycle: Facts from Consumer Expenditure Survey Data", National Bureau of Economic Research, Working Paper.

French, E. (2005), "The Effects of Health, Wealth, and Wages on Labour Supply and Retirement Behaviour", *Review of Economic Studies*, Vol. 72, No. 2, pp. 395-427.

Gourinchas, P. and J. Parker (2002), "Consumption Over the Life Cycle", *Econometrica*, Vol. 70, No. 1, pp. 47-89.

Haan, P. and V. Prowse (2010), "A Structural Approach to Estimating the Effect of Taxation on the Labour Market Dynamics of Older Workers", *The Econometrics Journal*, Vol. 13, No. 3, pp. S99–S125.

Imai, S. and M. Keane (2004), "Intertemporal Labor Supply and Human Capital Accumulation", *International Economic Review*, Vol. 45, No. 2, pp. 601-41.

ISTAT (2008), "L'indagine europea sui redditi e le condizioni di vita delle famiglie (Eu-Silc)", Collana Metodi e Norme, No. 37.

Jappelli, T. and L. Pistaferri (2000), "The Dynamics of Household Wealth Accumulation in Italy", *Fiscal Studies*, Vol. 21, No. 2, pp. 269-95.

Keane, M. (2011), "Labor Supply and Taxes: A Survey", *Journal of Economic Literature*, Vol. 49, No. 4.

Keane, M.P. and K.I. Wolpin (1994), "The Solution and Estimation of Discrete Choice Dynamic Programming Models by Simulation and Interpolation: Monte Carlo Evidence", *Review of Economics and Statistics*, Vol. 76, No. 4, pp. 648-72.

―――――― (2010), "The Role of Labor and Marriage Markets, Preference Heterogeneity, and the Welfare System in the Life Cycle Decisions of Black, Hispanic, and White Women", *International Economic Review*, Vol. 51, No. 3, pp. 851-92.

Laibson, D., A. Repetto and J. Tobacman (2007), "Estimating Discount Functions with Consumption Choices Over the Lifecycle", National Bureau of Economic Research, Working Paper.

Marcassa, S. and F. Colonna (2011), "Taxation and Labor Force Participation: The Case of Italy", THEMA (THéorie Economique, Modélisation et Applications), Université de Cergy-Pontoise, Working Paper.

McFadden, D. (1989), "A Method of Simulated Moments for Estimation of Discrete Response Models Without Numerical Integration", *Econometrica*, Vol. 57, No. 5, pp. 995-1026.

Meyer, B. (2002), "Labor Supply at the Extensive and Intensive Margins: The EITC, Welfare, and Hours Worked", *The American Economic Review*, Vol. 92, No. 2, pp. 373-79.

Nelder, J. and R. Mead (1965), "A Simplex Method for Function Minimization", *The Computer Journal*, Vol. 7, No. 4, p. 308.

Sheran, M. (2007), "The Career and Family Choices of Women: A Dynamic Analysis of Labor Force Participation, Schooling, Marriage, and Fertility Decisions", *Review of Economic Dynamics*, Vol. 10, No. 3, pp. 367-99.

Van der Klaauw, W. and K.I. Wolpin (2008), "Social Security and the Retirement and Savings Behavior of Low-income Households", *Journal of Econometrics*, Vol. 145, No. 1, pp. 21-42.

DO PUBLIC POLICIES OF A NET-REVENUE-MAXIMIZING GOVERNMENT ALSO PROMOTE INFORMALITY?

Nivedita Mukherji[*] *and Fuad Hasanov*[**]

This paper examines the effects of fiscal and regulatory policies on the size of a country's informal economy and its government's net revenue. Introducing two types of formal goods with only one having a substitute in the informal economy, this paper finds that changes in public policies influence not only the size of the informal economy, they influence the composition of production within the formal sectors as well. Public policies that impact informality often have differential impact on the two types of formal production. This redistribution of production within the formal sector influences the impact of policies on the government's net revenue. The paper also allows some formal producers to evade taxes and informal producers to pay bribes. Tax evasion and the necessity of informal producers to pay bribes to hide their informal status further influence how public policies impact informality and distribute production within the formal sectors. Prior research on informality largely ignores multiple formal goods and fails to account for the differential impact of policies on the different formal sectors. These effects are further amplified when tax evasion and bribes are taken into consideration.

1 Introduction

In recent years the issue of production in informal sectors has drawn considerable attention. De Soto (1989) provides valuable information regarding factors which promote the development of informal markets. Although it has been recognized for long that the presence of these markets may adversely affect an economy, it is only recently that serious theoretical and empirical studies of the issue are being conducted.[1]

A large portion of the current literature has studied the effects of regulations and taxation on the size of the informal economy.[2] See Schneider and Enste (2000) for a review of many such studies. While this literature focuses on how government tax and regulatory policies promote the growth of informal economies, there is insufficient attention given to the reasons behind such policies. Marcouiller and Young (1995), Azuma and Grossman (2008) and Mukherji (2004) are some theoretical papers that study the possible rationale behind such government policies. These papers view the governments of proprietory or predatory states as agents that maximize tax revenue net of public services (termed net revenue by Azuma and Grossman and graft by Marcoullier-Young and Mukherji). Azuma and Grossman (2008) find that the distribution of productive endowments and access to private substitutes of public services impact public policies that induce some producers to operate in the informal sector. Hibbs and Pichulescu (2009) also incorporate public services and the quality of public institutions in a model of informality. They find that the incentive to operate in the informal sector is influenced by the quality of institutions

---

[*] Department of Economics, Oakland University, Rochester, MI 48309, USA. E-mail: mukherji@oakland.edu

[**] International Monetary Fund, Washington, DC 20431, E-mail: fhasanov@imf.org

The views expressed herein are those of the author and should not be attributed to the IMF, its Executive Board, or its management.

[1] Papers such as Viramani (1989), Goswami *et al.* (1991), Besley and McLaren (1993), Shleifer and Vishny (1993), Jain (1998), Tanzi (1994, 1998), Bardhan (1997), Johnson, Kaufmann, Zoido-Lobaton (1998a, b) view informality to be a result of corruption of officials, such as tax collectors, and show that the government is better off if such corruptions can be eliminated. Loayza (1996), Sarte (2000), Loayza, Oviedo, Serven (2005) study the adverse impact of the informal economy on the economy's growth path.

[2] Feige (1989), Cebula (1997), Johnson, Kaufmann, Zoido-Lobaton (1998a and b), Friedman, Johnson, Kaufman and Zoido-Lobaton (1999), Ihrig and Moe (2001), Fugazza and Jacques (2004) and Chong and Gradstein (2007) are some recent papers in this literature.

and governance available to private sector producers. Marcoullier and Young (1995) show that in some cases a "black hole" of graft exists when public policies aimed at maximizing graft almost drive the formal sector out of existence. Mukherji (2004) extends Marcoullier and Young's model by endogenizing the labor supply decision of households and challenges the "black hole" result.

This paper extends the theoretical models in Marcoullier and Young (1995) and Mukherji (2004) to further examine how public policies affect informality and net revenue in a richer model. The paper's extensions involve i) introducing government regulations ii) increasing the number and types of goods produced by the economy, iii) allowing some formal producers to evade taxes, and iv) allowing informal producers to pay bribes to stay informal. Since the empirical literature finds a strong relationship between regulations and informality,[3] the extension related to regulation is natural. The paper extends the number of goods to simply recognize that most informal goods are produced in both formal and informal sectors and that some goods like automobiles are produced in formal sectors alone. Finally, it is well documented that many formal producers evade taxes and informal producers pay many bribes to remain informal. Hence these extensions are also natural.

Schneider and Enste (2000) cautions that the conventional result that higher taxes increase informality may not be robust and must be studied in a general equilibrium context that takes into the account the impact of taxes on individual labor-leisure decisions and demand and supply of formal and informal goods. The results of this paper demonstrate that indeed in a richer model, the conventional results may not hold. Dessy and Pallage (2001) also find ambiguous effects of tax policy on informality and caution against "simple-minded" policy recommendation based on taxation.

The extensions noted above are found to have significant impact on results. The inclusion of a formal sector that has no informal counterpart introduces some interesting sectoral redistributions of production in response to policy changes. These are further amplified when tax evasion is possible and informal producers must pay bribes to maintain their status. For example, when neither tax evasion nor bribes are allowed, informality increases as the tax rate increases. This is consistent with other papers in the literature. However, when tax evasion is allowed, a higher tax rate increases the price of the good that has no informal counterpart and causes sectoral redistribution of production within the two formal sectors of the economy. This effect is further affected when informal producers must pay bribes. The interaction of the tax evasion and bribes effects reduces the the positive impact of higher tax rates on informal production. It is possible for higher tax rates to actually reduce informality if the price effect noted above is strong enough. The rearrangement of production within the two formal sectors also impacts how higher taxes affect overall tax revenue. Existing theoretical literature on informality concentrates only on the movement of labor and production between the formal and informal sectors. This paper demonstrates that public policies impact the distribution of production also within formal sectors. If this effect is ignored, the results capture only a portion of the full impact of public policies on informality and net revenue.

Robinson and Slemrod (2011) suggest that when multiple types of taxes and methods of enforcement exist, the impact of taxation on informality is influenced by the complexity of the system. Consistent with Dessy and Pallage (2001) these studies show that the effect of taxation and other public policies on informality is more complex than what some prior research suggests.

Since some production such as large scale manufacturing always remains formal, some taxes are evaded, and informal producers routinely pay bribes, it is important to incorporate them in the study of informality. To our knowledge, there is no other paper in the literature that examines this

[3] Johnson, Kaufmann and Shleifer (1997) and Friedman, Johnson, Kaufman and Zoido-Lobaton (1999) show that higher regulations of all types increase the size of the informal economy.

interaction in the context of informality. The results related to net revenue demonstrate that public policies influence the two formal sectors in opposite directions in most cases. Hence even if a change in policy increases informality, it may decrease production and revenue of one formal industry but increase the same for another. The net impact on net revenue depends on the strengths of these two opposing effects on tax revenue. Existing literature that mainly considers the presence of one formal sector fails to account for this inter-sectoral redistribution of production in the formal economy as a result of changes in public policy.

These results then also raise concerns about the choice of net revenue as the maximand for a government otherwise interested in policies that promote informal production. While theoretically it appears sensible to assume that a proprietory state would be interested in maximizing tax revenue net of some minimal productive services it must provide, the paper finds that the factors that contribute to informality do not necessarily increase net revenue. This suggests that if one needs to understand the motivations behind policies that promote informality, an alternative objective function is perhaps called for. Some metric measuring government extraction from publicly funded projects might be a better alternative.

Major implications of the relationship between public policies and both informality and net revenue are investigated empirically using data from about 50 countries. To our knowledge this paper provides the first attempt in the literature to empirically measure net revenue to study the impact of public policies on it in the context of informality. The empirical results related to informality and regulations are mostly consistent with existing literature. If indicators of democracy/bureaucracy and corruption are included in the estimation, regulations fail to have a significant impact on informality. This result is consistent with the results found in Chong and Gradstein (2007). The results on taxation and public services differ from other studies. The paper finds that higher taxes reduce informality and not increase it. This supports the theoretical result of the paper but is generally at odds with many other empirical studies cited above. Additionally, the existing literature argues that higher public services entice producers to operate in the formal sector and reduce informality. It also increases tax revenue (see Johnson and Kauffman, 1998b). While this paper finds that higher public services increase net revenue in most cases, it also increases informality. Unlike regulation, if indicators of democracy/bureaucracy and corruption are included in the estimation, public services and taxes continue to have a statistically significant impact on informality.

The empirical results related to net revenue show that higher taxes, lower regulations, and higher public services increase net revenue. Furthermore, countries with higher income, good democratic/bureaucratic and corruption indicators have higher net revenue. These are the factors that also reduce informality. These empirical results then raise concerns about the choice of net revenue as the maximand for a government otherwise interested in policies that promote informal production. While theoretically it appears sensible to assume that a proprietory state would be interested in maximizing tax revenue net of some minimal productive services it must provide, empirically the paper finds generally a negative correlation between factors that contribute to informality and the factors that increase net revenue.

Due to the lack of reliable data for countries run by dictatorships it is difficult to compare their graft or net revenue with the net revenue of other countries. However, the strength and robustness of the relationships found here for a very diverse group of countries question the ability of a government to extract increasing amounts of net revenue for itself by pursuing economically detrimental public policies. Thus policies that promote informality do not increase net revenue empirically, with the exception of public services. If public services are used to improve a country's institutions, law and order, bureaucracy, infrastructure and such, in the long run these improvements will reduce informality.

The rest of the paper is organized as follows. Section 2 describes the theoretical model, Section 3 addresses the key theoretical results, Section 4 includes an empirical investigation, and Section 5 provides concluding remarks.

2 Description of the economy

The model-economy analyzed here is similar to the one used in Mukherji (2004) and Marcouiller and Young (1995). Individuals in this economy produce two distinct goods, H and J. Unlike Mukherji's and Marcouiller-Young's papers, one of these two goods, denoted by H, can be produced in either the formal sector or an informal sector since its production can be concealed. If it is produced in the formal sector it is called F. Otherwise it is called I. Production of the other good, J, however cannot be concealed and hence must occur in the formal sector alone. All production requires some public services, g. If production of a good occurs in the informal economy, producers have only partial access to these public services. Hence, informal producers must bear the cost of acquiring private substitutes of necessary excludable public services to remain productive.

All formal production is taxed at the rate τ. Since good H is concealable, producers of F can evade taxes. Tax evasion of good J is not possible since output is costlessly verifiable by the government.

2.1 Description of production functions

2.1.1 Good F (Good H produced in the formal sector)

Recall that output of good H can be concealed. To reduce the incidence of tax evasion that concealment makes possible, the government requires all formal producers of good H, that is producers of F, to comply with some regulations. These regulations, represented by R, determine the government's success in catching such evasions. That remains the sole purpose of regulations in this economy. In the simplest case, R is also the probability that a firm will be caught in its efforts to evade taxes. If caught, a firm pays a penalty at a rate ν. The effective tax rate in that case becomes $\tau(1+\nu) \equiv T$.

A formal producer has the choice to truthfully report all production or to conceal it. Truthful reporting necessitates paying taxes at the rate τ while efforts to conceal leads to an expected tax rate of $R\tau(1+\nu) = R*T$. If $\tau < R*T$, all formal producers will truthfully report their production. If $\tau \geq R*T$, however, producers will misreport their earnings. After-tax return to the producers of F then depends on the above tax-regulatory situation.

Case 1: $\tau < R*T$

After-tax output when all firms truthfully report their production is given by:

$$Y_F = (1-\tau)\psi*((1-R)l_F)^{1-\phi} g^{\phi} \tag{1}$$

This production function demonstrates that output depends on the amount of labor, l, and access to productive public services, g. Production in this economy is organized in units where the owner is the sole provider of labor. Hence l_F in equation (1) denotes the amount of labor supplied by a producer of good F. The term $(1-R)$ multiplying labor supply captures the reduction in productive labor services caused by regulations. ψ is a technology parameter and ϕ is a positive fraction capturing the elasticity of output to public services.

Case 2: $\tau \geq R*T$

In this scenario all firms choose to conceal their production. Hence after-tax production is given by:

$$Y_F = (1-R+R(1-T))\psi*((1-R)l_F)^{1-\phi}g^{\phi}) \quad (2)$$

Recall that a firm successfully evades taxes with probability 1–*R* and is caught with probability *R*. In case it evades, it keeps the entire output. Otherwise it retains only the fraction 1–*T*. Hence the term 1–*R*+*R*(1–*T*) in the above equation. The remaining variables and parameters are as described above.

2.1.2 Good I (Good H produced in the informal sector)

The informal sector producing good H works much like the formal sector, except that output here is not taxed and producers do not have to comply with any regulations. Producers here, however, do not have access to all public services. While some infrastructure related public services such as roads are available to all producers, certain other services are only partially available at best. Informal producers may expend some resources in the form of bribes to gain increased access to these services and in some cases provide private substitutes of these services. Thus, they have to divert some of their labor services for gaining more complete access to partially available public services and/or for the production of substitutes of the public services enjoyed by producers in the formal sector.

An informal producer is assumed to have full access to only a fraction γ of the public services g available to producers in the formal sector. By expending some effort they can increase that fraction to $\gamma + s$, where $0 < s < 1$ also represents the fraction of labor diverted for this purpose. The production function of the informal good I is then given by:

$$Y_I = \psi[(1-s)l_I]^{1-\phi}[(\gamma+s)g]^{\phi}) \quad (3)$$

A positive solution for the fraction s requires the assumption $\phi > \gamma 1 + \gamma$.

Informal producers get caught by the authorities with probability π. This probability is assumed to be proportional to the ratio of informal to total population. That is:

$$\pi = \theta\, n_I(N) \quad (4)$$

where n_I equals the number of people who produce in the informal sector, N equals total population, and θ is a positive parameter reflecting the government's success in capturing informal producers. The positive relationship between the probability π and the ratio of informal to total population is based on the observation that it is much easier to escape the authorities if a very small fraction of producers produce informally than if a much larger fraction did. The government's incentive to go after these producers will also tend to increase as the proportion rises. Once caught, however, these producers have to give up their entire output. Hence expected output of an informal producer is $(1-\pi)Y_I$.

2.1.3 Good J

This good is produced in the formal sector alone and cannot be concealed from the government. Hence production here is not subject to regulations. The production function is similar to that of good H and is given by:

$$Y_J = \delta\psi l_J^{1-\phi} g^{\phi} \tag{5}$$

where δ is a positive constant indicating that the technology used by this sector is different from the technology used in the production of good *H*. The elasticities of output to labor and government services are assumed to be the same as those for good H to keep the problem tractable.

2.2 Preferences and optimal consumption-labor supply decisions

The producers of goods H (*F*, *I*) and J are individuals who choose the amount of labor they supply by balancing the disutility of labor and the consumption it makes possible. The utility function of a representative producer-consumer is as follows:

$$U(H_i, J_i, l_i) = [H_i^{\sigma-1\sigma} + J_i^{\sigma-1\sigma}]^{\sigma\sigma-1} - \alpha l_i \tag{6}$$

$i = F, I, J$. This utility function shows that individuals derive utility from the consumption of goods H and J and leisure. σ is the elasticity of substitution between the two goods and α is a parameter denoting the weight of leisure in the utility function. Assuming that the output of good H produced formally and informally are indistinguishable, utility is a function of *H*.

2.2.1 Consumption and labor supply decisions of producers of good F

Case 1: $\tau < R*T$

When the tax and regulatory structure is such that producers report their production truthfully to the government, the budget constraint producers of F face is as follows:

$$H_F + pJ_F = (1-\tau)\psi * ((1-R)l_F)^{1-\phi} g^{\phi} \tag{7}$$

The formal good H is treated as the numeraire in this economy and p is the price of good J in terms of good *H*. Producers of F choose their consumption and labor supplies by maximizing the utility given by equation (6) subject to the above budget constraint. Routine calculations yield:

$$H_F = p^{\sigma} J_F \tag{8}$$

$$l_F = ((1-\phi)\psi\alpha)^{1\phi}(1-\tau)^{1\phi}(1-R)^{(1-\phi)\phi}(1+p^{1-\sigma})^{1\phi(\sigma-1)} g \tag{9}$$

Substituting from equations (8) and (9) in the budget constraint, consumption of the formal good is given by:

$$H_F = (1-\tau)^{1\phi}\psi^{1\phi}(1-R)^{(1-\phi)\phi}(1-\phi\alpha)^{1-\phi\phi}(1+p^{1-\sigma})^{1-\phi\sigma\phi(\sigma-1)} g \tag{10}$$

Indirect utility of producers of the formal good, V_F, then equals:

$$V_F = \phi(1-\phi\alpha)^{1-\phi\phi}\psi^{1\phi}(1-\tau)^{1\phi}(1-R)^{(1-\phi)\phi}(1+p^{1-\sigma})^{1\phi(\sigma-1)} g \tag{11}$$

Case 2: $\tau \geq R*T$

Case 2 parallels Case 1. The only difference here is the after-tax term in the solutions. The budget constraint in this case changes to:

$$H_F + pJ_F = (1-R*T)\psi*((1-R)l_F)^{1-\phi} g^{\phi} \tag{12}$$

The solutions are changed as follows:

$$l_F = ((1-\phi)\psi\alpha)^{1\phi}(1-R*T)^{1\phi}(1-R)^{(1-\phi)\phi}(1+p^{1-\sigma})^{1\phi(\sigma-1)} g \tag{13}$$

$$H_F = (1-R*T)^{1\phi}\psi^{1\phi}(1-R)^{(1-\phi)\phi}(1-\phi\alpha)^{1-\phi\phi}(1+p^{1-\sigma})^{1-\phi\sigma\phi(\sigma-1)} g) \tag{14}$$

$$V_F = \phi(1-\phi\alpha)^{1-\phi\phi}\psi^{1\phi}(1-R*T)^{1\phi}(1-R)^{(1-\phi)\phi}(1+p^{1-\sigma})^{1\phi(\sigma-1)} g \tag{15}$$

2.2.2 *Consumption and labor supply decisions of producers of good I*

The budget constraint facing these producers is given by:

$$H_I + pJ_I + B = (1-\pi)\psi[(1-s)l_I]^{1-\phi}[(\gamma+s)g]^{\phi} \tag{16}$$

In this equation B represents the amount of bribes or additional expenses expended by these producers to remain informal.[4] s, as described above, is the fraction of labor services diverted by these producers to increase their access to public and/or private substitutes of public services.

Maximizing equation (6) subject to equation (16) results in the following optimal solutions:

$$s = \phi - \gamma(1-\phi) \tag{17}$$

$$H_I = p^{\sigma} J_I \tag{18}$$

$$l_I = ((1-\phi)\psi\alpha)^{1\phi}(1-\pi)^{1\phi}(1+p^{1-\sigma})^{1\phi(\sigma-1)}(1-s)^{1-\phi\phi}(\gamma+s)^{1\phi} g \tag{19}$$

$$H_I = (1-\pi)^{1\phi}\psi^{1\phi}((1-\phi)\alpha)^{1-\phi\phi}(1+p^{1-\sigma})^{1-\phi\sigma\phi(\sigma-1)}(1-s)^{1-\phi\phi}(\gamma+s)^{1\phi} g - B(1+p^{1-\sigma})^{-1} \tag{20}$$

$$V_I = \phi((1-\phi)\alpha)^{1-\phi\phi}\psi^{1\phi}(1-\pi)^{1\phi}(1+p^{1-\sigma})^{1\phi(\sigma-1)}(1-s)^{1-\phi\phi}(\gamma+s)^{1\phi} g - B(1+p^{1-\sigma})^{1\sigma-1} \tag{21}$$

where V_I is the indirect utility of the informal producers.

2.2.3 *Consumption and labor supply decisions of producers of good J*

The problem faced by these producers parallels the one faced by the producers of good *F*. The optimal choices of consumption and leisure are also similar and are as follows:

$$l_J = ((1-\phi)\delta\psi\alpha)^{1\phi}(1-\tau)^{1\phi} p^{1\phi}(1+p^{1-\sigma})^{1\phi(\sigma-1)} g \tag{22}$$

$$H_J = (1-\tau)^{1\phi}(\delta\psi)^{1\phi} p^{(1-\phi)\phi}(1-\phi\alpha)^{1-\phi\phi}(1+p^{1-\sigma})^{1-\phi\sigma\phi(\sigma-1)} g \tag{23}$$

Indirect utility of the producers equals:

---

[4] If producers in the formal sector have to pay bribes instead of informal producers as discussed in this paper, a negative value is assigned to B.

$$V_J = \phi(1-\phi\alpha)^{1-\phi\phi}(\delta\psi)^{1\phi}(1-\tau)^{1\phi}p^{1\phi}(1+p^{1-\sigma})^{1\phi(\sigma-1)}g \quad (24)$$

2.3 Equilibrium allocation of labor

In this economy, producers can freely move from one production to another. With such free mobility, for these three sectors to co-exist, utilities in all three sectors must be identical, that is $V_F = V_I = V_J$. The price that sets $V_F = V_J$, is given by:

$$p = (1-R)^{1-\phi}\delta \quad (25)$$

if $\tau < R*T$ and:

$$p = (1-R*T)(1-R)^{1-\phi}\delta(1-\tau) \quad (26)$$

if $\tau \geq R*T$.

Result 1

The price of good J is higher when taxes are evaded. This price decreases as regulations increase. The relationship between the price and the tax rate depends on the tax and regulatory condition of the economy. If they are such that producers of F truthfully report their earnings, changes in taxes do not affect the price. If the tax-regulatory structure causes producers of F to evade taxes ($1 > R(1+\nu)$), the price increases as the tax rate increases.

This result follows directly from equations (25) and (26). As regulations increase, the indirect utility of producers of good F decreases. This increases the utility of producers of good *J*. To restore equality of utilities the price of good J must decrease. A reduction in the price increases the utility of the producers of good F (the buyers of the good whose price is falling) and decreases the utility of the suppliers of good *J*. Hence a rise in regulations reduces the price of the good exempt from regulations.

When the tax rate increases it affects the producers of goods F and J equivalently if producers of good F do not evade taxes. In that event the price p does not change. If the producers of good F evade their taxes, however, taxes impact the price *p*. Differentiation of the price p in equation (26) with respect to the tax rate τ shows that the derivative is positive if $1-R(1+\nu) > 0$. (Recall ν is the penalty for tax evasion). Since $\tau \geq R*T = R*\tau(1+\nu)$ is the same as $1 \geq R*(1+\nu)$, the price of good J increases as the tax rate increases. This shows that as long as the probability of getting caught, R, and the penalty for getting caught, ν, are reasonably small compared to the tax rate, an increase in the tax rate increases the price of good *J*. This is because the marginal impact of a one unit increase in the tax rate on the producers of good *F*, $R(1+\nu)$ is less than its impact on producers of J which results in a more adverse effect on the utility of the producers of good *J*. This is compensated by an increase in the price of *J*. The condition $1 \geq R*(1+\nu)$ also indicates that the price is higher when taxes are evaded. Hence the result.

For the informal production of good H to occur in equilibrium in this economy, the utility of these producers must equal the utility of producers in other sectors. Setting $V_I = V_F$ yields:

$$\pi = 1-1(1-s)^{1-\phi\phi}(\gamma+s)^{1\phi}\left[B(1+p^{1-\sigma})^{1-\phi\phi(1-\sigma)}\phi\psi^{1\phi}(1-\phi\alpha)^{1-\phi\phi}g+(1-\tau)^{1\phi}(1-R)^{1-\phi\phi}\right]^{\phi} \quad (27)$$

if $\tau < R*T$, but:

$$\pi = 1 - 1(1-s)^{1-\phi\phi}(\gamma + s)^{1\phi}\left[B(1+p^{1-\sigma})^{1-\phi\phi(1-\sigma)}\phi\psi^{1\phi}(1-\phi\alpha)^{1-\phi\phi}g + (1-R*T)^{1\phi}(1-R)^{1-\phi\phi}\right]^{\phi} \quad (28)$$

if $\tau \geq R*T$. Recall that the probability of getting caught in the informal sector is proportional to the fraction of the population working there. Thus, having determined π in equations (27) and (28), the number of producers in the informal sector directly follows from equation (4).[5] Thus:

$$n_I = N\theta\left[1 - 1(1-s)^{1-\phi\phi}(\gamma + s)^{1\phi}\left\{B(1+p^{1-\sigma})^{1-\phi\phi(1-\sigma)}\phi\psi^{1\phi}(1-\phi\alpha)^{1-\phi\phi}g + (1-\tau)^{1\phi}(1-R)^{1-\phi\phi}\right\}^{\phi}\right] \quad (29)$$

if $\tau < R*T$, but:

$$n_I = N\theta\left[1 - 1(1-s)^{1-\phi\phi}(\gamma + s)^{1\phi}\left\{B(1+p^{1-\sigma})^{1-\phi\phi(1-\sigma)}\phi\psi^{1\phi}(1-\phi\alpha)^{1-\phi\phi}g + (1-R*T)^{1\phi}(1-R)^{1-\phi\phi}\right\}^{\phi}\right] \quad (30)$$

if $\tau \geq R*T$.

Given the solution for n_I , the number of producers who produce either good F or produce good J equals $N - n_I \equiv n$. Market clearing conditions in the goods market determine the distribution of producers in the two formal product markets.

Demand for good H comes mainly from the producers of good J since the formal and informal producers of good H use portions of their own production for consumption. The supply of good H equals the portion that remains after personal consumption of the formal and informal producers of H. Demand for good J equals the demand by the formal and informal producers of good H. The supply of good J equals the demand for good H by the producers of good J divided by the price of good J. This market clearing condition is given by the following equation:[6]

$$n_J H_J = n_F H_F p^{\sigma-1} + n_I H_I p^{\sigma-1} \quad (31)$$

It follows from the condition $n_F + n_J = n \equiv N - n_I$ and equation (31) that:

$$n_F = nH_J - 1p^{\sigma-1}n_I H_I H_F p^{\sigma-1} + H_J \quad (32)$$

$$n_J = nH_F p^{\sigma-1} + 1p^{\sigma-1}n_I H_I H_F p^{\sigma-1} + H_J \quad (33)$$

It follows from the equality of indirect utilities of producers producing F and J that:

$$H_F = pH_J \quad (34)$$

Equating indirect utilities of producers of F and I yields:

$$H_I = H_F + (1-\phi)\phi B(1+p^{1-\sigma})^{-1} \quad (35)$$

---

5 Note that if the relationship between π and n_I , as given in equation (4), was assumed to be non-linear, there would be no qualitative impact on the solution for n_I and hence results.

6 Note from equation (8) that $J_F = H_F P^{\sigma}$. With n_F producers of good F, total demand for good J by them equals $n_F H_F P^{\sigma}$. The value of that in terms of good H is obtained by multiplying this amount by the price p . Similar calculations explain the second term on the right hand side of equation (31).

Result 2

When informal producers must pay bribes, the loss in utility caused by the bribe is compensated in the form of higher output and consumption made possible by the lack of taxes, regulations, and free access to some public services.

This result follows from equation (35). Informal producers have a direct cost in the form of bribes that formal producers do not bear. For indirect utilities to be equalized across sectors, as is evident from a comparison of V_F and V_I, the indirect utility informal producers derive from consumption and leisure to offset bribery costs must exceed the indirect utility formal producers derive from the same factors. This is made possible by the higher output informal producers succeed in appropriating for themselves because of their ability to evade taxes, avoid regulations, and gain partial access to free public services. Comparison of V_I and V_F shows that the reduction in utility caused by the bribe, $B(1+p^{1-\sigma})^{1\sigma-1}$ is compensated in the form of higher consumption of goods H and J due to the increased output made possible by evading taxes and regulations. This extra amount equals:

$$\phi\big((1-\phi)\alpha\big)^{1-\phi\phi}\psi^{1\phi}(1+p^{1-\sigma})^{1\phi(\sigma-1)}g\big[(1-\pi)^{1\phi}(1-s)^{1-\phi\phi}(\gamma+s)^{1\phi}-(1-R*T)^{1\phi}(1-R)^{(1-\phi)\phi}\big]$$

This expression shows that this advantage increases with higher regulations and public services and thereby increases π and n_I. It also increases with higher taxes if the direct effect on it dominates the impact of taxes on the price p.

Using equations (34) and (35), the number of producers of goods F and J simplify to:

$$n_F = Np^{2-\sigma} + 1 - n_I - (1-\phi)\phi B n_I H_F (1+p^{\sigma-2})(1+p^{1-\sigma}) \quad (32')$$

$$n_J = N1 + p^{\sigma-2} + (1-\phi)\phi B n_I H_F (1+p^{\sigma-2})(1+p^{1-\sigma}) \quad (33')$$

These equations complete the determination of all endogenous variables.

