THE RIMINI CENTRE FOR ECONOMIC ANALYSIS

WP 52_13

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ROBUST MULTIPLE REGIMES IN GROWTH VOLATILITY

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Robust Multiple Regimes in Growth Volatility

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August 15, 2013

Abstract

In this paper we uncover growth volatility regimes and identify their robust determinants using a large international panel of countries. In doing so we propose a novel empirical methodology that allows us to simultaneously deal with two key elements of model uncertainty, namely theory uncertainty and parameter heterogeneity, by unifying two recent econometric techniques: Bayesian Model Averaging and Threshold Regression. We find ample evidence of parameter heterogeneity and model uncertainty. Our results highlight the role of Macroeconomic Policy, Institutional variables, and Neoclassical growth variables in generating multiple volatility regimes.

Keywords: growth volatility, multiple regimes, threshold regression.

JEL Classification Codes: C59, O40, Z12.

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1 Introduction

The seminal work of Ramey and Ramey (1995) on the adverse effects of volatility on economic growth has led to a considerable amount of interest in the need to understand the sources of growth volatility. Notable examples include Acemoglu, Johnson, Robinson, and Thaicharoen (2003) who find that institutions are a fundamental determinant of volatility through a number of microeconomic and macroeconomic channels, Mobarak (2005) who emphasizes the role of democracy in reducing growth instability, and Bekaert, Harvey, and Lundblad (2006) who provide strong evidence that financial liberalization is associated with lower growth volatility. More recently, Malik and Temple (2009) find an especially important role for geography since remote countries are more likely to have undiversified exports.

Despite all this work there is remarkably little consensus on which determinants are the most important sources of growth volatility. We posit that the major reason for this problem is that the existing empirical studies generally ignore model uncertainty that typically plague cross-country regressions. Therefore, the objective of this paper is to identify robust determinants of growth volatility by addressing two key facets of model uncertainty: parameter heterogeneity and theory uncertainty.

Parameter heterogeneity refers to the idea that the data generating process that describes the stochastic phenomenon of growth volatility is not common for all observations (countries). There are reasons to believe that different countries may follow different growth volatility processes. For example, countries that are facing structural adjustment issues; such as those experiencing particularly high debt-to-GDP ratios or hyper-inflation, may face greater financing constraints that reduce the ability of countries to smooth out income across time. Alternatively, policy instruments that aim to stabilize growth may have different effects for countries at different levels of development. While the issue of parameter heterogeneity in growth regressions has been investigated thoroughly by a number of papers, this issue has not been systematically addressed in growth volatility regressions.

One approach that deals with the problem of parameter heterogeneity is to use threshold regression models or classification algorithms such as a regression tree. These models classify observations into stochastic processes depending on whether the observed value of a threshold variable is above (or below) a threshold value. In a seminal paper, Durlauf and Johnson (1995) employed 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] 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).

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 the present context, theory uncertainty implies that in the empirical modeling of growth volatility there is no a priori justification for focusing on a specific subset of explanatory variables. For example while Di Giovanni and Levchenko (2009) emphasize the importance of trade openness as a growth volatility determinant, Acemoglu, Johnson, Robinson, and Thaicharoen (2003) argue that institutions is the main source of growth volatility. 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., trade openness, does not automatically preclude the other; e.g., institutions, from also being a determinant of growth volatility. However, the estimated partial effect, say, of any particular determinant on growth volatility may vary dramatically across model specifications. How should one deal with the dependence of inference on model specifications?

One way to deal with this problem 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). However, in the context of growth volatility the benefits of BMA have been largely ignored. A notable exception is the paper by Malik and Temple (2009) who employ BMA to identify structural determinants of output

[1] One difference is that Papageorgiou (2002) employs the threshold regression of Hansen (2000) while Tan (2010) employs a generalized regression tree algorithm.

volatility in developing countries.

In this paper, we attempt to deal with both parameter heterogeneity and theory uncertainty in the growth volatility process by synthesizing threshold regression and model averaging methods. The existing literature either deals with model uncertainty in the linear context or attempts to systematically uncover possible nonlinearity/heterogeneity, but approaches that coherently address both problems at the same have been lacking. Some initial attempts in this direction have been made by Brock and Durlauf (2001), Kourtellos, Tan, and Zhang (2007), and Cuaresma and Doppelhofer (2007). Our paper is closest in spirit to Brock and Durlauf (2001). Brock and Durlauf show in their paper how researchers can simultaneously address issues of parameter heterogeneity and theory uncertainty when the nature of the parameter heterogeneity is known. In the example in their paper, for instance, they model the a priori heterogeneity between the Sub-Saharan African growth process compared with that for the rest of the world to be given (known). Here, we treat the potential sources for parameter heterogeneity as unknown and conduct a series of tests for the existence of thresholds to identify the strongest evidence for sources of parameter heterogeneity from the set of growth volatility determinants. Once the source of parameter heterogeneity has been identified, we then proceed to investigate the robust determinants of growth volatility. Our methodology can be viewed as an extension of Brock and Durlauf (2001) in that we employ threshold regression models to estimate the multiple regimes and account for model uncertainty within and across various threshold regression models.

In particular, we start by investigating the sources of growth volatility among linear models using a BMA analysis. Our findings highlight the mitigating role of health via life expectancy in reducing growth volatility. Additionally, we find evidence that macroeconomic policy via trade openness and public debt increase growth volatility. Next, we investigate the presence of multiple growth volatility regimes using threshold regression models. First, we employ a testing strategy that uncovers the significant regimes for a range of threshold variables and then use BMA analysis within each regime to uncover the robust regime-specific sources of growth volatility. Our tests reveal substantial evidence for parameter heterogeneity over a range of plausible threshold variables including proxies for the growth theories of Solow, Macroeconomic Policy, Institutions, Financial Development, Health, and Geography. Notably, inflation volatility appears to be the most plausible explanation for the presence of growth volatility regimes.

In terms of the effects of trade openness, life expectancy, and public debt on growth volatility, our results reveal substantial heterogeneity. More precisely, both trade openness and public debt contribute positively to growth volatility in the low or high regime but never in both. Furthermore, life expectancy reduces volatility in both regimes but the magnitude of its effect varies according to the threshold variable. Moreover, across all threshold regression models life expectancy appears to have the strongest role as source of growth volatility while trade openness has the weakest role.

Finally, we propose a model averaging strategy across the various threshold regression models in order to account for the uncertainty that arises due to several plausible threshold variables. Our findings verify the importance of inflation volatility as an important threshold variable. More generally, we find substantial evidence for multiple regimes driven by variables that measure Macroeconomic Policy and Institutions, and Solow (Neoclassical) growth. We also find some weak evidence for multiple regimes due to Financial Development.

The paper is organized as follows. Section 2 describes the canonical linear growth volatility model and our data. Section 3 presents model averaging estimates of the linear growth volatility model. In section 4 we describe the threshold growth regression model and present our main findings that attempt to account for model uncertainty in multiple growth regimes. In section 5, we conclude.

2 The canonical growth volatility model and data description

Following the literature we define the volatility of economic growth, $\sigma_{g,i}$, as the standard deviation of the growth rate of real per capita GDP over three 10-year period time intervals sampled from PWT 7.0. Specifically, our dataset takes the form of a pooled panel for the periods 1980-89, 1990-99, and 2000-2009 and 76 countries.[2] Then, the canonical growth volatility regression takes the form:

$$\sigma_{g,i} = x_i'\beta + u_i, \tag{2.1}$$

[2] In the growth volatility literature there seems to be no consensus on the way to estimate the standard deviation. For example, while Acemoglu, Johnson, Robinson, and Thaicharoen (2003) use a 27-year time interval to estimate the standard deviation Bekaert, Harvey, and Lundblad (2006) only use 5 years. For robustness we also used 20-year periods and find similar results.

where x_i is a $p \times 1$ vector of growth volatility determinants, and u_i is an *i.i.d.* error term for $i = 1, 2, ..., N$.

In the absence of strong theoretical guidance we follow the conventional practice and assume that the process of growth volatility shares the same information set as the process of economic growth. This suggest that the set of possible theories and their proxies that have been proposed in the empirical growth literature can also be used in the context of growth volatility. In particular, we consider determinants from 7 broad categories or theories of growth volatility: Solow growth theory, macroeconomic policy, finance, institutions, ethnic fractionalization, geography, and health.

We start with the Solow or Neoclassical growth 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 (*Initial Income*). Theoretical work by Acemoglu and Zilibotti (1997) and Koren and Tenreyro (2007) suggest a negative relationship between growth volatility and initial income. Specifically, richer countries are less volatile because they are able to achieve a more balanced sectoral distribution of output.

As argued in Acemoglu, Johnson, Robinson, and Thaicharoen (2003) the traditional macroeconomic argument links growth volatility to bad macroeconomic policies. To account for the effect of macroeconomic policy on volatility we use the logarithm of average inflation rate (*Inflation Rate*), the standard deviation of the Inflation Rate (*Inflation Volatility*), the ratio of exports plus imports to GDP (*Openness*), the ratio of government consumption to GDP (*Government*), and the logarithm of the average public debt to GDP (*Debt*).

