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The effect of public debt on growth in multiple regimes*

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Abstract

We employ a structural threshold regression methodology to investigate the heterogeneous effects of debt on growth using public debt as a threshold variable as well as several other plausible variables. Our methodology allows us to address three sources of model uncertainty that characterize cross-country growth data: parameter heterogeneity, theory uncertainty, and endogeneity. We find strong evidence for threshold effects based on democracy, which implies that higher public debt results in lower growth for countries in the Low-Democracy regime. Our results are consistent with the presence of parameter heterogeneity in the cross-country growth process due to fundamental determinants of economic growth proposed by the new growth theories.

Keywords: parameter heterogeneity, public debt, debt threshold, threshold regression.

JEL Classification Codes: C59, O40, Z12.

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1 Introduction

There is a growing concern that current debt trajectories in several economies around the world are not sustainable implying risks to long-term growth and stability. For example, at the end of 2011, Japan's debt-to-GDP of 233% was the highest debt-to-GDP ratio among the world's developed countries. The US debt-to-GDP ratio reached 102% after the government's debt ceiling was lifted, and in Europe, the prime example is Greece with a 165.3% debt-to-GDP ratio. The outlook for a number of countries does not look any better under existing fiscal policies. As argued by Cecchetti, Mohanty, and Zampolli (2011a) projections of debt-to-GDP ratios look even worse, especially when one takes into account expected future age-related spending.

All this evidence has created an urgent need for policymakers in governments, central banks, and international policy organizations to understand the effects of public debt on economic growth. The fear that investors may interpret the high debt-to-GDP ratios as the result of time inconsistent or inflationary policies has led countries to implement immediate and severe austerity measures on their citizens and adopt fiscal discipline in order to restore their credibility irrespective of the costs in terms of high unemployment, deflation, and the possibility of depression. But is this fear justified for all countries? A key focus of the current literature on the effects of public debt on economic performance has been the attempt to identify nonlinear and in particular threshold effects. The idea is that debt levels that are above a particular threshold value may have different implications for growth compared to more moderate levels of debt. For example, a prominent study by Reinhart and Rogoff (2010) found that there is generally a weak relationship between government debt and economic growth for countries with debt below 90% of GDP. However, for countries with debt-to-GDP over 90%, debt can have adverse consequences on growth.

Other studies have attempted to provide a formal test for the 90% threshold value of Reinhart and Rogoff (2010). For example, Cecchetti, Mohanty, and Zampolli (2011b) and Caner, Grennes, and Koehler-Geib (2010) employ the threshold regression of Hansen (2000) to estimate public debt thresholds. Cecchetti, Mohanty, and Zampolli (2011b) study the effects of public debt on growth using a new dataset on debt levels in 18 OECD countries from 1980 to 2010. Using threshold regression, they find that government debt is bad for growth when it is above the threshold value of 85% of GDP. Caner, Grennes, and Koehler-Geib (2010) using threshold regression methods on data for a larger set of countries for 1980 to 2008 find that a threshold of 77 percent public debt-to-GDP ratio is the critical level after which debt becomes damaging to growth.

Current work suffers from a number of conceptual and methodological issues. An important limitation of the recent work has been the failure to adequately account for heterogeneity in the effect of debt on growth, which may arise due to alternative growth theories. Specifically, researchers have been searching for threshold effects of public debt on growth when debt is above or below a particular public debt threshold value. The alternative that has been considered is simply that there is no nonlinearity in the effect of public debt on growth. However, these studies do not investigate other possible threshold variables beyond the debt-to-GDP ratio. But, why would we believe a priori that the effect of public debt on growth is characterized only by excessive levels of debt?

This paper is designed to elucidate our understanding by providing answers to the above questions using an econometric methodology that allows us to deal with parameter heterogeneity more generally. Parameter heterogeneity refers to the idea that the data generating process that describes the cross-country growth process is not common for all observations. For example, theory suggests that other factors besides just the debt-to-GDP ratio; e.g., a country's trade openness or institutional quality, are plausible sources of convergence clubs and therefore can be used as threshold variables to sort countries into multiple growth regimes in which countries obey the same growth model.

One approach that deals with the problem of parameter heterogeneity is to use threshold regression (TR) or sample splitting models. In a seminal paper, Durlauf and Johnson (1995) employed a sample splitting (specifically, a regression tree) approach to uncover multiple growth regimes in the data. Following a similar strategy Papageorgiou (2002) organized countries into multiple growth regimes using the trade share and Tan (2010) classified countries into development clubs using the average expropriation risk.[1] A key goal of this paper therefore is to evaluate the strongest evidence for a particular factor (be it the debt-to-GDP ratio, institutions, etc) out of a large set of plausible candidates, in the context of threshold regression models, as being the most plausible threshold variable to characterize the heterogeneous effects of public debt on growth and thereby, consequently, organizing countries into multiple growth regimes.

[1] An alternative approach employs semiparametric models based on nonparametric smooth functions to identify general nonlinear growth patterns. Notable examples include Durlauf, Kourtellos, and Minkin (2001) and Mamuneas, Savvides, and Stengos (2006).

One difficulty with all the above studies is that they ignore the problem of endogeneity in the threshold variable. This is important because, as Kourtellos, Stengos, and Tan (2011) argue, if the threshold variable is endogenous, the above approaches will yield inconsistent parameter estimates for the regime-specific partial effects. In fact, there is strong evidence that variables such as public debt, trade, and institutions are endogenous; see Panizza and Presbitero (2012), Frankel and Romer (1999) and Acemoglu, Johnson, and Robinson (2001), respectively. In this paper, we therefore model parameter heterogeneity using the structural threshold regression (STR) model, which was proposed by Kourtellos, Stengos, and Tan (2011). Threshold regression models classify observations into stochastic processes depending on whether the observed value of a threshold variable is above (or below) a threshold value. A key feature of STR is that it allows for the endogeneity of the threshold variable as well as for the endogeneity of regressors. Our analysis augments the Solow growth model with the debt-to-GDP ratio and investigates the possibility of multiple growth regimes in the data using a comprehensive set of growth determinants as threshold variables including among others the debt-to-GDP ratio, institutions, ethnic fractionalization, and trade openness.

The final issue that has been left unaddressed by the recent literature is that of theory uncertainty. The term theory uncertainty was first coined by Brock and Durlauf (2001) to refer to the idea that new growth theories are open-ended, which means that any given theory of growth does not logically exclude other theories from also being relevant. In our context, theory uncertainty implies that the role of debt in economic growth should be evaluated against alternative growth variables that have been suggested by theory and/or found to be empirically important. For example, while Acemoglu, Johnson, and Robinson (2001) and Alesina, Devleeschauwer, Easterly, Kurlat, and Wacziarg (2003) emphasize the importance of institutions and ethnic fractionalization, respectively, it is not clear if the correct model specification should include both theories, or just one (or none) of them, since the inclusion of one theory; e.g., institutions, does not automatically preclude the other; e.g., ethnic fractionalization, from also being a determinant of growth. However, the estimated partial effect of debt on growth may vary dramatically across model specifications depending on what other auxiliary variables are included in the regression. How should one deal with the dependence of inference on model specifications? More specifically, how does one address the issue of model uncertainty within the context of threshold regression (e.g., STR) models?