The above solutions for n_F, n_J, and n_I show that if informal producers do not pay any bribes, that is $B=0$:

$$n_F = N1 + p^{2-\sigma} - n_I \quad (36)$$

since $H_I = H_F$. Also:

$$n_J = Np^{2-\sigma}1 + p^{2-\sigma} \quad (37)$$

$$n_I = N\theta\big[1-1(1-s)^{1-\phi\phi}(\gamma+s)^{1\phi}\{(1-\tau)^{1\phi}(1-R)^{1-\phi\phi}\}^{\phi}\big] \quad (38)$$

if $\tau < R*T$. This expression is appropriately adjusted if $\tau > T*R$. The following result follows from a comparison of the solutions for number of producers when $B>0$ and when $B=0$.

Result 3

When informal producers pay bribes, the size of the informal economy is lower than when $B=0$*. The increase in the size of the formal economy caused by the reduction in informality is entirely absorbed by sector* F*. The bribe, however, causes an additional direct effect on the formal sector by moving some producers away from sector* F *to sector* J*. The number of producers of good* J *increases but the number of producers of good* F *may or may not increase when* $B>0$.

This result follows directly from equations (32) and (33). The ambiguity in the change for good F occurs because it experiences an increase due to the decrease in informal producers but experiences a loss of producers to industry J. The net change depends on which of these changes is stronger.

The following section examines the impact of government services, regulations and taxes on the distribution of producers and net revenue.

3 Impact of public services, regulations, and taxation on informality and net revenue

The last section showed that the government's tax and regulatory policies can shift production to the informal sector and also motivate some formal producers to evade taxes. A question that remains is what motivates governments to adopt policies that motivate such behaviors.

Marcouiller-Young (1995), Mukherji (2004) and Azuma-Grossman (2008) consider the government's objective to be the maximization of graft or tax revenue net of productive public services particularly in the context of predatory states. The objective of this section is to determine the relationship between this net revenue or graft and public policy instruments such as public services, tax rates, and regulations. The objective is not to determine the tax rate, regulation, and public services that maximize net revenue. Rather, the objective here is to examine how net revenue responds to each of these policy instruments for given values of the other two. This helps to answer questions such as: given the current level of public services and regulatory environment, can a government increase net revenue by taxing more?

As defined in Marcouiller and Young (1995) and Mukherji (2004), net revenue (or graft) equals tax revenue net of public services. In this paper tax revenue is obtained from the formal production of goods H and J. Thus net revenue, denoted by G, equals:

$$G = n_F R^* T\psi^* ((1-R)l_F)^{1-\phi} g^{\phi} + n_J \tau\delta\psi l_J^{1-\phi} g^{\phi} - g \tag{39}$$

Public policies impact this net revenue by changing production and by changing the sectoral distribution of producers. Analysis of this revenue is based on the assumption that the degree of substitutability between the two goods in consumption is not large ($\sigma < 1$). It follows from the solutions of labor supplies that higher taxes and regulations reduce labor supplies while higher public services increase them and these changes will have the expected changes on net revenue. That is, the decrease in labor supply as a result of higher taxes will interact with the direct impact of the higher tax rate and produce a Laffer curve type relationship. In this economy, these changes interact with the movement of labor within different sectors of the formal economy and from the formal to the informal economy. Interestingly, a sector may be impacted by regulation not because production there is subject to regulation but because regulations drive producers of other goods there. These movements are influenced by the possibility to evade taxes and the necessity to pay bribes in the informal economy, among other factors.

Result 4

When $B > 0$ tax revenue generated by industry J increases. Tax revenue generated by industry F may increase or decrease.

This result is a direct consequence of Result 3 which shows that the size of the informal sector is reduced. This increases the number of producers of F. However, an additional movement of producers from F to J occurs as a result of the bribe. If the decrease in F due to this effect exceeds the rise in F due to the reduction in informality, tax revenue from F will decline; otherwise it will increase. The unambiguous increase in the number of producers of J will increase tax revenue generated by that industry.

An examination of how public policies impact the distribution of producers and tax revenues follows.

3.1 Change in the tax rate

Changes in policy variables impact sectoral distribution of labor and net revenue in three ways: 1) through their direct impact, 2) by changing the price/the price channel and 3) by changing the impact of bribes on utilities of producers. The net effect is the combined effects of these three changes. The analyses below separate these effects to gain a better understanding of the changes.

Case 1: No tax evasion and no bribes

To gain an understanding of how public policies impact informality and G, it is instructive to start from the simplest case: there is no tax evasion and informal producers do not pay any bribes, that is $\tau < R*T$ and $B = 0$.

Equations (25) and (34)-(36) show that in such a situation, higher taxes do not impact the price p and the number of producers who produce good J. Higher taxes, however, increase the size of the informal economy and reduce the number of producers of F.

The solutions for l_F and l_J show that both decrease as the tax rate rises. Hence as the tax rate increases there is a decrease in the number of producers of good F and the amount of labor supplied by these producers, The negative effects of these on tax revenue is mitigated by the increase in revenue generated by the higher rate. This is also true for good J with the exception that there is no decline in number of producers here. The combined effects of the higher rate directly on revenue and indirectly through its impact on labor supply and number of producers of good F generate a Laffer curve type relationship between the tax rate and revenue.

Case 2: Tax evasion and no bribes

If the possibility of tax evasion is allowed, the main difference with Case 1 is that now the price p becomes a function of the tax rate. This creates an additional channel through which taxes impact both the sectoral distribution of producers and net revenue. Result 1 based on equation (26) shows that the price increases as the tax rate increases. Equations (36)-(38) show that as p increases, n_F decreases but n_J increases. This effect reinforces the decrease in n_F due to the direct effect of the tax change discussed in Case 1. The price change does not impact the size of the informal sector but increases the number of producers of J. Thus tax collection from production of good J increases but tax collection from production of F is reduced as the higher price drives producers away from good F to good J. The impact of this redistribution on net revenue will depend on the tax generating capacity of the two formal sectors.

Case 3: Tax evasion and bribes

If $B > 0$, equation (30) shows that n_I becomes smaller due to the additional term

$B(1+p^{1-\sigma})^{1-\phi\phi(1-\sigma)}\phi\psi^{1\phi}$. This term rises as the tax rate rises (see Result 1). Hence this will reduce the positive effect of higher taxes on informality due to the direct and price effects noted above. Informality then will not increase as much, or in the more extreme situation, decrease when $B > 0$.

The relative reduction in informality will directly cause an increase in n_F (see Result 3). The change in the tax rate also impacts the term multiplying Bn_I in equations (32') and (33'). Substituting for H_F it follows that the term increases as the tax rate increases. If n_I is increased by the higher tax rate, this additional factor causes a decline in the number of producers of *F*. All of these producers move to sector *J*.

Result 5

When taxes are not evaded and informal producers do not pay bribes, higher taxes increase the number of informal producers. All of these producers are diverted from the formal sector F; there is no impact on number of producers of J. When taxes are evaded, the price of J increases and some producers move to industry J from F as taxes are increased. There is no additional impact on informality. However, if informal producers have to pay bribes, an increase in the tax rate may or may not increase informality. If informality increases, the producers will be drawn from good F. There will be a further loss of producers from good F to good J. The overall impact on net revenue depends on this redistribution and the revenue generating capacities of the two industries F and J.

3.2 Change in regulation

An increase in regulation decreases the price when both taxes are evaded and when they are not. The reduction in price becomes larger when taxes are evaded as equation (26) shows. So the impact of a change in regulation on sectoral distribution of producers and their labor supply will be in the same direction for these two cases. Hence these two cases are not treated separately for changes in *R*.

Case 1: Tax evasion and no bribes

When $B = 0$, an increase in R increases n_I. This follows from equation (30). Also equation (36) can be rearranged as:

$$n_F + n_I = N1 + p^{2-\sigma}$$

Since p decreases as R increases, the right side of the above equation increases implying that n_J decreases. While n_I increases and n_J decreases, the impact on n_F is less clear. Higher regulation drives more producers to become informal but the lowering of the price of good *J* stimulates some producers to good *F*. The price effect should be dominated by the direct impact of regulations on formal production. Hence higher regulations are expected to decrease n_F.

The reduction in n_J decreases the tax revenue from this sector as R increases. The higher R is also expected to reduce n_F and labor supply. This is offset by the increase in revenue brought about by the increased ability to catch tax evaders due to the increase in regulations. Hence the net impact of higher regulation on net revenue depends on the relative strengths of the positive and negative effects on tax collection, number of producers, and labor supplies.

Case 2: Tax evasion and bribes

When $B > 0$, equation (30) shows that the number of informal producers is smaller. However, the increase in n_I as R increases is larger. This outflow of producers to the informal sector occurs from the sector producing F. There is also a redistribution of some producers between goods F and J from equations (32), (33), and (14)). This redistribution is proportional to n_I and follows $(1+p^{1-\sigma})^{(1-\phi)\phi(1-\sigma)}1+1p^{2-\sigma}$. While n_I increases, the other term decreases with a rise in regulations. If the net change is an increase, the number of producers of F is further reduced. Otherwise the decline in F is less sharp. Net revenue depends on this redistribution.

Result 6

When $B = 0$, an increase in R increases n_I but n_J and n_F decrease. Higher regulations reduce tax revenue from industry J. Higher regulations increase tax revenue from industry F only if the direct effect of higher tax collection as a result of the increased regulation is strong enough to offset the reduction in n_F and l_F. Otherwise, net revenue will decrease with higher regulation. If $B > 0$, higher regulations will divert some producers away from F to I, further reducing revenue from F. Higher regulations additionally will cause some redistribution of producers between goods F and J. If there is an increase in the number of producers of J as a result of this redistribution, it offsets the negative impact on production of J due to the price effect. The overall impact on net revenue will depend on the net flow of producers between the sectors and the revenue generating capacities of the two formal sectors.

3.3 Change in public services

The price p does not depend on government services g. Like the regulation case there is no benefit in separating out the possibility of no tax evasion since there is no additional impact through the price channel brought about by tax evasion. The presence of bribes, however, matters.

Case 1: Tax evasion and no bribes

When $B = 0$, g has no impact on n_F, n_J, or n_I. However, g increases labor supplies l_F and l_J. Substitution of these labor supplies in the net revenue equation shows that the revenues are linear functions of g. Hence an increase in g increases net revenue if net revenue is positive and decreases it if net revenue is negative. If net revenue is negative, a decrease in g to 0 will eliminate the deficit by eliminating production. This is similar to Marcoullier-Young's "black hole" result with the exception that informal production will also stop.

Case 2: Tax evasion and bribes

When $B > 0$, equation (30) shows that n_I is smaller but increases as g increases. This increase occurs because the higher public service increases the value of the additional consumption informal producers enjoy as compensation for the bribes they pay. This motivates more producers to become informal.

Overall tax revenue will be higher than when $B = 0$ but declining as g increases and induces an increase in informality. If $n_I g$ increases as g increases there is an additional movement of producers out of good F to good J.

Result 7

When informal producers do not pay any bribes, there is no sectoral redistribution of producers as a result of change in government services. Net revenue increases if it is positive and decreases if it is negative. When informal producers pay bribes, the number of producers of good F is reduced and higher public services may further reduce this number. Some of these producers move to the informal sector while some may move to good J. Hence the overall number of producers in the formal sector declines and mitigates the positive effects of higher public services on production and labor supplies.

The results highlight the importance of the sectoral redistribution of production in determining the impact of public policies on net revenue. The results also show that public policies can have different impacts on different types of formal production. That is, the impacts they have on goods that have close substitutes in the informal sector (good F) are often the exact opposite of the effects they have on goods that are produced formally only (good J). This is summarized in the following result.

Result 8

When goods with substitutes in the informal sector coexist with goods which can only be produced in the formal sector and informal producers pay bribes, government tax and regulatory policies that increase informality may also increase production of the good which has no informal substitute. The loss to the economy due to higher informality may be offset by the increased production of this formal good.

These results highlight the significant sectoral redistribution of production caused by tax and regulatory policies. Policies that promote and increase informality may positively benefit an industry that has no direct connection to informal production. Thus policymakers need to be aware of redistribution of production within the formal sector since it has significant impacts on production and net revenue.

4 Empirical investigation

The previous sections developed a model that examined the combined roles of multiple goods, tax evasion, and bribery on the relationship between public policies and informality and public policies and net revenue. This section investigates empirically these relationships when such differences in economic environments for conducting business are taken into account. Lack and unreliability of cross-country data on tax evasion, bribery and relative price of goods which have informal substitutes and goods which do not, limit the scope of conducting a full-scale empirical test of the theoretical model. Nonetheless, data on governance and corruption indicators allow for the possibility of capturing the general business environment that foster activities such as tax evasion and the burden of conducting business in the formal economy. There is no formal test of the price effect of public policies and the sectoral redistribution of production within the formal sector as a result of changes in public policies. So the scope of the empirical investigation of this section is limited to the main objective of the paper - do public policies that promote informality also increase net revenue? While several papers have studied the public policy such as taxation and regulation and informality relationship empirically as the introductory section shows, there is no study that empirically considers how these policies also impact net revenue.

4.1 Data and descriptive statistics

The informal economy data come from Schneider (2004). Schneider estimates the size of the informal economy using a dynamic multiple-indicators multiple-causes framework. The informal economy is specified as a latent (unobservable) variable and various causes and indicators of the informal economy are used as observable variables. This method captures more than one "indicator" of the shadow economy as well as considers more than "one cause" in estimating the size of the informal sector. Three major types of causes identified in the literature include the burden of taxation, the burden of regulation, and citizens' attitude toward the state ("tax morality"). Three major types of indicators for the size of the shadow economy are monetary indicators (monetary transactions), developments in the labor market (movement of labor), and the developments in the production market (movement of inputs). Schneider compiles the size of the shadow economy for 145 countries for 1999-2000, 2000-01 and 2002-03. In this paper, the 1999-2000 data are used to conduct a cross-sectional analysis.

The tax rate used is the top marginal individual income tax rate obtained from the World Tax Database published by the University of Michigan. The series provide comprehensive data coverage across time and countries. The regulation variable is taken from the Heritage Foundation's component of the Index of Economic Freedom (with higher values indicating more regulation). As discussed below, to control for the quality of institutions, a democracy/bureaucracy measure that is the sum of democratic accountability and bureaucratic quality provided by the PRS Group's International Country Risk Guide (ICRG) is used. Additionally, a measure of corruption provided by ICRG (with higher values indicating better institutions) is also used. These two measures capture the general economic environment that foster activities such as tax evasion and bribery. It is worth noting that the bribery considered in the theoretical part of the paper deals with bribery in the informal sector only. Log real per capita GDP is used as another control variable and is taken from the World Bank's World Development Indicators.

Data on tax revenues and productive expenditures, necessary to compute net revenue, are obtained from the Government Finance Statistics yearbook's consolidated accounts (budgetary, extra budgetary, and social security) of the central government, published annually by the International Monetary Fund (IMF). The data expressed as percentages of GDP are available at the NYU's Development Research Institute (DRI) website. The series, however, exclude state and local government expenditures. While the tax revenue data are available, measuring government productive services is not straightforward. From a theoretical standpoint, these services include productive services that are part of formal sector firms' production functions. These services also impact firms in the informal sector although to a lesser extent. Thus to measure productive government services, government expenditures are defined as the sum of the expenditures on public order and safety, fuel and energy, and transportation and communications. Of course, this is not a perfect measure but given data limitations, it should provide a useful benchmark.[7] In addition,

[7] The issue of measurement error in the expenditure variable needs to be taken seriously since the variable is also a regressor thus potentially resulting in the errors-in-variables problem. In our estimations we use an instrumental variable approach that should mitigate this problem.

since education and health could probably be considered as productive government services affecting firms' output, an alternative analysis including these expenditures is also conducted.

To mitigate measurement problems and business cycle effects in the data, 5-year averages taken over 1995-1999 are used, except for the GDP variable that uses only 1995 data. The use of the beginning-of-the-period data reduces possible endogeneity problems and thus GDP is not instrumented in estimations below. In total, data are available for 75 countries for net revenue and productive government expenditures. However, in estimations that follow, only about 50 observations are used since there are missing data for other variables.[8]

Table 1 presents descriptive statistics of the variables used. It also gives a list of the countries that are included in the study. The choice of countries is exclusively driven by data availability considerations. The average size of the informal economy in the data is about 30 per cent of the official GDP with a range from 8.6 to 67.1 per cent. Interestingly, the informal economy has a negative correlation –0.25) with individual income tax rate, but perhaps not surprisingly, a positive correlation with regulation and institutional measures (higher values indicate stronger institutions, so the correlation coefficients are negative). The relationship with productive government expenditures excluding education/health is positive but relatively small (0.09). The average net revenue relative to GDP is about 18 per cent and with education/health expenditures, it is about 12.5 per cent. The correlation of the net revenue measure with productive government expenditures is mainly negative. Yet interestingly, expenditures with education/health and the other measure of net revenue (revenue less expenditures excluding education/health) is positive at about 0.23, which is perhaps due to education/health expenditures being incorporated in the net revenue. Lastly, higher values of net revenue are associated with higher taxes but with less regulation and better institutions.

The countries sorted by net revenue excluding education/health are shown in Table 2. Since net revenue as defined in this paper does not mean government corruption, the pattern in the data is not as straightforward. Generally, more developed countries have higher net revenues suggesting that these countries generate larger tax revenues in excess of productive government expenditures. In addition, given the definition of net revenue, it may seem that instead of measuring government's "profit", a proxy is calculated for budget surplus or deficit. However, the relationship between these measures is very weak with a correlation of less than 0.1.[9]

4.2 Estimation and results

To analyze the effects of productive government expenditures, taxes, and regulation on the informal economy and net revenue, the following equations are specified:

$$Informal_j = \alpha_0 + \alpha_1 Expend_j + \alpha_2 Tax_j + \alpha_3 Regul_j + X\delta + \varepsilon_j \tag{40}$$

for $j = 1,2,\dots J$.

---

[8] Future work can probably incorporate more data into the analysis and also use panel data to check for robustness of the results.

[9] The net revenue estimations discussed in the next section have also been estimated using surplus/deficit as a dependent variable. The OLS and GMM results produce mostly insignificant coefficients except for the coefficient on regulation in some instances. The coefficient on expenditures, in contrast to the net revenue estimations, is negative but insignificant in all but a few estimations at the 10 per cent level (using GMM). The GMM-CUE approach (discussed in the next section) also produces insignificant coefficients in most estimations. However, with the expenditures variable excluding education/health, in estimations using log GDP per capita and democracy/bureaucracy variables, a negative coefficient on expenditures with significance at 5 per cent (but not 1 per cent) and 10 per cent, respectively are obtained. In summary, given that other variables are insignificant and the expenditures variable is insignificant or marginally significant in a few estimations (yet with a different sign), there does not seem to be a statistical relationship between the regressors and the surplus/deficit variable.

Table 1

Descriptive Statistics and Correlation Matrix

	Informal Economy	**Net Revenue**	**Net Revenue (educ/health)**	**Deficit**	**Expenditures**	**Expenditures (educ/health)**	**Indidual Income Tax Rate**	**Regulation**	**Log Real GDP per Capita**	**Democracy/ Bureaucracy**	**Corruption**
Mean	29.98	18.34	12.52	–2.33	2.98	8.8	35.03	2.95	8.19	6.99	3.76
Standard Deviation	13.04	9.66	8.84	2.9	1.88	4.56	14.95	0.85	1.49	2.26	1.21
Minimum	8.6	–6.69	–15.98	–8.7	0.01	0.02	0	1	5.09	1.52	1.37
Maximum	67.1	39.67	30.88	9.97	12.33	21.66	61.1	5	10.69	10	6
Observations	64	75	75	75	75	75	59	71	74	61	61
Correlation Matrix											
Informal Economy	1										
Net Revenue	–0.255	1									
Net Revenue (educ/health)	–0.254	0.938	1								
Deficit	–0.241	0.085	0.096	1							
Expenditures	0.089	–0.166	–0.363	–0.117	1						
Expenditures (educ/health)	–0.006	0.231	–0.101	–0.055	0.763	1					
Indiv. Income Tax Rate	–0.249	0.411	0.43	0.006	–0.273	–0.062	1				
Regulation	0.414	–0.267	–0.19	–0.273	–0.183	–0.284	0.171	1			
Log Real GDP per Capita	–0.538	0.485	0.461	0.264	–0.119	0.076	0.012	–0.598	1		
Democracy+Bureaucracy	–0.514	0.523	0.513	0.124	–0.194	0.071	0.236	–0.343	0.71	1	
Corruption	–0.552	0.555	0.54	0.112	0.078	0.188	0.155	–0.353	0.636	0.762	1

$$NetRevenue_j = \beta_0 + \beta_1 Expend_j + \beta_2 Tax_j + \beta_3 Regul_j + X\gamma + \varepsilon_j \tag{41}$$

for $j = 1,2,\ldots J$.

Expend, *Tax*, and *Regul* variables are productive government expenditures with and without education/health, individual income tax rates, and regulation, respectively. The variable X includes log real GDP per capita and institutional measures (democracy/bureaucracy or corruption) that capture the general economic environment.

Several estimators are used for the above equations. The first estimator used is OLS. However, since the regressors could be endogenous in the above specifications resulting in inconsistent estimates, the generalized method of moments, GMM (Hansen, 1982), and the continuously updated GMM (CUE) of Hansen, Heaton, and Yaron (1996), estimators are used. The CUE has been shown to have better properties in small samples (Hansen, Heaton, and Yaron, 1996) and in the presence of weak instruments (Stock and Wright, 2000 and Stock, Wright, and Yogo, 2002). Four different instrument sets are also used: (i) constant, log real GDP per capita in 1995, latitude, and lagged values of expenditure, individual income tax rate, regulation, and corruption (averaged over 1990-94); (ii) the first set plus two interaction terms of lagged expenditure and lagged tax rate with a developing country dummy; (iii) the first set plus dummies for South Asia and British legal origin (other region and legal origin dummies are insignificant in the first stage regressions); and (iv) the first set and all regional and legal origin dummies (10 dummies).

In the above instrument sets, when the democracy/bureaucracy variable is used as a regressor, its lag rather than lagged corruption variable is used. In using lagged values of the regressors as instruments, it is assumed that the regressors are predetermined; namely, the innovation/error term is uncorrelated with the past values of regressors (a similar assumption is made in panel data models).[10] This allows for the use of GMM or CUE to obtain consistent estimates. The validity of the instruments are tested by using Hansen's (1982) *J*-test of overidentifying restrictions. Additionally, to obtain right inferences, relevant instruments are necessary. The Cragg-Donald (CD) (1993) statistic for weak instruments is used to assess the strength of the instruments in the first stage regressions. Using lagged variables rather than just regional and legal origin dummies helps alleviate the weak instrument problem as indicated by the CD statistic. Lastly, with cross-sectional regressions, country-specific effect can correlate with the regressors or instruments. Since panel data are not used, country effect cannot be differenced out. The check on this issue is the *J*-test of overidentifying restrictions, and if the test does not reject the validity of the instrument set, the equations are less likely to be misspecified.

4.2.1 *The informal economy*

Table 3 shows the estimation results for the informal economy as a dependent variable.[11] Estimations using government productive expenditures with and without education/health as well as using OLS and CUE are presented.[12] The instrument set used is (i) discussed above and is based on the high Cragg-Donald statistic indicating the relevance of the instruments (Stock and Yogo,

---

[10] Thus log real GDP per capita in 1995 is a valid instrument.

[11] The outlier observation for expenditures, Kuwait, is omitted in informal economy estimations, and Bahrain and Kuwait are omitted in net revenue estimations. The data for these countries have large expenditures (Bahrain: 6.8 per cent and Kuwait: 8.4 per cent with a mean of 3 per cent and standard deviation of 1.9 per cent for 75 observations of the data) and small tax revenues relative to total revenues (Bahrain: 0.31 and Kuwait: 0.04). Adding these observations to the estimations produces imprecise coefficients on expenditures and in the case of the informal economy, on tax rates as well.

[12] The GMM estimates are close to those using CUE but have a higher precision. Thus the GMM estimates result in stronger inference. Yet for the sake of brevity and since CUE is a better estimator, the CUE results are reported.

Table 2

Net Revenue, Expenditures, and Deficit

(average, 1995-99, sorted)

Country Code	Country Name	Net Revenue	Expenditures	Net Revenue	Expenditures	Deficit
NLD	Netherlands	39.667	3.084	27.449	15.302	–2.967
LUX	Luxembourg	35.998	4.98	30.882	10.096	2.276
SVN	Slovenia	34.042	3.858	24.134	13.766	–0.557
ISR	Israel	32.565	2.551	20.124	14.992	–2.402
SWE	Sweden	32.559	2.679	29.646	5.593	–3.333
GBR	United Kingdom	32.057	1.83	24.892	8.995	–2.096
DNK	Denmark	31.729	1.925	27.27	6.384	0.139
LSO	Lesotho	31.362	5.013	14.711	21.665	–0.957
SVK	Slovak Republic	31.361	4.056	18.804	16.612	–3.399
POL	Poland	30.781	2.706	24.097	9.39	–1.549
NOR	Norway	30.762	2.739	26.547	6.954	0.344
HUN	Hungary	30.124	3.346	24.104	9.366	–3.031
SYC	Seychelles	30.011	4.458	19.501	14.968	–6.265
IRL	Ireland	29.033	1.769	18.918	11.884	–0.522
CZE	Czech Republic	28.417	3.893	18.318	13.991	–0.777
BLR	Belarus	26.421	2.85	23.723	5.548	–1.829
ESP	Spain	26.203	2.052	22.819	5.435	–4.85
DEU	Germany	25.686	1.33	19.219	7.796	–1.912
EST	Estonia	25.164	4.915	16.247	13.831	0.183
FIN	Finland	25.14	2.421	20.166	7.394	–4.614
URY	Uruguay	24.992	1.189	21.079	5.102	–1.667
MLT	Malta	24.506	3.796	15.763	12.539	–6.737
LVA	Latvia	23.495	3.858	17.739	9.614	–1.626
BGR	Bulgaria	22.325	3.84	18.997	7.168	–2.858
TUN	Tunisia	22.129	3.248	14.09	11.287	–2.527
AUS	Australia	21.88	0.872	16.262	6.49	–0.042
ROM	Romania	21.723	3.243	16.372	8.594	–3.634
ISL	Iceland	21.698	3.975	10.904	14.769	–0.687
CYP	Cyprus	21.532	3.792	15.192	10.132	–3.83
ZWE	Zimbabwe	21.223	4.182	10.768	14.637	–8.464
TTO	Trinidad and Tobago	21.024	2.985	14.611	9.398	0.203
CHE	Switzerland	20.098	1.918	13.928	8.088	–1.037
MAR	Morocco	19.717	4.145	13.147	10.715	–4.397
BRA	Brazil	18.719	1.072	15.799	3.993	–7.311
USA	United States	18.062	0.836	13.546	5.352	–0.344
CHL	Chile	17.998	1.033	11.757	7.274	1.162

Country Code	Country Name	Net Revenue	Expenditures	Net Revenue	Expenditures	Deficit
GRC	Greece	17.589	2.62	12.223	7.986	–7.128
RUS	Russian Federation	17.55	1.277	16.523	2.304	–4.775
MYS	Malaysia	17.42	3.259	11.16	9.519	2.335
CAN	Canada	17.392	1.168	16.407	2.153	–1.666
BHS	Bahamas, The	16.652	2.727	9.706	9.673	–0.42
PAN	Panama	15.749	1.64	5.582	11.807	0.418
CRI	Costa Rica	15.501	2.696	6.462	11.735	–1.996
KOR	Korea, Rep.	15.501	2.79	11.645	6.647	–0.32
MUS	Mauritius	15.428	2.906	9.357	8.977	–2.045
EGY	Egypt, Arab Rep.	15.413	2.968	9.901	8.479	–1.02
VUT	Vanuatu	15.113	3.676	7.874	10.915	–2.606
TUR	Turkey	14.929	2.238	10.788	6.379	–7.359
TJK	Tajikistan	14.076	2.535	12.938	3.673	–4.656
BDI	Burundi	13.726	1.34	9.18	5.887	–5.021
SGP	Singapore	13.715	2.107	9.268	6.555	9.97
LKA	Sri Lanka	13.522	2.505	9.397	6.63	–7.089
IDN	Indonesia	13.447	1.399	11.84	3.006	–0.02
SYR	Syrian Arab Republic	13.362	3.455	10.197	6.62	–0.736
MNG	Mongolia	13.357	2.804	11.441	4.721	–8.698
MDV	Maldives	13.072	7.538	–0.569	21.178	–4.908
THA	Thailand	12.287	3.741	6.785	9.244	–3.046
DOM	Dominican Rep.	11.846	3.078	7.854	7.07	0.365
MEX	Mexico	11.596	1.277	7.333	5.541	–0.609
ARG	Argentina	11.278	1.235	10.018	2.494	–1.58
KAZ	Kazakhstan	10.791	2.057	8.309	4.539	–4.041
BOL	Bolivia	10.019	3.898	4.798	9.119	–2.327
CMR	Cameroon	9.417	0.81	7.212	3.015	0.841
IND	India	8.889	0.233	8.317	0.805	–4.918
SLV	El Salvador	8.681	3.705	4.972	7.414	–1.807
YEM	Yemen, Rep.	8.38	3.328	1.707	10.001	–3.15
COL	Colombia	8.299	2.032	3.284	7.047	–4.364
MDG	Madagascar	7.598	0.749	4.748	3.599	–1.452
IRN	Iran, Islamic Rep.	7.538	4.362	1.591	10.31	–1.022
NPL	Nepal	4.482	4.23	1.215	7.497	–4.088
MMR	Myanmar	2.503	1.406	1.244	2.666	–2.16
BHR	Bahrain	0.981	6.799	-4.599	12.379	–4.755
HRV	Croatia	0.037	0.006	0.027	0.016	–0.001
BTN	Bhutan	–5.177	12.33	–12.523	19.675	–0.004
KWT	Kuwait	–6.689	8.386	–15.976	17.674	–7.059

Table 3

Estimation of the Informal Economy

	Excluding Education/Health										Including Education/Health									
	OLS					CUE					OLS					CUE				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Expenditures	3.24	1.62	2.15	3.73	2.97	3.79	2.46	2.75	4.47	4.72	0.90	0.59	0.58	0.93	0.71	1.58	0.50	0.80	1.59	1.43
Standard error	1.32	1.58	1.28	1.30	1.66	1.63	1.53	1.06	1.11	1.29	0.51	0.51	0.56	0.55	0.57	0.60	0.60	0.44	0.46	0.53
p -value	0.02	0.31	0.10	0.01	0.08	0.02	0.11	0.01	0.00	0.00	0.08	0.25	0.31	0.10	0.22	0.01	0.41	0.07	0.00	0.01
Indiv. Income Tax Rate	–0.36	–0.35	–0.32	–0.31	–0.32	–0.73	–0.19	–0.28	–0.26	–0.28	–0.40	–0.38	–0.35	–0.35	–0.36	–0.84	–0.30	–0.35	–0.34	–0.35
Standard error	0.17	0.13	0.15	0.14	0.13	0.18	0.18	0.14	0.15	0.15	0.18	0.14	0.15	0.15	0.13	0.22	0.17	0.15	0.16	0.15
p-value	0.04	0.01	0.03	0.03	0.01	0.00	0.27	0.05	0.08	0.05	0.03	0.01	0.03	0.02	0.01	0.00	0.07	0.02	0.03	0.02
Regulation	7.48	1.65	2.93	3.27	1.86	6.79	–0.47	–0.26	1.22	2.04	8.65	2.19	3.60	4.76	2.10	9.13	0.51	1.51	4.93	3.03
Standard error	1.58	1.85	2.73	2.01	2.00	2.30	2.16	2.25	1.99	3.02	1.81	1.95	2.64	2.09	2.23	2.13	2.17	2.31	2.04	3.21
p-value	0.00	0.38	0.29	0.11	0.36	0.00	0.83	0.91	0.54	0.50	0.00	0.27	0.18	0.03	0.35	0.00	0.81	0.51	0.02	0.35
Log of GDP/Capita		–5.95			–2.27		–6.17			1.03		–6.18			–3.72		–6.54			–1.69
Standard error		1.66			2.20		1.28			3.06		1.49			2.11		1.34			2.64
p-value		0.00			0.31		0.00			0.74		0.00			0.09		0.00			0.52
Democracy+Bureaucracy			–2.84					–4.49					–2.95					–4.93		
St. error			1.44					1.07					1.48					1.04		
p-value			0.06					0.00					0.05					0.00		
Corruption				–5.72	–4.33				–6.89	–7.84				–5.41	–3.24				–7.46	–5.97
Standard error				1.41	2.11				1.52	3.36				1.42	1.97				1.58	2.78
p-value				0.00	0.05				0.00	0.02				0.00	0.11				0.00	0.03
Constant	12.99	84.18	48.92	44.39	64.80	29.81	83.56	67.64	52.02	44.75	11.77	84.86	49.18	41.96	75.22	24.18	90.15	69.20	44.96	60.65
Standard error	9.71	20.61	17.63	10.73	19.34	11.83	16.66	14.01	10.83	23.96	8.84	17.17	14.82	8.54	18.77	11.91	16.39	11.66	8.49	24.21
p-value	0.19	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.06	0.19	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.01
R^2	0.36	0.53	0.46	0.55	0.56						0.34	0.53	0.44	0.51	0.55					
Adjusted R^2	0.32	0.48	0.40	0.51	0.51						0.30	0.49	0.39	0.46	0.49					
J-test						5.09	3.23	1.31	0.81	0.69						5.42	1.78	1.52	0.47	0.07
p-value						0.17	0.20	0.52	0.67	0.40						0.14	0.41	0.47	0.79	0.80
CD stat						9.19	10.22	9.39	9.02	4.27						18.39	14.56	10.66	10.85	4.10
Number of observations	49	49	47	47	47	46	46	44	44	44	49	49	47	47	47	46	46	44	44	44

Notes: Heteroskedasticity-consistent standard errors.
Instrument set: Log GDP/capita in 1995, latitude, and lagged expenditure, individual tax rate, regulation, and corruption (1990-94).
When Democracy+Bureaucracy variable is used in estimations, lagged democracy/bureaucracy rather than lagged corruption is used in the instrument set. *J*-test: Test of overidentifying restrictions.
CD stat: Cragg-Donald statistic for weak instruments.