The negative impact of financial liberalization and development on economic growth and its volatility has also been documented in the literature; see for example Bekaert, Harvey, and Lundblad (2006), Levine, Loayza, and Beck (2000), and McCaig and Stengos (2005). Following this literature we include two measures of financial (intermediary) development: (i) private credit by deposit money banks as a share of demand, time and saving deposits in deposit money banks (*BCBD*) and (ii) the ratio of deposit money bank claims on domestic non-financial real sector to the sum of deposit money bank and Central Bank's claims on domestic non-financial real sector (*DBACBA*).[3]

[3] We did not include any financial liberalization variables due to their unavailability for the time periods

Following the recent literature in economic growth that emphasizes the role of fundamental determinants we include variables that measure institutions, geography and climate, health, and ethnolinguistic fractionalization. For institutions we use ten variables that proxy different aspects of country's institutional quality as suggested by a number of papers in the literature; see for example Acemoglu, Johnson, Robinson, and Thaicharoen (2003), Mobarak (2005), and Bekaert, Harvey, and Lundblad (2006). In particular, we include the variable constraints placed on the executive (*Executive Constraints*), which measures institutional and other constraints that are placed on presidents and dictators (or monarchies). As argued by Acemoglu-et-al, countries with weak institutions are more likely to experience high volatility. We also include a variable measuring the level of institutionalized democracy, which ranges from zero to one where higher values equal a greater extent of institutionalized democracy. Additionally, we use Corruption, Law and Order, Bureaucratic Quality, External and Internal Conflict, and Religion and Ethnic tensions. Finally, we control for the presence of political stability measured as the average of the first differences (in absolute values) of the Polity2 variable from Polity IV. The Polity2 variable is a measure of the degree of democracy in a country with a score of +10 representing most democratic and -10 signifying most autocratic.

Geographic and climatic characteristics have also been associated with growth volatility. Using a BMA methodology Malik and Temple (2009) found robust evidence that geographical characteristics of countries have effects on growth volatility. Therefore, we include both a climate variable and a geography variable. The climate variable is the percentage of a country's land area classified as tropical and subtropical via the Koeppen-Geiger system (*Tropics*) while the geography variable measures geographic isolation, which is proxied by the percentage of a country's land area within 100km of an ice-free coast (*LCR100KM*).

For health we include the logarithm of the average of life expectancy (*Life Expectancy*), which was found to be an important determinant of growth volatility by Bekaert, Harvey, and Lundblad (2006). Finally, our proxy for linguistic and ethnic heterogeneity is the variable of linguistic fractionalization (*Language*) based on data describing shares of languages spoken as "mother tongues" due to Alesina, Devleeschauwer, Easterly, Kurlat, and Wacziarg (2003).

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 A1 of the Appendix.

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of our data.

3 Model Uncertainty in a linear world

In this section we employ the BMA approach to identify robust determinants of growth volatility in equation (2.1). By robust we mean that our estimates do not condition on a specific choice of determinants but rather depend on a model space whose elements span an appropriate range of determinants suggested by a large body of work. The model space is denoted by $\mathcal{M} = \{\mathcal{M}_1, .., \mathcal{M}_M\}$. Put differently, model averaging integrates out the uncertainty over models by taking the weighted average of model-specific estimates, where the weights $W = (w_1, ..., w_M)'$, reflect the evidentiary support for each model given the data, D, and which are constructed to be analogous to posterior model probabilities.

In particular, the BMA estimator of β takes the form of a weighted average of model-specific LS coefficients estimates

$$\widehat{\beta}_{BMA}^{\mathcal{M}} = \sum_{m=1}^{M} w_m \widehat{\beta}_m. \tag{3.2}$$

with standard errors based on their corresponding model averaging variance estimator

$$\widehat{V}_{BMA}^{\mathcal{M}} = \sum_{m=1}^{M} w_k \widehat{V}_m^{\beta} + \sum_{m=1}^{M} w_m (\widehat{\beta}_m - \widehat{\beta}_{BMA}^{\mathcal{M}})^2, \tag{3.3}$$

where the first term captures the variance of the within model estimates and the second term captures the variance model-specific estimates across models. The latter is an additional source of variance, which does not arise when computing variances in absence of model uncertainty. The notation $\widehat{\beta}_{BMA}^{\mathcal{M}}$ and $\widehat{V}_{BMA}^{\mathcal{M}}$ emphasizes the dependence of the estimator on the model space $\mathcal{M}$ instead of individual model $\mathcal{M}_m$.

The weights W are given by the posterior model probabilities, which are computed using the Bayes' rule, so that each weight is the product of the integrated likelihood of the data given a model and the prior probability for a model. 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; see for example Eicher, Papageorgiou, and Raftery (2011). Following Kass and Wasserman (1995) and Raftery (1995) we approximate the integrated likelihood of each model is approximated by the Bayesian information criterion (BIC).[4].

[4]The BIC approximation to the integrated likelihood implicitly defines that the parameter prior is the

Our BMA approach is similar to that of Sala-i Martin, Doppelhofer, and Miller (2004) and Durlauf, Kourtellos, and Tan (2011) who employ a “hybrid” model averaging method in the sense that frequentist probability statements about observables given unobservables are mixed with Bayesian probability statement about unobservables given observables. So while $\widehat{\beta}^{\mathcal{M}}_{BMA}$ and $\widehat{V}^{\mathcal{M}}_{BMA}$ are effectively Bayesian objects, namely, the posterior mean and variance of β given data, we report BMA posterior t-statistics for coefficient estimates and interpret them in the classical sense.[5] Additionally, we also report the posterior probability of inclusion (PIP) for each regressor, which is a more standard way to conduct inference in the context of BMA. PIP is computed as the sum of posterior probabilities of the models, which contain that variable. Following Eicher, Henn, and Papageorgiou (2012) and Kass and Raftery (1995) we interpret the values of PIP as follows: PIP$<$ 50% indicates lack of evidence for an effect, 50% $<$PIP$<$ 75% indicates weak evidence for an effect, 75% $<$PIP$<$ 95% indicates positive evidence for an effect, 95% $<$PIP$<$ 99% indicates strong evidence for an effect, and 99% $<$PIP$<$ 100% indicates decisive evidence for an effect.

3.1 BMA results for the linear volatility growth model

In this section we discuss the BMA findings for robust sources of growth volatility in the context of the linear volatility growth model in equation 2.1. Table 2 present the results from our model averaging analysis sorted by PIP, which is reported in the first column. The second and third columns present the BMA posterior means and standard errors for each covariate, respectively. The remaining four columns show LS results from two individual models: the posterior mode model and the full (or largest) model, which includes all variables that are included in the model space $\mathcal{M}$. Our reason for reporting the results from the posterior mode and full model is to provide the reader with the ability to compare findings via model selection - using the best model (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.

Our BMA findings highlight the key role of life expectancy. In particular, consistent with

unit information prior, which can be viewed as a special case of the Zellner’s (fixed) g-prior that contains information approximately equal to that contained in a single observation

[5]A caveat of this kind of inference is that the asymptotic distribution of the t-statistic is a mixture of Normal distributions, which is often characterized by irregular shapes, far away from Normal, and thereby rendering inference based on classical interpretations invalid.

the findings of Bekaert, Harvey, and Lundblad (2006) we find decisive evidence for the effect of Life Expectancy with PIP of about 0.99. The negative and significant posterior mean at 1% suggests that higher levels of life expectancy result in lower growth volatility. One interpretation of this effect is that the high probability of survival increases the incentives for human and physical capital accumulation, which in turn reduce growth volatility.

We also find positive evidence for the effect of Trade Openness and Debt with PIP's 0.92 and 0.88, respectively. Consistent with the findings of Kose, Terrones, and Prasad (2003) and Easterly, Islam, and Stiglitz (2000) the positive and significant posterior mean at 5% of Trade Openness on growth volatility suggests that more open economies are more vulnerable to external shocks. The effect of Debt on growth volatility also appears to be positive and statistically significant at 5%, which implies the harmful role of public debt in creating volatility.

The BMA findings are confirmed by the results from the posterior mode and the full model. The posterior mode model includes all the model averaging covariates with statistically significant posterior mean. Interestingly, the posterior mode model also includes the variables Executive Constraints and Ethnic Tensions. In particular higher levels of Executive Constraints and lower levels of Ethnic Tensions affect negatively growth volatility at the 1% and 5% level respectively. Note, however, the posterior model probability for the mode model is 0.0693, whereas the full model has posterior model probability of 0.000 suggesting that the latter is a rather poor model choice.

A careful look into the individual posterior model probabilities suggests that the posterior mode model is not a dominant model but rather the posterior mass is spread evenly, and over larger models, resulting in a high share of important covariates. For example, beyond the posterior mode, the next best four models carry probabilities 0.0455, 0.0316, 0.0315, and 0.0185.