An important methodological contribution of this paper is to exploit a key finding in Kourtellos, Stengos, and Tan (2011), which shows that the threshold parameters in a threshold regression model can still be consistently estimated using the concentrated least squares strategy of Hansen (2000) even when linear restrictions are placed on regime-specific linear growth processes. One implication of their finding is that, even if we face theory uncertainty, we can still obtain consistent estimates for the threshold parameters by estimating regime-specific growth processes that include only a subset of the true set of slope variables; e.g., those suggested by the augmented neoclassical theory. Once the threshold parameters has been estimated, we can then address the issue of model uncertainty regime-by-regime.

One way to deal with regime-specific model uncertainty is to employ Bayesian Model Averaging (BMA), which dates back to Leamer (1978), and was further studied by Draper (1995), Kass and Raftery (1995), and Raftery, Madigan, and Hoeting (1997). Model averaging constructs estimates that do not depend on a particular model specification but rather use information from all candidate models. In particular, it amounts to forming a weighted average of model specific estimates where the weights are given by the posterior model probabilities. BMA has been widely applied in growth regressions and has proven to be particularly useful in identifying robust growth determinants; see for example, Brock and Durlauf (2001), Fernandez, Ley, and Steel (2001), Sala-i Martin, Doppelhofer, and Miller (2004), Durlauf, Kourtellos, and Tan (2008), and Masanjala and Papageorgiou (2008). We account for theory uncertainty in the STR context by applying BMA to each regime-specific linear growth process.

In terms of our findings, we find strong evidence for threshold effects based on democracy in the effect of debt on growth. More precisely, our findings show that there exists a critical level of democracy under which more public debt leads to lower growth, ceteris paribus. While the focus of the existing literature has been on whether there exist threshold effects of public debt on growth (tipping-points), this paper suggests that, once a rich set of alternative theories are considered, there is very little evidence for such nonlinearities. Instead, our findings suggest that the effect of public debt on growth depends on a country's democratic institutions. When a country's institutions are below a particular quality level, then, more public debt leads to lower growth (all else equal). However, if a country's institutions are of sufficiently high quality, then, public debt is growth neutral. Our paper therefore shifts the focus of research on the long-run effects of public debt towards the presence of parameter heterogeneity in the cross-country growth process due to fundamental determinants of economic growth proposed by the new growth theories.

The rest of the paper is organized as follows. Section 2 describes our empirical methodology and Section 3 describes our data. In Section 4 we present the main results of the paper and finally, in Section 5, we conclude.

2 Empirical methodology

2.1 The Solow growth regression model

We start our investigation of the effect of debt, d_{it}, on economic growth using a Solow growth model augmented with the debt-to-GDP ratio. This model assumes that the structural growth process for country i obeys a linear model and is common across countries. Specifically, the econometric model takes the form of a linear regression of the growth rate of real per capita GDP over the time interval $t-1$ to t, g_{it}. In particular, we consider three 10-year growth periods, $t = 1, 2, 3$, which allow us to exploit the panel structure of the data and at the same time average out business cycle effects. Our analysis focuses on the coefficient of debt, α_d, which estimates the effect of debt on growth, controlling for a set of standard Solow growth determinants, S_{it}.

$$g_{it} = X_{it}'\beta + e_{it} = d_{it}\alpha_d + S_{it}'\alpha_S + e_{it}, \tag{2.1}$$

where $i = 1, 2, ..., N_t$ and $t = 1, 2, ..., T$. X_{it} is a $k \times 1$ vector of variables that is partitioned into a $k_1 \times 1$ vector of exogenous/predetermined determinants, X_{1it}, and a $k_2 \times 1$ vector of right hand side endogenous determinants, X_{2it}. X_{1it} includes a constant and a time trend. X_{2it} is the $k \times 1$ vector of Solow variables, which include the logarithm of population growth plus 0.05 (*Population Growth*), the logarithm of the average investment to GDP ratio (*Investments*), the logarithm of the average years of secondary and tertiary schooling for male population over 25 years of age (*Schooling*), and the logarithm of real GDP per worker in the initial year of each 10-year period (*Initial Income*). e_{it} is an *i.i.d.* error term. Assuming a $l \times 1$ vector of instrumental variables $Z_{it} = (X_{1it}', Z_{2it}')'$ such that $l \geq k$ the implied reduced form for X_{2it} takes the following form

$$X_{2it} = \Gamma_2' Z_{it} + V_{Xit}, \tag{2.2}$$

where V_{Xit} is a vector of *i.i.d.* errors. In this paper we instrument all endogenous variables using their lagged values. Equation (2.1) is then estimated by 2SLS.

Putting aside issues related to the endogeneity of growth determinants and the validity of instruments we argue that the existing literature, which is based on equation (2.1) suffers from two important sources of model uncertainty: theory uncertainty and parameter heterogeneity.

As discussed in the Introduction, we propose an econometric methodology that unifies two recent econometric techniques; i.e., Bayesian Model Averaging and Structural Threshold Regression (STR), that will allow us to deal with the two problems of parameter heterogeneity and theory uncertainty.

Next, we describe a STR model for growth that deals with the problem of parameter heterogeneity alone. Then, we propose a model averaging approach to account for theory uncertainty.

2.2 Threshold Solow growth model

We now describe the STR model by Kourtellos, Stengos, and Tan (2011), that allows for endogeneity in the slope regressors X_{it} as well as the threshold variable.[2] This model can be viewed as a generalization of the simple threshold regression framework of Hansen (2000) and Caner and Hansen (2004) to allow for the endogeneity of the threshold variable and regime specific heteroskedasticity.

Consider a threshold variable q_{it} such as public debt that can organize the observations into regimes and define the following indicator function

$$I(q_i \leq \gamma) = \begin{cases} 1 & \text{iff } q_i \leq \gamma : \text{Regime 1} \\ 0 & \text{iff } q_i > \gamma : \text{Regime 2} \end{cases} \tag{2.3}$$

and $I(q_i > \gamma) = 1 - I(q_i \leq \gamma)$. In this paper, we assume that q_{it} can be any non-constant variable that belongs to the set of determinants X_{it}. We assume that q_{it} is endogenous so

[2]The threshold model of Caner and Hansen (2004) (IVTR) allows only for the endogeneity of the slope regressors and maintains the assumption of the exogeneity of the threshold. STR reduces to IVTR when $\kappa = 0$.

that the reduced form equation that determines which regime applies takes the form

$$q_i = \pi_q' Z_i + v_{qi}, \tag{2.4}$$

It is worth noting that the above reduced form equation is analogous to the selection equation that appears in the literature on limited dependent variable models. However, there is one important difference. While in sample selection models, we observe the assignment of observations into regimes but the (threshold) variable that drives this assignment is taken to be latent, here, it is the opposite; we do not know which observations belong to which regime (i.e., we do not know the threshold value), but we can observe the threshold variable.