2004).[13] In addition, in all estimations, the *J*-test of overidentifying restrictions does not reject the null hypothesis of the validity of the instruments.

The impact of government expenditures without education/health using the OLS estimator is positive and large with a coefficient between 1.5 and 4. It is, however, imprecise in two of four specifications. Since there could be endogeneity problems with the OLS estimator, the CUE is examined. The coefficients are more precise and larger, about 2.5 to 4.5. These numbers imply that everything else constant, a one percentage point increase in productive government expenditures relative to GDP, increases the informal sector by 2.5-4.5 percentage points of official GDP. This is a large impact and the theory above confirms this finding.

Including education/health into the expenditures measure produces low and imprecise coefficients using OLS. However, the CUE results in more precise estimates. The parameters are smaller than in the estimation without education/health – at approximately 1.5. Perhaps the effect is smaller and is not as precise as before since the inclusion of education/health expenditures does not impact firms' incentives immediately. It may take years before a more educated and healthy workforce may impact the firms' decision in terms of the benefits and costs of operating in the informal economy.

The results also show that size of the informal economy increases with more regulation, worse institutions or lower level of development, and lower individual income tax rates. The coefficients are statistically significant (at 5 or 10 per cent) but including regulation and institutions or log GDP variables together results mostly in an imprecise coefficient on regulation perhaps suggesting some collinearity issues. The inclusion of both corruption and GDP variables confirms the significance of corruption and results in similar parameter estimates. It is not surprising that higher regulation and worse institutions imply a higher informal sector. This also suggests that the cost of these factors on the formal economy is stronger than on the informal and drives production to the informal sector. A higher cost of the formal sector suggests that the value of B in the theoretical section of the model should perhaps be negative. Another interesting result is that higher income tax rates imply a lower informal sector of the economy. However, this is consistent with the theoretical findings (see Section 3.1 for details). Finally, another important result is that higher public services that increase informality as well as net revenue (see the next section), may not promote informality in the longer run. Although one percentage increase in public services increases informality by about 4.5 per cent, improving corruption environment from that of Bulgaria to that of Australia results in a decrease of the informal sector by about 7 per cent. With higher public services on law and order, infrastructure, communications, country's institutions would improve and thus reduce informality, which is confirmed by the empirical results. Thus, if the goal of states is to use such a policy to maximize net revenue, it may not be an informality-increasing policy in the longer run.

4.2.2 Net revenue

Table 4 presents estimations for net revenue. Excluding education/health and using the OLS estimator, the impact of productive government expenditures is positive and statistically significant at 5 or 10 per cent level. It seems that the expenditure variable creates a problem of simultaneity since expenditures are subtracted from tax revenues to arrive at net revenue while the same expenditures variable is also used as a regressor. However, it is precisely because expenditures are

---

[13] Using more instruments that include regional and legal origin dummies [instrument set (iv)], reduces the CD statistic to about 4, which is indicative of weak instruments. These estimations result in a higher precision of our estimates; however, given a weak instrument set, we cannot rely much on the inference. The results using instrument sets (ii) and (iii) are in general similar to those using (i). However, the CD statistic is smaller in size compared to that of instrument set (i).

Table 4

Estimation of Net Revenue

Excluding Education/health

	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)	CUE (6)	CUE (7)	CUE (8)	CUE (9)	CUE (10)
Expenditures	1.87	2.61	2.19	1.40	2.28	3.10	2.61	3.18	1.65	2.15
Standard error	0.77	0.76	0.81	0.82	0.85	1.00	0.63	0.80	0.79	0.86
p-value	0.02	0.00	0.01	0.09	0.01	0.00	0.00	0.00	0.04	0.01
Indiv. Income Tax Rate	0.19	0.15	0.11	0.12	0.13	0.59	0.07	0.09	0.06	0.07
Standard error	0.10	0.08	0.09	0.09	0.08	0.19	0.08	0.10	0.10	0.09
p-value	0.06	0.07	0.22	0.18	0.11	0.00	0.36	0.40	0.54	0.42
Regulation	–4.31	–0.18	–2.23	–2.86	–1.01	–3.56	2.79	0.30	–0.76	0.44
Standard error	1.05	1.24	1.46	1.08	1.18	1.39	1.61	1.32	1.19	1.78
p-value	0.00	0.89	0.13	0.01	0.39	0.01	0.08	0.82	0.52	0.81
Log of GDP/Capita		4.01			2.94		5.29			1.68
Standard error		0.66			1.17		0.88			2.01
p-value		0.00			0.02		0.00			0.40
Democracy+Bureaucracy			1.73					3.41		
Standard error			0.77					0.59		
p-value			0.03					0.00		
Corruption				2.94	1.12				5.35	3.69
Standard error				0.79	1.17				0.95	2.10
p-value				0.00	0.35				0.00	0.08
Constant	20.70	–25.87	3.99	9.09	–16.82	–1.89	–43.14	–18.02	–4.94	–18.22
Standard error	6.04	9.11	10.02	7.14	10.81	9.31	10.63	7.86	5.55	16.21
p-value	0.00	0.01	0.69	0.21	0.13	0.84	0.00	0.02	0.37	0.26
R^2	0.35	0.52	0.48	0.50	0.52					
Adjusted R^2	0.31	0.48	0.44	0.46	0.46					
J-test						9.72	3.22	0.49	0.72	0.19
p-value						0.02	0.20	0.78	0.70	0.66
CD stat						12.56	13.27	10.69	10.06	2.86
Number of observations	56	55	52	52	51	52	52	48	48	48

Including Education/health

	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)	CUE (6)	CUE (7)	CUE (8)	CUE (9)	CUE (10)
Expenditures	0.19	0.34	0.29	0.10	0.20	0.32	0.19	0.32	–0.09	–0.08
Standard error	0.21	0.20	0.24	0.22	0.19	0.24	0.22	0.30	0.31	0.31
p-value	0.37	0.09	0.24	0.64	0.30	0.19	0.39	0.28	0.77	0.80
Indiv. Income Tax Rate	0.14	0.10	0.06	0.07	0.07	0.27	0.05	–0.03	–0.01	–0.01
Standard error	0.09	0.07	0.08	0.08	0.07	0.11	0.08	0.09	0.09	0.09
p-value	0.11	0.16	0.47	0.38	0.33	0.01	0.48	0.76	0.90	0.90
Regulation	–3.02	0.94	–0.45	–1.22	0.10	–2.49	4.82	2.65	0.98	1.13
Standard error	1.03	1.19	1.16	1.00	1.09	0.98	1.61	1.45	1.21	1.99
p-value	0.00	0.43	0.70	0.23	0.93	0.01	0.00	0.07	0.42	0.57
Log of GDP/Capita		3.71			1.84		5.65			0.19
Standard error		0.78			1.02		1.01			1.96
p-value		0.00			0.08		0.00			0.92
Democracy+Bureaucracy			1.78					3.42		
Standard error			0.61					0.68		
p-value			0.01					0.00		
Corruption				3.11	2.01				5.23	5.06
Standard error				0.73	1.01				0.96	2.01
p-value				0.00	0.05				0.00	0.01
Constant	16.21	–26.59	–1.96	2.52	–13.49	7.49	–51.96	–20.92	–7.64	–9.17
Standard error	5.39	8.92	7.13	6.28	8.56	5.92	11.70	8.19	6.08	16.89
p-value	0.00	0.00	0.78	0.69	0.12	0.21	0.00	0.01	0.21	0.59
R^2	0.21	0.42	0.40	0.44	0.45					
Adjusted R^2	0.17	0.38	0.35	0.40	0.38					
J-test						10.70	3.82	0.81	0.26	0.25
p-value						0.01	0.15	0.67	0.88	0.62
CD stat						22.65	15.07	12.80	11.58	2.86
Number of observations	56	55	52	52	51	52	52	48	48	48

Notes: Heteroskedasticity-consistent standard errors.
Instrument set: Log GDP/capita in 1995, latitude, and lagged expenditure, individual tax rate, regulation, and corruption (1990-1994).
When Democracy+Bureaucracy variable is used in estimations, lagged democracy/bureaucracy rather than lagged corruption is used in the instrument set. *J*-test: Test of overidentifying restrictions.
CD stat: Cragg-Donald statistic for weak instruments.

subtracted from tax revenues, they are no longer part of the net revenue measure, which should avoid the simultaneity problem. Nonetheless, the expenditure variable could be endogenous along with other regressors; that is, they could be correlated with the innovation/error term, so the CUE was used. The coefficient becomes larger in magnitude and more precise. The estimations imply that if productive government expenditures increase by one percentage point relative to GDP, net revenue rises by about 2-3 percentage points relative to GDP. However, introducing education/health into the expenditures variable results in a very small and insignificant coefficient. This suggests that health/education expenditures may not have an immediate impact on net revenue, and it may take time before the benefits of better health and education are reaped through higher productivity and higher tax revenues.

Similar to the informal sector estimations, the impact of the level of development and institutions variables is highly statistically significant and large indicating that worse institutions and lower level of development decrease net revenue. Tax rates positively affect net revenue while regulation has a negative impact. However, the impact of taxes is small (0.1) and statistically insignificant. *J*-test of overidentifying restrictions rejects the null at 5 per cent level in specifications using only a regulation variable. Introducing GDP or institutions variables, the regulation variable becomes statistically insignificant. Interestingly, the coefficient becomes positive, which implies higher regulation increases net revenue,[14] and significant at 10 per cent in a couple of estimations using the CUE and mostly in estimations including education/health. However, the evidence of positive impact is not conclusive, and the coefficient is statistically significant in only a couple of estimations.

5 Conclusion

The paper finds that the inclusions of tax evasion by formal producers, bribes paid by informal producers, and multiple types of goods significantly affect how public policies affect informality and net revenue.

Changes in public policies cause changes in the price of the good that has no informal sector. This price change causes changes in the number of producers of this formal good. Often these producers are drawn from the formal good that has an informal sector. Hence public policies shift producers within the two formal sectors. The literature on informality largely fails to account for this production redistribution.

Furthermore, when informal producers pay bribes to maintain their status, informality is reduced. The producers that remain informal, however, derive more utility from direct consumption than their formal counterparts to compensate for the loss of income and utility caused by the bribe. This additional utility is made possible by avoiding regulations and taxes and equivalently captures the value of the bribe to an informal producer in terms of lost utility. These utility effects depend on the values taken by public policy variables. This factor further impacts the distribution of producers between the various sectors.

As public policies redistribute production, it often impacts the two formal sectors in opposite directions. Whether tax revenue rises in response to a policy change depends on the relative responsiveness of the two sectors to policy instruments. Hence the paper demonstrates the importance of taking into consideration multiple formal sectors and bribes in studies of informality.

Empirically, the paper finds:

---

14 The positive coefficient on regulation is also consistent with the theory presented.

- Productive public expenditures increase net revenue. Once education and health expenditures are added, the result becomes statistically insignificant. As mentioned above, expenditures related to health and education have more longer term than immediate effect on current production. Hence, the results without education and health may be more appropriate for the current study.
- Taxes have a positive but small impact on net revenue. Once institutional variables are considered, taxes fail to have any statistically significant effect on net revenue.
- The impact of regulation on net revenue is mixed. Estimations which yield a significant impact of regulations show that if GDP is included in the estimation, higher values of regulations increase net revenue. However, if GDP is not included, in most other instances where regulation has a significant effect, higher regulations are associated with lower net revenue.
- GDP and institutional variables have a large and statistically strong impact on net revenue. They also show that countries with better institutions and higher level of development have higher net revenue.

These results show that it is possible to increase net revenue by having higher taxes, more regulations, and higher public services. With the exception of taxes (which has a small, if any, effect on net revenue) these factors also increase informality. The results also show that to achieve higher net revenue, institutional reforms in the form of better bureaucratic quality and democratic accountability and less corruption are desirable. Once these institutional factors are introduced, while public services continue to remain significant, the effects of regulations and taxes on net revenue weaken. Furthermore, good institutions are usually not present in countries with predatory governments. Hence to understand why countries engage in policies that increase informality, researchers may want to consider an alternative objective.

REFERENCES

Azuma, Y. and H. Grossman (2008), "A Theory of the Informal Sector", *Economics and Politics*, Vol. 20, No. 1, pp. 62-79.

Bardhan, P. (1997), "Corruption and Development: A Review of Issues", *Journal of Economic Literature,* Vol. 35, No. 3, pp. 1320-46.

Besley, T.J. and J. Mclaren (1993), "Taxes and Bribery: The Role of Wage Incentives", *The Economic Journal*, pp. 119-41.

Cebula, R.J. (1997), "An Empirical Analysis of the Impact of Government Tax and Auditing Policies on the Size of the Underground Economy: The Case of the United States 1993-94", *American Journal of Economic Society*, Vol. 56, No. 2, pp. 173-85.

Chong, A. and M. Gradstein (2007), "Inequality and Informality", *Journal of Public Economics*, Vol. 91, pp. 159-79.

de Soto, Hernando (1989), *The Other Path: The Invisible Revolution in the Third World*, June Abbot, translation, New York (NY), Harper and Row.

Feige, E.L. (ed.) (1989), *The Underground Economies. Tax Evasion and Information Distortion*, Cambridge (MA), Cambridge University Press.

Friedman, E., S. Johnson, D. Kaufmann and P. Zoido-Lobaton (1999), "Dodging the Grabbing Hand: The Determinants of Unofficial Activity in 69 Countries", World Bank, Discussion Paper.

Goswami, O., I.N. Garg and A. Sanyal (1991), "Bureaucratic Corruption, Income Tax Enforcement and Collection", mimeo.

Jain, A. (ed.) (1998), *Economics of Corruption*, Boston (MA), Kluwer Academic Publishers.

Johnson, S., D. Kaufmann and A. Schleifer (1997), "The Unofficial Economy in Transition", Brookings Papers on Economic Activity, Vol. 1997, No. 2, pp. 159-239.

Johnson, S., D. Kaufmann and P. Zoido-Lobaton (1998a), "Regulatory Discretion and the Unofficial Economy", *American Economic Review,* Vol. 88, No. 2, pp. 387-92.

—————(1998b), "Corruption, Public Finances and the Unofficial Economy", The World Bank Discussion Paper.

Loayza, N.V. (1996), "The Economics of the Informal Sector: A Simple Model and Empirical Evidence from Latin America", Carnegie-Rochester Conference Series on Public Policy, No. 45, pp. 129-62.

Loayza, N.V., A.M. Oviedo and L. Serven (2005), "The Impact of Regulation on Growth and Informality – Cross-country Evidence", The World Bank, Policy Research, Working Paper.

Marcouiller, D. and L. Young (1995), "The Black Hole of Graft: The Predatory State and the Informal Economy", *American Economic Review*, Vol. 85, No. 3, pp. 630-46.

Mukherji, N. (2004), "Government Policies and Graft in an Economy with Endogenous Labor Supply", *Journal of Development Economics*, Vol. 73, pp. 423-34.

Sarte, P.D. (2000), "Informality and Rent-seeking Bureaucracies in a Model of Long-run Growth", *Journal of Monetary Economics*, No. 46, pp. 173-97.

Schneider, F. and D. Enste (2000), "Shadow Economies: Size, Causes and Consequences", *Journal of Economic Literature*, Vol. 38, No. 1, pp. 77-114, March.

Schneider, F. (2002), "Size and Measurement of the Informal Economy in 110 Countries Around the World", The World Bank, Working Paper, July.

Shleifer, A. and R.W. Vishny (1993), "Corruption", *Quarterly Journal of Economics,* Vol. 108, No. 4, pp. 559-617.

Tanzi, V. (1994), "Corruption, Governmental Activities, and Markets", IMF, Working Paper, No. 99, pp. 1-20.

———— (1998), "Corruption Around the World: Causes, Consequences, Scope, and Cures", IMF, Working Paper, No. 63, pp. 1-39.

Virmani, A. (1989), "Indirect Tax Evasion and Productive Efficiency", *Journal of Public Economics*, No. 39, pp. 223-37.

ECONOMIC PERFORMANCE, GOVERNMENT SIZE, AND INSTITUTIONAL QUALITY

António Afonso[, **] and João Tovar Jalles[**, ***]*

We outline a growth model with an explicit government role, where more government resources reduce the optimal level of private consumption and per worker output. For an unbalanced country panel we use different proxies for government size and institutional quality. Our results, consistent with the model, show a negative effect of the size of government on growth. Similarly, institutional quality has a positive impact on real growth, and government consumption is consistently detrimental to growth. Moreover, the negative effect of government size on growth is stronger the lower institutional quality, and the positive effect of institutional quality on growth increases with smaller government size. The negative effect on growth of the government size variables is more mitigated for Scandinavian legal origins, and stronger at lower levels of civil liberties and political rights.

1 Introduction

Governments tend to absorb a sizeable share of society's resources and, therefore, they affect economic development and growth in many countries.[1] Throughout history high levels of economic development have been attained with government intervention. Where government did not exist, little wealth was accumulated. However, despite necessary, government intervention is not a sufficient condition for prosperity, if it leads to the monopolization of the allocation of resources and other important economic decisions, and societies do not succeeded in attaining higher levels of income.[2]

In addition, economic progress is limited when government is zero per cent of the economy (absence of rule of law, property rights, etc.), but also when it is closer to 100 per cent (the law of diminishing returns operates in addition to, e.g., increased taxation required to finance the government's growing burden – which has adverse effects on human economic behaviour, namely on consumption decisions). This idea is related to the so-called "Armey Curve", after Richard Armey, who borrowed a graphical technique popularized by Arthur Laffer, whose crucial underpinnings were already present in Dupuit (1844). Friedman (1997) suggested that the threshold where government's role in economic growth is between 15-50 per cent of the national income.

The existing literature also presents mixed results as to the relationship between government size and economic development (for a recent survey see Bergh and Henrekson, 2011). Important differences in existing research concern the measurement of government size, the type of countries studied (rich vs. poor) and the time span considered. On the one hand, the former may impact economic growth negatively due to government inefficiencies, crowding-out effects, excess burden

* ISEG/UTL - Technical University of Lisbon, Department of Economics; UECE – Research Unit on Complexity and Economics. UECE is supported by FCT (Fundação para a Ciência e a Tecnologia, Portugal), E-mail: aafonso@iseg.utl.pt

** European Central Bank, Directorate General Economics, Kaiserstraße 29, D-60311 Frankfurt am Main, Germany. E-mail: antonio.afonso@ecb.europa.eu and joao.jalles@ecb.europa.eu

*** University of Aberdeen, Business School, Edward Wright Building, Dunbar Street, AB24 3QY, Aberdeen, UK. E-mail: j.jalles@abdn.ac.uk

1 According to the Wagner's Law the scope of the government usually increases with the level of income because government has to maintain its administrative and protective functions, its attempts to ensure the proper operation of market forces and provision of social and cultural (public) goods.

2 Public choice explanations of government growth are discussed in Holcombe (2005).

of taxation, distortion of the incentives systems and interventions to free markets (Barro, 1991; Bajo-Rubio, 2000). Indeed, several studies report that the efficiency of government spending can increase, either by delivering the same amount of services with fewer resources or by using more efficiently existing spending levels (see Afonso *et al.*, 2005, 2011; Angelopoulos *et al.*, 2008). Moreover, Slemrod (1995) and Tanzi and Zee (1997) find a negative impact if the size of government exceeds a certain threshold. The rationale behind this argument is that in countries with big governments the share of public expenditures designed to promote private sector productivity is typically smaller than in countries with small governments (Folster and Henrekson, 2001). On the other hand, government activities may also have positive effects due to beneficial externalities, the development of a legal, administrative and economic infrastructure and interventions to offset market failures (Ghali, 1998; Dalagamas, 2000). On the debate between the positive vs. negative effects of government growth, Grossman (1988) suggested that a non-linear model was preferred in explaining its impact on total economic output.

Our motivation also comes from Guseh (1997) who presents a model that differentiates the effects of government size on economic growth across political systems in developing countries. Growth in government size has negative effects on economic growth, but the negative effects are three times as great in non-democratic systems as in democratic systems.

Our paper includes several contributions: i) we first outline a growth model allowing for an explicit government role, we characterize the conditions underlying the optimal path of the economy and determine the steady-state solutions for the main aggregates; ii) we analyse a wide set of 108 countries composed of both developed and emerging and developing countries, using a long time span running from 1970-2008, and employing different proxies for government size and institutional quality to increase robustness; iii) we build new measures of extreme-type political regimes which are then interacted with appropriate government size proxies in non-linear econometric specifications; iv) we make use of recent panel data techniques that allow for the possibility of heterogeneous dynamic adjustment around the long-run equilibrium relationship as well as heterogeneous unobserved parameters and cross-sectional dependence (e.g. Pooled Mean Group, Mean Group, Common Correlated Pooled estimators, inter alia); and vi) we also deal with potentially relevant endogeneity issues.

Our results show a significant negative effect of the size of government on growth. Similarly, institutional quality has a significant positive impact on the level of real GDP per capita. Interestingly, government consumption is consistently detrimental to output growth irrespective of the country sample considered (OECD, emerging and developing countries). Moreover, i) the negative effect of government size on GDP per capita is stronger at lower levels of institutional quality, and ii) the positive effect of institutional quality on GDP per capita is stronger at smaller levels of government size.

On the other hand, the negative effect on growth of the government size variables is more attenuated for the case of Scandinavian legal origins, while the negative effect of government size on GDP per capita growth is stronger at lower levels of civil liberties and political rights

The remainder of the paper is organised as follows. Section two presents the theoretical model, which underlies and motivates the empirical specifications. Section three addresses data-related issues. Section four elaborates on the econometric methodology and presents and discusses our main results. Section five concludes the paper.

2 Model and econometric specification

In this section we present a growth model that relates output and government size and it will provide the theoretical motivation for our empirical (panel) analysis in Section 3. Our model fits within a broader literature that expands a Barro (1991)-type model where government plays an active role.[3] We consider a typical economy with a constant elasticity of substitution utility function of the representative agent given by:

$$U = \int_0^{\infty} e^{-\gamma t} \frac{c_t^{1-\theta} - 1}{1-\theta} dt \tag{1}$$

where c is per capita consumption, θ is the intertemporal substitution and γ is the (subjective) time discount rate or rate of time preference (a higher γ implies a smaller desirability of future consumption in terms of utility compared to utility obtained by current consumption. Population (which we assume identical to labour force, L) grows at the constant rate n, that is, $L_{it} = L_{i0} e^{n_i t}$. Output in each country i at time t is determined by the following Cobb-Douglas production function:

$$Y_{it} = K_{it}^{\alpha} G_{it}^{\beta} (A_{it} L_{it})^{1-\alpha-\beta}, 0 < \alpha < 1,\ 0 < \beta < 1,\ 0 < \alpha + \beta < 1 \tag{2}$$

Y is the final good, used for private consumption, G is public consumption expenditure, which proxies for government size, and K is investment in physical capital. We consider the case of no depreciation of physical capital. The output used to produce G equals qG (which one can think of as being equivalent to a crowding-out effect in private sector's resources). A is the level of technology and grows at the exogenous constant rate μ, that is, we have

$$A_{it} = A_{i0} e^{\mu_i t + I_{it} \rho_i} \tag{3}$$

with I_{it} being a vector of institutional quality, political regime, legal origin and other related factors that may affect the level of technology and efficiency in country i at time t, and ρ_i is a vector of (unknown) coefficients related to these variables. In this framework, the state of labour-augmenting technology (A) depends not only on exogenous technological improvements determined by μ, but also on the level of institutional quality (such as the rule of law), the degree of democratic political foundations, etc. Institutions may be critical in facilitating technological breakthroughs, which may not occur without appropriate sound institutional environments. The presence of efficient and effective institutions ensures that labour can be used for productive purposes, instead of being wasted with red tape or rent seeking activities (North, 1990; Nelson and Sampat, 2001).

We begin by writing down the resource constraint for this economy in per worker terms, given by:

$$\dot{K}_t = Y_t - C_t - qG_t \Leftrightarrow \dot{k}_t = y_t - c_t - qg_t - nk_i \tag{4}$$

where $\dot{K}_t$ is the time derivative of physical capital and small letters represent per worker terms (after scaling down by L).

---

[3] Peden and Bradley (1989) employ a theoretical model of output growth to derive an equation that controls for cyclical influencces and distinguishes the effects of government growth on the economic base from the effects on the economic growth rate. Lee (1992) and Devarajan *et al.* (1996) expand Barro's model, allowing different kinds of government expenditures to have different impacts on growth. At a more disaggregated level, distinguishing between productive and non-productive spending, Glomm and Ravikumar (1997) and Kneller *et al.* (1999) are able to determine the optimal composition of different kinds of expenditure, based on their relative elasticities. Similarly, Chen (2006) investigates the optimal composition of public spending and its relationship to economic growth.

We now write the conditions that characterize the optimal path for the economy and determine the steady-state solution for private and public consumption and income per worker. The optimal path is the solution of:

$$\max_{c_t, g_t} \int_0^\infty e^{-\gamma t} \frac{c_t^{1-\theta} - 1}{1-\theta} dt$$
$$s.t.: \dot{k}_t = k_t^{\alpha} g_t^{\beta} A_t^{1-\alpha-\beta} - c_t - qg_t - nk_i \tag{5}$$

Solving the Hamiltonian's corresponding first order conditions and after some manipulations yields:[4]

$$k^* = A\left(\frac{\alpha}{\theta\mu + \gamma + n}\right)^{\frac{1-\beta}{1-\alpha-\beta}} \left(\frac{\beta}{q}\right)^{\frac{1-\beta}{1-\alpha-\beta}}$$
$$g^* = A^{\frac{1-\alpha-\beta}{1-\beta}} \left(\frac{\beta}{q}\right)^{\frac{1-\beta}{1-\alpha-\beta}} k^{*\frac{\alpha}{1-\beta}} \tag{6}$$
$$y^* = k^{*\alpha} g^{*\beta} A^{1-\alpha-\beta}$$
$$c^* = y^* - (n+\mu)k^* - qg^*$$

A special case occurs when $\alpha + \beta = 1$ and $n = \mu = 0$ in which there is no transition dynamics and the economy is always in the balanced growth path.

We refrain from making full considerations on the model's solution, but one, in particular, is worth making:[5] an increase in *q* (which implicitly proxies the overall size of the public sector translating the fact that more resources are needed/required to finance *G*) reduces both the optimal level of private consumption per worker (and physical capital per worker) and, more importantly, the optimal level of output per worker in this model economy.

Turning to econometric specification, in the steady state, output per effective worker ($\hat{y}_{it} = Y_{it} / A_{it} L_{it}$) is constant while output per worker ($y_{it} = Y_{it} / L_{it}$) grows at the exogenous rate μ. In general, output in effective worker terms evolves as $\hat{y}_{it} = (k_{it})^{\alpha} (g_{it})^{\beta}$ and in (raw) worker terms, output evolves according to $y_{it} = A_{it} (k_{it})^{\alpha} (g_{it})^{\beta}$. Taking logs on both sides we get $\ln y_{it} = \ln A_{it} + \alpha \ln k_{it} + \beta \ln g_{it}$, and using (3) and the fact that in (2) we have $(A_{it} L_{it})^{1-\alpha-\beta}$ entering the utility function, we obtain,

$$\ln y_{it} = A_0 + (1-\alpha-\beta)\mu_i t + (1-\alpha-\beta)\rho_i I_{it} + \alpha \ln k_{it} + \beta \ln g_{it}. \tag{7}$$

Equation (7) describes the evolution of output per worker (or labour productivity), as a function of a vector of institutional and political related variables, which may change over time, the size of the public sector or government, the level of physical capital and the exogenous growth rate of output. Given the production function relationship, (7) is valid both within and outside the steady-state and this is important, particularly, if one makes use of static panel data techniques for estimation purposes. Moreover, it is not dependent on assumptions on the behaviour of savings, hence offering a reasonable basis for estimation. Based on (7), we will use both a linear and non-linear specification (in which interaction or multiplicative terms are included), as follows:

---

4 The derivation is available upon request.

5 In an alternative setting in which the government introduces a tax over total income (or production) to finance public consumption, the overall conclusion (with respect to the effect of government size) does not change.

$$\ln y_{it} = b_0 + b_1 t + b_3 I_{it} + b_4 \ln k_{it} + b_5 \ln g_{it} + \varepsilon_{it} \tag{8}$$

$$\ln y_{it} = b_{0i} + b_1 t + b_3 I_{it} + b_4 \ln k_{it} + b_5 \ln g_{it} + b_6 (I_{it} g_{it}) + \eta_{it} \tag{9}$$

where the *b*'s are (unknown) parameters to be estimated, I_{it} and g_{it} denote the proxies for institutional quality and government size, respectively, and ε_{it} and η_{it} are model specific error terms satisfying the usual assumptions of zero mean and constant variance. Equations (8) and (9) provide the basis for the empirical models to be estimated in Section 3.