In summing up our findings it is interesting to note that we do not find evidence that Solow variables, financial development, geography, and linguistic diversity affect growth volatility. Instead, we find a role for health via life expectancy and some macroeconomic policy via trade openness, and public debt.

It is important to realize that the above BMA findings are robust to the extent that the model space M is adequately specified. If growth volatility exhibits deep nonlinearities or parameter heterogeneity then the above BMA analysis in the context of linear models can fail to fully capture the model uncertainty and can yield misleading results. As argued in the introduction there are reasons to believe that different countries may exhibit different growth processes in a nonlinear way. This motivates us to investigate the threshold regression model that allows for parameter heterogeneity or nonlinearity in the following section.

Next we briefly describe the threshold regression model and propose a model averaging strategy that can account for parameter heterogeneity or nonlinearities.

4 Model Uncertainty in multiple growth volatility regimes

4.1 The Threshold growth volatility model

The threshold growth volatility model generalizes the linear model in equation (4.9) by allowing for the presence of multiple growth volatility regimes. In particular, we employ the threshold regression (TR) model that sorts the data into two groups of observations, on the basis of some threshold variable q_i, each of which obeys the same model. The key feature of this model is that it allows for an estimation of the threshold parameter (sample split) as well as the regression coefficients of the two regimes. This makes the model very appealing as it allows for increased flexibility in functional form and at the same time is not as susceptible to curse of dimensionality problems as nonparametric methods. Then, the TR can be described by the following two sub-sample regression equations

$$\sigma_{g,i} = \beta_1' x_i + e_i, \quad q_i \leq \gamma \tag{4.4a}$$

$$\sigma_{g,i} = \beta_2' x_i + e_i, \quad q_i > \gamma \tag{4.4b}$$

where γ is the scalar threshold parameter or sample split value and $(\beta_1', \beta_2')'$ is the vector of regression coefficients for the low and high regime, respectively.

It is also customary to express the TR in a single equation by defining the indicator variable

$$I(q_i \leq \gamma) = \begin{cases} 1 & \text{iff } q_i \leq \gamma : \text{Regime 1} \\ 0 & \text{iff } q_i > \gamma : \text{Regime 2} \end{cases} \tag{4.5}$$

and $I(q_i > \gamma) = 1 - I(q_i \leq \gamma)$. This yields

$$\sigma_{g,i} = \beta' x_i + \delta_s' x_i I(q_i \leq \gamma) + e_i, \tag{4.6}$$

where $E(e_i|x_i) = 0$, $\delta = \beta_1 - \beta_2$, and $\beta = \beta_2$. The parameter δ is interpreted as the threshold effect of x_i.

The statistical theory for this problem is provided by Hansen (2000) who proposed a concentrated least squares method for the estimation of the threshold parameter. The regression coefficients for the two regimes are obtained using LS on the two subsamples, separately. Under certain assumptions the asymptotic distribution of the threshold parameter γ is nonstandard as it involves two independent Brownian motions. Finally, the confidence intervals for γ are obtained by an inverted likelihood ratio approach.

4.2 Model averaging results within the growth volatility regimes

Estimation of the threshold growth volatility model requires decisions on the choice of the set of regressors x_i and threshold variable q_i. Our strategy in this subsection fixes the set of plausible threshold variables and then for each threshold regression model it employs BMA within each regime to uncover robust and regime-specific growth volatility determinants.[6]

To decide the set of plausible threshold variables, $\{q_{si},\ s = 1, .., r,\ r \leq p\}$, we employ a testing strategy for all the variables that were used as growth volatility determinants in equation (2.1). In particular, for each q_{si}, $s = 1, .., p$, we test the null hypothesis of a linear model against the alternative of a threshold, $H_0 : \delta_s = 0$ vs. $H_1 : \delta_s \neq 0$ and discard threshold variables that do not reject the null of the linear model at 10%. We do so by employing the heteroskedasticity-consistent Lagrange multiplier (LM) test for a threshold of Hansen (1996). It is worth noting that inference in this context is not standard since the threshold parameter, γ_s, is not identified under the null hypothesis of a linear model (i.e. no threshold effect), and therefore the p-values are computed by a bootstrap method. Specifically, the p-values are computed by a bootstrap that fixes the regressors from the right-hand side of equation (4.6) and generating the bootstrap dependent variable from the distribution $N(0, \hat{e}_i^2)$, where $\hat{e}_i$ is the residual from the estimated TR model.

[6]This approach is justified by the fact that the estimator of the threshold parameter is super-consistent while the regime-specific regression coefficient estimators are root-n consistent and thereby the latter can be estimated as if the threshold parameters were known; see for example Hansen (2000).

Before we consider testing for threshold effects we first need to choose the set of relevant regressors. One possibility is to use the full set of growth volatility determinants that we considered in section 3.1. This may sound a natural choice, especially since we plan to apply BMA within each regime subsequently. The problem with this solution is that the full model is a rather poor model in terms of posterior model probability, which may affect the inference in the threshold regression model. For example a poor model is likely to negatively affect the size and power of the threshold test. For this reason we focus on the set of robust regressors, denoted by $\breve{x}_i$, as determined by the rule of "PIP greater than 75%". The set of robust regressors in this case includes Trade Openness, Life Expectancy, and Debt. For robustness purposes we also investigate models with regressors identified by the posterior mode model.[7] In this case two more variables are added in the set of robust regressors $\breve{x}_i$, namely, Executive Constraints and Ethnic Tensions. These results are reported in the Appendix.

Table 3 shows in the first columns the results of the threshold test when $\breve{x}_i$ is determined by the rule of "PIP greater than 75%". Of the 25 potential candidates, 15 threshold variables appear as plausible threshold variables that sort the countries into two regimes at 10% size of the test. More precisely, Inflation Volatility, Bureaucratic Quality, Democracy, Ethnic Tensions, and Schooling reject the null of the linear model at 1% size of the test. Additionally, Government, Life Expectancy, Executive Constraints, Initial Income, Investments, and Inflation Rate reject the null at 5% size of the test and Internal Conflict, BCBD, Law and Order, and LCR100KM reject the null at 10% size of the test

The next five columns of Table 3 present results from the estimation of the corresponding threshold regression model including the threshold estimate, the confidence interval for the threshold parameter, the joint sum of squares (JSSE), and the sample sizes of the two regimes. For the models that reject the null at 10%, Inflation Volatility yields the lowest JSSE suggesting that it is the most plausible sample splitting variable if one uses the JSSE as a model selection criterion. The sample split of Inflation Volatility at 5.9335 corresponds to Cameroon. Table A2 in the Appendix presents the countries sorted into the two regimes of Inflation Volatility. Interestingly, when use the posterior mode model to determine the regressors in $\breve{x}_i$, we also find that the threshold regression model with the smallest JSSE is the that uses Inflation Volatility as a threshold variable. The only difference between the two sets of results is that at 10% size of the test the testing results based on the posterior mode

[7]We did not consider the full model since it was one of poorest models in terms of posterior model probability.

model adds to the above set of plausible threshold variables DBACBA, Debt, and Openness and drops Ethnic Tension and BCBD.

Table 3 also shows that the differences in JSSE between the competing threshold models are rather small. But, does this imply that the actual country groupings are also similar? To answer this question we present in Table 4 the regime-specific sample means of growth volatility and the regressors of the threshold regression model. It appears that the sample means between the 'bad' and 'good' regimes are not very different. For instance, the sample of mean of growth volatility in the low democratic regime is 0.0532 while in the high inflation volatility regime the sample mean is 0.0523, suggesting that the two groupings are not substantially different but rather the interpretation is different. Therefore, we choose to present the results for all 15 threshold regression models rather than focus only on the best model according to the JSSE criterion. We will attempt to address the issue of model uncertainty due to the various threshold variables in the next subsection.

Table 5 shows the BMA results for the two regimes that correspond to each of the significant threshold variables when $\breve{x}_i$ is determined by the rule of "PIP greater than 75%" grouped by growth theory. The columns show the regression coefficients for the low and high regimes. All the threshold regression models include a constant and a trend but they are not reported to save space. We report the PPI, PM, and the LS coefficient of the full model. To save space we also do not report the corresponding standard errors but simply denote their significance with stars. Table A4 in the appendix shows the corresponding results when $\breve{x}_i$ is determined by the posterior mode model.