Following Kourtellos, Stengos, and Tan (2011) we can generalize (2.1) to allow for two regimes as follows:

$$g_{it} = X_{it}'\beta + X_{it}'I(q_{it} \leq \gamma)\delta + \lambda_{it}(\gamma)\kappa + \varepsilon_{it}, \tag{2.5}$$

where $E(\varepsilon_{it}|Z_{it}) = 0$.

The term $\lambda_{it}(\gamma)$ is a scalar variable that involves an inverse Mills ratio term for each regime in order to restore the conditional mean zero property of the errors. In particular, $\lambda_{it}(\gamma)$ is defined as follows:

$$\lambda_{it}(\gamma) = \lambda_{1it}(\gamma)I(q_i \leq \gamma) + \lambda_{2it}(\gamma)I(q_{it} > \gamma),$$

with $\lambda_1(\gamma - Z_{it}'\pi_q) = -\frac{\phi(\gamma - Z_{it}'\pi_q)}{\Phi(\gamma - Z_{it}'\pi_q)}$ and $\lambda_2(\gamma - Z_{it}'\pi_q) = \frac{\phi(\gamma - Z_{it}'\pi_q)}{1-\Phi(\gamma - Z_{it}'\pi_q)}$. The functions $\phi(\cdot)$ and $\Phi(\cdot)$ are the normal pdf and cdf, respectively.

Finally, note that the coefficients β are the coefficients of the second regime, that is $\beta = \beta_2$ and δ is the difference between the coefficients of regime 1, β_1 and regime 2, β_2; that is, $\delta = \beta_1 - \beta_2$. Equation (2.5) reduces to the linear growth model in equation (2.1) when $\delta = \kappa = 0$.

The estimation of the threshold parameter is based on a concentrated least squares method while the slope coefficients are obtained using 2SLS or GMM. The asymptotic distribution of the threshold parameter γ is nonstandard as it involves two independent Brownian motions with two different scales and two different drifts. Confidence intervals are provided by an inverted likelihood ratio approach; see Kourtellos, Stengos, and Tan (2011).

Finally, we test the null hypothesis of a linear model against the alternative of a threshold for each candidate threshold variable, $H_0 : \delta = 0$. We do so by employing the sup Wald test of Kourtellos, Stengos, and Tan (2011), which is an extension of the Davies (1977) Sup test to the GMM framework.[3] Since the threshold parameter, γ_s, is not identified under the null hypothesis of a linear model (i.e. no threshold effect), the p-values are computed by a bootstrap method, which relies on the arguments of Hansen (1996). Specifically, the p-values are computed by a bootstrap that fixes the regressors from the right-hand side of equation (2.5) and generating the bootstrap dependent variable from the distribution $N(0, \widehat{\varepsilon}^2_{it})$, where $\widehat{\varepsilon}_{it}$ is the demeaned residual from the estimated STR model.

2.3 Theory Uncertainty

The structure of the STR model suggests model uncertainty with respect to potential threshold variables q_s, $s = 1, 2....Q$, as well as potential growth determinants, $\widetilde{X}$ beyond the Solow factors (e.g. geography, institutions, and ethic fractionalization).

We propose to deal with this problem in steps. First, we test for threshold effects in the Solow threshold regression using a large set of potential threshold variables: test the null hypothesis of a linear model, $H_0 : \delta_s = 0$, against the alternative of a threshold, $H_0 : \delta_s \neq 0$, for each candidate threshold variable, $s = 1, 2....Q$. Second, we select the best STR model using a J criterion. Third, for a given threshold estimate based on the best STR model we employ BMA to account for model uncertainty within each growth regime.

Specifically, given a threshold estimate, $\widehat{\gamma}$, that we obtained in Section 2.2, we get the following growth regressions for a particular $\widetilde{X}_m$ combination of regressors in each regime.

$$g_i = \begin{cases} \widetilde{X}'_{mit}\beta_{1m} + \lambda_{1it}(\widehat{\gamma})\kappa_{1m} + \varepsilon_{it}, & q_{sit} \leq \widehat{\gamma} \\ \widetilde{X}'_{mit}\beta_{2m} + \lambda_{2it}(\widehat{\gamma})\kappa_{2m} + \varepsilon_{it}, & q_{sit} > \widehat{\gamma} \end{cases} \tag{2.6}$$

The set of all possible combinations of regressors from this set constitutes the model space, denoted by M. For simplicity we only consider just-identified systems. This implies that for any given M_m we can obtain an associated first stage model given by model specific versions of equations (2.2) and (2.4). Given that the true model is in the model space, M, we

[3]For robustness purposes we also employed the threshold sup test by Hansen (2000) that ignores the issues of endogeneity and generally found similar results.

can think of each model M_m as a model that places linear restrictions on the largest model.

The justification for the third step of our strategy that for a given threshold variable the threshold estimate, $\widehat{\gamma}$, based on the Solow variables, X, also applies to any combination of regressors from the larger set $\widetilde{X}$ is based on an important finding in Kourtellos, Stengos, and Tan (2011) (see, Remark 1 of Proposition 4.1). This result says that the estimate of the threshold value from the restricted model, and the threshold value estimate from the unrestricted model, both converge to the true threshold value, asymptotically. The finding that the threshold estimate for the restricted model is a consistent estimator for γ is therefore particularly useful when we do not know what the true model is due to theory uncertainty. Kourtellos, Stengos, and Tan (2011) also show that the estimator of the threshold parameter is super-consistent while the slope estimators, are root-n consistent and hence the slope parameters, $\theta_{jm} = (\beta'_{1m}, \kappa_{jm})'$, $j = 1, 2$ can be estimated as if the threshold parameters were known.

How can we obtain robust determinants in equation (2.6) and more generally robust inference about the structural parameters θ_m that do not condition on the model choice? We do so by employing a BMA approach by constructing estimates conditional not on a single model, but on a model space whose elements span an appropriate range of determinants suggested by a large body of work. In particular, we employ the 2SLS-BMA approach proposed by Durlauf, Kourtellos, and Tan (2011) and Eicher, Lenkoski, and Raftery (2010) that computes the weighted average of model-specific estimates using 2SLS estimates; the weights are constructed to be analogous to posterior model probabilities.