Finally, the variation of causality between government size and growth detected in cross-section and time-series papers suggests that there are important differences in the way in which governments influence economic performance across countries. We argue that it may reflect, lato sensu, institutional differences across countries and, while this is a plausible conjecture, there is as yet little direct evidence to confirm that institutions and political regimes make a difference to the way in which governments affect economic outcomes.

3 Data

The dataset consists of an unbalanced panel of observations for 108 heterogeneous countries for the period 1970-2008 in 5-year averages (to overcome short-run business cycle fluctuations as is common practice in the growth literature).[6] Countries are grouped into developed (OECD) and emerging and developing based on the World Bank classification. Annual data on real GDP per capita (*y*) and gross fixed capital formation (*inv*) are retrieved from the World Bank' World Development Indicators. We estimate the capital stock (*Ky*) using the perpetual inventory method, that is, $Ky_t = Inv_t + (1-\delta)Ky_{t-1}$, where Inv_t is the investment and δ is the depreciation rate. Data on Inv_t comes from Summers and Heston's PWT 6.3 as real aggregate investment in PPP. We estimate the initial value of the capital stock (Ky_0), in year 1950 as $Inv_{1950}/(g+\delta)$ where *g* is the average compound growth rate between 1950 and 1960, and δ is the depreciation rate (set to 7 per cent for all countries and years).

Our proxies of government size (*g*) will be the respective Gwartney and Lawson's (2008) composite variable (*govsize*). This variable includes government consumption expenditures (as a percentage of total consumption), transfers and subsidies (as a percentage of GDP), the underlying tax system (proxied by top marginal tax rates) and the number of government enterprises. We also make use of total government expenditures (*totgovexp_gdp*), government consumption (*govcons_gdp*) – as in our theoretical model - and, finally, total government debt (*govdebt_gdp*). The first two variables come from a merger between WDI, the IMF's International Financial Statistics (IFS) and Easterly's (2001) datasets.[7] The latter was retrieved from the recent IMF's historical debt series due to Abas *et al.* (2010).

For institutional-related variables (our *I*) we rely on:[8] i) the Polity 2 (*polity*) measure and regime durability in years (*durable)* (from Marshall and Jaegger's Polity's 4 database), ii) Freedom House's Political Rights (*pr*), Civil Liberties (*cl*) and composite index (*fh*),[9] iii) the corruption

---

6 Summary statistics and correlation matrices are omitted for economy of space but they are available upon request.

7 The classification of the data is described in IMF (2001).

8 The interested reader should refer to the original sources for the full definition of the variables used.

9 Constructed by simply averaging Political Rights and Civil Liberties.

perception index (*cpi*) (from the Transparency International database).[10] iv) an index of democratization (*demo*) due to Vanhanen (2005), v) a governance index (*governance*)[11] from Kaufman *et al.* (2009) (World Bank project), vi) the political system (*ps*), a dummy variable that takes a value zero for presidential regime, the value one for the assembly-elected presidential regime and two for parliamentary regime (from the Database of Political Institutions), and vii) countries' legal origins, English (*bri*), French (*fre*), German (*ger*) or Scandinavian (*sca*)[12] (from La Porta *et al.*, 1999).[13]

For robustness purposes we will also make use of factor analysis and combine different sets of institutional-related variables (in particular, *pr*, *cl*, *polity*, *demo* and *cpi*) and then look at the first common factor. However, the sampling technique is unfortunately restricted to the fact that cross-country data are limited in the country coverage and vary widely across different data sources. This limitation creates an incomplete data issue and poses a problem for the Principal Component Analysis (PCA) that we wish to employ. Indeed, PCA is based on an initial reduction of the data to the sample mean vector and sample covariance matrix of the variables, and this cannot be estimated from datasets with a large proportion of missing values (Little and Rubin, 1987).[14] Hence, imputation is required prior to extracting the first principal component.[15] The Expectation-Maximization Algorithm (EMA) as suggested by Dempster *et al.* (1977) is used to fill in missing data. This algorithm is based on iterating the process of regression imputation and maximum likelihood and it consists of two steps: the first step, the "E (expectation)-step" computes expected values (conditional on the observed data) and the current estimates of the parameters. Using the estimated "complete data", in the second step or "M-step", the EMA re-estimates the means, variances and covariances using a formula that compensates for the lack of residual variation in the imputed values.[16]

The first principal component is normalized in such a way that high values indicate higher institutional quality. Our standardized index, *EMA_PCA*, can be written as:[17]

$$EMA\_CA = 0.78cl + 0.89pr + 0.92polity + 0.69demo + 0.34cpi$$

In addition, the first principal component explains 73.6 per cent of the total variance in the standardized data.[18] This aggregate index will be used in the empirical analysis below.

---

[10] See Goel and Nelson (1998) for a disaggregated analysis on the effect of government size on corruption.

[11] This is the result of averaging six variables: voice and accoutability, political stability, government effectiveness, regulatory quality, rule of law and control of corruption.

[12] There is no risk of multicollinearity since "socialist" legal origin is not included explicitly on the right-hand-side as an explanatory variable.

[13] Data sources and definitions are provided in the Appendix.

[14] Moreover, the lack of data also increases the degree of uncertainty and influences the ability to draw accurate conclusions.

[15] The varimax rotation method is chosen.

[16] The EMA assumes that the data are missing at random (MAR) and in order to check that the MAR assumption can be applied to the measures of institutional quality, a test analysis called "separate variance *t*-test", in which rows are all variables which have 1 per cent missing or more, and columns are all variables, is carried out. The *p*-values are more than 5 per cent meaning that missing cases in the row variable are not significantly correlated with the column variable and this, can be considered as MAR.

[17] A likelihood ratio test was used to examine the "sphericity" case, allowing for sampling variability in the correlations. This test comfortably rejects sphericity at the 1 per cent level with a Kaiser-Meyer-Olkin measure of sampling adequacy equal to 0.831.

[18] Given that the PCA is based on the classical covariance matrix, which is sensitive to outliers, we take one further step by basing it on a robust estimation of the covariance (correlation) matrix. A well suited method is the Minimum Covariance Determinant (MCD) – we implement Rousseeuw and Van Driessen's (1999) algorithm. After re-computing the same measure with the MCD version we obtain similar results, meaning that outliers are not driving our factor analysis (the correlation coefficient between the two equals 98,04 per cent, statistically significant at 1 per cent level).

4 Methodology and results

4.1 Baseline results

Equations (8) and (9) can be estimated directly using panel data techniques, which allow for both cross-section and time-series variation in all variables and present a number of advantages *vis-à-vis* standard Barro-type pooled cross-section estimation approaches (see Greene, 2003).

Table 1.a and 1.b present our first set of results for the pooled OLS and fixed-effects specifications, respectively (the former is presented for completeness). Both tables are divided into two panels (A and B) covering different proxies for institutional quality (eight in total). At this point, we use Gwartney and Lawson's government size measure only and discuss its individual inclusion in our regression of interest as well as its interaction with a variable I_{it}.

A few remarks are worth mentioning. There is a positive effect of the capital stock on the level of real GDP per capita throughout the different specifications regardless of the institutional variable employed. One also finds a consistent and statistically significant negative coefficient on the government size (less so when fixed-effects are used, see Table 1.b). Its coefficient varies between 0.03 and 0.11 across the two tables, meaning that an increase in government size by 10 percentage points is associated with a 0.3 to 1.1 per cent lower annual growth. This order of magnitude is consistent with previous studies. Similarly, institutional quality has a consistent and statistically significant positive impact on the level of real GDP per capita (more mitigated with fixed-effects). Finally, when statistically significant the interaction term is negative, meaning that i) the negative effect of government size on GDP per capita is stronger at lower levels of institutional quality, and ii) the positive effect of institutional quality on GDP per capita is stronger at smaller levels of government size. The interaction term means that the marginal effect of government size will differ at different levels of institutional quality. However, this result depends on the proxy used for I_{it}. Nevertheless, we obtain in most regressions considerably high R-squares. Moreover, when regional dummies are included, coefficients keep their statistical significance and sign.

If we redo the exercise with the EMA_PCA variable instead, for both pooled OLS and fixed-effects estimators, Table 2 shows meaningful results for the size of the government and for the institutional quality index, when OLS is considered.

4.2 Endogeneity and dynamic panel estimation

In the analysis of empirical production functions, the issue of variable endogeneity is generally of concern. Moreover, instead of estimating static equations, we now allow for dynamics to play a role. A negative correlation between government size and economic growth does not imply causality. In fact, the most obvious reason (among many) to suspect reverse causality a problem is that welfare states social insurance schemes act as automatic stabilizers. Hence, we reformulate our regression equation(s) and take real GDP growth per capita as our dependent variable being a function of lagged real GDP per capita, investment (gross fixed capital formation as percentage of GDP), a government-size proxy and an interaction term (with an institutional quality proxy) – as common practice in the empirical growth literature. We estimate this new specification by means of the Arellano-Bover system-GMM estimator[19] which jointly estimates the

[19] The GMM approach estimates parameters directly from moment conditions imposed by the model. To enable identification the number of moment conditions should be at least as large as the number of unknown parameters. Moreover, the mechanics of the GMM approach relates to a standard instrumental variable estimator and also to issues such as instrumental validity and informativeness.

Table 1.a

Results of OLS Estimation, with Interaction Terms

Sample	**Full**											
Estimator	**Pooled OLS**											
Spec.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Institutional Proxy	cl			pr			polity			demo		
ln k	0.942***	0.908***	0.941***	1.032***	0.999***	1.031***	1.086***	1.025***	1.080***	0.954***	0.905***	0.958***
	(0.043)	*(0.042)*	*(0.044)*	*(0.044)*	*(0.043)*	*(0.045)*	*(0.038)*	*(0.039)*	*(0.040)*	*(0.041)*	*(0.039)*	*(0.041)*
g	–0.064***	–0.039**	–0.037	–0.076***	–0.040**	–0.070	–0.061***	–0.027	–0.036	–0.028**	–0.004	–0.067**
	(0.013)	*(0.016)*	*(0.050)*	*(0.016)*	*(0.017)*	*(0.058)*	*(0.017)*	*(0.017)*	*(0.026)*	*(0.014)*	*(0.015)*	*(0.031)*
I	0.220***	0.201***	0.255***	0.112***	0.107***	0.120*	0.021***	0.024***	0.043**	0.025***	0.024***	0.016**
	(0.026)	*(0.023)*	*(0.064)*	*(0.021)*	*(0.018)*	*(0.072)*	*(0.005)*	*(0.005)*	*(0.020)*	*(0.003)*	*(0.002)*	*(0.007)*
I*g			–0.006			–0.001			–0.004			–0.002*
			(0.010)			*(0.011)*			*(0.003)*			*(0.001)*
Latin America		–0.240***			–0.297***			–0.337***			–0.275***	
		(0.070)			*(0.072)*			*(0.071)*			*(0.064)*	
Asia		–0.773***			–0.783***			–0.842***			–0.848***	
		(0.092)			*(0.100)*			*(0.098)*			*(0.085)*	
Africa		–0.015			0.099			0.032			–0.011	
		(0.110)			*(0.119)*			*(0.112)*			*(0.099)*	
N	437	437	437	437	437	437	448	448	448	476	476	476
R^2	0.923	0.934	0.923	0.909	0.924	0.909	0.897	0.915	0.897	0.917	0.931	0.918

Sample	Full											
Estimator	Pooled OLS											
Spec.	1	2	3	4	5	6	7	8	9	10	11	12
Institutional Proxy		cpi			governance			ps			pc	
ln k	0.813***	0.828***	0.805***	0.763***	0.771***	0.758***	1.182***	1.150***	1.183***	1.249***	1.205***	1.252***
	(0.048)	*(0.042)*	*(0.047)*	*(0.058)*	*(0.055)*	*(0.056)*	*(0.045)*	*(0.049)*	*(0.045)*	*(0.039)*	*(0.047)*	*(0.039)*
g	–0.007	–0.003	–0.109**	–0.039**	–0.037*	–0.080***	–0.041*	–0.009	–0.034*	–0.039	–0.017	0.034
	(0.015)	*(0.015)*	*(0.053)*	*(0.018)*	*(0.020)*	*(0.027)*	*(0.023)*	*(0.023)*	*(0.021)*	*(0.025)*	*(0.026)*	*(0.064)*
I	0.200***	0.201***	0.103**	0.563***	0.574***	0.240*	0.001	0.053*	0.085	0.182*	0.047	0.674
	(0.017)	*(0.016)*	*(0.042)*	*(0.061)*	*(0.051)*	*(0.126)*	*(0.036)*	*(0.032)*	*(0.178)*	*(0.109)*	*(0.104)*	*(0.425)*
I*g			–0.017**			–0.054***			–0.014			–0.084
			(0.007)			*(0.021)*			*(0.031)*			*(0.072)*
Latin America		0.088			0.120			–0.317***			–0.254***	
		(0.067)			*(0.092)*			*(0.097)*			*(0.096)*	
Asia		–0.579***			–0.528***			–0.755***			–0.547***	
		(0.077)			*(0.111)*			*(0.148)*			*(0.150)*	
Africa		0.289***			0.219			0.126			0.062	
		(0.105)			*(0.151)*			*(0.167)*			*(0.152)*	
N	240	240	240	176	176	176	258	258	258	225	225	225
R^2	0.954	0.964	0.955	0.950	0.958	0.951	0.919	0.932	0.919	0.935	0.942	0.936

Note: The models are estimated by Pooled OLS. The dependent variable is the logarithm of real GDP per capita. A time trend has been included but is not reported for reasons of parsimony. Robust heteroskedastic-consistent standard errors are reported in parenthesis below each coefficient estimate. A constant term has been estimated but it is not reported for reasons of parsimony. *, **, *** denote significance at 10, 5 and 1 per cent levels.

Table 1b

Results of FE Estimation, with Interaction Terms

Estimator	FE							
Spec.	1	2	3	4	5	6	7	8
Institutional Proxy	cl		pr		polity		demo	
ln k	0.691***	0.692***	0.687***	0.688***	0.575***	0.574***	0.609***	0.605***
	(0.078)	*(0.079)*	*(0.077)*	*(0.078)*	*(0.079)*	*(0.080)*	*(0.079)*	*(0.080)*
g	–0.006	–0.005	–0.005	–0.010	–0.029**	–0.038***	–0.018	–0.042**
	(0.016)	*(0.024)*	*(0.016)*	*(0.019)*	*(0.011)*	*(0.012)*	*(0.014)*	*(0.017)*
I	0.009	0.011	0.013	0.022	0.009***	0.004	0.002	0.005*
	(0.013)	*(0.036)*	*(0.010)*	*(0.028)*	*(0.003)*	*(0.007)*	*(0.002)*	*(0.003)*
I*g		0.003		0.006		–0.002*		–0.001**
		(0.006)		*(0.005)*		*(0.001)*		*(0.001)*
N	437	437	437	437	448	448	476	476
R2	0.823	0.824	0.825	0.826	0.836	0.839	0.821	0.826

Estimator	FE							
Spec.	1	2	3	4	5	6	7	8
Institutional Proxy	cpi		governance		ps		pc	
ln k	0.611***	0.611***	0.215	0.245*	0.586***	0.582***	0.588***	0.590***
	(0.152)	*(0.151)*	*(0.152)*	*(0.130)*	*(0.141)*	*(0.141)*	*(0.157)*	*(0.154)*
g	–0.002	–0.006	–0.015*	–0.021**	0.033	–0.058***	0.034	0.026
	(0.007)	*(0.019)*	*(0.008)*	*(0.009)*	*(0.024)*	*(0.020)*	*(0.029)*	*(0.059)*
I	0.004	0.012	0.128**	0.247**	–0.032	0.256*	–0.041	–0.094
	(0.013)	*(0.019)*	*(0.061)*	*(0.112)*	*(0.041)*	*(0.136)*	*(0.040)*	*(0.293)*
I*g		0.001		0.018		–0.043**		0.009
		(0.003)		*(0.013)*		*(0.020)*		*(0.054)*
N	240	240	176	176	258	258	225	225
R^2	0.722	0.723	0.468	0.488	0.767	0.785	0.748	0.748

Note: The models are estimated by Fixed-Effects. The dependent variable is the logarithm of real GDP per capita. A time trend has been included but is not reported for reasons of parsimony. Robust heteroskedastic-consistent standard errors are reported in parenthesis below each coefficient estimate. A constant term has been estimated but it is not reported for reasons of parsimony. *, **, *** denote significance at 10, 5 and 1 per cent levels.

Table 2

Results of OLS and FE Estimation, with Interaction Terms. PCA-based Institutional Measure

Estimator	OLS		FE	
Spec.	1	2	3	4
ln k	0.976***	0.970***	0.675***	0.676***
	(0.048)	*(0.050)*	*(0.079)*	*(0.079)*
g	–0.066***	–0.046*	–0.018	–0.019
	(0.015)	*(0.024)*	*(0.014)*	*(0.016)*
I	0.423***	0.307***	–0.016	–0.029
	(0.064)	*(0.113)*	*(0.035)*	*(0.057)*
I*g		0.029		0.003
		(0.026)		*(0.012)*
N	411	411	411	411
R^2	0.913	0.913	0.821	0.821

Note: The models are estimated by Fixed-Effects. The dependent variable is the logarithm of real GDP per capita. A time trend has been included but is not reported for reasons of parsimony. Robust heteroskedastic-consistent standard errors are reported in parenthesis below each coefficient estimate. A constant term has been estimated but it is not reported for reasons of parsimony. *, **, *** denote significance at 10, 5 and 1 per cent levels.

equations in first differences, using as instruments lagged levels of the dependent and independent variables, and in levels, using as instruments the first differences of the regressors.[20] Intuitively, the system-GMM estimator does not rely exclusively on the first-differenced equations, but exploits also information contained in the original equations in levels.

Another contribution of our study is the construction of new (and more meaningful) democracy measures based on the variable *polity* (described in the Appendix). The role of political systems and democracy in particular, on the government size-growth relationship is assessed by regressing three structural aspects of democracy (to be defined below) on 5-year averages of real GDP per capita growth rates.[21] Indeed, *polity* does not capture two important dimensions of political regimes – either their newness (following, for example, democratization or a return to authoritarian rule) or their more established (consolidated) nature.

Therefore, Rodrik and Wacziarg (2005) define a major political regime change to have occurred when there is a shift of at least three points in a country's score on *polity* over three years or less. Using this criterion we define new democracies (ND=1) in the initial year (and subsequent four years) in which a country's *polity* score is positive and increases by at least three points and is sustained, ND=0 otherwise. Established democracies (ED=1) are those new democratic regimes that have been sustained following the 5 years of a new democracy (ND). In any subsequent year, if established democracies (ED) fail to sustain the status of ND, ED=0. Using these criteria, they define sustained democratic transitions (SDT) as the sum of ND and ED. They use the same procedure, mutatis mutandis, to define new autocracies (NA), established autocracies (ES) and sustained autocratic transition (SAT).

This yields six distinct binary-type measures of the character of political regimes – ND, ED, NA, EA, SDT, and SAT – for most years during 1970-2008. Finally, Rodrik and Wacziarg (2005) define small regime changes (SM) as changes in *polity* from one year to the next that are less than three points.[22] A recent empirical application of these measures to explain the impact of extreme-type political regimes on economic performance can be found in Jalles (2010). There are several advantages from creating these new measures, which allow us to distinguish the impact of new and established electoral democracies and autocracies on economic development, and also to assess the impact of sustained democratic and autocratic transitions on economic growth.

Endogeneity[23] between right-hand side measures of democracy and autocracy and a standard set of control variables is corrected for by taking a system-GMM (SYS-GMM) approach – as detailed above. As suggested in Mauro (1995), La Porta *et al.* (1997), Hall and Jones (1999), Acemoglu *et al.* (2001) and Dollar and Kraay (2003), the democracy measures are instrumented by:

1 the durability (age in years) of the political regime type (*durable*) retrieved from Marshall and Jaeggers' database;[24]

---

[20] As far as information on the choice of lagged levels (differences) used as instruments in the differences (levels) equation, as work by Bowsher (2002) and, more recently Roddman (2009) has indicated, when it comes to moment conditions (as thus to instruments) more is not always better. The GMM estimators are likely to suffer from "overfitting bias" once the number of instruments approaches (or exceeds) the number of groups/countries (as a simple rule of thumb). In the present case, the choice of lags was directed by checking the validity of different sets of instruments.

[21] An equation with real GDP per capita growth as the dependent variable is motivated by (standard) augmentation of Solow-Swan type models with a government size proxy (similarly to our production function in Section 2) and following Barro and Sala-i-Martín's (1992) and Mankiw *et al.*'s (1992) approaches.

[22] Thus SM = 1 for a small regime change and SM = 0 otherwise.

[23] And also the existence of possible measurement errors when accounting for democracy.

[24] The average age of the party system is also used in Przeworski *et al.* (2000) and Beck *et al.* (2001). This potential instrument is also in line with Bockstette, Chanda and Putterman (2002) who document the use of the state antiquity index as an appropriate instrument for institutional quality.

2 *latitude* (from La Porta *et al.*, 1998, 1999): Hall and Jones (1999) launched the general idea that societies are more likely to pursue growth-promoting policies, the more strongly they have been exposed to Western European influence, for historical or geographical reasons. In this context, other two possible instruments could be common and civil law, translating the type of legal origin of each country;

3 ethnic fragmentation (*ethnic*) (from Alesina *et al.*, 2003): on a broad level, the role of ethnic fragmentation in explaining the (possible) growth effect of democracy can be derived from the literature on the economic consequences of ethnic conflict. It has been shown that the level of trust is low in an ethnically divided society (Alesina and La Ferrara, 2000). Moreover, the lack of co-operative behaviour between diverse ethnic groups, leads to the tragedy of the commons as each group fights to divert common resources to non-productive activities (e.g., Mauro, 1995).[25]

Table 3 reports the results with the four proxies for government size defined in Section 3 and splitting the sample into OECD, emerging and developing countries groups.[26] Focusing on the full sample first we observe that the Gwartney and Lawson's government size measure appears with a statistically significant negative coefficient. When interacted with SAT it has a negative and statistically significant coefficient, meaning that in autocratic countries increased government size has greater negative effect on output growth. The reverse is true for democratic countries, whose negative impact of government size is mitigated but remains mostly negative. The remaining proxies keep the statistically negative coefficient, but interaction terms lose economic and statistical relevance. For the OECD sub-group the individual effects of the different proxies of government size are similar but interaction terms are never statistically significant. Developing countries report a statistically negative coefficient on government consumption expenditure and debt-to-GDP ratio, with the latter having a lesser detrimental effect in democratic countries. All in all, government consumption is the proxy that is more consistently and clearly detrimental to output growth.

More stringent empirical tests on the role of democracy on the government size-growth relation were carried out, for robustness purposes (similarly to Rock, 2009). We defined "extreme" democratic transitions as those where the *polity* variable is greater than 5. In these instances, a new sustainable democratic transitions variable, SDT1=1 when *polity*>5, otherwise SDT1=0. Similarly, a new sustainable autocratic transitions variable was created, SAT1=1 when *polity*<–5, otherwise SAT1=0. The logic behind this construction is to test for the impact of democracy and autocracy on growth in cases where countries' governments are closer to either pure democracies or pure autocracies.[27] Results (not shown) using the new SAT1 and SDT1 variables do not qualitatively change the results presented in Table 3 and discussed above.

We also assessed the importance of political-institutional measures, specifically legal origins. From Table 4 a first general conclusion is that interaction terms with a Scandinavian legal origin dummy yields the higher (in absolute value) estimated coefficients (when significant), compared with other legal origins. More particularly, in specification 4 and 5, for the full sample and OECD respectively, the government debt-to-GDP ratio and government size appear with a

---

25 Other similarly possible instruments are the historical settler mortality or population density in 1500, as in Acemoglu and Robinson (2005), the constitutional initiative which allows citizens to amend or demand a revision of the current constitution (as in Poterba, 1996), the share of population that speaks any major European language – *Eurfrac* –, inter alia. For the three instruments chosen the exclusion restriction is that durability, latitude and ethnic fragmentation do not have any impact on present economic growth other than their impact on democracy.

26 In the great majority of our system-GMM regressions the Hansen-*J*-statistic is associated with p-values larger than 10 per cent. This statistic tests the null hypothesis of correct model specification and valid overindentifying restrictions, *i.e.*, validity of instruments.

27 The cut-off point for defining these measures of democracy/autocracy was taken directly from Marshall and Jaeggers (http://www.systemicpeace.org/polity/polity4.htm).

Table 3

Results of Estimations Controlling for Endogeneity (with Interaction Terms of New Political Systems' Measures)

Sample	**All**				**OECD**				**Emerging**				**Developing**			
Estimation	**SYS-GMM**															
Spec.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
gfcf_gdp	–0.25	0.11*	0.13**	0.14**	0.67*	–0.07	–0.06	0.07	0.66**	0.02	0.29**	0.28*	–0.15	0.24***	0.13*	0.12*
	(0.192)	(0.661)	(0.058)	(0.036)	(0.363)	(0.188)	(0.155)	(0.222)	(0.262)	(0.306)	(0.137)	(0.155)	(0.203)	(0.088)	(0.075)	(0.073)
Government size proxy	govsize	Totgovexpp	Govcons	Govdeb	govsize	Totgovexpp	Govcons	Govdebt	govsize	Totgovexpp	Govcons	Govdebt	govsize	Totgovexpp	Govcons	Govdebt
g	–2.37**	–0.20***	–0.37***	–0.02***	–1.88**	–0.20	–0.79***	0.02	–1.51	–0.14	0.16	–0.02	–1.64	–0.14	–0.33**	–0.02***
	(1.088)	*(0.049)*	*(0.122)*	*(0.005)*	*(0.871)*	*(0.158)*	*(0.273)*	*(0.062)*	*(1.525)*	*(0.139)*	*(0.340)*	*(0.034)*	*(1.937)*	*(0.087)*	*(0.154)*	*(0.004)*
g*SAT	–0.70*	0.03	–0.05	–0.01	0.18	0.08	0.23	0.04	–17.61*	0.03	–0.49**	0.03	–0.14	–0.11*	0.06	0.01
	(0.393)	*(0.027)*	*(0.056)*	*(0.005)*	*(0.206)*	*(0.138)*	*(0.380)*	*(0.056)*	*(10.570)*	*(0.182)*	*(0.211)*	*(0.025)*	*(1.677)*	*(0.060)*	*(0.101)*	*(0.010)*
g*SDT	0.78**	0.04	–0.01	0.02***	–0.05	–0.04	0.02	0.01		–0.12	–0.03	–0.01	–0.29	0.16**	0.05	0.01***
	(0.354)	*(0.045)*	*(0.057)*	*(0.003)*	*(0.141)*	*(0.124)*	*(0.273)*	*(0.054)*		*(0.166)*	*(0.148)*	*(0.028)*	*(2.086)*	*(0.069)*	*(0.115)*	*(0.004)*
Observations	383	1757	3653	3200	116	716	938	849	117	454	868	779	170	642	1,964	1,677
Hansen (*p*-value)	0.04	1.00	1.00	1.00	0.89	1.00	1.00	1.00	0.95	1.00	1.00	1.00	0.38	1.00	1.00	1.00
AB AR(1) (*p*-value)	0.02	0.00	0.00	0.00	0.15	0.01	0.00	0.01	0.05	0.01	0.00	0.00	0.08	0.00	0.00	0.00
AB AR(2) (*p*-value)	0.29	0.00	0.01	0.04	0.36	0.00	0.01	0.06	0.14	0.04	0.19	0.32	0.39	0.11	0.03	0.13

Note: The models are estimated by system GMM (SYS-GMM). The dependent variable is real GDP per capita growth. "*SDT"* and "*SAT*" stand for sustained democratic transition and sustained autocratic transition – for more details refer to the main text. Robust heteroskedastic-consistent standard errors are reported in parenthesis below each coefficient estimate. The Hansen test evaluates the validity of the instrument set, *i.e.*, tests for over-identifying restrictions. AR(1) and AR(2) are the Arellano-Bond autocorrelation tests of first and second order (the null is no autocorrelation), respectively. Also a constant term, lagged dependent variable and a time trend have been included but are not reported for reasons of parsimony. *, **, *** denote significance at 10, 5 and 1 per cent levels.

Table 4

Results of Estimations Controlling for Endogeneity (with Interaction Terms of Legal Origins' Type)

Sample	**All**				**OECD**				**Emerging**				**Developing**			
Estimation	**SYS-GMM**															
Spec.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
gfcf_gdp	–0.19	0.12*	0.16***	0.14***	1.13***	–0.09	–0.12	0.30	0.67***	–0.06	0.14	0.22**	–0.13	0.28***	0.09	0.11
	(0.287)	*(0.065)*	*(0.052)*	*(0.054)*	*(0.345)*	*(0.146)*	*(0.140)*	*(0.187)*	*(0.255)*	*(0.400)*	*(0.145)*	*(0.110)*	*(0.291)*	*(0.083)*	*(0.068)*	*(0.066)*
Government size proxy	govsize	Totgovexpp	Govcons	Govdebt	govsize	Totgovexpp	Govcons	Govdebt	govsize	Totgovexpp	Govcons	Govdebt	govsize	Totgovexpp	Govcons	Govdebt
g	–0.11	–0.14	–1.02***	–0.12*	–7.06*	–0.27	–0.80	–0.19	–0.05	–0.31	0.58	–0.02	15.74	–1.30**	–1.11**	–0.51*
	(0.287)	*(0.299)*	*(0.327)*	*(0.061)*	*(3.946)*	*(0.775)*	*(0.926)*	*(0.154)*	*(2.929)*	*(0.396)*	*(0.395)*	*(0.020)*	*(14.481)*	*(0.602)*	*(0.465)*	*(0.282)*
g*british	–4.77	–0.04	0.61*	0.10*	5.58	–0.22	–0.54	0.33	–3.28	0.42	–1.48***	0.11	–19.14	1.28**	0.80	0.48*
	(4.481)	*(0.319)*	*(0.371)*	*(0.062)*	*(4.154)*	*(0.992)*	*(0.936)*	*(0.410)*	*(4.053)*	*(0.792)*	*(0.560)*	*(0.157)*	*(14.805)*	*(0.648)*	*(0.543)*	*(0.279)*
g*french	–1.71	0.01	0.72**	0.11*	5.50	0.24	0.21	0.20	2.70	0.15	–0.72*	–0.04	–20.12	1.25**	0.66	0.51*
	(3.190)	*(0.326)*	*(0.362)*	*(0.061)*	*(4.069)*	*(0.910)*	*(1.688)*	*(0.142)*	*(4.094)*	*(0.540)*	*(0.410)*	*(0.039)*	*(16.637)*	*(0.573)*	*(0.505)*	*(0.281)*
g*german	1.17	0.36	0.99	0.17*	3.88	–0.35	–0.83	0.33	–	–	–	–	–	–	–	–
	(2.167)	*(0.426)*	*(0.836)*	*(0.101)*	*(4.741)*	*(0.746)*	*(1.701)*	*(0.217)*								
g*scandinavian	–0.87	–0.13	0.785	0.21**	7.01	0.24	0.29	0.39*	–	–	–	–	–	–	–	–
	(2.782)	*(0.537)*	*(0.682)*	*(0.087)*	*(5.294)*	*(1.219)*	*(1.220)*	*(0.216)*								
Observations	393	1886	4010	3483	116	794	1,006	910	111	462	894	798	178	677	2,201	1,858
Hansen (*p*-value)	0.34	1.00	1.00	1.00	0.90	1.00	1.00	1.00	0.93	1.00	1.00	1.00	0.37	1.00	1.00	1.00
AB AR(1) (*p*-value)	0.02	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.11	0.00	0.00	0.00
AB AR(2) (*p*-value)	0.15	0.00	0.00	0.01	0.76	0.00	0.02	0.04	0.31	0.02	0.29	0.30	0.15	0.03	0.00	0.05

Note: See note in Table 3 for details. "British", "French", "German" and "Scandinavian" denote British, French, German and Scandinavian legal origins, respectively.