We first examine the effect of Openness on growth volatility. We find that the role of trade openness as a source of growth volatility crucially depends on choice of the threshold variable. While there is no evidence for an effect in some threshold regression models, there is decisive evidence for an effect in other models. Furthermore, the effect of trade openness appears to be asymmetric in the sense that when there is evidence for an effect in the low/high regime of a threshold variable then there is no evidence for an effect in the high/low (opposite) regime of the same threshold variable. In particular, in the case of Solow threshold variables there is lack of evidence for an effect of trade openness. In contrast, the role of openness as a source of growth volatility is particular important when the threshold variables are based on macroeconomic policy, Institutions, and Geography. More precisely, we find that there is decisive evidence that trade openness positively contributes to growth volatility in low Inflation Volatility, low Inflation, low Ethnic Tensions, high Bureaucratic

Quality, and high LCR100km regimes. These effects are statistically significant at 1% for both the PM estimates of the BMA and the LS coefficients of the full model. Additionally, we note some positive evidence for an effect of Openness in high Government and high Executive Constraint regimes with PIP's 0.82 and 0.78, respectively. Both effects are significant at 1% in the case of the full model, but when we consider the PM of the BMA estimates, we only find that Openness is significant at 10% in the case of high Government, suggesting that classical inference based on the full is fragile. All this evidence suggests that the effect of trade openness on growth volatility is not constant but it is rather heterogeneous. Perhaps,the mixed evidence found in the literature can be understood as an implication of omitted parameter heterogeneity. For example, while Mobarak (2005) finds that trade openness has a negative effect on volatility, Easterly, Islam, and Stiglitz (2000).

The results for Life Expectancy show that there are strong or decisive effect on growth volatility in both regimes and across all threshold variables. Out of the total number of 30 regimes, 25 regimes have PIP's greater than 0.95% and 20 regimes have PIP's greater than 0.99. However, these effects are always negative but heterogeneous as they generally differ in magnitude both across threshold variables and between the low and high regimes for given threshold variable. In general, we find that the effect of Life Expectancy is larger in the high regime with the exceptions of the threshold variables of Inflation Rate, Democracy, and BCBD. Furthermore, the difference in the effect between the two regimes can be quite large. For example, in the case of high Internal Conflict the effect of Life Expectancy is five times in absolute value larger than the corresponding effect in the low Internal Conflict regime. In addition to the ample evidence of parameter heterogeneity we should note that the effect of Life Expectancy also exhibits nonlinearity given the results in Panel 14 highlighting the mitigating role of Life Expectancy in reducing volatility in the high Life Expectancy regime.

Finally, we find that Debt is a source of growth volatility in all threshold regression models but its effect is asymmetric depending on the threshold variable. As in the case of trade openness, public debt is an important source of growth volatility in either the low or the high regime but not in both. Put differently, debt does not affect growth volatility in all countries but rather it positively affects volatility in certain groups of countries as determined by specific sorting mechanisms. In particular, we find strong or decisive evidence for a positive effect of public debt on growth volatility in low Schooling, low Initial Income, high Investments, high Inflation Volatility, high Government, low Democracy, low Bureaucratic Quality, low Ethnic Tensions, low Executive Constraints, low Internal Conflict, low Law and

Order, low Life Expectancy, and low LCR100km. All these effects are positive and significant at 1% for both PM of the BMA and LS coefficient of the full model. For the regimes of high Inflation Rate and low BCBD we find again positive effects but the evidence is weaker with PPIs of 0.83 and 0.81, respectively. It interesting to note that Table 4 suggests that regimes with poor institutions or bad macroeconomic policies have on average a much higher public debt than the opposite regimes with good institutions or good macroeconomic policies. For example, in the case of the high Inflation Volatility regime the debt to GDP ratio is about 89% while the corresponding ratio in the low Inflation Volatility regime is about 61%.

In summing up, we find that the effects of Openness, Life Expectancy, and Debt are heterogeneous between the two regimes of the same threshold variable as well as across regimes of different threshold variables. Both openness and Debt contribute positively to growth volatility in the low or high regime but never in both. Life Expectancy reduces volatility in both regimes but the magnitude of its effect varies according to the threshold variable. Across all threshold regression models the role of trade openness as a source of growth volatility appears to be the weakest while the role of life expectancy appears to be the strongest. Finally, we should note that Table A4 in the appendix shows that the results when $\breve{x}_i$ is determined by the posterior mode model are generally similar. Additionally, the effects from the added sources of growth volatility, namely Executive Constraints and Ethnic Tensions, also appear to be heterogeneous, albeit weaker.

We finish this section with a caveat. The implicit assumption in our regime specific BMA analysis is that given a threshold variable q_{si}, the threshold estimate, $\widehat{\gamma}_s$, based on the full set of regressors $\breve{x}_i$ is also consistent estimate for all threshold regression models with regressors $\breve{x}_{mi}$ that belong to the model space $\breve{\mathcal{M}}$ spanned by the set of regressors $\breve{x}_i$. The justification for this approach is based on a corollary in Kourtellos, Stengos, and Tan (2013), which says that when the constraints are valid the estimated threshold parameter for both the constrained and unconstrained problem will converge to the same true value. In our context the unconstrained model is the threshold regression model based on the full set of regressors $\breve{x}_i$ and the constrained models are the ones based on any $\breve{x}_{mi} \in \breve{\mathcal{M}}$.

Next, we propose a model averaging strategy across the various threshold regression models in order to account for the uncertainty that arises due to several plausible threshold variables.

4.3 Model averaging results across multiple threshold variables

One way to understand the uncertainty that arises due to the presence of alternative threshold variables is to consider the multiple threshold regression model, which encompasses all individual two-regime threshold regression models. To understand the multiple threshold regression model it is instructive to consider a simple example with two possible threshold variables q_1 and q_2 and threshold parameters γ_1 and γ_2. For simplicity let us assume that the same variable cannot be used to split any subsequent subsamples again. Then, the model in equation (2.1) generalizes into the following threshold regression model with four regimes

$$\sigma_{g,i} = \begin{cases} \beta_{11}' x_i + e_i, & \text{if } q_{1i} \leq \gamma_1 \text{ and } q_{2i} \leq \gamma_2 \\ \beta_{12}' x_i + e_i, & \text{if } q_{1i} \leq \gamma_1 \text{ and } q_{2i} > \gamma_2 \\ \beta_{21}' x_i + e_i, & \text{if } q_{1i} > \gamma_1 \text{ and } q_{2i} \leq \gamma_2 \\ \beta_{22}' x_i + e_i, & \text{if } q_{1i} > \gamma_1 \text{ and } q_{2i} > \gamma_2 \end{cases} \tag{4.7}$$

As we did previously in the context of a threshold regression model with a single threshold variable we can express the threshold regression model in a single equation by including one indicator function for each threshold variable $x_i I(q_{1i} \leq \gamma_1)$ and $x_i I(q_{2i} \leq \gamma_2)$ as well as their product $x_i I(q_{1i} \leq \gamma_1) I(q_{2i} \leq \gamma_2)$.

$$\sigma_{g,i} = \theta' x_i + \delta_1' x_i I(q_{1i} \leq \gamma_1) + \delta_2' x_i I(q_{2i} \leq \gamma_2) + \delta_3' x_i I(q_{1i} \leq \gamma_1) I(q_{2i} \leq \gamma_2) + \varepsilon_i, \tag{4.8}$$

where $\theta = \beta_{22}$, $\delta_1 = \beta_{12} - \beta_{22}$, $\delta_2 = \beta_{21} - \beta_{22}$, and $\delta_2 = \beta_{11} - \beta_{12} - \beta_{21} + \beta_{22}$. This equation implies $4p + 2$ unknown parameters to estimate and a model space with $2^{4p} - 1$ possible model combinations of regression terms suggesting that both the parameter and model space grow exponentially with the number of threshold variables. In general, when we consider r threshold variables the multiple threshold regression with $2r$ regimes involves $2^r p + r$ unknown parameters and a model space of $2^{2^r p} - 1$ possible model combinations. This is a massive model space that raises both computational as well as identification challenges.

To deal with these challenges we proceed as follows. First, we propose an Occam's razor that induces a parsimonious model space by excluding determinants or threshold variables that are unlikely to be relevant. More precisely, as in section 4 we focus on the set of robust regressors, denoted by $\breve{x}$, as determined by the rule of "PIP greater than 75%". Additionally, we only consider threshold variables for which the bootstrap threshold test rejects the null hypothesis of the linear model at most at 10% significance level. Furthermore, given the relatively small sample size of our data we believe that it is rather innocuous to ignore terms that include interaction of indicators functions. This results to a model space with $2^{(r+1)p}-1$ possible combinations. Second, we switch off estimation uncertainty in the multiple threshold regression model by simply using the same sample splits that were estimated in the two-regime threshold regression models in section 4. While this assumption limits the interpretation of our results as multiple regimes we believe that it can provide a preliminary insight at least about the robustness of the individual sample splits.[8] Our pruning strategy results to the following m^{th} approximating model

$$\sigma_{g,i} = \theta' \breve{x}_{mi} + \sum_{s=1}^{r} \delta'_{ms} \breve{x}_{mi} I(q_{si} \leq \widehat{\gamma}_s) + \varepsilon_i, \tag{4.9}$$

Table 6 presents the BMA results that investigate the explanatory power of the 15 threshold indicators beyond the linear part, which is always kept in all models when $\breve{x}_i$ is determined by the rule of "PIP greater than 75%". This model space comprises 2^{60} possible combinations. Panel A present the PPIs for individual indicator terms $x_i I(q_{si} \leq \widehat{\gamma}_s)$ above the prior of 50%. We see that there is a positive only for $Debt \cdot I(Democracy \leq \widehat{\gamma}_{Democracy})$ with PIP of 0.85. This suggests that there is positive evidence that the effect of Debt on growth volatility is heterogeneous and differs between low and high Democracy regimes.