Model averaging integrates out the uncertainty over models by taking the weighted average of model-specific estimates, where the weights reflect the evidentiary support for each model given the data, D, and which are constructed to be analogous to posterior model probabilities. The posterior distribution of θ_j given the data, D, is given by

$$\widehat{\mu}(\theta_j|D) = \sum_{m \in M} \widehat{\mu}(\theta_j|M_m, D)\widehat{\mu}(M_m|D)) \tag{2.7}$$

where $\mu(\theta|M_m, D)$ is the posterior distribution of θ given a particular model M_m, and $\mu(M_m|D)$ is the posterior probability of model M_m.

For the model weights, $\widehat{\mu}(M_m|D)$ we use the Bayes' rule, so that each weight is the product of the integrated likelihood of the data given a model, $\widehat{\mu}(D|M_m)$, and the prior probability for a model, $\mu(M_m)$:

$$\widehat{\mu}(M_m|D) \propto \widehat{\mu}(\theta|M_m)\mu(M_m) \tag{2.8}$$

As standard in the literature, we assume a uniform model prior so that the prior probability that any variable is included in the true model is taken to be 0.5. The integrated likelihood of model M_k reflects the relative goodness of fit of different models and is approximated by the Bayesian information criterion (BIC).

Then, the model average estimator for the slope parameters takes the form of the posterior mean:

$$\widehat{\theta}_M^{2SLS} = \sum_{m \in M} \widehat{\mu}(M_m|D)\widehat{\theta}_m^{2SLS} \tag{2.9}$$

We also compute the corresponding standard errors using the posterior variance of θ

$$\widehat{V}_{D,M}^{\theta} = \sum_{k \in M} \widehat{V}_{D,k}^{\theta}\widehat{\mu}(M_k|D) + \sum_{k \in M}(\widehat{\theta}_{D,k}^{2SLS} - \widehat{\theta}_{D,M}^{2SLS})^2\widehat{\mu}(M_k|D) \tag{2.10}$$

where $\widehat{V}_{D,k}^{\theta}$ is the model-specific posterior variance of the partial likelihood estimator estimator. The first term in equation (2.10) is the average of the posterior variances within models and the second term is the variance of the posterior means across models (i.e. weighted average of the squared deviations of the model-specific from the model averaged estimates). We also report the posterior probability of inclusion for each covariate, which is the sum of the posterior probability of all the models for which that variable appears. It is meant to capture the (posterior) probability that that covariate is in the true model after looking at the data.[4]

[4] As a final note this approach can be viewed as a "hybrid" approach to model averaging in the sense that we mix frequentist probability statements about observables given unobservables and Bayesian probability statement about unobservables given observables; see Durlauf, Kourtellos, and Tan (2011) for more details.

3 Data

We employ a balanced 10-year period panel dataset covering 82 countries in 1980-89, 1990-99, and 2000-2009. The dependent variable is computed as the growth rate of real per capita GDP over the time interval sampled from PWT 7.0.

We next describe the variables that we consider in addition to the Solow variables and the debt-to-GDP ratio (*Public Debt*), and which generate the model space, M. We should also note that in all exercises we include a constant and a time trend. In addition to these variables, we include (i) three other policy variables; i.e., a measure of trade *Openness* (the average ratio for each period of exports plus imports to GDP), the log of the average inflation rate (plus one) for each period (*Inflation*), and a measure of the size of *Government* relative to the economy (log of the average ratio for each period of government consumption net of outlays on defense and education to GDP), (ii) two measures of institutions; i.e., a measure of the extent of institutionalized *Democracy* and a measure of the extent of institutionalized constraints on the decision making powers of chief executives (*Executive Constraints*), and a measure of ethnolinguistic fractionalization (*Language*), (iii) two geographic variables; i.e., the percentage of a country's land area that is classified as tropical or subtropical (*Tropics*) and the percentage of a country's land area within 100km of an ice-free coast (*LCR100km*), and, finally, (iv) two demographic variables; i.e., the log of the average *Life Expectancy* and the log of the average total fertility rate (*Fertility*) for each period.

As detailed in Section 2.3, once we have obtained a consistent estimator for the threshold value using the augmented Solow STR model, we then carry out regime-by-regime BMA. The model space for each of the regime-specific linear growth models then includes all of the variables described above, plus a set of eight variables describing the fraction of the population that adheres to particular religions, as well as regional dummy variables for East Asia, Latin America, and Sub-Saharan Africa.

Table 1 presents summary statistics for the pooled data. The variables are drawn from various sources. A detailed description of the variables and their sources is given in Table 8 of the Appendix.

4 Results

We first present results for our STR model with the Solow model augmented with public debt as the regime-specific linear model as described in equation (2.5). Table 2 shows in the first two columns the results of a test of the existence of a threshold effect against the null of global linearity for each of the candidate threshold variables described in Section (3) above.

Of the 15 potential candidates, 9 cases; i.e., Initial Income, Schooling, Investments, Population Growth, Fertility, Life Expectancy, Inflation, Tropics, and Democracy, resulted in a rejection of the null. Significantly, there is very little evidence that Public Debt is a good threshold variable for sample splitting. At least for this sample of countries, therefore, there seems to be little evidence of nonlinearity in the effects of public debt on growth. However, there is strong evidence of parameter heterogeneity as suggested by the significant threshold effects obtained using several threshold variables other than the debt-to-GDP ratio.

Table 3 shows the estimate for the threshold value for each of the 9 threshold variables, the associated 90% confidence interval for the threshold value, the number of observations for each of the two regimes that come from splitting the sample according to each of these threshold variables, and the associated J statistic for the STR model using each of these threshold variables, respectively.

Each of these 9 threshold variables therefore constitutes a potential STR model for the data. Hence, we need to select the model that best fits the data. We do so according to the J criterion. As Table 3 shows, the J criterion is minimized when Democracy is the threshold variable. Hence, we present our findings for the model that splits the sample into a Low-Democracy regime (i.e., countries with Democracy scores below 4.5) and a High-Democracy regime (i.e., countries with Democracy scores above 4.5) in Table 4. The threshold estimate of 4.5 corresponds to Malaysia in period 2 and Nepal in period 3 and the lower and upper bounds of the 90% confidence interval, [2.949, 4.799], correspond to Philippines in period 1 and Brazil in period 1, respectively. Table 5 shows the the exact sample of countries that fall within each regime and for each period as well as the Democracy scores.

The findings from this STR model are quite striking and point to parameter heterogeneity in the sense that the effect of debt on growth depends on democracy. All else equal, higher public debt results in lower growth for countries in the Low-Democracy regime. The coefficient to public debt for this regime is negative and strongly significant at the 1% level. However, for countries with better quality institutions; i.e., countries in the High-Democracy regime, public debt has no significant effect on growth. We should also note that countries in the Low-Democracy regime tend to have, on average, higher public debt levels than those in the High-Democracy countries. The mean public debt level for countries in the Low-Democracy regime is around 0.8. In this sense, our results reflect those in the existing literature that suggest that more highly indebted countries are also the ones that tend to experience more negative growth effects from higher levels of debt. However, our findings highlight that the threshold effects that are important in determining the effect of debt on growth are governed by institutions rather than the level of debt itself. Interestingly, the Low-Democracy regime is also characterized by lower growth and income compared to the High-Democracy regime.