(statistically) negative coefficient; however, this effect on growth is mitigated particularly if a country has a Scandinavian legal origin.[28] For developing countries, both French and British legal origins appear with statistically significant positive interaction term coefficients when the government size proxy is total government expenditures.

As suggested by Ram (1986) another possible specification is the use of the growth rate of the government size proxy. We also test this specification to determine its impact on growth across political systems or levels of institutional quality. All variables are retained except G_{it} that is now replaced by dG_{it} / G_{it} together with the corresponding interaction terms.[29] Comparing with our previous results the coefficients of the linear term of government size proxies are positive and statistically significant in two out of five specifications. According to Conte and Darrat (1988) Ram's specification is suitable for testing short-term growth effects, while the specification used in this paper assesses the effects of government size on the underlying growth rate. Growth and development are long-run concepts whereas management of aggregate demand, a Keynesian prescription, is basically a short-term concept. Hence, while short-term measures of government may have a positive impact on an economy, the impact of government on the underlying growth rate generally differs between political regimes and legal origins as found in this paper (a comparable robustness analysis is available upon request).

Further in our inspection, similar regressions, where the I_{it} variable is now replaced with the composite Freedom House index, were estimated.[30] Two main results are worth mentioning: i) government size keeps its statistically significant negative sign, but its interaction with the Freedom House index yields a statistically negative coefficient (for the full sample), suggesting that the negative effect of government size on GDP per capita growth is stronger at lower levels of civil liberties and political rights; and ii) for the OECD sub-group debt has a statistically significant negative coefficient estimate and its interaction with the Freedom House index results in a negative estimate significant at 5 per cent level.

4.3 Robustness checks

One concern when working with time-series data is the possibility of spurious correlation between the variables of interest (Granger and Newbold, 1974). This situation arises when series are not stationary, that is, they contain stochastic trends as it is largely the case with GDP and investment series. The advantage of panel data integration is twofold: firstly, the tests are more powerful than the conventional ones: secondly, cross-section information reduces the probability of a spurious regression (Barnerjee, 1999). Results of first (Im, Pesaran and Shin, 1997; Maddala and Wu, 1999) and second generation (Pesaran, 2007) panel integration tests (not shown) suggest that we can accept most conservatively that non-stationarity cannot be ruled out in our dataset.

In face of this finding, it seems that the time-series properties of the data play an important role: we suggest that the bias in our models is the result of non-stationary errors, which are introduced into the fixed-effects and GMM equations by the imposition of parameter homogeneity. Hence, careful modelling of short-run dynamics requires a slightly different econometric approach. We assume that (8), or (9), represents the equilibrium which holds in the long-run, but that the

---

[28] Bergh and Henrekson (2011) propose two explanations for why countries (such as Scandinavian ones) with high taxes (hence, larger government size) are able to enjoy above average growth (which supports the absence of conclusive or statistically significant coefficients). One is that these countries have higher social trust; another is that their larger governments compensate for high taxes and spending by implementing market-friendly policies in other areas.

[29] The full table is available upon request.

[30] Ibidem.

dependent variable may deviate from its path in the short-run (due, e.g., to shocks that may be persistent). There are often good reasons to expect the long-run equilibrium relationships between variables to be similar across groups of countries, due e.g. to budget constraints or common technologies (unobserved TFP) influencing them in a similar way. In fact, in line with discussions in the empirical growth literature for modelling the "measure of our ignorance" we shall assume that the long-run relationship is composed of a country-specific level and a set of common factors with country-specific factor loadings.

The parameters of (8) and (9) can be obtained via recent panel data methods. Indeed, at the other extreme of panel procedures, based on the mean of the estimates (but not taking into account that certain parameters may be the same across groups), we have the Mean Group (MG)[31] estimator (Pesaran and Smith, 1995) and as an intermediate approach the Pooled Mean Group (PMG)[32] estimator, which involves both pooling and averaging (Pesaran *et al.*, 1999). These estimators are appropriate for the analysis of dynamic panels with both large time and cross-section dimensions, and they have the advantage of accommodating both the long-run equilibrium and the possibly heterogeneous dynamic adjustment process.

Therefore, a second step in our empirical approach is to make use of the Common Correlated Effects Pooled (CCEP) estimator that accounts for the presence of unobserved common factors by including cross-section averages of the dependent and independent variables in the regression equation and where averages are interacted with country-dummies to allow for country-specific parameters. In the heterogeneous version, the Common Correlated Effects Mean Group (CCEMG), the presence of unobserved common factors is achieved by construction and the estimates are obtained as averages of the individual estimates (Pesaran, 2006). A related and recently developed approach due to Eberhardt and Teal (2010) was termed Augmented Mean Group (AMG) estimator and it accounts for cross-sectional dependence by inclusion of a "common dynamic process".[33]

We base our panel analysis on the unrestricted error correction ARDL(*p,q*) representation:

$$\Delta y_{it} = \phi_i y_{it-1} + \beta'_i x_{it-1} + \sum_{j=1}^{p-1} \lambda_{ij} \Delta y_{it-j} + \sum_{q=1}^{q-1} \gamma'_{ij} \Delta x_{it-j} + \mu_i + u_{it}, i = 1,2,...,N; t = 1,2,...,T \qquad (10)$$

where y_{it} is a scalar dependent variable, x_{it} is the $k \times 1$ vector of regressors for group *i*, μ_i represents the fixed effects, ϕ_i is a scalar coefficient on the lagged dependent variable. β'_i's is the $k \times 1$ vector of coefficients on explanatory variables, λ_{ij}'s are scalar coefficients on lagged first-differences of dependent variables, and γ_{ij}'s are $k \times 1$ coefficient vectors on first-differences of explanatory variables and their lagged values. We assume that the disturbances u_{it}'s in the ARDL model are independently distributed across *i* and *t*, with zero means and constant variances. Assuming that $\phi_i < 0$ for all *i*, there exists a long-run relationship between y_{it} and x_{it} defined as:

$$y_{it} = \theta'_i y_{it-1} + \eta_{it}, i = 1,2,...,N; t = 1,2,...,T \qquad (11)$$

where $\theta'_i = -\beta_i' / \phi_i$ is the $k \times 1$ vector of the long-run coefficients, and η_{it}'s are stationary with possible non-zero means (including fixed effects). Equation (10) can be rewritten as:

[31] The MG approach consists of estimating separate regressions for each country and computing averages of the country-specific coefficients (Evans, 1997; Lee *et al.*, 1997). This allows for heterogeneity of all the parameters.

[32] This estimator allows the intercepts, short-run coefficients and error variances to differ freely across groups, but the long-run coefficients are constrained to be the same. The group-specific short-run coefficients and the common long-run coefficients are computed by the pooled maximum likelihood estimation.

[33] We thank Markus Eberhardt for making his code available.

$$\Delta y_{it} = \phi_i \eta_{it-1} + \sum_{j=1}^{p-1} \lambda_{ij} \Delta y_{it-j} + \sum_{q=1}^{q-1} \gamma'_{ij} \Delta x_{it-j} + \mu_i + u_{it}, i = 1,2,...,N; t = 1,2,...,T \quad (12)$$

where η_{it-1} is the error correction term given by (11), hence ϕ_i is the error correction coefficient measuring the speed of adjustment towards the long-run equilibrium.

Table 5 presents our first set of robustness results, and it includes for each sub-sample both the PMG and MG estimates using different proxies for institutional quality entering in linear form together with the Gwartney and Lawson government size variable. For the OECD sub-group we get a positive and statistically significant coefficient on democracy in specification 4 and three statistically negative coefficients of government size when using the MG estimator. One should expect rich countries to get a negative correlation between government size and growth if thought in terms of the Olson's (1982) mechanism: organized interest groups tend to evolve, and struggle to get advantages for themselves in the form of transfers or legislation, which have a side effect, delaying the regular functioning and growth of economy. The scope for interest group action is likely to be greater in countries with larger governments, where there is increased potential for profits from rent-seeking activities, leading to a greater diversion of resources to unproductive ends (Buchanan, 1980). In a recent paper, Bergh and Karlsson (2010) also uncovered a detrimental growth effect of larger governments in a panel of rich countries using the Bayesian Average over Classical Estimates approach. For both emerging and developing countries (Panels B and C) statistical significance of government size is hard to find,[34] but the institutional proxy is statistically significant for emerging countries (*pr*, political rights, and democracy), and for developing countries (*cl*, civil liberties).

The MG estimator provides consistent estimates of the mean of the long-run coefficients, though these will be inefficient if slope homogeneity holds. Under long-run slope homogeneity, the pooled estimators are consistent and efficient. The hypothesis of homogeneity is tested empirically in all specifications using a Hausman-type test applied to the difference between MG and PMG. Under the null hypothesis the difference in the estimated coefficients between the MG and the PMG estimators is not significant and the PMG is more efficient. The p-value of such a test is also present in Table 6.a, and only for the OECD the null is rejected, being the MG estimator more efficient, and the long-run slope homogeneity rejected.

An equivalent set of results (not shown) with the interaction term between government size and an institutional proxy of interest reveals shows that in the case of the OECD the interaction term is negative and statistically significant for the polity indicator instance. However, the government size is not significant. In the case of developing countries, with the polity variable, government size negatively affects the level of per capita GDP, institutional quality appears with positive and statistically significant estimate and, we get a negative interaction coefficient.

We redo the exercise but similarly to Tables 3 and 4 allow for other proxies of government size to play a role (see Table 6). Only estimated coefficients of the government size proxy, the institutional quality PCA-based measure and the interaction term are reported for reasons of parsimony (full results are available upon request). We present different econometric specifications mainly for robustness and completeness. All in all, we get negative and statistically significant coefficients on total government expenditure, government consumption and public debt-to-GDP ratio irrespectively of the sample under scrutiny. Our results are in line with Romero-Avila and Strauch (2008) who found a negative a significant effect from government consumption (and

[34] In poor countries public sectors are typically small, and the relationship between government size and growth can even be positive (because a state typically succeeds in collecting taxes when successful at providing the stability necessary for economic activity – sound institutions – to start growth) – see Besley and Persson (2009).

Table 5

Results of Estimations Allowing for Heterogeneous Technology Parameters but Homogeneous Factor Loadings

Panel A

Sample	**OECD**							
Estimator	**PMG**				**MG**			
Spec.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Institutional variable	cl	pr	polity	demo	cl	pr	polity	demo
ln k	0.73^{***} *(0.090)*	0.55^{***} *(0.082)*	0.71^{***} *(0.085)*	0.54^{***} *(0.104)*	0.68^{***} *(0.101)*	0.68^{***} *(0.097)*	0.39^{***} *(0.068)*	0.47^{***} *(0.105)*
G	–0.01 *(0.010)*	–0.01 *(0.009)*	–0.01 *(0.011)*	–0.00 *(0.012)*	-0.02^{*} *(0.012)*	-0.02^{**} *(0.010)*	-0.01^{*} *(0.009)*	–0.02 *(0.012)*
I	0.01 *(0.005)*	0.00 *(0.006)*	0.00 *(0.002)*	0.001^{**} *(0.001)*	0.01 *(0.013)*	0.00 *(0.007)*	0.00 *(0.002)*	0.00 *(0.002)*
Error Correction	-0.75^{***} *(0.192)*	-0.46^{***} *(0.156)*	-0.79^{***} *(0.000)*	-0.65^{***} *(0.000)*	–0.57 *(0.852)*	–0.62 *(0.904)*	–0.88 *(0.909)*	–0.79 *(0.837)*
Hausman test for homogeneity (*p*-value)	0.05	0.03	0.01	0.03				

Panel B

Sample	**Emerging**							
Estimator	**PMG**				**MG**			
Institutional variable	cl	pr	polity	demo	cl	pr	polity	demo
ln k	0.88^{***} *(0.173)*	0.94^{***} *(0.163)*	0.76^{***} *(0.200)*	1.33^{***} *(0.340)*	–0.12 *(0.642)*	0.28^{*} *(0.155)*	–0.09 *(0.391)*	–0.69 *(0.544)*
G	–0.01 *(0.020)*	–0.00 *(0.014)*	–0.01 *(0.011)*	–0.01 *(0.020)*	–0.02 *(0.028)*	–0.02 *(0.024)*	0.01 *(0.031)*	0.01 *(0.029)*
I	0.01 *(0.007)*	0.02^{*} *(0.120)*	–0.01 *(0.007)*	0.01^{*} *(0.004)*	0.02 *(0.040)*	–0.02 *(0.021)*	0.01 *(0.019)*	0.00 *(0.008)*
Error Correction	-0.69^{***} *(0.000)*	-0.72^{***} *(0.001)*	-0.75^{***} *(0.000)*	0.83^{***} *(0.002)*	-0.90^{***} *(0.172)*	–0.51 *(1.43)*	-0.71^{***} *(0.181)*	-0.92^{***} *(0.177)*
Hausman test for homogeneity (*p*-value)	0.31	0.02	0.31	0.26				

Panel C

Sample	**Developing**							
Estimator	**PMG**				**MG**			
Institutional variable	cl	pr	polity	demo	cl	pr	polity	demo
ln k	0.33^{***} *(0.091)*	0.11 *(0.110)*	0.63^{***} *(0.109)*	0.45^{***} *(0.113)*	0.81^{***} *(0.255)*	0.79^{***} *(0.234)*	0.52^{***} *(0.193)*	0.68^{***} *(0.230)*
g	0.01 *(0.007)*	0.01 *(0.004)*	0.003 *(0.009)*	0.001 *(0.009)*	–0.02 *(0.021)*	–0.02 *(0.018)*	–0.01 *(0.011)*	-0.02^{*} *(0.012)*
I	–0.01 *(0.008)*	–0.01 *(0.012)*	0.01 *(0.012)*	–0.001 *(0.002)*	0.03^{**} *(0.016)*	–0.02 *(0.016)*	0.00 *(0.020)*	0.003 *(0.003)*
Error Correction	-0.54^{***} *(0.001)*	-0.18^{***} *(0.001)*	-0.72^{***} *(0.000)*	-0.60^{***} *(0.000)*	-0.76^{***} *(0.085)*	-0.71^{***} *(0.088)*	–0.25 *(0.249)*	-0.93^{***} *(0.128)*
Hausman test for homogeneity (*p*-value)	0.11	0.85	0.15	0.18				

Note: The models are estimated by either PMG or MG estimators. The dependent variable is the logarithm of real GDP per capita. A time trend has been included but is not reported for reasons of parsimony. Hausman test for homogeneity: under the null hypothesis the difference in the estimated coefficients between the MG and PMG estimators, it is not significant and PMG is more efficient. *, **, *** denote significance at 10, 5 and 1 per cent levels.

Table 6

Results of Estimations Allowing for Homogeneous and/or Heterogeneous Technology Parameters and Factor Loadings, With and Without Interaction Terms. PCA-based Institutional Measure. Different Government Size Proxies

Sample	**OECD**				**Emerging**				**Developing**			
Estimator	**OLS**	**MG**	**CCEP**	**AMG**	**OLS**	**MG**	**CCEP**	**AMG**	**OLS**	**MG**	**CCEP**	**AMG**
Spec.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
totgovexp_gdp	0.00	–0.002***	–0.01***	–0.00*	–0.03***	0.00	–0.001***	0.00	–0.00	–0.00	–0.001***	–0.00
	(0.001)	*(0.001)*	*(0.001)*	*(0.001)*	*(0.005)*	*(0.001)*	*(0.001)*	*(0.002)*	*(0.003)*	*(0.001)*	*(0.001)*	*(0.001)*
I	1.02***	0.02	0.014	–0.49	0.43***	–2.60	0.01	–4.29	0.65***	–3.91	0.01	–0.00
	(0.059)	*(2.491)*	*(0.032)*	*(2.903)*	*(0.068)*	*(2.598)*	*(0.010)*	*(4.293)*	*(0.039)*	*(3.894)*	*(0.017)*	*(0.019)*
govcons_gdp	–0.02***	0.00	–0.02***	0.00	–0.06***	–0.00	–0.001**	–0.00	–0.02***	0.00	–0.003**	–0.00
	(0.005)	*(0.002)*	*(0.002)*	*(0.002)*	*(0.006)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.003)*	*(0.002)*	*(0.001)*	*(0.002)*
I	0.93***	1.56	0.04***	3.89**	0.46***	–0.01	0.00	–0.00	0.63***	–0.04	–0.00	–0.02
	(0.058)	*(1.056)*	*(0.012)*	*(1.768)*	*(0.058)*	*(0.017)*	*(0.010)*	*(0.016)*	*(0.028)*	*(0.027)*	*(0.011)*	*(0.022)*
govdebt_gdp	0.00	–0.00	–0.001***	–0.00	–0.001***	–0.00	0.00	–0.001**	–0.002**	–0.00	–0.001***	–0.002**
	(0.001)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.001)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.002)*	*(0.000)*	*(0.001)*
I	1.09***	1.17	0.04***	1.99	0.45***	0.00	–0.01	–0.01	0.62***	–2.86	0.00	–2.86
	(0.053)	*(1.988)*	*(0.013)*	*(2.410)*	*(0.062)*	*(0.020)*	*(0.011)*	*(0.019)*	*(0.031)*	*(2.414)*	*(0.011)*	*(2.628)*
totgovexp_gdp	–0.001*	4.42	0.01***	–0.26	–0.03***	6.94	–0.001***	–0.00	0.00	–0.02	–0.01***	–0.01*
	(0.003)	*(5.179)*	*(0.001)*	*(0.747)*	*(0.005)*	*(6.946)*	*(0.001)*	*(0.002)*	*(0.003)*	*(0.020)*	*(0.001)*	*(0.006)*
I	1.16***	152.49	0.01	–10.31	0.76***	243.48	0.03	0.07	0.28**	–0.40	0.12***	0.12
	(0.091)	*(180.465)*	*(0.033)*	*(16.802)*	*(0.229)*	*(243.301)*	*(0.028)*	*(0.083)*	*(0.118)*	*(0.837)*	*(0.039)*	*(0.251)*
I*g	–0.00*	–4.53	0.00	0.22	–0.01*	–6.96	–0.00	–0.00	–0.02***	0.01	–0.004***	–0.00
	(0.003)	*(5.162)*	*(0.001)*	*(0.624)*	*(0.007)*	*(6.959)*	*(0.001)*	*(0.003)*	*(0.005)*	*(0.027)*	*(0.001)*	*(0.009)*
govcons_gdp	–0.09***	–2.04	0.00	–2.66	–0.06***	0.68	–0.01***	–0.63	–0.02***	–0.17	–0.003***	–0.16
	(0.014)	*(2.120)*	*(0.004)*	*(2.215)*	*(0.006)*	*(0.980)*	*(0.002)*	*(0.743)*	*(0.003)*	*(0.173)*	*(0.001)*	*(0.175)*
I	0.26*	–46.66	0.11***	0.78*	0.73***	12.56	0.16***	–12.10	0.78***	–10.40	0.09***	–10.57
	(0.155)	*(32.780)*	*(0.039)*	*(0.394)*	*(0.179)*	*(19.236)*	*(0.028)*	*(14.459)*	*(0.077)*	*(10.266)*	*(0.024)*	*(10.325)*
I*g	–0.10***	1.74	–0.01***	2.37	–0.02*	–0.68	–0.01***	0.64	–0.01**	0.30	–0.01***	0.31
	(0.012)	*(1.775)*	*(0.003)*	*(1.907)*	*(0.010)*	*(0.981)*	*(0.002)*	*(0.743)*	*(0.005)*	*(0.290)*	*(0.001)*	*(0.292)*
govdebt_gdp	–0.00	–0.26	–0.001***	–0.32	–0.002***	0.89	0.00	0.41	–0.00	0.24	–0.002***	0.20
	(0.002)	*(0.288)*	*(0.000)*	*(0.271)*	*(0.001)*	*(1.096)*	*(0.000)*	*(0.476)*	*(0.000)*	*(0.188)*	*(0.000)*	*(0.204)*
I	0.91***	–9.52	0.05**	–9.93	0.60***	15.50	–0.02	7.53	0.72***	1.64	0.00	5.23
	(0.104)	*(9.635)*	*(0.019)*	*(9.260)*	*(0.119)*	*(21.701)*	*(0.017)*	*(9.332)*	*(0.049)*	*(4.870)*	*(0.014)*	*(5.012)*
I*g	–0.002*	0.24	–0.00	0.29	–0.001*	–0.90	0.00	–0.42	–0.002**	–0.24	–0.00	–0.34
	(0.002)	*(0.256)*	*(0.000)*	*(0.241)*	*(0.002)*	*(1.096)*	*(0.000)*	*(0.476)*	*(0.001)*	*(0.307)*	*(0.000)*	*(0.342)*

Note: The models are estimated by Pooled OLS, MG, CCEP or AMG estimators. The dependent variable is the logarithm of real GDP per capita. *, **, *** denote significance at 10, 5 and 1 per cent levels.

transfers) on economic growth. We refrain from making a detailed analysis. Still, for instance, specifications 7 and 11 for the emerging and developing countries groups and with the government consumption as a proxy for government size show a negative effect of government consumption, and a positive effect of the PCA-based institutional measure. Finally, there is a negative interaction term: i) the negative effect of government consumption on GDP per capita is stronger at lower levels of institutional quality, and ii) the positive effect of institutional quality on GDP per capita increases at smaller levels of government consumption.

5 Conclusion

We outlined a growth model with an explicit government role showing that more resources required to finance government spending reduce both the optimal level of private consumption and of output per worker. Following up on that theoretical motivation we perform an empirical panel analysis with 108 countries from 1970-2008, employing different proxies for government size and institutional quality.

Therefore, we provide additional evidence on the issue of whether "too much" government is good or bad for economic progress and macroeconomic performance, particularly when associated with differentiated levels of (underlying) institutional quality and alternative political regimes.

Moreover, we make use of recent panel data techniques that allow for the possibility of heterogeneous dynamic adjustment around the long-run equilibrium relationship as well as heterogeneous unobserved parameters and cross-sectional dependence (e.g., Pooled Mean Group, Mean Group, Common Correlated Pooled estimators, inter alia); we also deal with potentially relevant endogeneity issues.

Our results allow for several conclusions regarding the effects on economic growth of the size of the government: i) there is a significant negative effect of the size of government on growth; ii) institutional quality has a significant positive impact on the level of real GDP per capita; iii) government consumption is consistently detrimental to output growth irrespective of the country sample considered (OECD, emerging and developing countries); iv) moreover, the negative effect of government size on GDP per capita is stronger at lower levels of institutional quality, and the positive effect of institutional quality on GDP per capita is stronger at smaller levels of government size. Therefore, our empirical results are consistent with the growth model presented in the paper.

In addition, the negative effect on growth stemming from the government size variables is more attenuated for the case of Scandinavian legal origins, while the negative effect of government size on GDP per capita growth is stronger at lower levels of civil liberties and political rights.

APPENDIX
VARIABLES AND SOURCES

Variable	Definition/Description	Acronym	Source
REAL GDP per capita		*Gdppc*	World Bank's Word Development Indicators (WDI)
gross fixed capital formation (% GDP)		*Gfcf_gdp*	WDI
Public investment (% GDP)		*Pubinv_gdp*	WDI and AMECO for advanced countries
real aggregate investment in PPP		*Inv*	Summers and Heston's PWT 6.3
Government size	Composite variable (*govsize*). This variable includes government consumption expenditures (as percentage of total consumption), transfers and subsidies (as percentage of GDP), the underlying tax system (proxied by top marginal tax rates) and the number of government enterprises.	*govsize*	Gwartney and Lawson (2008)
Central Government Debt (% GDP)		*Govdebt_gdp*	IMF (Abas *et al.*, 2010)
Total Government Expenditure (% GDP)		*Totgovexp_gdp*	WDI, IMF IFS, Easterly (2001)
Public Final Consumption Expenditure (% GDP)		*Govcons_gdp*	WDI, IMF IFS, Easterly (2001)
Polity 2	The polity score is computed by subtracting the autoc score (autocracy index) from the democ score (democracy index); the resulting unified polity scale ranges from +10 (strongly democratic) to –10 (strongly autocratic). Refer to the database's supporting documentation for more details.	*polity*	Marshall and Jaegger's Polity's 4 database
Political Rights	Political rights enable people to participate freely in the political process, including the right to vote freely for distinct alternatives in legitimate elections, compete for public office, join political parties and organizations, and elect representatives who have a decisive impact on public policies and are accountable to the electorate.	*pr*	Freedom House
Civil Liberties	Civil liberties include freedom of speech, expression and the press; freedom of religion; freedom of assembly and association; and the right to due judicial process.	*cl*	Freedom House
corruption perception index	The CPI focuses on corruption in the public sector and defines corruption as the abuse of public office for private gain. The CPI Score relates to perceptions of the degree of corruption as seen by business people, risk analysts and the general public.	*cpi*	Transparency International database
index of democratization	This index combines two basic dimensions of democracy – competition and participation – measured as the percentage of votes not cast for the largest party (Competition) times the percentage of the population who actually voted in the election (Participation).	*demo*	Vanhanen (2005)
governance index	This is the result of averaging 6 variables: voice and accoutability, political stability, government effectiveness, regulatory quality, rule of law and control of corruption.	*governance*	Kaufman *et al.* (2009)
legal origins	English, French, German or Scandinavian	*bri*, *fre*, *ger* and *sca*	La Porta *et al.*, 1999
Regime durability	The number of years since the most recent regime change (defined by a three point change in the p_polity score over a period of three years or less) or the end of transition period defined by the lack of stable political institutions (denoted by a standardized authority score).	*Durable*	Marshall and Jaegger's Polity's 4 database
latitude		*latitude*	La Porta *et al.*, 1999
ethnic fragmentation	Reflects probability that two randomly selected people from a given country will not belong to the same ethnolinguistic group. The higher the number, the more fractionalized society.	*ethnic*	Alesina *et al.*, 2003

Countries in the dataset

Afghanistan, Albania, Algeria, Angola, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahrain, Bangladesh, Belarus, Belgium, Benin, Bhutan, Bolivia, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Canada, Chad, Chile, China, Colombia, Comoros, Congo, Dem. Rep., Congo, Rep., Costa Rica, Cote d'Ivoire, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, Arab Rep., El Salvador, Equatorial Guinea, Estonia, Finland, France, Gabon, Gambia, The, Georgia, Germany, Ghana, Greece, Guatemala, Guinea, Guyana, Hungary, Iceland, India, Indonesia, Iran, Islamic Rep., Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kiribati, Korea, Rep., Kuwait, Kyrgyz Republic, Lao PDR, Latvia, Lebanon, Lesotho, Liberia, Libya, Lithuania, Luxembourg, Macedonia, FYR, Madagascar, Malawi, Malaysia, Mauritania, Mauritius, Mexico, Mongolia, Montenegro, Morocco, Namibia, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russian Federation, Rwanda, Samoa, San Marino, Saudi Arabia, Senegal, Serbia, Sierra Leone, Singapore, Slovak Republic, Slovenia, Somalia, South Africa, Spain, Sri Lanka, Sudan, Suriname, Swaziland, Sweden, Switzerland, Syrian Arab Republic, Thailand, Trinidad and Tobago, Tunisia, Turkey, Uganda, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Uzbekistan, Venezuela, RB, Vietnam, Yemen, Rep., Zambia, Zimbabwe.

REFERENCES

Abas, A., N. Belhocine, A. El Ganainy and M. Horton (2010), "A Historical Public Debt Database", IMF, Working Paper, No. 10/245.

Acemoglu, D. and J. Robinson (2005), *Economic Origins of Dictatorship and Democracy*, Cambridge University Press.

Acemoglu, D., S. Johnson and J.A. Robinson (2001),"The Colonial Origins of Comparative Development: An Empirical Investigation", *American Economic Review*, No. 91, pp. 1369-401.

Afonso, A., L. Schuknecht and V. Tanzi (2005). "Public Sector Efficiency: An International Comparison", *Public Choice*, Vol. 123, No. 3-4, pp. 321-47.

—————(2011), "Income Distribution Determinants and Public Spending Efficiency", *Journal of Economic Inequality*, Vol. 8, No. 3, pp. 367-89.

Alesina, A. and E. La Ferrara (2000), "The Determinants of Trust", NBER, Working Paper, No. 7621.

Alesina, A., A. Devleeschauwer, W. Easterly, S. Kurlat and R. Wacziarg (2003), "Fractionalization", *Journal of Economic Growth*, No. 8, pp. 155-94.

Angelopoulos, K., A. Philippopoulos and E. Tsionas (2008), "Does Public Sector Efficiency Matter? Revisiting the Relation Between Fiscal Size and Economic Growth in a World Sample", *Public Choice*, Vol. 137, No. 1-2, pp. 245-78.

Bajo-Rubio, O. (1991), "A Further Generalization of the Solow Growth Model: The Role of the Public Sector", *Economic Letters*, Vol. 68, pp. 79-84.

Banerjee, A. (1999), "Panel Data, Unit Roots and Cointegration: An Overview", *Oxford Bulletin of Economics and Statistics*, special issue on "Testing Unit Roots and Cointegration Using Panel Data", *Theory and Applications*, No. 61, pp. 607-29, November.

Barro, R. (1991), "Economic Growth in a Cross Section of Countries", *Quarterly Journal of Economics*, No. 106, pp. 407-43.

Barro, R. and X. Sala–i–Martín, (1992), "Convergence", *Journal of Political Economy*, No. 100, p. 223-51.

Beck, T., G. Clarke, A. Groff, P. Keefer and P. Walsh (2001), "New Tools and New Tests in Comparative Political Economy: The Database of Political Institutions", *World Bank Economic Review*, No. 15, pp. 165-76.

Bergh, A. and M. Karlsson (2010), "Government Size and Growth: Accounting for Economic Freedom and Globalization", *Public Choice*, No. 142, pp. 195-213.

Bergh, A. and M. Henrekson (2011), "Government Size and Growth: A Survey and Interpretation of the Evidence", *Journal of Economic Surveys*, Vol. 25, No. 5, pp. 872-97.

Besley, T. and T. Persson (2009), "The Origins of State Capacity: Property Rights, Taxation, and Policy", *American Economic Review*, Vol. 99, No. 4, pp. 1218-44.

Bockstette, V, A. Chanda and L. Putterman (2002), "States and Markets: The Advantage of an Early Start", *Journal of Economic Growth*, Vol. 7, No. 4, pp. 347-69.

Browsher, C.G. (2002), "On Testing Overidentifying Restrictions in Dynamic Panel Data Models", CEPR, Discussion Paper, No. 3048, London.

Buchanan, J. (1980), "Rent-seeking and Profit-seeking", in J.M. Buchanan and G. Tullock (eds.), *Towards a Theory of the Rent–seeking Society*, College Station (TX).

Chen, B. (2006), "Economic Growth with Optimal Public Spending Composition", *Oxford Economic Papers*, No. 58, pp. 123-36.

Coakley, J., A.M. Fuertes and R. Smith (2006), "Unobserved Heterogeneity in Panel Time Series Models", *Computational Statistics and Data Analysis*, Vol. 50, No. 9, pp. 2361-80.

Conte, M.A. and A.F. Darrat (1988), "Economic Growth and the Expanding Public Sector", *Review of Economics and Statistics*, Vol. 70, No. 2, pp. 322-30.