Panel B computes PIP for each threshold variable. Specifically, following Durlauf, Kourtellos, and Tan (2008) we compute posterior probabilities of group of variables, which is the sum of posterior model probabilities over all those models that contain at least one variable of the underlying group. In this case, the group consists of variables that have a common threshold variable q_{si}: $I(q_{si} \leq \widehat{\gamma}_s)$, $Openness \cdot I(q_{si} \leq \widehat{\gamma}_s)$, $Debt \cdot I(q_{si} \leq \widehat{\gamma}_s)$, and $Life\ Expectancy \cdot I(q_{si} \leq \widehat{\gamma}_s)$. We find that there is decisive evidence for multiple regimes determined by Inflation Volatility with 0.99 PIP and positive evidence for Initial Income, Government, Democracy, and Ethnic Tensions with 0.91. These results are consistent with the findings of Table 3 that show that Inflation Volatility has the smallest JSSE.

Finally, Panel C can be viewed as a summary of our results. Here, we compute PIP for

[8] In principle one can estimate a multiple threshold regression model using the repartitioning technique as in Gonzalo and Pitarakis (2002). However, the computational costs are prohibitive in a model averaging framework. A more promising approach is the predictive density approach of Canova (2004), which can be extended to account for model uncertainty using a BMA approach. We leave this investigation for future research.

growth theories by considering groups that consist of vectors of indicator variables whom their threshold variable belongs to the same theory. Our findings show decisive evidence for multiple regimes using Macroeconomic Policy and Institutional variables, strong evidence using Solow variables, and weak evidence for Financial Development.

5 Conclusion

In this paper we uncover growth volatility regimes and identify their robust determinants using a large international panel of countries over the period 1980-2009. In order to account for both theory uncertainty and parameter heterogeneity we propose an econometric modeling that unifies two econometric techniques: Bayesian Model Averaging and Threshold Regression.

We start by investigating the sources of growth volatility among linear models using a BMA analysis. Our results emphasize the decisive role of life expectancy in reducing volatility but also find substantial evidence for the positive effects of public debt and trade openness.

We then shift our focus to modeling parameter heterogeneity in the growth volatility process by investigating the presence of multiple regimes using threshold regression models. First, we test for the presence of a threshold effect using a range of threshold variables and then use BMA analysis within each regime to uncover the robust regime-specific sources of growth volatility. Our tests reveal substantial evidence for parameter heterogeneity over a range of plausible threshold variables including proxies for the growth theories of Solow, Macroeconomic Policy, Institutions, Financial Development, Health, and Geography. Notably, inflation volatility appears to be the most plausible explanation for the presence of growth volatility regimes.

Our regime specific BMA analysis shows that there exists substantial heterogeneity in the effects of trade openness, life expectancy, and public debt on growth volatility. More precisely, we find substantial differences in the effects between the two regimes of the same threshold variable as well as across regimes of different threshold variables. More precisely, both trade openness and public debt contribute positively to growth volatility in the low or high regime but never in both. Furthermore, life expectancy reduces volatility in both regimes but the magnitude of its effect varies according to the threshold variable. Moreover, across all threshold regression model life expectancy appears to have the strongest role as source of growth volatility while trade openness has the weakest role.

Last but not least, we propose a model averaging strategy across the various threshold regression models that allows us to account for model uncertainty due to the presence of several plausible threshold variables. Our findings verify the importance of inflation volatility as an important threshold variable. More generally, we find substantial evidence for multiple regimes driven by variables that measure Macroeconomic Policy and Institutions, and Solow (Neoclassical) growth. We also find some weak evidence for multiple regimes due to Financial Development.

Finally, our results should not be interpreted as strong structural claims but rather as evidence that can help policy makers enhance their understanding of the growth volatility process in order to design economic policies aiming at stabilizing the growth path especially in economies that are generally characterized by bad macroeconomic policies and poor institutions.

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Table 1: Descriptive Statistics

This table presents the list of countries. In the bracket we note the date of the actual starting date of each country.

Variable	Mean	Std. Dev.	Min	Max
Growth Volatility	0.0388	0.0245	0.0059	0.1407
Tropics	0.4246	0.4336	0.0000	1.0000
LCR100KM	0.5032	0.3552	0.0000	1.0000
Language	0.3718	0.3039	0.0021	0.8980
Initial Income	8.5622	1.2280	5.9046	10.711
Population Growth	-2.7282	0.1647	-3.2289	-2.385
Investments	3.0551	0.3394	1.8732	3.8915
Schooling	0.7032	0.7214	-2.1835	1.9702
Openness	66.305	34.251	13.173	199.86
Inflation rate	2.2255	1.0833	-1.9518	7.2824
Executive Constraints	0.6877	0.3353	0.0000	1.0000
Government	2.1924	0.4252	1.0779	3.2246
Life Expectancy	4.1761	0.1698	3.6564	4.3954
Inflation Volatility	63.8928	429.45	0.3276	4429.1
Debt	72.8547	63.6492	7.6898	559.73
Democracy	0.6068	0.3835	0.0000	1.0000
External Conflict	0.8136	0.1611	0.1486	1.0000
Internal Conflict	0.7285	0.1832	0.0764	1.0000
Religion Tensions	0.7585	0.2198	0.0194	1.0000
Ethnic Tensions	0.6648	0.2259	0.1306	1.0000
Bureaucratic Quality	0.5906	0.2905	0.0000	1.0000
Corruption	0.5362	0.2235	0.0000	1.0000
Law and Order	0.6063	0.2426	0.1278	1.0000
Political Stability	0.3606	0.6200	0.0000	4.0000
DBACBA	0.8072	0.1894	0.1683	1.0279
BCBD	0.9869	0.3964	0.2314	3.0265

Table 2: BMA results for the linear volatility growth model

This table presents BMA results for the linear growth volatility model in equation (2.1). The results are sorted by the posterior inclusion probability (PIP), which is the sum of posterior model probablities over all those models that contain that variable. The posterior mean (PM) is the average of the LS coefficient estimates (COEF) of individual models weighted by the posterior model probability. The posterior standard error (PSE) is the BMA estimate for the standard error (SE) taking model uncertainty into account. The last four columns report LS estimates of two individual models: the posterior mode model and the full model. All specifications always included an intercept and a time trend. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

	Model Averaging			Posterior Mode		Full	
Determinants	PIP	PM	PSE	COEF	SE	COEF	SE
Solow							
Population Growth	0.1463	-0.0025	0.0074			-0.0138	0.0139
Investments	0.3893	0.0032	0.0049			0.0077	0.0050
Schooling	0.1410	-0.0003	0.0016			-0.0021	0.0043
Initial Income	0.0537	-0.0001	0.0006			-0.0016	0.0040
Macroeconomic Policy							
Inflation Volatility	0.2320	0.0000	0.0000			0.0000	0.0000
Inflation Rate	0.3847	0.0013	0.0020			0.0047**	0.0022
Government	0.2543	-0.0017	0.0034			-0.0068*	0.0038
Openness	0.9207	0.0001**	0.0001	0.0001***	0.0000	0.0002***	0.0001
Debt	0.8863	0.0001**	0.0000	0.0001***	0.0000	0.0001**	0.0000
Institutions							
Executive Constraints	0.5353	-0.0082	0.0090	-0.0156***	0.0059	-0.0286	0.0210
Bureaucratic Quality	0.1567	0.0003	0.0032			0.0084	0.0098
Democracy	0.2037	-0.0020	0.0053			0.0175	0.0196
Corruption	0.1200	-0.0007	0.0042			-0.0072	0.0117
Law and Order	0.1137	0.0008	0.0040			0.0178	0.0145
Political Stability	0.0647	0.0000	0.0006			0.0004	0.0025
Internal Conflict	0.1063	0.0007	0.0046			0.0001	0.0162
External Conflict	0.0987	-0.0011	0.0048			-0.0188	0.0126
Ethnic Tensions	0.5083	0.0085	0.0098	0.0165**	0.0072	0.0137	0.0096
Religion Tensions	0.1010	0.0007	0.0033			0.0019	0.0084
Financial Development							
BCBD	0.0687	0.0000	0.0011			-0.0002	0.0040
DBACBA	0.2247	-0.0047	0.0107			-0.0113	0.0151
Health							
Life Expectancy	0.9903	-0.0564***	0.0165	-0.0559***	0.0154	-0.0552*	0.0308
Ethnic Fractionalization							
Language	0.1850	-0.0013	0.0039			-0.0023	0.0069
Geography and Climate							
LCR100KM	0.0923	-0.0004	0.0018			-0.0035	0.0053
Tropics	0.0680	0.0002	0.0012			0.0030	0.0052

Table 3: Threshold tests and threshold estimates

This table presents the threshold tests and threshold estimates. It reports the bootstrap p-value for the test of the null hypothesis of the linear growth volatility (2.1) against the alternative hypothesis of the threshold model in equation (4.6) using alternative threshold variables (one at a time) as indicated by each row. ***, **, and * denote significance of the threshold effect at 1%, 5%, and 10%, respectively, as implied by the p-value. All underlying models were based on the full vector of regressors that included a constant, a trend, Life Expectancy, Openness, and Debt. The last four columns present the corresponding threshold estimate, 90% confidence intervals for the threshold parameter γ, the joint sum of squares (JSSE), and the sample size of the sub-samples.