Now that we have consistently estimated the threshold value for splitting the sample, we next relax the restriction on the regime-specific linear growth model that the coefficients for all variables in the model space other than those for the Solow variables and Public Debt are zero. We report three sets of results. In Tables 6 and 7, we show the findings for the BMA analysis for the Low-Democracy and High-Democracy regimes, respectively. The first column shows the posterior probability that each of the covariates is included in the true growth model, while the second and third columns present the BMA posterior means and standard errors for each covariate. The remaining four columns show, respectively, the coefficient estimate and standard error for each covariate for the posterior mode models from the BMA analysis, and the largest model in the model space considered in the BMA analysis. The variables are sorted by the posterior inclusion probability.

Our reason for reporting the results from the posterior mode and largest models is to provide the reader with the ability to compare findings via model selection - using the best models (in terms of posterior weights) or a low-bias model (at the cost of reduced efficiency) with potentially many irrelevant covariates - with those obtained via BMA. Finally, we also note that the posterior means are interpreted as the marginal effect of each covariate conditional on being in the High- or Low-democracy regime.

In all three cases, our findings affirm what we had found earlier using the augmented Solow model. Public Debt is very likely to be in the true model (with a posterior inclusion probability of over 0.99 and statistically significant at 10%) only in the Low-Democracy regime.[5] In this case, the partial effect of public debt on growth is negative (and highly

[5] In the Bayesian context a posterior t-ratio of 1.3 is equivalent to a test with 10% size in frequentist

significant in the posterior mode model). It has negligible posterior probability of inclusion in the High-Democracy growth model.

5 Conclusion

This paper contributes to an important contemporary debate on the relationship between public debt and long-run economic performance. The focus of the existing literature has been on whether there exist nonlinear effects of public debt on growth. Is there a critical level of public debt such that over it, more public debt leads to lower growth, all else equal? The findings in this paper suggest that, once a rich set of alternative theories are considered, there is very little evidence for such nonlinearities. Instead, our findings suggest that the relationship between public debt and growth is mitigated crucially by the quality of a country's institutions. When a country's institutions are below a particular quality level, then, more public debt leads to lower growth (all else equal). However, if a country's institutions are of sufficiently high quality, then, public debt is growth neutral. Our paper therefore shifts the focus of research on the long-run effects of "high levels" of public debt towards its interplay with the deep (fundamental) determinant of growth as recently proposed by the new growth theories.

hypothesis testing; see Eicher, Papageorgiou, and Roehn (2007).

Table 1: Descriptive Statistics

This table presents the summary statistics for our dataset.

	Mean	Std Dev	Max	Min
Growth	0.013737	0.02296	0.083383	-0.09946
Initial Income	8.423263	1.266566	10.71059	5.868249
Lag of Initial Income	8.335907	1.232224	10.54767	5.779916
Schooling	0.598071	0.768791	1.970172	-2.18351
L ag of schooling	0.320655	0.901583	1.901029	-2.66267
Investments	3.046038	0.351779	3.891546	1.87323
Lag of Investments	3.055552	0.394586	4.312729	1.743324
Population Growth	-2.71142	0.160957	-2.38471	-3.2289
Lag of Population Growth	-2.69098	0.16542	-2.27681	-3.08358
Fertility	1.165151	0.501702	2.051261	0.188966
Lag of fertility	1.27774	0.521549	2.057247	0.153579
Life Expectancy	4.152884	0.176415	4.395388	3.656394
Lag of Life Expectancy	4.129947	0.179433	4.376214	3.614339
Public Debt	0.725291	0.626556	5.59726	0.087895
Lag of Public debt	0.660963	0.609409	6.405994	0.030556
Government	2.195023	0.439004	3.560925	1.056177
Lag of Government	2.192095	0.477742	3.694487	1.014359
Inflation	2.298081	1.167341	7.571372	-1.95183
Lag of Inflation	2.33869	1.193889	8.258299	-1.45953
Openness	66.51136	36.48778	199.8575	9.768346
Lag of openness	61.00657	35.80411	180.0895	9.697868
Democracy	5.742649	3.834012	10	0
Lag of Democracy	5.021545	4.167344	10	0
Executive Constraints	4.958977	2.047979	7	1
Lag of Executive Constraints	4.512398	2.332962	7	1
LCR100km	0.458926	0.361177	1	0
Tropics	0.428233	0.425988	1	0
Language	0.38244	0.297867	0.898015	0.002113
Eastern Religion	0.013972	0.057151	0.383	0
Hindu	0.032785	0.134879	0.881	0
Jew	0.011728	0.090915	0.854	0
Muslim	0.20115	0.340285	0.993	0
Orthdox	0.025122	0.129584	0.942	0
Other Religion	0.211955	0.248529	0.931	0
Protestant	0.132325	0.215225	0.974	0
Non-religion	0.027402	0.053705	0.331	0

Table 2: Threshold tests

This table presents sup Wald tests for the null hypothesis that the linear Solow growth model augmented by the debt-gdp-ratio in equation (2.1) against the alternative hypothesis of the threshold model in equation (2.5). ***, **, and * denote significance at 1%, 5%, and 10%, respectively. All models include constant and trend. It also shows the point estimate of the threshold parameter along with the associated the 90% confidence interval, the sample size of two growth regimes, and the J statistic for the STR models that rejected the null of the linear model in Table 2.

Threshold Variable	sup Wald	Boot p-value
Initial Income	53.575*	0.057
Schooling	43.1849***	0.002
Investments	30.1235*	0.067
Population growth	57.804**	0.015
Fertility	51.9421**	0.037
Life expectancy	81.4932***	0.000
Public Debt	16.4969	0.517
Government	20.2704	0.29
Inflation	28.7319*	0.066
Openness	25.9372	0.131
Democracy	31.7114*	0.096
Executive constraints	21.1275	0.202
Tropics	42.1866***	0.006
LCR100km	21.5703	0.208
Language	20.2187	0.235

Table 3: Threshold tests

This table shows the point estimate of the threshold parameter along with the associated the 90% confidence interval, the sample size of two growth regimes, and the J statistic for the STR models that rejected the null of the linear model in Table 2.