Dalamagas, B. (2000), "Public Sector and Economic Growth: The Greek Experience", *Applied Economics*, No. 32, pp. 277-88.

Dempster, A.P., N.M. Laird and D.B. Rubin (1977), "Maximum Likelihood from Incomplete Data Via the EM Algorithm", *Journal Royal Statistical Society B*, No. 39, pp. 1–22.

Devarajan, S., V. Swaroop and H. Zou (1996), "The Composition of Public Expenditure and Economic Growth", *Journal of Monetary Economics*, No. 37, pp. 313-44.

Dollar, D. and A. Kraay (2003), "Institutions, Trade and Growth", *Journal of Monetary Economics*, No. 50, pp. 133-62.

Dupuit, J. (1844), "De la Mesure de l'Utilité des Travaux Publiques", in *Annales des Ponts et Chaussées, Vol. 8*, translated and reprinted in: K. Arrow and T. Scitovski (eds.) (1969), *AEA Readings in Welfare Economics*, AEA, pp. 255-83.

Easterly, W.R. (2001), "The Lost Decades: Developing Countries Stagnation in Spite of Policy Reform 1980-1998", *Journal of Economic Growth*, Vol. 6, No. 2, pp. 135-57.

Eberhardt, M. and F. Teal (2010), "Productivity Analysis in Global Manufacturing Production", Oxford University, Discussion Paper, No. 515, November.

Evans, P. (1997), "How Fast Do Economies Converge", *Review of Economics and Statistics*, No. 46, pp. 1251-71.

Fölster, S. and M. Henrekson (2001), "Growth Effects of Government Expenditure and Taxation in Rich Countries", *European Economic Review*, No. 45, pp. 1501-20.

Friedman, M. (1997), "If Only the US Were as Free as Hong Kong", *Wall Street Journal*, July 8, A14.

Ghali, K.H. (1998), "Government Size and Economic Growth: Evidence from a Multivariate Cointegration Analysis", *Applied Economics*, Vol. 31, pp. 975-87.

Glomm, G. and B. Ravikumar (1997), "Productive Government Expenditures and Long-run Growth", *Journal of Economic Dynamics and Control*, Vol. 21, pp. 183-204.

Goel, R. and M. Nelson (1998), "Corruption and Government Size: A Disaggregated Analysis", *Public Choice*, Vol. 97, No. 1-2, pp. 107-20.

Granger, C.W.J. and P. Newbold (1974), "Spurious Regressions in Econometrics", *Journal of Econometrics*, No. 2, pp. 111-20.

Greene, W. (2003), *Econometric Analysis*, Pearson Education Inc. (NJ).

Grossman, P. (1988), "Government and Economic Growth: A Non–linear Relationship", *Public Choice*, Vol. 56, No. 2, pp. 193-200.

Guseh, J.S. (1997), "Government Size and Economic Growth in Developing Countries: A Political–economy Framework", *Journal of Macroeconomics*, No. 19, pp. 175-92.

Gwartney, J. and R.A. Lawson (2008), "Economic Freedom of the World: 2008 Annual Report", available at: http://freetheworld.com/

Hall, R.E. and C. Jones (1999), "Why Do Some Countries Produce So Much More Output per Worker than Others?", *Quarterly Journal of Economics*, No. 114, pp. 83-116.

Holcombe, R. (2005), "Government Growth in the Twenty–first Century", *Public Choice*, Vol. 124, No. 1-2, pp. 95-114.

Im, K.S., M.H. Pesaran and Y. Shin (2003), "Testing for Unit Roots in Heterogeneous Panels", *Journal of Econometrics*, No. 115, pp. 53-74.

IMF (2001), "A Manual on Government Finance Statistics 2001", (GFSM 2001), IMF, Washington (D.C.), available at: http://www.imf.org/external/pubs/ft/gfs/ manual/gfs.htm

Jalles, J.T. (2010), "Does Democracy Foster or Hinder Growth? Extreme–type Political Regimes in a Large Panel", *Economics Bulletin*, Vol. 30, No. 2, pp. 1359-72.

Kapetanios, G., M.H. Pesaran and T. Yamagata (2011), "Panels with Non-stationary Multifactor Error Structures", *Journal of Econometrics*, Vol. 160, No. 2, pp. 326-48.

Kaufmann, D., A. Kraay and M. Mastruzzi (2009), "Governance Matters VIII: Aggregate and Individual Governance Indicators for 1996-2008", World Bank, Policy Research Paper, No. 4978, available at: http://ssrn.com/abstract=1424591

Kneller, R., M. Bleaney and N. Gemmell (1999), "Fiscal Policy and Growth: Evidence from OECD Countries", *Journal of Public Economics*, No. 74, pp. 171-90.

La Porta, R., F. López-de-Silanes, A. Shleifer and R. Vishny (1997), "Legal Determinants of External Finance", *Journal of Finance*, No. 52, pp. 1131-50.

—————— (1998), "Law and Finance", *Journal of Political Economy*, No. 106, pp. 1113-55.

—————— (1999), "The Quality of Government", *Journal of Law, Economics and Organization*, Vol. 15, No. 1, pp. 222-79.

Lee, J. (1992), "Optimal Size and Composition of Government Spending", *Journal of the Japanese and International Economies*, No. 6, pp. 423-39.

Lee, K., M.H. Pesaran and R.P. Smith (1997), "Growth and Convergence in a Multi–country Empirical Stochastic Solow Model", *Journal of Applied Econometrics*, No. 12, pp. 357-92.

Little, J.A. and D.B. Rubin (1987), *Statistical Analysis with Missing Data*, John Wiley and Sons, New York (NY).

Maddala, G.S. and S. Wu (1999), "A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test", *Oxford Bulletin of Economics and Statistics*, Vol. 61, pp. 631-52, November.

Mankiw, N.G., D. Romer and D.N. Weil (1992), "A Contribution to the Empirics of Economic Growth", *Quarterly Journal of Economics*, No. 107, pp. 407-37.

Mauro, P. (1995), "Corruption and Growth", *Quarterly Journal of Economics*, No. 110, pp. 681-712.

Nelson, R.R. and B.N. Sampat (2001), "Making Sense of Institutions as a Factor Shaping Economic Performance", *Journal of Economic Behavior and Organization*, No. 44, pp. 31-54.

North, D. (1990), *Institutions, Institutional Change and Economic Performance*, Cambridge University Press, Cambridge (MA).

Olson, M. (1982), *The Rise and Decline of Nations: Economic Growth, Stagflation, and Social Rigidities*, Yale University Press, New Haven (CN).

Peden, E. and M. Bradley (1989), "Government Size, Productivity and Economic Growth: The Post–war Experience", *Public Choice*, Vol. 61, No. 3, pp. 229-45.

Pesaran, M.H. (2006), "Estimation and Inference in Large Heterogeneous Panels with a Multifactor Error Structure", *Econometrica*, Vol. 74, No. 4, pp. 967-1012.

—————(2007), "A Simple Panel Unit Root Test in the Presence of Cross Section Dependence", *Journal of Applied Econometrics*, Vol. 22, No. 2, pp. 265-312.

Pesaran, M.H. and R.P. Smith (1995), "Estimating Long–run Relationship from Dynamic Heterogeneous Panels", *Journal of Econometrics*, No. 68, pp. 79-113.

Pesaran, M.H., Y. Shin and R.P. Smith (1999), "Pooled Mean Group Estimation of Dynamic Heterogeneous Panels", *Journal of American Statistical Association*, No. 94, pp. 31-54.

Poterba, J.M. (1996), "Budget Institutions and Fiscal Policy in the U.S. States", *American Economic Review*, Vol. 86, No. 2, pp. 395-400.

Przeworski, A., M. Alvarez, J. Cheibub and F. Limongi (2000), "Democracy and Development: Political Regimes and Economic Well–being in the World, 1950-1990", Cambridge University Press, New York (NY).

Ram, R. (1986), "Government Size and Economic Growth: A New Framework and Some Evidence from Cross–section and Time Series Data", *American Economic Review*, No. 76, pp. 191-203.

Rock, M. (2009), "Has Democracy Slowed Growth in Asia?", *World Development*, Vol. 37, No. 5, pp. 941-52.

Rodrik, D. and R. Wacziarg (2005), "Do Democratic Transitions Produce Bad Economic Outcomes?", *American Economic Review*, Vol. 95, No. 3, pp. 50-55.

Romero–Ávila, D. and R. Struch (2008), "Public Finances and Long–term Growth in Europe: Evidence from a Panel Data Analysis", *European Journal of Political Economy*, Vol. 24, No. 1, pp. 172–91.

Roodman, D.M. (2009), "A Note on the Theme of Too Many Instruments", *Oxford Bulletin of Economics and Statistics*, Vol. 71, No. 1, pp. 135-58.

Rousseeuw, P.J. and K. Van Driessen (1999), "A Fast Algorithm for the Minimum Covariance Determinant Estimator", *Technometrics*, No. 41, pp. 212-23.

Slemrod, J. (1995), "What Do Cross–country Studies Teach About Government Involvement, Prosperity, and Economic Growth?", Brookings Papers on Economic Activity, No. 2, pp. 373-431.

Tanzi V. and H. Zee (1997), "Fiscal Policy and Long–run Growth", IMF, Staff Papers, No. 44, pp. 179-209.

Vanhanen, T. (2005), "Measures of Democracy 1810-2004" [computer file]. FSD1289, version 2.0 (2005-08-17), Tampere: Finnish Social Science Data Archive [distributor].

FISCAL POLICY AND ECONOMIC GROWTH: THE CASE OF ALBANIA

Gerti Shijaku[*] *and Arlind Gjokuta*[**]

This discussion material analysis the effects of fiscal policy on the economic growth in the case of a small open developing country, Albania, by employing an endogenous growth model on a GMM approach. The results obtained show that government revenue growth has a higher effect on economic growth than government expenditure. The impact of revenue and expenditure on growth were analysed by categorising tax revenue into distortionary and non-distortionary, whilst government expenditure were divided into productive and non-productive. Under such composition we found that revenue sub-categories reduce growth, while distortionary taxation has much larger and statistically significant effect. Besides, the parameter values show that growth is effected positively by productive expenditure and negatively by non-productive. This material also analysis the impact of public debt on growth and finds that the size of public debt is negatively related to growth rate.

1 Introduction

The role of fiscal policy (FP) on economic growth has driven several studies both on the theoretical and on the empirical fronts. Modern macroeconomic literature emphasises both the short run and the long run objectives of FP (Romer, 2006). In the short run it can be used to counter output cyclicality and/or stabilise volatility in macro variables, which is descriptively same as the effects of the short run monetary policy. Further for the long-run, FP and the debt financing methods can also affect both demand and supply side of the economy. The subject on the effects of FP on economic growth is quite relevant, since the development of appropriate fiscal instruments could lead to a persistent and sustainable boost on economic growth. Thus, the aim of this paper is to examine the fiscal policy-growth relationship in the case of a small open developing country, Albania, as it is crucial to know how public activities through taxation and expenditure policies have served as an incentive to growth.

By the end of the '90s and during the last decade, Albanian economic policies aimed at maintaining macroeconomic stability, enable poverty-reducing and non-inflationary economic growth policies and achieving fiscal consolidation through budget deficit and public debt reduction. As such public finance saw major reformation aiming at government expenditure cuts and boosting revenues, expanding the tax base, simplifying and implementing new tax system, promoting tax intensive through reducing tax burden on business, and reducing informality and tax evasion. Tax revenues witnessed major reductions in custom duties rate due to Free Trade Agreements under the Stabilization and Association agreement with the European Union, the CEFTA and World Trade Organization membership. This was followed by considerable raise in national, local and excise tax level, cuts in social contributions and small business tax and the changes in the threshold for VAT registration. In addition, tax legislation changes were finalised with the elimination of all exclusions and facilitations under the old tax system, the approval of a 10 per cent flat income tax in 2007 and the reduction of the profit tax to only 10 per cent in 2008.

Further, the Albanian economy took advantages of macroeconomic stimulus in the form of fiscal expansion during 2007-09, mainly as a result of previous work to consolidate the fiscal

[*] Bank of Albania, Research Department, E-mail: gshijaku@bankofalbania.org

[**] Bank of Albania, Monetary and Operational Department, E-mail: agjokuta@bankofalbania.org

The views expressed herein are of the authors and do not necessarily reflect the views of the Bank of Albania.

position and the anchoring of macroeconomic policies and public expectations. Albanian economy, hence, was faced with the effect of global crisis enjoying a counter-cyclical FP during 2009, reinforcing the trend that began during the period 2007-08. On the other hand, apparently these economic incentives mitigated the adverse effects that had on the Albanian economy the global financial crisis.

In this case the questions coming up relate to the analysis of what are the concrete effects of fiscal policies on economic growth, in the case of Albania? Have they stimulated economic growth? This discussion paper focused on how the government activities, namely composition of expenditures and revenues, affect the long run growth rate? The answer to these questions is quite difficult because the transmission operation mechanisms of the effects of FP are quite complex and above all the effects take time to be displayed fully.

To our best knowledge, fiscal-growth relationship has only recently been empirically studied in the case of Albania, so far. In a recent discussion material, Mançellari (2011) studied the effects of FP in Albania based on a model with four macroeconomics variables, namely FP, Gross Domestic Product (GDP), interest rates and the prices level, through a SVAR and impulse responses approach. The analysis was based on the methodology developed by Blanchard and Perotti (2002). The main findings of this paper, concluded that FP does affect economic activity, cuts in tax burden has the highest cumulative GDP multiplier and the GDP multiplier of capital expenditure is greater that current expenditure multiplier.

In this paper, unlike Mançellari (2011), we contribute to the fiscal-growth subject in the case of Albania in various ways. First, FP is considered to be endogenous, but we based our empirical analysis of fiscal-growth relationship on a different endogenous economic growth model. This approach incorporates the public sector, namely FP, into the growth model of Solow. Second, by doing so, we can include a richer menu of FP effects by identifying and incorporating the specific FP variables as to enhance economic growth in Albania, namely the distortionary and non-distortionary public revenues and productive and non-productive public expenditures. Additionally, we consider the effect of public debt to GDP ratio to examine whether financing capital expenditures through borrowing (indebtedness) has served as growth-promoting or reducing. Finally, we tried to empirically identify the effect of FP throughout different time-samples, mainly 1998-2006 and 1998-2010.

In Section 2 we summarise some key developments in Albanian FP during 1998-2010. The relevant empirical model and the data are outlined in following section. Then, Section 4 presents the empirical results. The material concludes with main findings in Section 5.

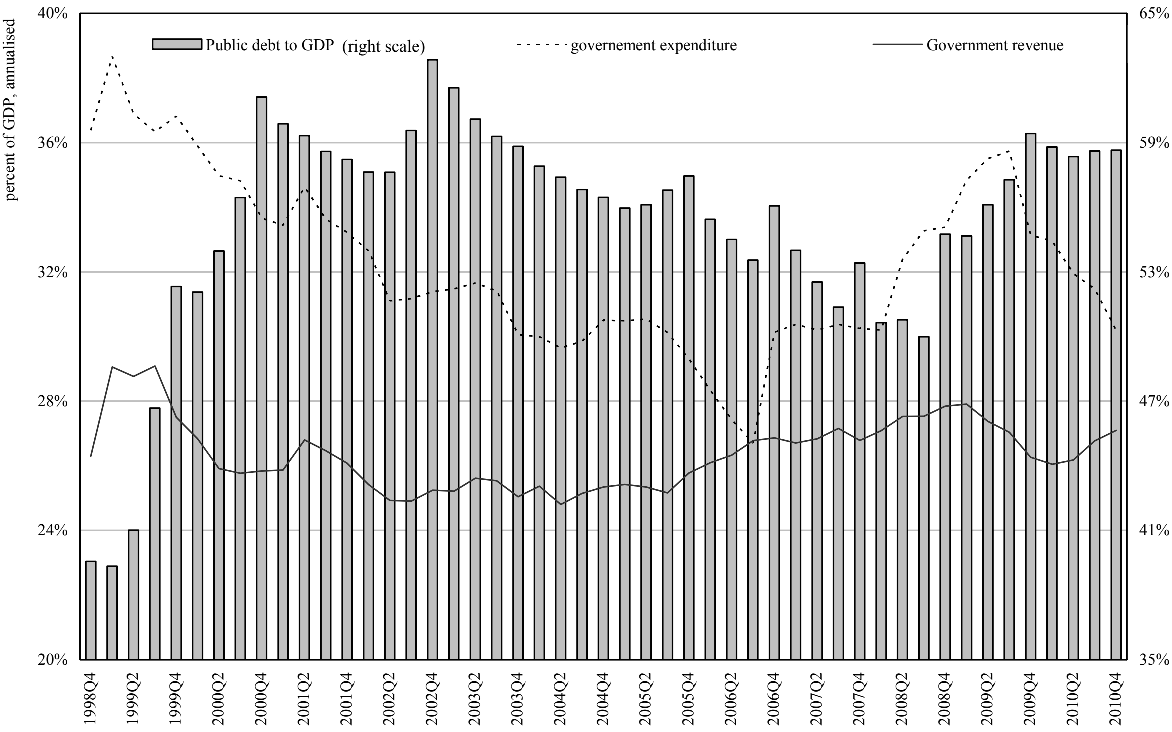
2 Albanian fiscal policy during 1998-2010

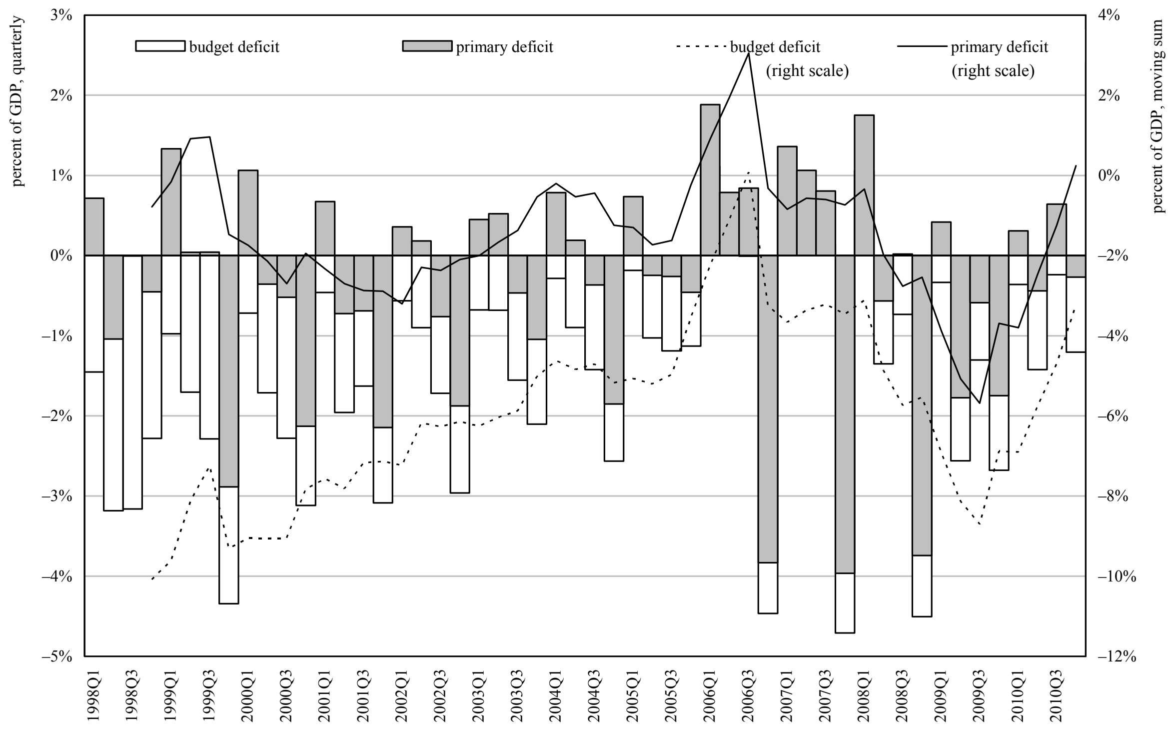
Under the IMF program support, the Albanian government focused on maintaining macroeconomic stability, reducing poverty and achieving sustainable non-inflationary economic growth,[1] after gradual orientation towards a market economy in early 1990 and fast improvement of an important part of economic indicators by the end of the ’90s. The government also aimed at achieving fiscal consolidation through budget deficit and public debt reduction through continuous fiscal consolidation. For this reason, public finance has been under continuous scrutiny of major reformation on expenditure and tax collection system. The philosophy of these fiscal reforms was based on the idea of reducing current expenditures (mainly personnel expenditure, subsidies and

[1] See: Enhanced Structural Adjustment Facility (ESAF – 1998-2001), Poverty Reduction and Economic Growth (PREG – 2002-05) and it was extended to Extended Fund Facility (EFF – 2006-09). In January 2009, Albania graduated from the Fund-supported program.

Figure 1

Selected Fiscal Indicators, 1998-2010

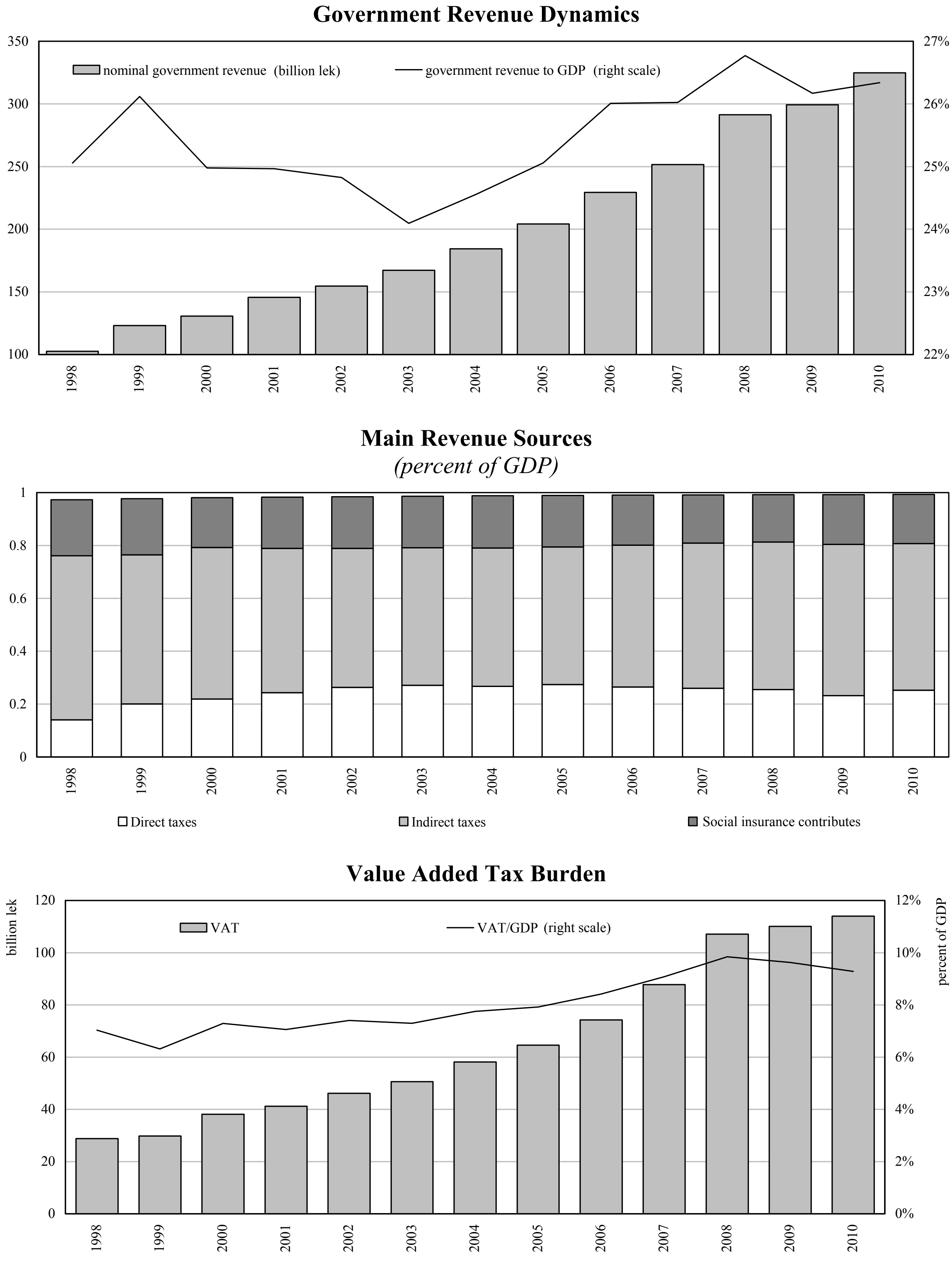




Source: Ministry of Finance.

Figure 2

Government Revenue Indicators, 1998-2010

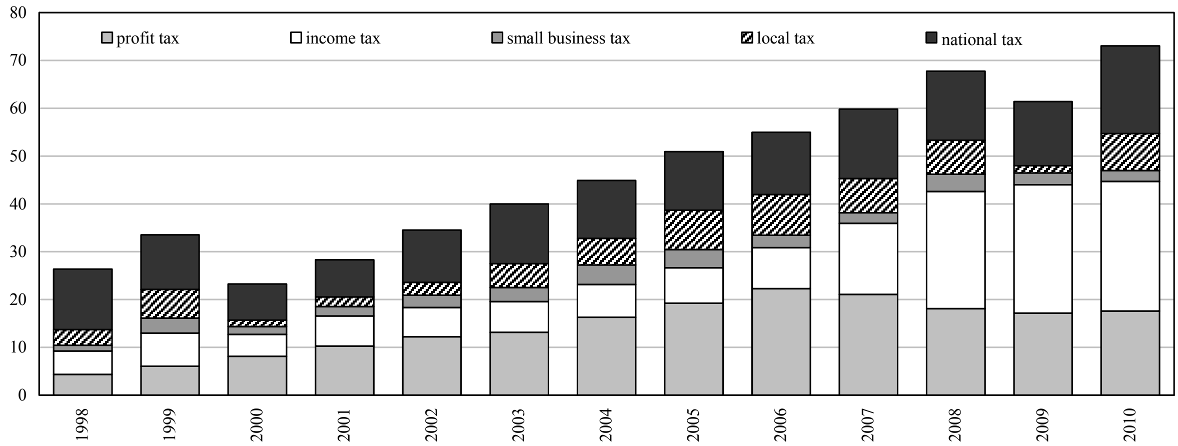


Source: Ministry of Finance.

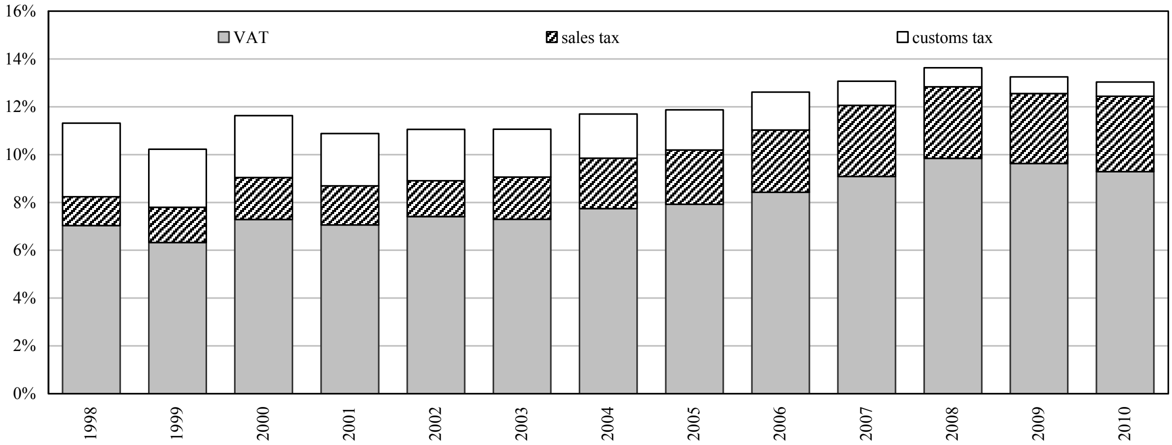
Figure 2 (continued)

Government Revenue Indicators, 1998-2010

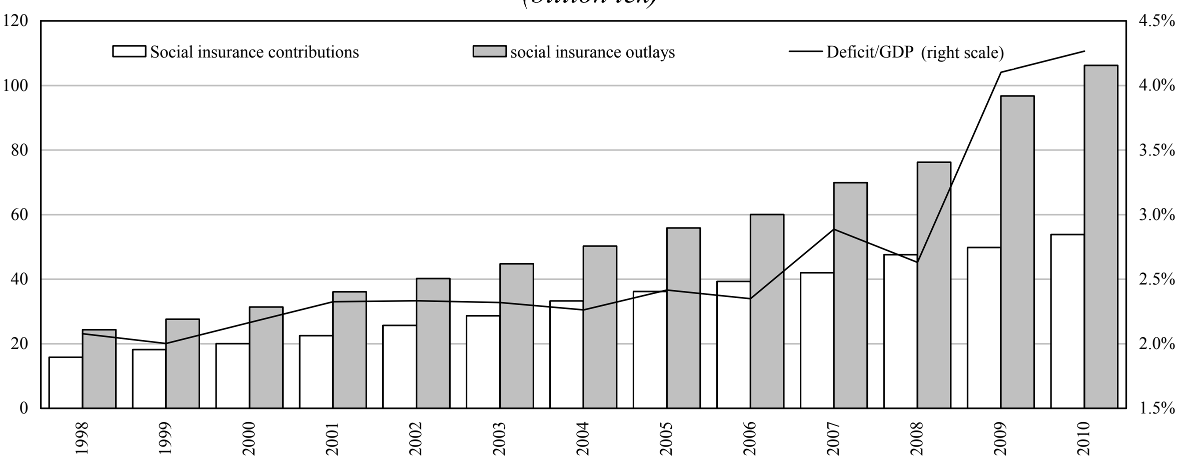
Performance of Direct Tax Burden
(billion lek)



Performance of Indirect Tax Burden



Social Insurance Deficit
(billion lek)



Source: Ministry of Finance.

privatising public-owned companies), expanding the tax base, simplifying and implementing new tax system, promoting tax intensive through reducing tax burden on business, and reducing informality and tax evasion.[2] As a result, budget deficit in 2010 was gradually reduced to 3.2 per cent of GDP from 9.6 per cent in 1998, mainly through cuts in government subsidies, personnel expenditure and interest payments on debt servicing. However, raising budget deficit and public debt during 2007-09 reflected both the action of automatic stabilizers in the form of reduced income and the countercyclical FP through wages and capital expenditure increases.

During the last decade, Albanian tax system also saw major reformations.[3] A series of additional initiatives took place as part of tax legislation changes and were finalised with the approval of a new fiscal package in the second half of 2007. Some of these changes intended to stimulate business incentives and at the same time regenerate more tax revenues. Such reforms consisted of the change from a progressive to a 10 percentage flat income (2007) and profit (2008) tax system and the elimination of all exclusions and facilitations under the old tax system. Besides, there were major reductions in customs duties due to the CEFTA and World Trade Organization membership, the Stabilization and Association agreement with the European Union, etc. Other changes spotted were a considerable rise in national, local and excise tax levels, cuts in social contributions from 42.5 per cent in 2006 to only 17 per cent in 2009, the diminishing of the small business tax to 1.5 per cent in 2006 from 4 per cent in 2005 and a change in the threshold for VAT registration to 5 million ALL turnover per calendar year (2010). All these reforms and structural changes have resulted in a moderated balance growth of government tax revenues, even though increasingly in nominal terms. Indirect taxes such as customs duties, VAT and excise tax are among main indicators of economic activity movements of the country and give the main contribute of tax revenues, reaching round 50 per cent of total level. Profit tax and personal income tax are the main contributors in the group of direct taxes, counting about 13.8 per cent of total revenue in 2010 from only 8 per cent in 1998, even though they are applicable to several categories of income and have been affected by fiscal evasion and non-declaration.