Threshold variable	p-value	Threshold Estimate	90% C.I.	JSSE	n_1	n_2
Solow						
Population Growth	0.1700	-2.8871	[-2.9264, -2.5518]	0.0793	54	162
Investments**	0.0330	3.2019	[2.7553, 3.3453]	0.0832	149	67
Schooling***	0.0100	0.8449	[-0.0025, 1.4303]	0.0815	117	99
Initial Income**	0.0310	8.7203	[7.0800, 10.074]	0.0802	123	93
Macroeconomic Policy						
Inflation Volatility***	0.0000	5.9335	[1.6030, 14.666]	0.0764	124	92
Inflation Rate**	0.0380	2.7661	[1.2388, 3.0681]	0.0794	165	51
Government**	0.0170	2.2113	[1.6951, 2.6418]	0.0824	110	106
Openness	0.1600	58.152	[33.698, 101.68]	0.0821	103	113
Debt	0.4090	57.472	[35.257, 99.571]	0.0842	105	111
Institutions						
Executive Constraints**	0.0300	0.6833	[0.2333, 0.9833]	0.0785	93	123
Bureaucratic Quality***	0.0070	0.5458	[0.2500, 0.9990]	0.0808	114	102
Democracy***	0.0050	0.5200	[0.0300, 0.9800]	0.0778	78	138
Corruption	0.1800	0.6458	[0.3333, 0.8292]	0.0819	151	65
Law and Order*	0.0950	0.8333	[0.3333, 0.9472]	0.0840	170	46
Political Stability	0.7830	0.0000	[0.0000, 0.8000]	0.0852	111	105
Internal Conflict*	0.0590	0.8910	[0.5271, 0.9167]	0.0829	172	44
External Conflict	0.1340	0.9316	[0.6667, 0.9743]	0.0837	162	54
Ethnic Tensions***	0.0080	0.6667	[0.4097, 0.9208]	0.0769	111	105
Religion Tensions	0.2800	0.5722	[0.5000, 0.9889]	0.0841	46	170
Financial Development						
BCBD**	0.0810	0.6417	[0.5881,1.3368]	0.0804	42	174
DBACBA	0.1080	0.8446	[0.6175, 0.9793]	0.0834	105	111
Health						
Life Expectancy**	0.0200	4.2228	[3.9750, 4.3374]	0.0804	101	115
Ethnic Fractionalization						
Language	0.1300	0.4472	[0.0468, 0.7680]	0.0835	127	89
Geography and Climate						
Tropics	0.1350	0.8773	[0.0000, 0.9926]	0.0818	160	56
LCR100KM*	0.0990	0.5821	[0.1031, 0.9922]	0.0815	131	85

Table 4: Sample means of the growth volatility regimes

This table presents the sample means for Growth Volatility, Openness, Life Expectancy, and Debt in the low and high regimes that were identified by the various threshold regression models.

	Growth Volatility		Openness		Life Expectancy		Debt	
Threshold Variable	Low	High	Low	High	Low	High	Low	High
				Solow				
Investments	0.0386	0.0394	60.817	78.510	4.1700	4.1896	67.517	84.726
Schooling	0.0467	0.0295	63.307	69.849	4.0908	4.2769	79.565	64.924
Initial Income	0.0445	0.0314	66.796	65.656	4.0794	4.3040	81.237	61.768
				Macroeconomic policy				
Inflation Volatility	0.0288	0.0523	66.464	66.091	4.2358	4.0956	60.852	89.032
Inflation Rate	0.0343	0.0536	69.885	54.724	4.1952	4.1145	64.854	98.739
Government	0.0404	0.0373	64.246	68.442	4.1838	4.1681	58.754	87.487
				Institutions				
Executive Constraints	0.0511	0.0296	68.743	64.462	4.0632	4.2615	82.745	65.377
Bureaucratic Quality	0.0445	0.0325	67.541	64.925	4.1066	4.2538	82.875	61.655
Democracy	0.0532	0.0307	69.858	64.297	4.0571	4.2434	86.345	65.230
Law and Order	0.0431	0.0230	67.333	62.506	4.1346	4.3294	76.085	60.916
Internal Conflict	0.0417	0.0275	66.944	63.810	4.1404	4.3156	75.997	60.572
Ethnic Tensions	0.0420	0.0355	69.561	62.864	4.0979	4.2588	77.861	67.562
				Financial Development				
BCBD	0.0570	0.0345	67.901	65.920	4.0824	4.1987	116.070	62.423
				Health				
Life Expectancy	0.0475	0.0312	63.295	68.949	4.0320	4.3027	84.533	62.598
				Geography				
LCR100KM	0.0430	0.0325	59.261	77.162	4.1236	4.2570	72.411	73.538

Table 5: Threshold Regressions

This table presents regression coefficient estimates for threshold regression models using threshold variable q_i in equation (4.6). Panels (1)-(15) report the results for various threshold variables grouped by growth theory. The significance of the corresponding threshold effect is noted with star. Each panel refers to a threshold regression based on the corresponding threshold variable and shows the posterior inclusion probability (PIP), the posterior mean (PM), and the LS coefficient of the full model (Full) for the regression coefficients of Life Expectancy, Openness, and Debt in the low and high regimes. All models included a constant and a trend. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

	Regression coefficients for the two regimes					
	Openness		Life Expectancy		Debt	
	Low	High	Low	High	Low	High
			Solow			
			*Panel 1: q_i = Schooling****			
PIP	0.50200	0.50867	0.91100	1.00000	0.99300	0.14267
PM	0.00008	0.00005	-0.03909**	-0.08367***	0.00011***	-0.00001
Full	0.00017***	0.00009**	-0.04614***	-0.08331***	0.00011***	-0.00005
			*Panel 2: q_i = Initial Income***			
PIP	0.46133	0.41633	1.00000	1.00000	0.99900	0.14400
PM	0.00007	0.00004	-0.06154***	-0.15708***	0.00012***	-0.00001
Full	0.00015***	0.00007	-0.06492***	-0.15856***	0.00010***	-0.00004
			*Panel 3: q_i = Investments***			
PIP	0.73833	0.71633	1.00000	1.00000	0.14000	0.99667
PM	0.00012	0.00009	-0.06038***	-0.08695***	0.00001	0.00009***
Full	0.00014***	0.00013***	-0.05908***	-0.08587***	0.00006	0.00009***
			Macroeconomic policy			
			*Panel 4: q_i = Inflation Volatility****			
PIP	0.99267	0.17033	0.99067	0.99300	0.10667	0.95033
PM	0.00015***	0.00002	-0.03856***	-0.05227***	0.00000	0.00009**
Full	0.00016***	0.00009	-0.03880***	-0.05496***	-0.00004	0.00008**
			*Panel 5: q_i = Inflation Rate***			
PIP	0.99800	0.25633	1.00000	0.69633	0.08167	0.82567
PM	0.00018***	0.00005	-0.06372***	-0.03564	0.00000	0.00008*
Full	0.00018***	0.00013	-0.06237***	-0.05285**	0.00003	0.00008*
			*Panel 6: q_i = Government***			
PIP	0.27233	0.82433	0.92167	1.00000	0.17733	1.00000
PM	0.00003	0.00012*	-0.04314**	-0.07659***	0.00002	0.00010***
Full	0.00013**	0.00016***	-0.04190**	-0.07707***	0.00010	0.00010***