Threshold Variable	threshold estimate	90% Confidence Interval	n^{low}	n^{High}	J statistic
Initial Income	6.93585	[6.9258, 7.4708]	36	210	2.3E-21
Schooling	0.95985	[0.4689, 1.3219]	163	83	6.39E-21
Investments	2.729622	[2.7296, 2.7476]	35	211	5.89E-22
Population growth	-2.87913	[-2.9211,-2.5471]	54	192	1.17E-18
Fertility	1.067608	[0.8776, 1.2866]	109	137	1.7E-19
Life expectancy	3.97159	[3.9706, 3.9716]	43	203	9.52E-22
Inflation	2.776564	[1.7656, 2.8246]	192	54	3.38E-21
Democracy	4.599	[2.949, 4.799]	90	156	1.58E-22
Tropics	0.443	[0, 0.967]	129	117	9.57E-21

Table 4: STR estimation

This table presents the estimation of the STR model of Kourtellos, Stengos, and Tan (2011) using Democracy as a threshold variable. All variables are instrumented using their lagged values. It also presents the TR model of Hansen (2000) that ignores endogeneity. The last two columns report the GMM and LS results for the global estimation that ignores the presence of a threshold. JSTAT refers to the J-statistic of the STR estimation. The means of the variables are also reported for each regime. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Method	STR-GMM		TR-LS		Linear-GMM	Linear-LS
Threshold Estimate	4.500		4.600			
90% Confidence Interval	[2.949, 4.799]		[1.2, 5.6]			
J statistic	1.577E-22					
	Low	**High**	**Low**	**High**		
Initial Income	0.0023	-0.0147***	0.0013	-0.0118***	-0.0047**	-0.0032*
	(0.0052)	(0.0031)	(0.0047)	(0.0023)	(0.0022)	(0.0019)
Schooling	0.0056	0.0083*	0.0047	0.0099***	0.0056*	0.0062**
	(0.0050)	(0.0046)	(0.0049)	(0.0037)	(0.0033)	(0.0029)
Investments	0.0060	-0.0042	0.0173***	0.0116*	0.0061	0.0187***
	(0.0069)	(0.0103)	(0.0057)	(0.0064)	(0.0051)	(0.0039)
Population growth	-0.0132	-0.0811***	0.0283	-0.0630***	-0.0554***	-0.0197*
	(0.0514)	(0.0237)	(0.0341)	(0.0144)	(0.0164)	(0.0109)
Public debt	-0.0109***	0.0040	-0.0121***	-0.0028	-0.0004	-0.0071***
	(0.0036)	(0.0045)	(0.0031)	(0.0032)	(0.0029)	(0.0022)
Const	-0.0571	-0.0680	0.0200	-0.0928**	-0.1227***	-0.0738***
	(0.1110)	(0.0490)	(0.0638)	(0.0363)	(0.0383)	(0.0282)
Trend	-0.0005	-0.0001	0.0040	0.0003	0.0020	0.0028
	(0.0040)	(0.0017)	(0.0033)	(0.0017)	(0.0020)	(0.0018)
IMR-kappa	-0.0063***					
	(0.0017)					
Number of obs	90	156	91	155		
Means						
Growth	0.0052	0.0187	0.0050	0.0189		
Public debt	0.8288	0.6656	0.8270	0.6656		
Initial Income	7.5315	8.9378	7.5454	8.9387		
Schooling	0.1268	0.8700	0.1314	0.8721		
Investments	2.9927	3.0768	2.9906	3.0786		
Population growth	-2.6149	-2.7671	-2.6178	-2.7664		
Democracy	1.1737	8.3786	1.2114	8.4030		

Table 5: Low- and High-Democracy regimes

This table presents the countries marked as Low-Democracy countries (L) (i.e. countries with democracy scores less than or equal to 4.5) and High-Democracy countries (H) (i.e. countries with democracy scores greater than 4.5) for each period.

	1980-89	1990-99	2000-09
Europe			
Austria	(H) 10	(H) 10	(H) 10
Belgium	(H) 10	(H) 10	(H) 9.4
Denmark	(H) 10	(H) 10	(H) 10
Finland	(H) 10	(H) 10	(H) 10
France	(H) 8.4	(H) 9	(H) 9
Greece	(H) 8.8	(H) 10	(H) 10
Ireland	(H) 10	(H) 10	(H) 10
Italy	(H) 10	(H) 10	(H) 10
Netherlands	(H) 10	(H) 10	(H) 10
Norway	(H) 10	(H) 10	(H) 10
Portugal	(H) 9.8	(H) 10	(H) 10
Spain	(H) 9.8	(H) 10	(H) 10
Sweden	(H) 10	(H) 10	(H) 10
United Kingdom	(H) 10	(H) 10	(H) 10
Offshoots			
Australia	(H) 10	(H) 10	(H) 10
Canada	(H) 10	(H) 10	(H) 10
New Zealand	(H) 10	(H) 10	(H) 10
United States	(H) 10	(H) 10	(H) 10
East Asia and the Pacific			
Indonesia	(L) 0	(L) 0.7	(H) 7.6
Japan	(H) 10	(H) 10	(H) 10
Korea Republic of	(L) 1.75	(H) 7.2	(H) 8
Malaysia	(H) 5	(L) 4.5	(L) 4.4
Papua New Guinea	(L) 4	(L) 4	(L) 4
Philippines	(L) 3	(H) 8	(H) 8
Thailand	(L) 3.2	(H) 7.7	(H) 6.6
Europe and Central Asia			
Turkey	(H) 5.7	(H) 8.7	(H) 8
Middle East and North Africa			
Algeria	(L) 0.1	(L) 0.7	(L) 2.2
Cyprus	(H) 10	(H) 10	(H) 10
Egypt	(L) 0	(L) 0	(L) 0.5
Iran	(L) 0	(L) 1.2	(L) 1.6
Israel	(H) 9	(H) 9.1	(H) 10
Morocco	(L) 0	(L) 0	(L) 0
Syria	(L) 0	(L) 0	(L) 0
Tunisia	(L) 0	(L) 0.7	(L) 1
South Asia			
Bangladesh	(L) 0	(H) 5.4	(H) 4.8
India	(H) 8	(H) 8.5	(H) 9
Nepal	(L) 1.8	(H) 5.2	(L) 4.5
Pakistan	(L) 1.6	(H) 7	(L) 1.2
Sri Lanka	(H) 6	(H) 6	(H) 6.6