In addition, the public expenditure policies have been focused on promoting sustainable growth and reducing poverty and wealth inequalities. Thus, based on the medium-term fiscal framework (MTFF),[4] a reducing-oriented government expenditure policy aimed at cutting current expenditure to create more funds for strategic capital expenditure identified in the MTFF. As a result, total public expenditure to GDP ratio has shown a declining tendency from 35 per cent in 1998 to approximately 29 per cent in 2010. Current expenditures to GDP ratio have been diminishing, decreasing in 2010 to 24.4 per cent from 28.7 per cent in 1998, even though they capture more than 80 per cent of total expenditure. During this period, personnel (26 per cent), interest payment (18 per cent) and social contribution (27 per cent) represent the highest percentage share of the total current expenditure. Although, FP is oriented to raise wages in the public sector, cuts in personal expenditure are mainly due to reducing the number of employees in the public sector through increasing efficiency and privatisation process and lowering of social contribution expenditure. Interest payments have been diminishing mainly through improvements in government timescale borrowing and cuts in public debt and in interest rates and extending the debt maturity period, followed by considerable raise in social insurance outlays. Further, capital expenditures have on average remained at 6.3 per cent of GDP in the period 1998-2010, even though they have been subject of raise and/or cut based on the Albanian macroeconomic conditions and priorities identified in the MTFF. As such, due to the priorities in infrastructure investment, capital investments reached 8.6 per cent and 8.4 in 2008 and 2009. The distribution of capital

2 See also Shijaku (2009).

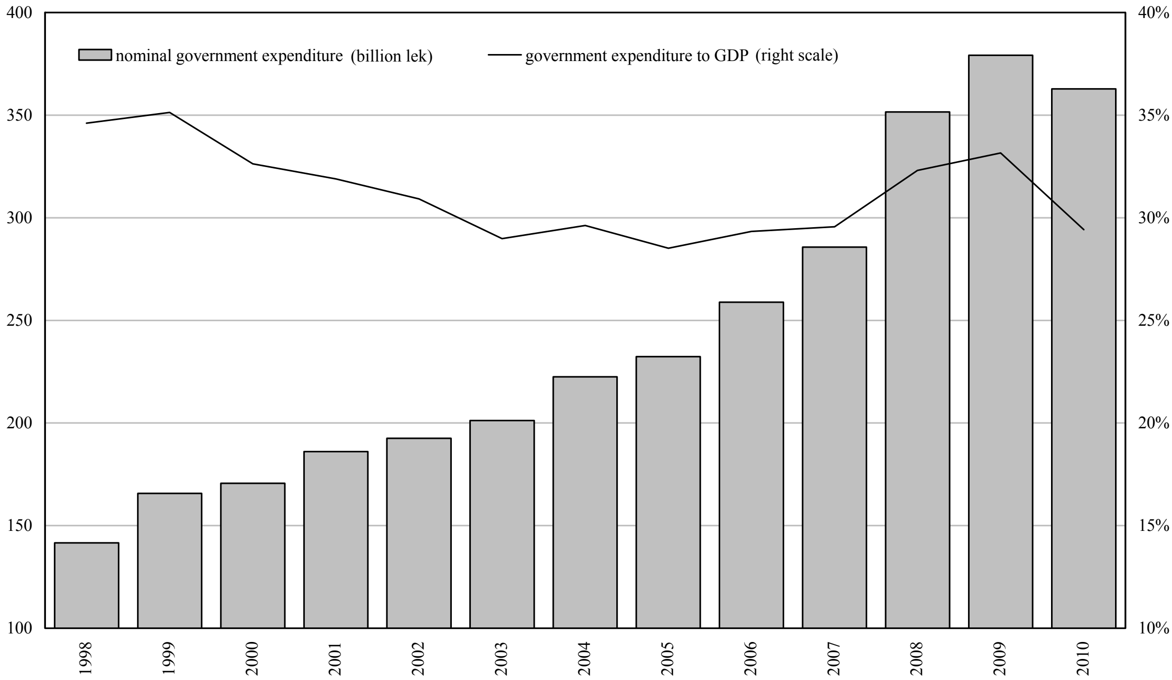
3 Following the introduction of profit (1994) and VAT (1996) tax, the Albanian tax system introduced an income and small and medium business enterprise tax (1998) and customs duties tax (1999).

4 Known also as Medium-Term Economic Program

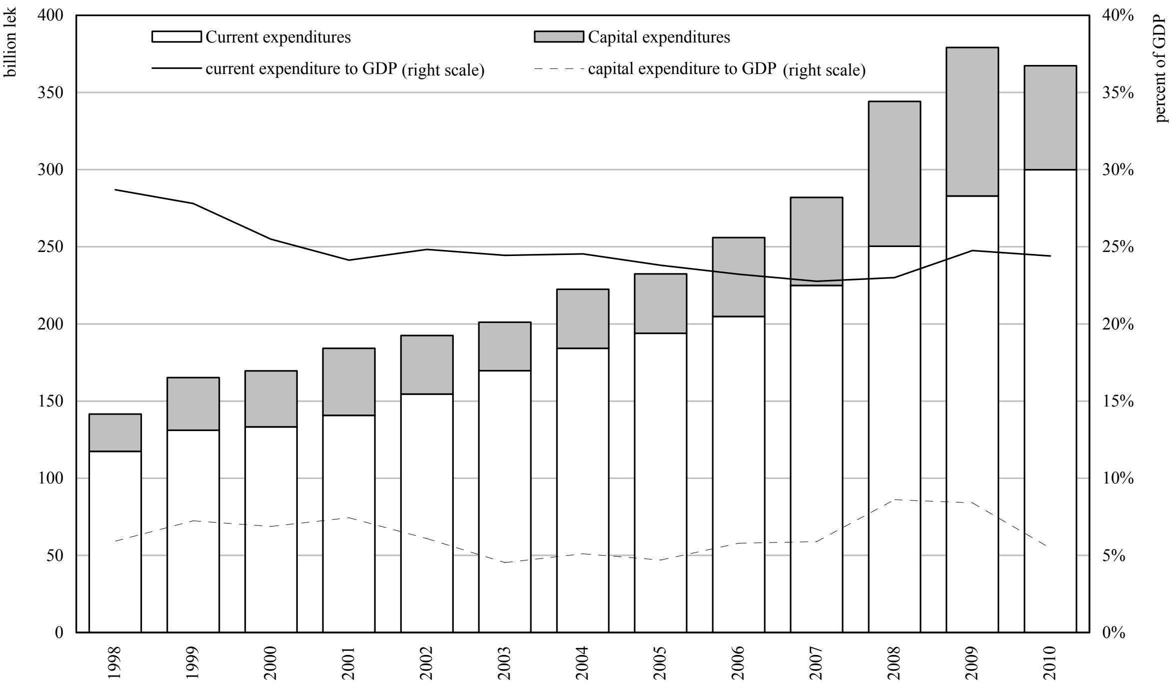
Figure 3

Government Expenditure Indicators, 1998-2010

Government Expenditure Dynamics



Current and Capital Expenditures



Source: Ministry of Finance.

expenditure, in general, was orientated to maintain a relatively high level of spending for areas such as health, education and infrastructure. Mainly these expenditures are financed mostly through domestic borrowing contributing on average by more than 60 per cent.

3 The methodology and data

3.1 Methodology

Neoclassical growth models, based upon the rational expectations assumption, imply that FP can affect only output level but not the long-run growth rate. The steady-state growth rate is driven by the exogenous factors e.g. population growth and technological progress, whilst FP can affect only transition path to this steady state (Judd, 1985). By contrast, under the growth model of Solow, Barro (1990) and Baxter and King (1993) considered a Cobb-Douglas production function and incorporated channels through which FP can determine both the level of the output path and the steady-state growth rate.[5] Instead of only including physical and human capital, the growth rate now depends on the government activity as well, by putting public sector into the production function. To put it formally, we follow Kneller *et al.* (1999) basing the growth model on the following equation:

$$Ø_t = f\left(X_{i_t}, Z_{i_t}\right) \tag{1}$$

or:

$$Ø_t = \alpha + \sum_{i=1}^{k} \beta_i X_{it} + \sum_{j=1}^{m} \gamma_j Z_{jt} + \varepsilon_t \tag{2}$$

where $Ø_t$ is the growth rate of country i at time t, which is a function of conditioning (non-fiscal) variables (X_{it}) based on Solow growth model and fiscal variables (Z_{it}) based on budgetary indicators.[6] Further, α, β_i and γ_j represent the constant term and the slope coefficient of the growth impact of non-fiscal and fiscal variables and $\varepsilon_t \sim iid\ (0, \sigma^2)$ represents the stochastic error term.

Turning to the specification of our model, we build and estimated three variants of endogenous growth model based on identity (2), as follows:

---

5 According to Barro and Sala-i-Martín (1992), output (y) is provided by both private and public sector according to the production function:

$$y = Ak^{1-x}g_x \tag{a}$$

where k represents private capital and g is a publicly provided input. Considering the inter-temporal budget constraint, the government balances its budget in each period by raising a proportional tax on output at rate τ and lump-sum taxes of L, expressed as follows:

$$g + C = L + \tau y \tag{b}$$

where C represents government consumption goods. Taxes on output, in contrast to the lump-sum taxes, will affect private sector incentives to invest in the input goods, such that under such utility function the growth rate will take the form:

$$Ø = \lambda(1-\tau)(1-\alpha)A^{\frac{1}{1-x}}\left(\frac{g}{y}\right)^{\frac{x}{1-x}} - \varepsilon \tag{c}$$

where λ and ε are constant and reflect parameters in the utility function, while the growth rate is decreasing by the rate of (τ) and increasing by the rate of (g). In practice, however government budget is not balanced in every period, so the constraint becomes:

$$g + C + b = L + \tau y \tag{d}$$

where b is budget surplus.

6 Kneller *et al.* (1999) specified a model including investment to GDP ratio, labour force growth rate, net lending, budget surplus, while classified fiscal variables into one of six types. Government revenues are divided into distortionary, non-distortionary and other revenues and government expenditures are classified into productive, non-productive and other expenditures.

$$\varnothing_t = \alpha + \beta_1^* \eta_t + \beta_2^* \varphi_t + \beta_3^* \mu_t + \beta_4^* \tau_t + \beta_5^* g_t + \beta_6^* \text{debt}_t + \varepsilon_t \quad (3.1)$$

and:

$$\varnothing_t = \alpha + \beta_1 * \eta_t + \beta_2 * \varphi_t + \beta_3 * \mu_t + \beta_4 * \theta_t + \beta_5 * \sigma_t + \beta_6 * \rho_t + \beta_7 * \pi_t + \beta_8 * \text{debt}_t + \varepsilon_t \quad (3.2)$$

where $\varnothing_t$ is Albanian annual real economic growth rate (recongr_yoy); η_t is the fixed gross capital formation[7] (fgcf_ratio); φ_t is the employment annual growth rate (empgr_yoy); μ_t is a proxy for trade openness index measured as the sum of total import + exports to nominal GDP ratio (opentb_ratio); τ_t and g_t represent fiscal indicators and stands for government revenues excluding grants (rev_ratio) and expenditure (exp_ratio); θ_t and σ_t represents revenue counterpart sub-categories, standing for the distorsionary (*disrev_ratio*) and non-distortionary (*nddrev_ratio*) revenues; ρ_t and π_t stand for the expenditure counterpart sub-categories, representing productive (pexp_ratio) and non-productive (npexp_ratio) expenditure; $debt_t$ represents the ratio of public debt to nominal GDP (*debt_ratio*).

From a theoretical point of view, physical and human capitals are the main factors of production in the growth model of Solow. Thus, fixed gross capital formation to GDP ratio (fgcf_ratio) and employment annual growth rate (*EMPGR)* entered the model as explanatory variables. Besides, *EMPGR* controls for business cycle effects on growth (Benos, 2009). Regarding other non-fiscal variables, we used the sum of imports and exports as a proportion of GDP (opentb_ratio), to account for external effects on the economic growth. Regarding fiscal variables, accordingly, we considered some notable exceptions when modelling endogenous fiscal-growth relationship. First, a model suffers from substantial bias coefficients estimation if both sides of budget are not taken into account, given that FP affects output through taxation and expenditures policies (Kneller *et al.*, 1999). Thus, in our model the fiscal variables encounter to capture full effects of FP by entering into the model both government revenues and expenditures indicators. Second, Kneller *et al.* (1999) and Benos (2009) finds out that some types of government expenditures and taxation can be either growth-enhancing or reducing. Hence, following Barro and Sala-i-Martín (2004), the public revenues were categorised into distortionary (disrev_ratio), non-distortionary (nddrev_ratio) and other public revenues (orev_ratio), whislt public expenditure were categorised into productive (pexp_ratio), non-productive (npexp_ratio) and other public expenditures, (oexp_ratio).

Additionally, according to Kneller *et al.* (1999), if budget constraint is fully specified, so that:

$$\sum_{j=1}^{m} X_{jt} = 0$$

One element of Z must be omitted in the estimation of equation (2) in order to avoid perfect colinearity. In other words, this exclusion also offers a proper way to interpret any changes in fiscal variables included in the model. As such, we omitted the variables of other revenue and expenditure from our model, given their relatively size and impact on economic growth and the critical value of the *F*-test based on an omitted variables test and correlation test (Table 3). Finally, empirical models of FP may suffer from bias estimation if they do not impose debt indicators (Favero and Giavazzi, 2007). But, the debt financing methods can affect both the supply and demand side of the economy (Klalid *et al.*, 2007). Besides, as it increases, indebtedness can turn from initially growth-enhancing (or neutral) to eventually growth reducing (Cecchetti *et al.*, 2011). Thus, we have also included in our model public debt to GDP ratio to examine potential effects of the level of indebtedness on growth and to distinguish whether debt is growth-enhancing or reducing.

7 Refer also as total capital investments. We also specify the growth model using as proxy the private investment to GDP ratio and found the same results.

The endogenous fiscal-growth model does not place restrictions on the sign of the coefficients. But a negative sign (–) represents a negative impact on growth and vice versa. Kneller *et al.* (1999) suggested that increasing burden of taxation weakens the incentives to invest, hence reducing growth. Government expenditures influence the marginal product of private capital through increase consumption goods and services, henceforth boost growth. Amanja and Morrissey (2006) imply that taxation and expenditure policies can harm or promote growth. A tax system that causes distortions to private agents' investment incentives can retard investment and growth. Analogously, if the system is such that it leads to internationalization of externalities by private agents, it may induce efficiency in resource allocation and thus foster investment and growth. The same applies with the nature of government expenditure, where excessive current expenditure at the expense of investment is likely to discourage growth and vice versa.

In addition, some types of government expenditures and taxation can be either growth-enhancing or reducing. We expect that distortionary taxation weakens the incentives to invest in physical/human capital, hence reducing growth. Benos (2009) reveals that non-distortionary taxation does not affect the above incentives, therefore growth, due to the nature of the utility function assumed for the private agents. However, we would expect that raising non-distortionary taxation would affect production through increasing marginal costs whether tax is levied on producers or consumers. Therefore, if tax is levied on producers it reduces the marginal return to private capital and if it is levied on consumers it effects the incentives to consume more, hence harming growth. Further, an augmenting productive spending financed by non-distortionary taxes will boost growth. But, this effect is ambiguous if distortionary taxation is used. In the latter case, there is a growth-maximizing level of productive expenditure, which may or may not be Pareto efficient (Irmen-Kuehnel, 2008). Rising also non-productive spending financed by non-distortionary taxes will be neutral for growth. But, if distortionary taxes are used the impact on growth will be negative. Besides, if non-productive expenditure serves as means to create consumption based expenditure, then an increase will boost growth.

Finally, as Cecchetti *et al.* (2011) puts forward, the impact of debt burden to growth is ambiguous, given that raising indebtedness can turn from initially growth-enhancing (or neutral) to eventually growth reducing. Public debt burden can smooth consumption not only through lifetime, but also across generations, by providing more human capital and productive technology as long as they are not constrained by macroeconomic instability, distorted policies and institutional weaknesses. It can also provide liquidity services and increase financial intermediation, which can contribute to easing the credit conditions faced by firms and households, thus crowding in private investment and helping growth. Above a certain threshold, however, debt is found to reduce growth as rising indebtedness, including its domestic component, above a country's repayment ability would discourage private investment due to the expectation of higher future taxes (Blavy, 2006). Several types of risk factors related to rising debt would account on raising domestic interest rates, crowding out public investment within the budget and private investment in general, a rowing portion of savings would go towards purchases of government debt, rather than capital investments and higher marginal tax rates may be used to pay rising interest cost, leading to reducing of saving rates and discouraged work. This may harm the economic growth.

In the specified models, we also assumed that there exist some strong potential for endogeneity of the fiscal and debt variables, especially reverse causation (low or negative growth rates are likely to induce higher expenditure–revenues and debt burdens).[8] The models, hence, are estimated by Generalised Moments of Movements (GMM). GMM approach allows the usage of instrumental variables regression to deal with a situation where some of the right-hand side (RHS)

8 While the economic growth rate is likely to have a linear negative impact on the public debt-to-GDP ratio, high levels of public debt are also likely to be deleterious for growth.

variables are correlated with disturbances due to endogeneity problems. [9] The idea behind instrumental variables is to find a set of variables, termed instruments, which are both correlated with the explanatory variables in the equation and eliminate the correlation between RHS variables and the disturbances. For the GMM estimator to be identified, there must be at least as many instrumental variables as there are parameters to estimate. As such, RHS with four lags are used as the relevant instrumental variables in our GMM models, given also that empirical evidence[10] suggests that there are lagged effects of fiscal and non-fiscal policy on growth. In models for which there are more moment conditions than model parameters, GMM estimation provides a straightforward way to test the specification of the proposed model through the *J*-statistic hypothesis test. A simple application of the *J*-statistic is to test the validity of overidentifying restrictions, under the null hypothesis that the overidentifying restrictions are satisfied.

3.2 Data

The paper considers quarterly data from 1998Q01 to 2010Q04, but we also tried to evaluate the effect of FP prior to the effects of fiscal expansion and reforms after 2007 and also prior to the effects of the recent financial and economic crisis that affected the economic activity in Albania. Thus, we tried to empirically identify the effect of FP throughout different time-samples, mainly 1998-2006 and 1998-2010. The economic growth model is based on capital, labour, trade openness and fiscal variables. The data on fixed gross capital formation, real economic growth and employment rate are taken from the Albanian Institute of Statistics (INSTAT). Quarterly FGCF is interpolated from annual data by linear match last approach using E-views. The series on FGCF and private investment are extended to 2010Q04 by an Autoregressive Integrated Moving Average (ARIMA) forecast process.[11] The data on exports and imports of goods and services are taken from Bank of Albania.

Government expenditure represents the total level and government revenues do not include grants since the later are donations and do not account for the state of the Albanian economic activity.[12] As noted above, within the class of endogenous growth models relevant to this study, results are driven by classification of fiscal variables into different types and a key issue is the allocation of taxes and expenditures, respectively, to distortionary vs. non-distortionary revenues and productive vs. non-productive expenditures. Distortionary government revenue is the sum of profit tax + personal income tax + national taxes and others + revenues from local government + social insurance contributions. Non-distortionary government revenue is the sum of Custom Duties + VAT + Excise Tax. Disaggregation of expenditure relates to the classification of the public expenditures based on budgetary indicators as an alternative solution to the unavailability of the appropriate time series for the public expenditures as in Barro and Sala-i-Martín (2004). Therefore, productive government expenditure is the sum of public capital expenditures. Non-productive government expenditure is the sum of personnel expenditure + subsidies + social insurance outlays + operational & maintenance + other expenditures + electricity compensation + compensation for expropriation + interest cost of bank restructuring + loans to KESH + payment for participation in

---

9 Ordinary Least Square (OLS) and weighted LS (WLS) are biased and inconsistent if right-hand side variables are correlated with the disturbance term.

10 See Amanja and Morrissey (2005) and Burger (2011).

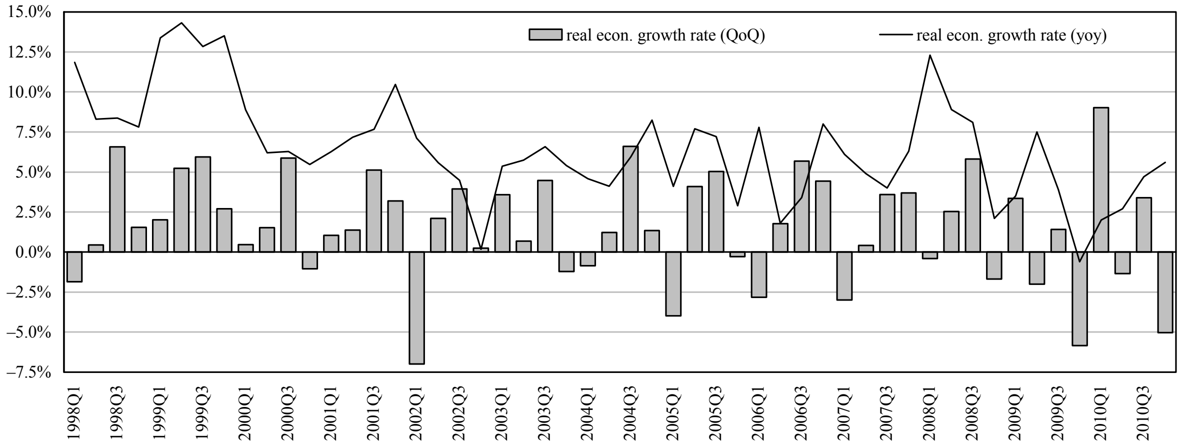
11 The Albanian Institute of Statistics (INSTAT), which produces the official country statistics, has only annual data from 1996 to 2008, which can limit the purpose of this study. Kota (2007) has used the real economic growth rate as a benchmark to generate the data on FGCF for the period 2008-10.

12 We also specify the growth model using as proxy the total government revenue to GDP ratio and found the same results.

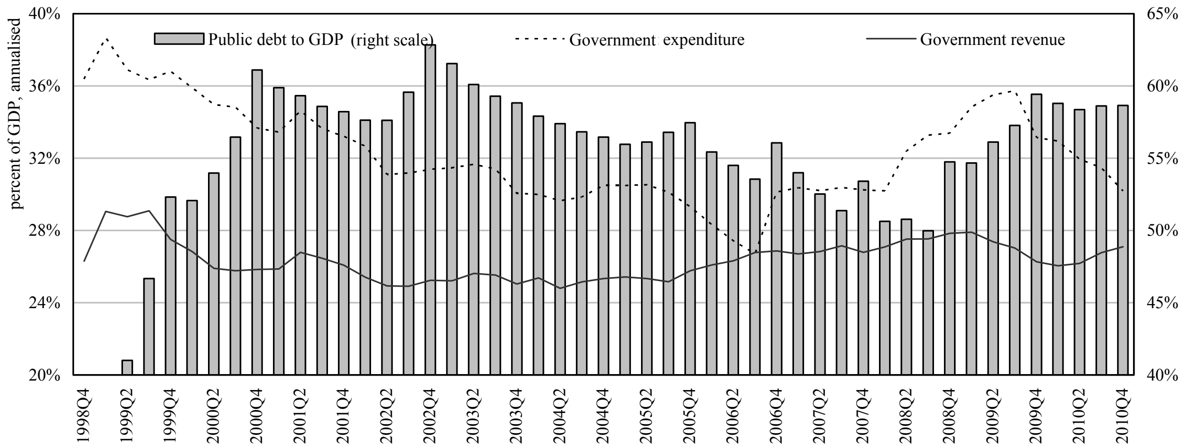
Figure 4

Economic Growth and Explanatory Variables

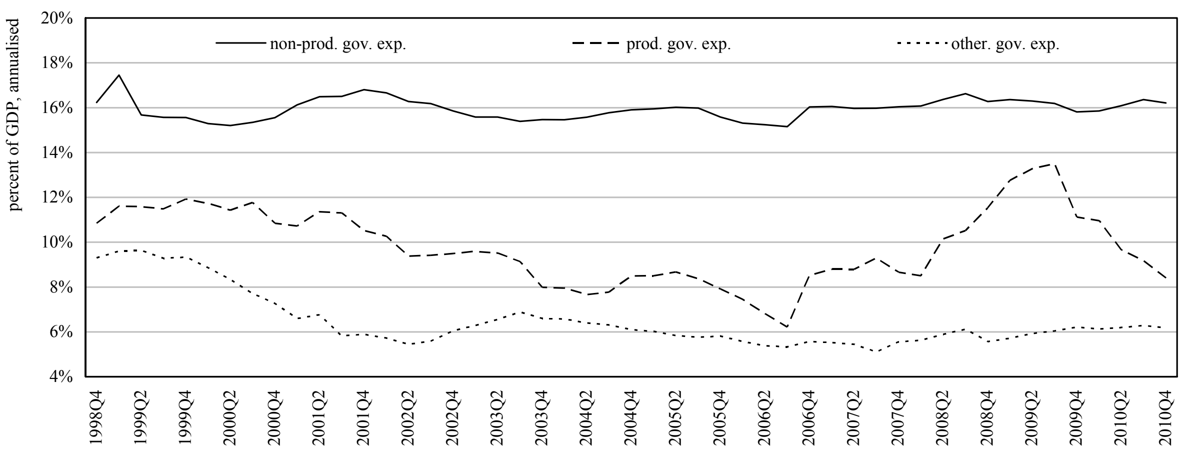
Real Economy Growth Rate



Fiscal Indicators



Government Expenditures

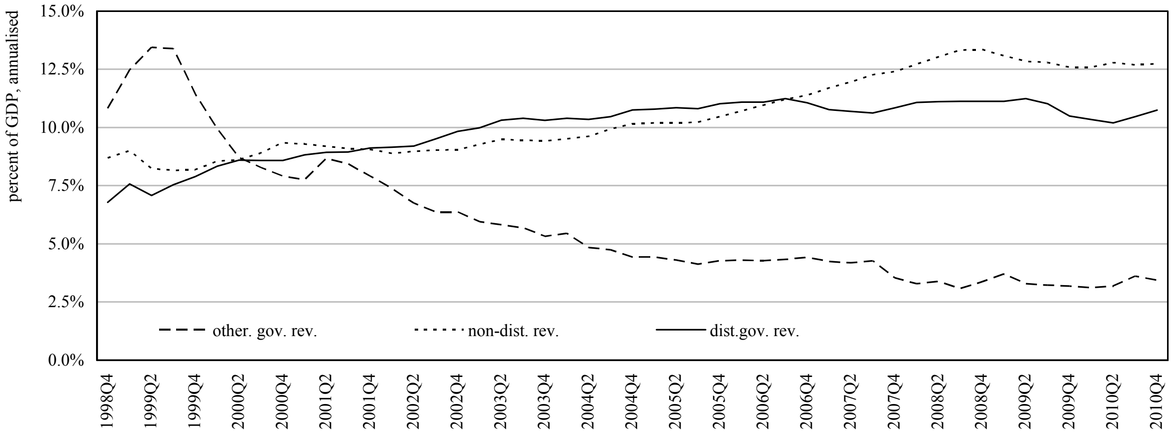


Source: Bank of Albania, Ministry of Finance and INSTAT.

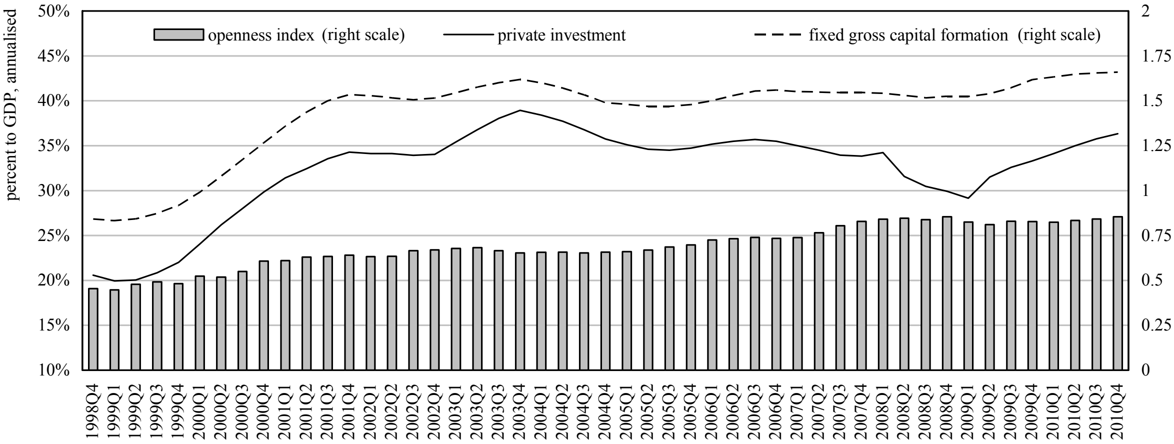
Figure 4 (continued)

Economic Growth and Explanatory Variables

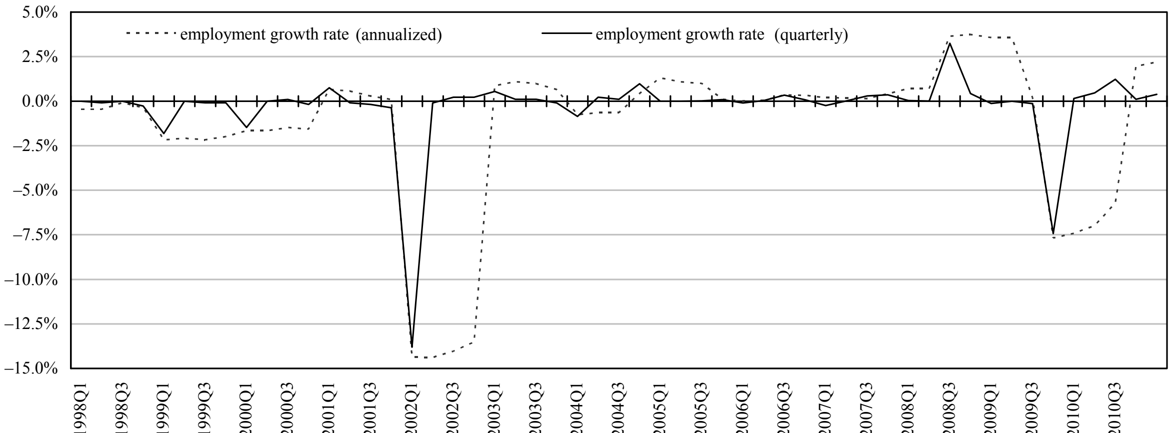
Revenues



Openness Index, Fixed Gross Capital Formation and Private Investment



Employment Growth Rate



Source: Bank of Albania, Ministry of Finance and INSTAT.