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Table 5 continued

Regression coefficients for the two regimes

	Openness		Life Expectancy		Debt	
	Low	High	Low	High	Low	High
			Institutions			
			*Panel 7: q_i = Democracy****			
PIP	0.16200	0.63767	0.96900	0.94467	0.99900	0.09000
PM	0.00002	0.00007	-0.05644***	-0.03186***	0.00015***	0.00000
Full	0.00011	0.00010**	-0.06284***	-0.03501***	0.00013***	0.00000
			*Panel 8: q_i = Bureaucratic Quality****			
PIP	0.10367	0.99767	0.95800	1.00000	1.00000	0.15867
PM	0.00000	0.00018***	-0.04169***	-0.08921***	0.00012***	-0.00001
Full	0.00005	0.00017***	-0.04421***	-0.09498***	0.00011***	-0.00005
			*Panel 9: q_i = Ethnic Tensions****			
PIP	0.99467	0.12867	1.00000	1.00000	0.97700	0.07600
PM	0.00022***	0.00000	-0.06531***	-0.10880***	0.00010***	0.00000
Full	0.00023***	0.00001	-0.06313***	-0.11142***	0.00010***	0.00000
			*Panel 10: q_i = Executive Constraints***			
PIP	0.17233	0.77867	0.98133	0.45367	0.99933	0.08000
PM	0.00001	0.00009	-0.05592***	-0.01069	0.00015***	0.00000
Full	0.00009	0.00012***	-0.06134***	-0.02409***	0.00014***	0.00001
			*Panel 11: q_i = Internal Conflict**			
PIP	0.74667	0.21933	1.00000	1.00000	0.99533	0.19400
PM	0.00010	0.00001	-0.05912***	-0.24208***	0.00010***	-0.00001
Full	0.00015***	0.00004	-0.05891***	-0.23619***	0.00009***	-0.00006
			*Panel 12: q_i = Law and Order**			
PIP	0.55500	0.30933	1.00000	0.96333	0.99367	0.14833
PM	0.00007	0.00002	-0.05333***	-0.14312***	0.00010***	0.00000
Full	0.00014***	0.00006	-0.05525***	-0.16661***	0.00009***	-0.00001

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Table 5 continued

Regression coefficients for the two regimes

	Openness		Life Expectancy		Debt	
	Low	High	Low	High	Low	High
			Financial Development			
			*Panel 13: q_i = BCBD**			
PIP	0.36667	0.85000	0.91267	1.00000	0.81133	0.05700
PM	0.00009	0.00010*	-0.06232**	-0.05548***	0.00009	0.00000
Full	0.00022*	0.00013***	-0.07235***	-0.05307***	0.00009***	0.00001
			Health			
			*Panel 14: q_i = Life Expectancy***			
PIP	0.82900	0.19633	0.99800	1.00000	0.95833	0.08367
PM	0.00020*	0.00001	-0.07471***	-0.17141***	0.00010***	0.00000
Full	0.00025***	0.00005	-0.07800***	-0.16960***	0.00010***	-0.00002
			Geography			
			*Panel 15: q_i = LCR100KM**			
PIP	0.12300	0.99533	0.99933	1.00000	0.99667	0.12367
PM	0.00001	0.00016***	-0.04787***	-0.08398***	0.00015***	0.00000
Full	0.00010	0.00015***	-0.04731***	-0.08788***	0.00013***	0.00001

Table 6: BMA results of the multiple threshold regression

This table presents posterior probabilities of theory or group of variables, which is the sum of posterior model probabilities over all those models that contain at least one variable of the underlying group. We present PPI's for individuals indicator variables, PPI's for groups of threshold variables, where the group includes all the indicator variables for each threshold variable, and PPIs for theories of threshold variables, where the group includes all the indicator variables for the threshold variables of the same theory. x_i includes intercept, Debt, Openness, and Life Expectancy.

Panel A: Individual indicator variables	
$Debt \cdot I(Democracy \leq \widehat{\gamma}_{Democracy})$	0.85
$Openness \cdot I(Investments \leq \widehat{\gamma}_{Investments})$	0.66
$Life\ Expectancy \cdot I(Infation\ Volatility \leq \widehat{\gamma}_{Infation\ Volatility})$	0.51
$Debt \cdot I(Investments \leq \widehat{\gamma}_{Investments})$	0.51
Panel B: Threshold Variables	
$x_i \cdot I(Investments \leq \widehat{\gamma}_{Investments})$	0.41
$x_i \cdot I(Schooling \leq \widehat{\gamma}_{Schooling})$	0.10
$x_i \cdot I(Initial\ Income \leq \widehat{\gamma}_{Initial\ Income})$	0.91
$x_i \cdot I(Inflation\ Volatility \leq \widehat{\gamma}_{Inflation\ Volatility})$	0.99
$x_i \cdot I(Inflation\ Rate \leq \widehat{\gamma}_{Inflation\ Rate})$	0.37
$x_i \cdot I(Government \leq \widehat{\gamma}_{Government})$	0.94
$x_i \cdot I(Executive\ Constraints \leq \widehat{\gamma}_{Executive\ Constraints})$	0.11
$x_i \cdot I(Bureaucratic\ Quality \leq \widehat{\gamma}_{Bureaucratic\ Quality})$	0.15
$x_i \cdot I(Democracy \leq \widehat{\gamma}_{Democracy})$	0.93
$x_i \cdot I(Internal\ Conflict \leq \widehat{\gamma}_{Internal\ Conflict})$	0.03
$x_i \cdot I(Law\ and\ Order \leq \widehat{\gamma}_{Law\ and\ Order})$	0.13
$x_i \cdot I(Ethnic\ Tensions \leq \widehat{\gamma}_{Ethnic\ Tensions})$	0.77
$x_i \cdot I(BCBD \leq \widehat{\gamma}_{BCBD})$	0.73
$x_i \cdot I(Life\ Expectancy \leq \widehat{\gamma}_{Life\ Expectancy})$	0.36
$x_i \cdot I(LCR100KM \leq \widehat{\gamma}_{LCR100KM})$	0.02
Panel C: Theories of Threshold Variables	
$x_i \cdot I(Solow \leq \widehat{\gamma}_{Solow})$	0.98
$x_i \cdot I(Macroeconomic\ Policy \leq \widehat{\gamma}_{Macroeconomic\ Policy})$	0.99
$x_i \cdot I(Institutions \leq \widehat{\gamma}_{Institutions})$	0.99
$x_i \cdot I(Financial\ Development \leq \widehat{\gamma}_{Financial\ Development})$	0.73
$x_i \cdot I(Health \leq \widehat{\gamma}_{Health})$	0.36
$x_i \cdot I(Geography \leq \widehat{\gamma}_{Geography\ and\ Climate})$	0.02

Table A1: Data Appendix

Variable	**Description**
Time trend	Time trend variable for the periods 1980-89, 1990-99 and 2000-2009
Growth volatility	Standard deviation of the growth rate of real per capita GDP for the periods 1980-89, 1990-99 and 2000-2009. Source: PWT 7.0
Initial Income	Logarithm of per capita GDP in chain series at 1980, 1990, 2000. Source: PWT 7.0
Population Growth	Logarithm of average population growth rates plus 0.05 for the periods 1980-89, 1990-99 and 2000-2009. Source: PWT 7.0
Investments	Logarithm of average ratios over each period of investment to GDP for the periods 1980-89, 1990-99 and 2000-2009. Source: PWT 7.0
Schooling	Logarithm of average years of male secondary and tertiary school attainment (25+) in 1980, 1990, and 1999. Source: Barro and Lee (2000).
Debt	Logarithm of public debt to GDP for the periods 1980-89, 1990-99 and 2000-2009. Source:IMF, Debt Database Fall 2011 Vintage.
Government	Log of average ratios for each period of government consumption (net of outlays on defense and education) to GDP for the periods 1980-89, 1990-99 and 2000-2009. Source: PWT 7.0
Inflation Rate	Log average inflation for the periods 1980-89, 1990-99 and 2000-2009. Source: Worldbank
Inflation Volatility	Standard deviation of inflation for the periods 1980-89, 1990-99 and 2000-2009. Source: Worldbank.
Openness	Average ratios for each period of exports plus imports to GDP for the periods 1980-89, 1990-99 and 2000-2009. Source: PWT 7.0
Life Expectancy	Log of average life expectancy for the periods 1980-89, 1990-99 and 2000-2009. 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 zero to one where higher values equal a greater extent of institutionalized constraints on the power of chief executives. Averages for the periods 1980-89, 1990-99 and 2000-2009. Source: Polity IV, `http://www.systemicpeace.org/polity/polity4.htm`

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Table A1 continued

Variable	**Description**
Democracy	Level of institutionalized democracy. This variable ranges from zero to one where higher values equal a greater extent of institutionalized democracy. Averages for the periods 1980-89, 1990-99 and 2000-2009. Source : Polity IV.
External Conflict	The external conflict measure is an assessment of the risk to both the incumbent government and inward investment. It ranges from trade restrictions and embargoes, whether imposed by a single country, a group of countries, or the whole international community, through geopolitical disputes, armed threats, exchanges of fire on borders, border incursions, foreign-supported insurgency, and full-scale warfare. Averages for the periods 1980-89, 1990-99 and 2000-2009. The max value for this variable is 1. Source: International Country Risk Guide.
Internal Conflict	This is an assessment of political violence in the country and its actual or potential impact on governance. The highest rating is given to those countries where there is no armed opposition to the government and the government does not indulge in arbitrary violence against its own people. The lowest rating is given to a country embroiled in an on-going civil war. Averages for the periods 1980-89, 1990-99 and 2000-2009. The max value for this variable is 1. Source: International Country Risk Guide.
Religion Tensions	Religious tensions may stem from the domination of society and/or governance by a single religious group that seeks to replace civil law by religious law and to exclude other religions from the political and/or social process; the desire of a single religious group to dominate governance; the suppression of religious freedom; the desire of a religious group to express its own identity, separate from the country as a whole. Averages for the periods 1980-89, 1990-99 and 2000-2009. The max value for this variable is 1. Source: International Country Risk Guide.
Ethnic Tensions	This component measures the degree of tension within a country attributable to racial, nationality, or language divisions. Averages for the periods 1980-89, 1990-99 and 2000-2009. The max value for this variable is 1. Source: International Country Risk Guide.