	1980-89	1990-99	2000-09
Latin America and the Caribbean			
Argentina	(H) 5.5	(H) 7.1	(H) 8
Bolivia	(H) 6.9	(H) 9	(H) 8.2
Brazil	(H) 4.7	(H) 8	(H) 8
Chile	(L) 1	(H) 8	(H) 9.4
Colombia	(H) 8	(H) 7.9	(H) 7
Costa Rica	(H) 10	(H) 10	(H) 10
Dominican Republic	(H) 6	(H) 6.6	(H) 8
Ecuador	(H) 8.6	(H) 8.9	(H) 5.8
Guatemala	(L) 2	(H) 5.6	(H) 8
Guyana	(L) 0	(H) 4.8	(H) 6
Honduras	(H) 5.6	(H) 6.1	(H) 7
Jamaica	(H) 10	(H) 9.3	(H) 9
Mexico	(L) 1.2	(L) 3.8	(H) 8
Nicaragua	(L) 0.625	(H) 7	(H) 8.3
Panama	(L) 0.8	(H) 8.6	(H) 9
Paraguay	(L) 0.3	(H) 6.1	(H) 7.9
Peru	(H) 7	(L) 3.9	(H) 9
Trinidad &Tobago	(H) 8.6	(H) 9.3	(H) 10
Uruguay	(H) 4.6	(H) 10	(H) 10
Venezuela	(H) 9	(H) 8.1	(H) 5.3
Sub-Saharan Africa			
Benin	(L) 0	(H) 6	(H) 6.4
Botswana	(H) 6.3	(H) 7.3	(H) 8
Burundi	(L) 0	(L) 0.25	(L) 4
Cameroon	(L) 0	(L) 0.8	(L) 1
Central African Republic	(L) 0	(L) 3.5	(L) 2.2
Congo Republic of	(L) 0	(L) 3.45	(L) 0
Cote d'Ivoire	(L) 0	(L) 0	(H) 5
Gabon	(L) 0	(L) 0	(L) 0.4
Gambia The	(H) 7.1	(L) 3.2	(L) 0
Ghana	(L) 0.6	(L) 1.675	(H) 7.2
Kenya	(L) 0	(L) 0.6	(H) 6.5
Lesotho	(L) 0	(H) 5.6	(H) 8
Malawi	(L) 0	(L) 3.6	(H) 5.9
Mali	(L) 0	(H) 5.825	(H) 6.8
Mauritania	(L) 0	(L) 0	(L) 0.4
Niger	(L) 0	(L) 4.4	(H) 5.9
Senegal	(L) 2	(L) 2	(H) 7.7
Sierra Leone	(L) 0	(L) 1.25	(H) 5.9
South Africa	(H) 7	(H) 8.33	(H) 9
Swaziland	(L) 0	(L) 0	(L) 0
Togo	(L) 0	(L) 0.83	(L) 1
Zambia	(L) 0	(L) 4.2	(H) 5.2
Zimbabwe	(L) 2.7	(L) 0.1	(L) 1.2

Table 6: Bayesian Model Averaging results for the Low-Democracy regime

The table presents 2SLS-BMA results for the linear growth model in equation (2.6) for countries in the Low-Democracy regime, democracy ¡ 4.5. The results are sorted by the posterior inclusion probability (PIP), which is the sum of the posterior probabilities models that include that variable. The posterior mean (PM) is the average of the coefficient estimates (COEF) of individual models weighted by posterior probability. The posterior standard error (PSE) is the BMA estimate for the standard error (SE) taking model uncertainty into account. All reported standard errors refer to heteroskedasticity consistent standard errors. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

	Model Averaging			Posterior Mode		Largest	
	PIP	PM	PSE	COEF	SE	COEF	SE
Constant	1	0.32282	0.27301	0.34982**	0.16256	0.33744	0.84165
Trend	1	-0.00232	0.00353	-0.00174	0.00307	-0.00804	0.00676
Public Debt	0.9916	-0.0079*	0.00436	-0.00797**	0.00405	-0.00907	0.00769
Fertility	0.91211	-0.05078**	0.02522	-0.05041***	0.01532	-0.08243	0.07325
Population Growth	0.90736	0.09763*	0.06799	0.10183*	0.05492	0.11364	0.1689
LCR100km	0.64058	0.00877	0.00946	0.01263	0.0079	0.00969	0.01583
Muslim	0.63474	0.01052	0.0093	0.01514***	0.00502	0.02051	0.02545
Orthdox	0.42223	0.04622	0.07466	-	-	0.13249	0.10048
Jew	0	-2.19	3.7987	-	-	-161,647	532,334
Hindu	0.16019	0.00397	0.01159	-	-	0.01457	0.03711
East Asia	0.12416	0.00145	0.005	-	-	-0.00937	0.03253
Latin America	0.12264	-0.00216	0.00674	-	-	-0.00926	0.02789
Life Expectancy	0.10999	0.00618	0.02195	-	-	0.03855	0.07462
Other Religion	0.09143	0.00021	0.00493	-	-	0.00654	0.02843
Initial Income	0.08321	-0.0006	0.00255	-	-	-0.0128	0.00885
Schooling	0.07951	-0.0003	0.0018	-	-	-0.01092	0.00942
Investments	0.05529	0.00002	0.00185	-	-	-0.00304	0.01025
Protestant	0.04023	-0.00109	0.00761	-	-	0.01062	0.04213
Non-religion	0.02462	-0.0089	0.07794	-	-	-0.07569	0.41924
Sub-saharan	0.01735	0.00002	0.00165	-	-	0.00108	0.0191
Executive Constraints	0.01454	0.00008	0.00085	- -		0.00508	0.01101
Democracy	0.01334	0.00003	0.00048	-	-	0.00133	0.00893
Eastern Religion	0.00599	0.00035	0.00535	- -		0.04175	0.08576
Language	0.00389	-0.00005	0.00102	-	-	0.01486	0.01967
Tropics	0.00292	-0.00003	0.0006	-	-	-0.00159	0.013
Government	0.00289	0.00001	0.00039	-	-	-0.00399	0.01015
IMR	0.00229	0	0.00011	-	-	-0.00314	0.00353
Openness	0.0021	0	0	-	-	0.00021	0.00013
Inflation	1.00E-05	0	0.00002	-	-	0.01073	0.00706

Model Averaging Posterior Mode Largest
PIP PM PSE COEF SE COEF SE

Table 7: Bayesian Model Averaging results for the High-Democracy regime

The table presents 2SLS-BMA results for the linear growth model in equation (2.6) for countries in the High-Democratic regime, democracy ¿ 4.5. The results are sorted by the posterior inclusion probability (PIP), which is the sum of the posterior probabilities models that include that variable. The posterior mean (PM) is the average of the coefficient estimates (COEF) of individual models weighted by posterior probability. The posterior standard error (PSE) is the BMA estimate for the standard error (SE) taking model uncertainty into account. All reported standard errors refer to heteroskedasticity consistent standard errors. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