BISH capital + energy support. Fiscal data and the public debt are taken from the Ministry of Finance. Data, besides economic and employment growth rate, are generated as a ratio of GDP.[13]

4 Empirical results

Table 1 summarises the results according to the GMM techniques. Coefficients on models (A) of the table is based on the sample time: 1998:01-2010:04 estimation, models (C) add the effects of dummy variables on fiscal reforms, expansionary and effects of financial and economic crisis and model (B) estimate the relationship before these phenomena, respectively the sample time: 1998:01-2006:04. After conducting Augmented Dickey Fuller and Philips Perron unit root tests (Table 2) we find conclusive evidence only on the non-stationary of non-distortionary of government revenue. Hence, ndrev_ratio entered the model in first difference. The results on GMM specification are also based on model diagnostic tests (Table 1). The statistical value of the regression determination coefficient (R^2) and a set of diagnostic tests conducted on the model specification reveal no problems with respect to serial correlation (*Q*-statistic and Squared Residuals) and Hausman test on over-identification of the instrumental variables (*J*-statistic and Coefficient of over-ID and Prob.).

Empirical results in Table 1 demonstrate that the value of the coefficients is statistically significant at conventional levels, regarding the non-fiscal. Employment growth and fixed gross capital formation[14] are estimated to have a positive effect on production growth, confirming the prediction of endogenous growth theory. These are expected since labour and capital are factors of production in most growth models and they support the endogenous growth models. Furthermore, as far as economic openness is concerned, it effects growth negatively.

Regarding the fiscal variables, results (Table 1) show that their effect on growth rate is statistically significant at conventional levels. Growth is affected negatively by government revenues and positively by expenditure policies. Government revenues effected growth more than the government expenditure, given the coefficient size for the estimated sample. This follows the same conclusions drawn by Mançellari (2011). Hence, raising rev_ratio by 1 percent will reduce growth by round .476 per cent and boosting exp_ratio by 1 percent stimulates growth by round .146 per cent. This would re-enforce a theory already expressed by Barro and Sala-i-Martín (1992) that revenues effect growth negatively and expenditure enhance growth. Under Barro and Sala-i-Martín (2004) fiscal decomposition, we found that revenue sub-categories reduce growth, but distortionary taxation has much larger and statistically significant effect. Growth rate will diminish by .6374 per cent in response of 1 percent increase in disrev_ratio (distorsionary revenues) and by round .128 percentage points in response of 1 percent raise in ndisrev_ratio (non-distorsionary revenues). On the other hand, the empirical results show that growth is positively affected by productive expenditure and negatively by non-productive. Productive expenditure has a much higher effect on growth than non-productive expenditure. Raise in pexp_ratio by 1 percent will boost growth positively by round .460 and a 1 percentage point decrease in npexp_ratio will improve growth by more than .272 percentage points. Based on the value of the coefficients, productive expenditures have a larger impact on growth than non-productive expenditure. Based on equation (3.1A), raising any type of revenues or decreasing expenditure by government bring along negative effects in economic growth, but it clearly matters what type of revenue to rise and what type of expenditure to decrease in order to improve the budget balance and at the same time achieve the best results on GDP growth. As such, based on the

[13] See Afonso and Jales (2011).

[14] We also specify the growth model using as a proxy the private investment to GDP ratio (invtprv_ratio) and found relatively the same results.

Table 1

Results of Macroeconomics and Fiscal Indicators on Real Economic Growth Rate (recongr_yoy) Based on GMM Specification Techniques(1)

	Equation (3.1)		Equation (3.2)	
	(A)	(B)	(A)	(B)
C	.415289*	.286233*	.528287*	.482663*
FGCF_RATIO	.183665	.727787	.699920*	.854009*
EMPGR_YOY	.130057*	.038906	.320074*	.027685*
OPENTB_RATIO	–.468705*	–.975659*	–.625912*	–.697641*
	FISCAL VARIABLES			
REV_RATIO	–.476155*	–.432053*		
EXP_RATIO	.146148*	.278665*		
DISREV_RATIO			–.637372*	–.610666*
NDREV_RATIO			–.127742***	–.108589*
PEXP_RATIO			.460154*	.344109*
NPEXP_RATIO			–.271892*	–.104717*
DEBT_RATIO	–.373513*	–.178836*	–.586688*	–.566797*
	DIAGNOSTIC TESTS			
J-static	.198145	.158028	.227737	.222982
Coef. OverID	9.3128	5.2149	10.7036	6.9124
(Prob.)	.9520	.7343	.9986	.9969

Sample Time: (A) – (1998q01 – 2010q04); (B) – (1998q01 – 2006q04).
(1) – variables on the RHS are used as instrumental variables.
Based on: * (1 per cent), ** (5 per cent), *** (10 per cent) level of significance.

value of the coefficients in Table 1 (equations (3.2A) and (3.2B)), if government wishes to boost budget revenue it should choose indirect taxes instead of direct taxes as raising this category has slightly less negative effects on growth. On the other hand, coefficients value suggests that if government wishes to reduce fiscal deficit through expenditure cuts policies it should consider non-productive rather productive expenditure cuts, as the former has a negative effect on economic growth.

Results imply that revenues have a higher negative effect on growth, compared to the estimated coefficient value for the period 1998-2006. The impact of revenue on growth has increased from .432 prior to 2007:01 to round .476 for the whole sample. Results demonstrate that amplifying negative impact is mostly due to extending effects through distortionary taxation policies. Their negative effect on growth has increased by round .0267 points compared to only round .192 points raise in non-distortionary negative impact. However, the impact of expenditure on growth is weaker compared to the estimated coefficient value for the period 1998-2006. The positive impact of expenditure on growth has shrunk to only .146 points compared to .279 it was prior to 2007, given the size of the coefficient. Considering the sub-categories of government expenditure, results imply that productive and non-productive expenditure have a higher respectively effect on growth after 2006. These reflect the attitude of the counter-cyclical FP through capital and wages increase. This proves that rising capital expenditure has provided bigger positive impact on growth and has also mitigated the negative affects that global financial and economic crisis had on the Albanian economy. This confirms findings by Bachmann and Sims (2011) that raising government investments, especially during downturns, boost business confidence. The positive effect of pexp_ratio on growth has increased by round .116 percentage points and the negative effect on npexp_ratio has gone up by round .167 per cent. First, these implying effects reflect mainly the attitude of the counter-cyclical FP through capital and wages raise in the period 2007-09. This, as Afonso (2006) puts forward, reveals the Albanian public sector efficiency on resource allocation and output scores maximisation. Second, the diminishing impact of expenditure on growth is mostly due to raising negative impact of non-productive expenditures.

Further, findings show that the coefficient on debt ratio is statistically significant at conventional levels and negatively related to growth rate. This effect is even greater compared to the estimated coefficient value for the period 1998-2006. This, according to Cecchetti *et al.* (2011), suggests that debt burden is above a threshold of growth-enhancing. Hence, raising debt burden reduce growth. According to results by Shijaku (2011) in the verge of raising cost of borrowing a further increase above Albanian repayment ability or sustainability level would discourage public investment within the budget structure and may crowd-out private investments. In addition, given the magnitude of the coefficients, raising debt ratio to finance capital public investment would crowds out the effects of productive expenditure. Instead, if government wishes to stimulate economic activity through boosting productive expenditure, it should do it through lowering the non-productive expenditure rather than borrowing instruments.

5 Conclusion

Albania FP has been under continuous scrutiny of major reformation on expenditure and tax collection system. The philosophy of these fiscal reforms was based on the idea of reducing current expenditures and boosting government revenues. The Albanian economy took advantages of macroeconomic stimulus in the form of fiscal expansion ahead of monetary adjustments, during the financial and global crisis. Raising budget deficit and public debt reflected both the action of automatic stabilizers in the form of reduced income and the countercyclical FP through wages and capital expenditure increases and also the cost of fiscal burden as a result of government decision to stimulate the economy, while fiscal incentives were narrowing.

This discussion material analysis the Albanian FP effects upon economic growth based on an endogenous fiscal-growth model. The aim of this paper is not to resolve the raging debate on the ability of FP to affect economic growth, but to examine the case of a small open developing country, Albania. Regarding fiscal variables, the results obtained show that overall growth rate is affected negatively by government revenues and positively by expenditure policies. Considering the parameter magnitude government revenue effected growth more than government expenditure. Categorising tax revenues into distortionary and non-distortionary, we found that government revenues and the sub-categories reduce growth, but distortionary taxation has much larger and significant effect. Further, growth is positively affected by productive expenditure and negatively by non-productive, but the former has a greater impact.

Additionally, based on the coefficient value, empirical results suggest that since 2007 expenditure-growth relationship is weaker, while revenues have a higher negative impact on growth. Results demonstrate that rising revenues negative impact is mainly due to distortionary policies. Expenditure policies reflect the attitude of the counter-cyclical FP through capital and wages increase. Further, findings show that the coefficient value of debt burden is negatively related to growth rate. This effect is statistically significant. This impact is even greater since 2007. Financing government capital investment through borrowing mechanism has stimulated growth, but according to Cecchetti *et al.* (2011) debt burden is above a threshold of growth-enhancing.

APPENDIX

Table 2

Unit Root Tests

Variable	ADF		Phillips-Perron		ADF		Phillips-Perron		ADF		Phillips-Perron	
	Null Hypothesis: Unit Root											
	Level	First Difference	Level	First Difference	Level	First Difference	Level	First Difference	Level	First Difference	Level	First Difference
	(Prob.)											
	Intercept				Intercept and Trend				None			
recongr_yoy	(.0049)	(.0000)	(.0049)	(.0000)	(.0040)	(.0000)	(.0048)	(.0000)	(.0617)	(.0000)	(.0985)	(.0000)
fgcf_ratio	(.0462)	(.0174)	(.3230)	(.0112)	(.2111)	(.0394)	(.7667)	(.0299)	(.8853)	(.0028)	(.9308)	(.0017)
empgr_yoy	(.0000)	(.0000)	(.0000)	(.0001)	(.0000)	(.0000)	(.0000)	(.0001)	(.0000)	(.0000)	(.0000)	(.0001)
opentb_ratio	(.6175)	(.0000)	(.0916)	(.0001)	(.0569)	(.0000)	(.0000)	(.0001)	(.9974)	(.0118)	(.9539)	(.0000)
exp_ratio	(.3667)	(.0001)	(.0000)	(.0001)	(.7335)	(.0000)	(.0000)	(.0001)	(.2894)	(.0000)	(.4514)	(.0000)
npexp_ratio	(.0250)	(.0001)	(.0000)	(.0001)	(.0486)	(.0000)	(.0001)	(.0001)	(.3317)	(.0000)	(.6533)	(.0000)
pexp_ratio	(.4958)	(.0000)	(.0000)	(.0000)	(.8138)	(.0000)	(.0000)	(.0000)	(.5027)	(.0000)	(.0008)	(.0000)
rev_ratio	(.6750)	(.0000)	(.0000)	(.0001)	(.0572)	(.0000)	(.0000)	(.0001)	(.8572)	(.0000)	(.9083)	(.0000)
ndrev_ratio	(.9129)	(.0007)	(.9235)	(.0001)	(.3712)	(.0041)	(.5217)	(.0006)	(.9748)	(.0000)	(.9921)	(.0000)
disrev_ratio	(.0863)	(.0000)	(.0002)	(.0000)	(.0000)	(.0000)	(.0000)	(.0000)	(.9688)	(.0000)	(.8706)	(.0000)
debt_ratio	(.0001)	(.0000)	(.0933)	(.0000)	(.0014)	(.0000)	(.4996)	(.0000)	(.7258)	(.0000)	(.9138)	(.0000)

[a] Automatic lag selection based on Schwarz Info Criterion (SIC).

Table 3

Estimated Results on Redundant Variables Test

Redundant Variables	Null Hypothesis: The Variable is Not Significant for the Model			
	F-statistic	Prob. *F*-statistic	Log Likelihood Ratio	Prob. Chi-square
DISREV_RATIO	1.387526	(0.2460)	1.782925	(0.1818)
NDREV_RATIO	4.385346	(0.0428)	5.434565	(0.0197)
OREV_RATIO	1.230876	(0.2740)	1.584729	(0.2081)
PEXP_RATIO	0.613775	(0.4381)	0.796378	(0.3722)
NPEXP_RATIO	0.245582	(0.6230)	0.320139	(0.5715)
OEXP_RATIO	0.639366	(0.4288)	0.829314	(0.3625)
DEBT_RATIO	2.540964	(0.1190)	3.219037	(0.0728)

Synthesis of results generated using E-views 6.

REFERENCES

Afonso, A. and G. Alegre (2008), "Economic Growth and Budgetary Components – A Panel Assessment for the EU", European Central Bank, Working Paper, No. 848, January.

Afonso, A. and J. Jallers (2011), "Economic Growth and Government Size", European Central Bank, Working Paper, No. 1399, November.

Afonso, A., L. Schuknecht and V. Tanzi (2006), "Public Sector Efficiency Evidence for New EU Member States and Emerging Markets", European Central Bank, Working Paper, No. 581, January.

Baldacci, E., B. Clements and S. Gupta (2003), "When Reducing Fiscal Deficits Makes Sense for Low-income Countries", *Finance & Development*, December.

Bachmann, R. and E. Sims (2011), "Confidence and the Transmission of Government Spending Shocks", NBER, Working Paper, No. w17063.

Bank of Albania, (2010), *Bulletin*, 2010H2.

Barro, R. (1979), "On the Determination of Public Debt", *Journal of Political Economy*, Vol. 87, No. 5, pp. 940-71.

—————(1990), "Government Spending in a Simple Model of Endogenous Growth – Part 2: The Problem of Development: A Conference of the Institute for the Study of Free Enterprise Systems", *Journal of Political Economy*, Vol. 98, No. 5, pp. S103-S125, October.

Barro, R. and X. Sala-i-Martín (2004), *Economic Growth*, 2nd edition, MIT Press, Cambridge (MA).

—————(1992), "Public Finance in Models of Economic Growth", *The Review of Economic Studies*, Vol. 59, No. 4, pp. 645-61, October.

Baxter, M. and R. King (1993), "Fiscal Policy in General Equilibrium", *American Economic Review*, Vol. 83, No. 3, pp. 315-34.

Benos, N. (2009), "Fiscal Policy and Economic Growth: Empirical Evidence from EU Countries", MPRA Paper, No. 19174, posted on 11 December.

Blanchard, O. and R. Perotti (2002), "An Empirical Characterisation of the Dynamic Effects of Changes in Government Spending and Taxes on Output", *The Quarterly Journal of Economics*, pp. 1329-68, November.

Blavy, R. (2006), "Public Debt and Productivity: The Difficult Quest for Growth in Jamaica", International Monetary Fund, Working Paper, No. WP/06/235.

Cecchetti, G.S., M.S. Mohanty and F. Zampolli (2011), "The Real Effects of Debt", Bank for International Settlements, Working Paper, No. 352.

Frankel, J. and D. Romer (1999), "Does Trade Cause Growth?", *American Economic Review*, Vol. 89, No. 3, pp. 379-99.

Irmen, A. and J. Kuehnel (2008), "Productive Government Expenditure and Economic Growth", University of Heidelberg, Discussion Paper, No. 464.

Judd, K. (1985), "On the Performance of Patents", *Econometrica*, Vol. 53, No. 3, pp. 567-86.

Kneller, R., M.F. Bleaney and N. Gemmell (1999), "Fiscal Policy and Growth: Evidence from OECD Countries", *Journal of Public Economics*, No. 74, pp. 171-90.

Kota, V. (2007), "Alternative Methods of Estimating Potential Output in Albania", Bank of Albania, Research Department.

Mançellari, A. (2011), "Macroeconomic Effects of Fiscal Policy in Albania: A SVAR Approach", Bank of Albania.

Shijaku, G. (2009), "The Development and Adoption of Fiscal Policy in Albania", Bank of Albania, Research Department, unpublished, August.

——————(2011), "Sustainability of Fiscal Policy: The Case of Albania", Bank of Albania, Research Department, unpublished.

Socol, C. and G.A. Socol (2009), "The Analysis of Fiscal Policy Management in Romania: Lessons for Emerging Countries", *African Journal of Business Management*, Vol. 3, No. 5, pp. 240-47, May.

World Bank (2006), *Albania Restructuring Public Expenditure to Sustain Growth – A Public Expenditure and Institutional Review*, December.

COMMENTS ON SESSION 2
GOVERNMENT BUDGETS AND POTENTIAL GROWTH

John Janssen[*]

I would like to thank Daniele and his team for the invitation to the workshop and the opportunity to comment on two interesting papers in this session. Although New Zealand's public debt levels are relatively low (albeit with relatively high levels of private sector debt), projections suggest that under existing policy, debt-to-GDP ratios are likely to rise (Buckle and Cruickshank, 2012). Hence the possible effects of higher public debt on economic growth are of interest.

1 Comments on "Debt and Growth: New Evidence for the Euro area" by Anja Baum, Cristina Checherita-Westphal and Philipp Rother

The focus of this paper is on the short-term, non-linear impact of public debt on GDP growth in the Euro area. Non-linear effects are captured via the use of a threshold regression model, where the threshold distinguishes the two regimes where the behaviour predicted by the model differs.

In terms of methodology, the paper contributes to the literature by extending the non-dynamic threshold panel methodology of Hansen (1999) to a dynamic setting (Caner and Hansen, 2004). The dynamic effects are captured by adding lagged GDP growth rates to the regression. The endogenous variable is the real GDP growth rate, and control variables include: lagged real GDP growth; openness; the investment-to-GDP ratio; and a dummy variable for EMU entry. Estimation uses annual data for 12 Euro area countries over the period 1980 to 2010.

An important part of the estimation involves finding the threshold debt ratio that divides the sample into two different regimes. The dynamic model is estimated with 2Stage Least Squares (2SLS) for each possible value of the threshold variable, and the corresponding sum of squared residuals (SSR) are calculated. The selected threshold value is the one that gives the smallest SSR. Based on this estimate, the slope parameters are estimated using Generalized Method of Moments (GMM). The results are reported both for the non-dynamic and dynamic panels. The possibility of more than one threshold value (*i.e.*, more than two regimes) is found to be insignificant.

In terms of the results, the short-run impact of additional debt is positive and highly significant at debt-to-GDP ratios below 67 per cent for the benchmark case (1980 to 2007). The impact reduces to zero if debt-to-GDP is above the threshold. A longer sample period, up to 2010, changes the dynamic panel results. The short-run impact of additional debt estimated by the dynamic panel is positive and is highly significant at debt-to-GDP ratio levels below 95.6 per cent. Additional debt has a negative impact on economic activity for high debt-to-GDP ratios above 95 per cent and is statistically significant.

The paper argues that the transmission channel behind the results works through long term interest rates and higher sovereign risk premia. Market sensitivity to debt-related news has recently increased in the Euro area. Therefore, an increase in debt levels today may raise concerns about debt sustainability and signal a tighter fiscal policy in the near future. This is likely to dampen the positive stimulus effects of policy that is the dominating factor behind the results. Therefore, it is

[*] New Zealand Treasury, P.O. Box 3724, Wellington, New Zealand.
E-mail: john.janssen@treasury.govt.nz
The views expressed are those of the author and do not necessarily reflect the views of the New Zealand Treasury.
Thanks to Tugrul Vehbi of the New Zealand Treasury for assistance in preparing these comments.

also important to understand the sources of debt increase. It could make a difference if the additional debt is simply for financing consumption spending versus productive investment.

2 Comments on "Public Debt and Growth" by Manmohan Kumar and Jaejoon Woo

The focus of this paper is on the relationship between high public debt and long-run economic growth. The paper provides further analysis of the findings of Reinhart and Rogoff (2009, 2010) and addresses several of the perceived shortcomings in that work. The contributions along these lines include: the treatment of the endogeneity by using the approach of Arellano and Bover (1995); using the initial level of debt to avoid the reverse causality problem; using an extensive set of regressors to control for the effects of other determinants of growth; and the use of extensive statistical techniques to validate the results.

The estimation starts with a baseline panel of 38 advanced and emerging economies, covering the period 1970 to 2008 and employing a variety of estimation techniques. The rationale for using different methods is based on the fact that different methods involve different tradeoffs (e.g., measurement error versus omitted variable bias). Alternative time period and country coverage are also considered.

The paper also attempts to determine the channels through which debt affects economic growth by considering its effects in a growth accounting framework (*i.e.*, total factor productivity and growth of output and capital stock per worker). The main result is that a 10 per cent increase in the initial debt-to-GDP ratio reduces the subsequent growth rate by 0.2 per cent per year.

The transmission channel is through a slowdown in labour productivity growth due to reduced investment and slower growth of the capital stock. The paper finds evidence of non-linearity, with higher levels of initial debt-to-GDP (>90%) having a proportionately larger negative effect on subsequent growth. Results appear to be robust to different estimation methods with the exception of the fixed effect estimator, where the debt-to-GDP ratio is insignificant.

The fiscal deficit variable is also found to be highly significant in affecting growth rates. Although removing it and other variables in alternative parsimonious specifications still yields an overall negative relationship. This suggests that both deficits and debt matter for growth. It would be interesting to test the results using net debt instead of gross debt. Although data may not be available for the majority of the countries included in the sample, it might be useful to test the validity of the results for a number of countries where net debt data is available. The selection of the thresholds (*i.e.*, low, medium, high) seems somewhat *ad hoc* – what is the rationale for choosing them? Finally, it would also be interesting to assess the sensitivity of the results given the post 2008 experience. Possible extensions to the paper could include the link to external net liabilities and the maturity structure of public debt (elements of these were included in the tabled version of the paper).

3 General comments

Both of the papers focus on relatively narrow aspects of public sector balance sheets, namely public debt. An important lesson from New Zealand's on-going publication of balance sheet information, including the recently published *Investment Statement,* is the insight that can be gained from decomposition. Table 1 lists some of the New Zealand Government's key balance sheet indicators, together with the net positions of portfolio groupings based upon financial, commercial and social objectives.

Table 1

New Zealand Government Balance Sheet Indicators and Portfolios
(billions of NZD dollars, year ended June 2011)

Indicator *(debt reported as +)*		**Portfolio** *(assets – liabilities)*	
Gross debt	72.4	Financial	(47.2)
Net debt	40.1	Commercial	30.9
Net debt including NZSF	24.0	Social	97.2
Net worth	80.9	**Sum = net worth**	**80.9**

Note: Gross debt is gross sovereign-issued debt excluding central bank settlement cash and bills. Net debt is for the core Crown. The NZSF is the New Zealand Superannuation Fund, an entity designed to partially pre-fund future public pensions. Nominal GDP for the year ended June 2011 was around $NZD 200 billion.
Source: Treasury, 2011 Pre-election Economic and Fiscal Update, 25 October.

Unsurprisingly, Table 1 indicates that the social portfolio, comprising assets and liabilities held to provide public services or protect assets for future generations, dominates the balance sheet. Although the (negative) net worth of the financial portfolio is broadly similar to net debt, the former includes a wider set of financial assets and liabilities. In terms of institutional form, these financial assets and liabilities are organized to achieve particular objectives. For example, there is some partial prefunding of public pensions (via the New Zealand Superannuation Fund) and of state-employee pensions (via the Government Superannuation Fund), some matching of accident liabilities (via the Accident Compensation Corporation), and some buffering against natural disasters (via the Earthquake Commission) and macroeconomic shocks (via net debt). Economic developments over recent years, together with significant earthquakes in the Canterbury region have depleted these last two buffers.

Buckle and Cruickshank (2012) assess the wide range of factors influencing the choice of debt targets in New Zealand, many of which interact with the wider elements and objectives of the balance sheet summarized above. A future path of rising gross public debt will, as the two papers commented on suggest, have implications for New Zealand's future economic growth. Nonetheless, the size of those effects and the nature of the transmission channels will likely be influenced by wider developments in the size and composition of the overall public sector balance sheet.

REFERENCES

Arellano, M. and O. Bover (1995), “Another Look at Instrumental Variables Estimation of Error-components Models”, *Journal of Econometrics*, Vol. 68, pp. 29-51.

Buckle, B. and A. Cruickshank (2012), “The Requirements for Long-run Fiscal Sustainability”, paper presented at the *New Zealand Association of Economists Conference*, 27-29 June, Palmerston North, New Zealand.

Caner, M. and B.E. Hansen (2004), “Instrumental Variable Estimation of a Threshold Model”, *Econometric Theory*, Vol. 20, pp. 813-43.

Hansen, B.E. (1999), “Threshold Effects in Non-dynamic Panels: Estimation, Testing and Inference”, *Journal of Econometrics*, Vol. 93, pp. 345-68.

Reinhart, C. and K. Rogoff (2009), “The Aftermath of Financial Crises”, *American Economic Review*, Vol. 99, pp. 466-72.

—————(2010), “Growth in a Time of Debt*”, American Economic Association*, Papers and Proceedings, Vol. 100, pp. 1-9.

COMMENTS ON SESSION 2
GOVERNMENT BUDGETS AND POTENTIAL GROWTH

Gilles Mourre[*]

Comments on "Dynamic Labor Supply with Taxes: The Case of Italian Couples" by Maria Rosaria Marino, Marzia Romanelli and Martino Tasso (Banca d'Italia) and "Do Public Policies of A Net Revenue Maximizing Government Also Promote Informality?" by Nivedita Mukherji and Fuad Hasanov

1 *Focus and complementarities of the two papers*

Both papers consider the impact of tax policy on economic behaviour (labour supply, informality and sectoral structure). The paper by Marino *et al.*, referred to as Paper 1 in the remainder of this discussion, focuses on the labour supply of second earners and the role of the tax and benefit system. It builds on a double consensus in the economic literature: financial incentives to work are key for growth, while labour supply issues are particularly relevant for specific labour-market groups, where elasticities to net earnings is stronger. This policy question is particularly relevant for Italy, where the labour force participation rate among married women is particularly low (see Table 1). The paper by Mukherji and Hasanov, referred to as Paper 2 later on, considers the impact of tax rates on informality and tax revenues. It revisits the consensus in the literature by taking into account sectoral heterogeneity, tax evasion and corruptions and enquires about the possibility of a Laffer curve effect in case of high taxation. This policy issue is of particular relevance for developing countries and EU countries with a large tax burden and high tax non-compliance.

The two papers take very different approaches. While the first one uses micro data on Italy, the second one is based on cross-country macroeconomic indicators. However, the complementarity is blatant between the two papers: they both address two relevant structural features of the economy. They both can also be seen as part of a fiscal optimization exercise. As such, they could also help policy makers to improve the design of fiscal policy, with a view to boosting female participation and reducing poverty (Paper 1) and increasing net revenues, via a modulating tax burden, providing an adequate level of public good and reshaping regulations (Paper 2).

2 *Results*

Paper 1 builds on a micro-econometric model to assess the effect of changes in the tax-benefit system on female labour market participation. Consistently with the prediction of the economic theory, an increase in households' non-labour income (e.g., income support to poor household) is estimated to decrease overall poverty (in terms of head-count ratio) but to lower the incentives of married women to participate in the labour market. In contrast, policies aimed at increasing the return of the hours worked have positive effects on both dimensions.

Paper 2 examines the effects of fiscal and regulatory policies on the size of a country's informal economy and its government's net revenue. Changes in public policies are found to influence not only the size of the informal economy, but also the composition of production within the formal sectors. These effects are amplified when tax evasion and bribes are taken into

[*] European Commission, Directorate-General for Economic and Financial Affairs (ECFIN) and Free University of Brussels (ULB).

Table 1

Tax Burden on Second Earners and Female Employment Rates

Country	Labour Market Performance[1]		Disincentives to Work[2]	
	Employment Rate Female (2010)	Employment Rate Male (2010)	Inactivity Trap (67% AW) 2009	Low-wage trap (33% to 67% AW, 2009)
BE	74.4	85.5	46.3	58.0
DE	76.3	86.5	51.0	49.0
EE	73.9	75.7	22.6	23.0
IE	65.7	75.0	35.4	32.0
EL	61.1	85.3	31.9	19.0
ES	63.2	75.7	17.5	18.0
FR	76.7	87.1	38.1	23.0
IT	58.7	83.5	42.5	48.0
CY	76.6	88.4	-	-
LU	72.6	92.0	32.8	29.0
MT	47.8	88.7	33.3	23.0
NL	79.3	90.0	46.8	41.0
AT	79.7	88.7	29.2	39.0
PT	74.6	83.9	21.5	28.0
SI	82.1	85.2	55.8	42.0
SK	70.1	81.4	21.1	34.0
FI	79.2	83.9	29.2	32.0
BG	73.6	77.9	20.1	22.0
CZ	73.4	90.5	33.9	28.0
DK	80.6	85.9	78.8	63.0
LV	73.8	72.9	31.9	30.0
LT	76.1	71.4	39.5	26.0
HU	67.1	77.9	32.0	42.0
PL	71.7	82.6	39.2	31.0
RO	67.2	81.5	26.3	31.0
SE	82.0	88.0	23.9	29.0
UK	74.3	85.4	43.7	31.0
EU-27	72.2	84.8	40.2	36.1
EA-17	71.5	84.8	39.7	37.1

Source: European Commission (2001), “Tax Reforms in EU Member States”, *European Economy*, No. 5/2011.

consideration. Productive public expenditures increase net revenue. Taxes are found to have a small positive impact, if any, on net revenue and to increase the informal economy. The impact of regulation on net revenue is mixed. The paper concludes that, to raise net revenue, institutional reforms are needed, aiming at better bureaucratic quality and more democratic accountability with a stepped-up fight against corruption.

3 *Methodologies and issues*

On a methodological standpoint, Paper 1 carries a thorough and very interesting analysis – albeit still preliminary – based on a micro-simulation model with a very rich theoretical specification. The model is extremely useful to simulate the impact of concrete parametric/systemic policy measures in Italy, as it consists of a structural dynamic life-cycle model well-suited to analyse household labour supply, saving, and consumption behaviour. The model captures several sources of heterogeneity regarding members of the couple (human capital and number of children) and incorporates most of the fiscal rules relevant for determining the net income of economic agents. Model parameters are estimated using cross-sectional and longitudinal data over 2004-10, which replicates the state of the Italian economy. The estimated model is used to simulate a few counterfactual policies and study their effect on labour supply and poverty.

Three issues could be taken into account as a valuable extension of the current paper 1. First, it may be worth taking varying risk aversion parameters into account, as unemployment risks are uneven across skill groups, regions and sectors. Second, some important factors are not explicitly taken into account: i) non-monetary incentives (not) to work, such as the supply of child care services, which is very relevant for Italy, ii) urban congestion, iii) costs of public transport. Third, it may also be interesting to examine the effect of moving toward a purely individual determination/calculation of tax and benefits, which are still partly computed at the level of the household (especially on the benefit side).

Paper 2 is well drafted and very policy relevant. It is based on a novel model with an attempt to validate it empirically despite strong data limitation. The model includes several types of goods. The empirical estimation uses cross-section data analysis (OLS, GMM), which benefits from a high data variability but faces serious robustness issues. The paper establishes a very relevant distinction between undeclared work and tax evasion in the formal sector.

However, Paper 2 faces some methodological limitations, which could be highlighted further as caveats, and may deserve some further sensitivity analysis. The theoretical model implies perfect labour mobility, which is not always seen in real life. The empirical results remain very fragile, as the number of observations is still very limited (around 50 observations) and the econometric specifications used consume many degrees of freedom. This poses serious problems of inference. Checking the empirical distribution of residuals may give an indication of the extent of the problem. Moreover, some pooled results may be regime dependent, as there is likely to be a great deal of non-linearity between advanced, emerging and developing economies. Therefore, one may wonder whether the results hold true for the euro area. It might also be worth using another variable of tax pressures instead of the Top Marginal Personal Income Rates. The statutory rate for corporate income taxes could be a candidate in this respect. Beside the role on the overall tax burden (highlighted in Paper 2), other relevant aspects should not be neglected and, at least, be mentioned in the paper: simplicity and stability of tax systems, the structure of taxation, the breadth of tax bases and existence of loopholes and the efficiency of individual tax design. As a more minor technical comment, standardising the institutional variables (using the standard deviation) will help interpret the size of the econometric coefficient.