	Model Averaging			Posterior Mode		Largest	
	PIP	PM	PSE	COEF	SE	COEF	SE
Constant	1	0.19776***	0.04145	0.19234***	0.02754	0.12269	0.34464
Trend	1	0.0007	0.00178	0.0009	0.00173	-0.00066	0.0028
Initial Income	0.99978	-0.01639***	0.00274	-0.01537***	0.00235	-0.02421***	0.00491
Fertility	0.99932	-0.0411***	0.00724	-0.04044***	0.00619	-0.03057	0.02279
Jew	0.48978	0.01323	0.01606	-	-	0.03944**	0.01654
Protestant	0.31776	0.00409	0.00682	-	-	0.00911	0.01009
Schooling	0.21215	0.00064	0.00218	-	-	0.0023	0.0059
Openness	0.12612	0.00001	0.00003	-	-	0.00017**	0.00008
Hindu	0.09616	0.00101	0.00452	-	-	0.0352*	0.01858
Latin America	0.02883	-0.00001	0.00054	-	-	0.00494	0.00809
Population Growth	0.01992	-0.00093	0.00777	-	-	-0.02515	0.05524
Other Religion	0.01499	0.00009	0.00104	-	-	0.02144	0.01006
Tropics	0.00463	-0.00001	0.0003	-	-	-0.01036	0.00857
Sub-saharan	0.00102	0.00001	0.00023	-	-	0.00644	0.01468
Public Debt	0.00077	0	0.00011	-	-	0.00451	0.00476
Non-religion	0.00071	-0.00003	0.00135	-	-	-0.06026	0.04165
IMR	0.00065	0	0.00006	-	-	0.00088	0.00214
Language	0.00061	0	0.00022	-	-	-0.01044	0.01161
Eastern Religion	0.00058	0.00001	0.00093	-	-	0.07571	0.05586
Inflation	0.00055	0	0.00005	-	-	0.00126	0.0035
LCR100km	0.00055	0	0.0001	-	-	-0.01023	0.00684
Government	0.00053	0	0.00013	-	-	-0.00769	0.00666
Life Expectancy	0.00051	0	0.00049	-	-	0.02974	0.05211
East Asia	0.0005	0	0.0002	-	-	0.00933	0.0126
Muslim	0.00049	0	0.00015	-	-	0.00462	0.00954
Orthodox	0.00049	0	0.0002	-	-	-0.00093	0.01092
Democracy	0.00013	0	0.00008	-	-	0.01257***	0.00487
Executive Constraints	0.00012	0	0.00007	-	-	-0.01088	0.00769
Investments	3.00E-05	0	0.00005	-	-	-0.02845**	0.0131

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Table 8: Data Appendix

Variable	Description
Time trend	Time trend variable for the periods 1980-89, 1990-99 and 2000-2009.
Growth	Growth rate of real per capita GDP in chain series for the periods 1980-89, 1990-99 and 2000-2009. Source: PWT 7.0.
Initial Income	Logarithm of real per capita GDP in chain series at 1980, 1990, 2000. Lagged values correspond to 1975, 1985 and 1995. Source: PWT 7.0.
Population Growth Rates	Logarithm of average population growth rates plus 0.05 for the periods 1980-89, 1990-99 and 2000-2009. Lagged values correspond to 1975-79, 1985-89 and 1995-1999. Source: PWT 7.0.
Investment	Logarithm of average ratios over each period of investment to real GDP per capita for the periods 1980-89, 1990-99 and 2000-2009. Lagged values correspond to 1975-79, 1985-89 and 1995-1999. Source: PWT 7.0.
Schooling	Logarithm of average years of male secondary and tetriary school attainment (25+) in 1980, 1990, and 1999. Lagged values correspond to 1975, 1985 and 1995. Source: Barro and Lee (2000).
Debt	Public debt to GDP for the periods 1980-89, 1990-99 and 2000-2009. Lagged values correspond to 1975-79, 1985-89 and 1995-1999. Source: IMF, Debt Database Fall 2011 Vintage
Government	Logarithm of average ratios for each period of government consumption to real GDP per capita for the periods 1975-79, 1985-89 and 1995-1999 and 2000-2009. Lagged values correspond to 1975-79, 1985-89 and 1995-1999. Source: PWT 7.0
Inflation	Logarithm of average inflation plus 1 for the periods 1980-89, 1990-99 and 2000-2009. Lagged values correspond to 1975-79, 1985-89 and 1995-1999. Source: Worldbank
Openness	Average ratios for each period of exports plus imports to real GDP per capita for the periods 1980-89, 1990-99 and 2000-2009. Lagged values correspond to 1975-79, 1985-89 and 1995-1999. Source: PWT 7.0.
Life Expectancy	Log of average life expectancy at birth for the periods 1980-89, 1990-99 and 2000-2009. Lagged values correspond to 1975-79, 1985-89 and 1995-1999. Source: World Bank
Fertility	Logarithm of the average total fertility rate (births per woman) in 1980-89, 1990-99 and 2000-2009. Lagged values correspond to 1975-79, 1985-89 and 1995-1999.Source: World Bank.
Executive Constraints	A measure of the extent of institutionalized constraints on the decision making powers of chief executives. This variable ranges from one to seven where higher values equal a greater extent of institutionalized constraints on the power of chief executives. This variable is calculated as the average for the periods 1980-89, 1990-99 and 2000-2009. Lagged values correspond to 1975-79, 1985-89 and 1995-1999. Source: Polity IV
Democracy	A measure of the extent of institutionalized democracy, presence of institutions and procedures, existence of institutionalized constraints on the exercise of power by the executive, and guarantee of civil liberties to all citizens. This variable ranges from one to ten where higher values equal a greater extent of institutionalized democracy. This variable is calculated as the average for the periods 1970-79, 1980-89, 1990-99 and 2000-2009. Lagged values correspond to 1975-79, 1985-89 and 1995-1999. Source: Polity IV

Table 8 continued

Variable	Description
Language	Measure of linguistic fractionalization based on data describing shares of languages spoken as mother tongues. Source: Alesina, A., A. Devleeschauwer, W. Easterly, S. Kurlat, and R. Wacziarg (2003).
Tropics	Percentage of land area classified as tropical and subtropical via the in Koeppen-Geiger system. Source: The Center for International Development at Harvard University
LCR100km	Percentage of a country's land area within 100km of an ice- free coast. Source: The Center for International Development at Harvard University
Eastern Religion	Eastern Religion share in 1970 and 2000 expressed as a fraction of the population. It includes Chinese Universists, Confucians, Neoreligionists, Shintos, and Zoroastrians (Parsis). Source: World Christian Encyclopedia
Hindu	Hindu share in 1970 and 2000 expressed as a fraction of the population who expressed adherence to some religion. It includes Hindus, Jains and Sikhs. Source: World Christian Encyclopedia
Jew	Jewish share in 1970 and 2000 expressed as a fraction of the population. Source: World Christian Encyclopedia
Muslim	Muslim share in 1970 and 2000 expressed as a fraction of the population. Source: World Christian Encyclopedia
Orthdox	Orthodox share in 1970 and 2000 expressed as a fraction of the population. Source: World Christian Encyclopedia
Other Religion	Other Religion in 1970 and 2000. It includes other christian, buddies and other religions. Source: World Christian Encyclopedia
Protestant	Protestant share in 1970 and 2000 expressed as a fraction of the population. It includes Protestants and Anglicans. Source: World Christian Encyclopedia
Non-religion	Atheists in 1970 and 2000 Expressed as a fraction of the population. Source: World Christian Encyclopedia