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Table A1 continued

Variable	**Description**
Bureaucratic Quality	PRSs bureaucratic quality index gives high points to countries where the bureaucracy has the strength and expertise to govern without drastic changes in policy or interruptions in government services. In these low risk countries, the bureaucracy tends to be somewhat autonomous from political pressure and to have an established mechanism for recruitment and training. Countries that lack the cushioning effect of a strong bureaucracy receive low points because a change in government tends to be traumatic in terms of policy formulation and day-to-day administrative functions. This variable ranges from zero to one. Averages for the periods 1980-89, 1990-99 and 2000-2009. Source: International Country Risk Guide.
Corruption	The PRS measure of corruption within the political system reflects actual or potential corruption in the form of excessive patronage, nepotism, job reservations, favor-forfavors, secret party funding, and suspiciously close ties between politics and business. In PRSs view these sorts of corruption pose risk to foreign business, potentially leading to popular discontent, unrealistic and inefficient controls on the state economy, and encourage the development of the black market. This variable ranges from zero to one. Averages for the periods 1980-89, 1990-99 and 2000-2009. Source: International Country Risk Guide.
Law and Order	PRS assesses Law and Order, separately. The Law subcomponent is an assessment of the strength and impartiality of the legal system, while the Order subcomponent is an assessment of popular observance of the law. Averages for the periods 1980-89, 1990-99 and 2000-2009. The max value for this variable is 1. Source: International Country Risk Guide.
Political Stability	Political stability is measured as the average of the first differences (in absolute values) of the Polity2 variable from Polity IV. The Polity2 variable is a measure of the degree of democracy in a country with a score of +10 representing most democratic and -10 signifying most autocratic. Averages for the periods 1980-89, 1990-99 and 2000-2009. Higher values indicate more political instability. Source: Polity IV, `http://www.systemicpeace.org/polity/polity4.htm`

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Table A1 continued

Variable	**Description**
DBACBA	Ratio of deposit money bank claims on domestic nonfinancial real sector to the sum of deposit money bank and Central Bank claims on domestic nonfinancial real sector. Averages for the periods 1980-89, 1990-99 and 2000-2009. Source: Beck, Demirgüç-Kunt, and Levine (2009)
BCBD	Private credit by deposit money banks as a share of demand, time and saving deposits in deposit money banks. Averages for the periods 1980-89, 1990-99 and 2000-2009. Source: Beck, Demirgüç-Kunt, and Levine (2009)
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 countrys land area within 100km of an ice- free coast. Source: The Center for International Development at Harvard University.
Language	Measure of linguistic fractionalization based on data describing shares of languages spoken as “mother tongues”. Source: Alesina, Devleeschauwer, Easterly, Kurlat, and Wacziarg (2003).

Table A2: Countries for Inflation Volatility Regimes

		Regime 1 *Inflation Volatility* ≤ 5.933			Regime 2 *Inflation Volatility* > 5.933		
	Country	1980-1989	1990-1999	2000-2009	1980-1989	1990-1999	2000-2009
1	Algeria				x	x	x
2	Argentina					x	x
3	Australia	x	x	x			
4	Austria	x	x	x			
5	Bangladesh	x	x	x			
6	Belgium	x	x	x			
7	Bolivia		x	x	x		
8	Brazil			x		x	
9	Cameroon		x	x	x		
10	Canada	x	x	x			
11	Chile			x	x	x	
12	China			x		x	
13	Colombia	x				x	x
14	Congo, Republic of				x	x	x
15	Costa Rica		x	x	x		
16	Cote d'Ivoire			x	x	x	
17	Cyprus		x	x			
18	Denmark	x	x	x			
19	Dominican Republic				x	x	x
20	Egypt		x	x	x		
21	Ecuador				x	x	x
22	Finland	x	x	x			
23	France	x	x	x			
24	Gambia, The		x		x		x
25	Gabon				x	x	x
26	Ghana				x	x	x
27	Greece	x	x	x			
28	Guatemala			x	x	x	
29	Ghana				x	x	x
30	Guyana				x	x	x
31	Honduras	x				x	x
32	Hungary			x		x	
33	India	x	x	x			
34	Indonesia		x	x			
35	Iran				x	x	x
36	Ireland	x	x	x			
37	Israel		x	x	x		
38	Italy	x	x	x			
39	Jamaica			x	x	x	
40	Jordan						x
41	Japan	x	x	x			
42	Kenya	x		x		x	
43	Korea, Republic of		x	x	x		
44	Malaysia	x	x	x			
45	Malawi				x	x	x
46	Mali			x	x	x	
47	Morocco	x	x	x			
48	Netherlands	x	x	x			
49	New Zealand		x	x			
50	Nicaragua			x		x	
51	Niger			x	x	x	
52	Norway	x	x				x
53	Pakistan	x	x				x
54	Panama		x	x	x		
55	Papua New Guinea		x		x		x
56	Paraguay			x	x	x	
57	Peru			x		x	
58	Philippines		x	x	x		
59	Portugal	x	x	x			
60	Senegal	x		x		x	
61	Sierra Leone				x	x	x
62	South Africa	x	x	x			
63	Spain	x	x	x			
64	Sri Lanka		x	x	x		
65	Sweden	x	x	x			
66	Syria				x	x	x
67	Thailand	x	x	x			
68	Togo	x		x		x	
69	Trinidad &Tobago		x		x		x
70	Tunisia	x	x	x			
71	Turkey				x	x	x
72	United Kingdom	x	x	x			
73	United States	x	x	x			
74	Uruguay			x	x	x	
75	Venezuela				x	x	x
76	Zambia				x	x	x
77	Zimbabwe					x	x

Table A3: Threshold tests and threshold estimates (posterior mode model)

This table presents the threshold tests and threshold estimates. It reports the bootstrap p-value for the test of the null hypothesis of the linear growth volatility (2.1) against the alternative hypothesis of the threshold model in equation (4.6) using alternative threshold variables (one at a time) as indicated by each row. ***, **, and * denote significance of the threshold effect at 1%, 5%, and 10%, respectively, as implied by the p-value. All underlying models were based on the full vector of regressors that included a constant, a trend, Life Expectancy, Openness, Debt, Executive Constraints, and Ethnic Tensions. The last four columns present the corresponding threshold estimate, 90% confidence intervals for the threshold parameter γ, the joint sum of squares (JSSE), and the sample size of the sub-samples.

Threshold variable	p-value	Threshold Estimate	90% C.I.	JSSE	n_1	n_2
Solow						
Population Growth**	0.0470	-2.8871	[-2.9264, -2.551]	0.0721	54	162
Investments**	0.0180	3.2258	[2.7553, 3.3453]	0.0738	155	61
Schooling*	0.0610	0.8601	[-0.0025, 1.4303]	0.0762	118	98
Initial Income**	0.0120	8.0399	[7.0799, 10.074]	0.0752	77	139
Macroeconomic Policy						
Inflation Volatility***	0.0020	5.9335	[1.6030, 14.666]	0.0720	124	92
Inflation Rate*	0.0840	2.7661	[1.2388, 3.0680]	0.0736	165	51
Government*	0.0530	2.1581	[1.6951, 2.6418]	0.0741	96	120
Openness*	0.0520	83.640	[33.698, 101.68]	0.0736	162	54
Debt**	0.0410	93.894	[35.257, 99.570]	0.0763	177	39
Institutions						
Executive Constraints**	0.0390	0.8500	[0.2333, 0.9833]	0.0754	125	91
Bureaucratic Quality**	0.0200	0.5458	[0.2500, 0.9989]	0.0748	114	102
Democracy	0.2970	0.7700	[0.0300, 0.9800]	0.0770	111	105
Corruption	0.1490	0.3653	[0.3333, 0.8292]	0.0745	56	160
Law and Order***	0.0040	0.7458	[0.3333, 0.9472]	0.0769	153	63
Political Stability	0.4460	0.0000	[0.0000, 0.8000]	0.0778	111	105
Internal Conflict**	0.0460	0.8854	[0.5271, 0.9166]	0.0773	168	48
External Conflict	0.2420	0.9056	[0.6666, 0.9743]	0.0759	153	63
Ethnic Tensions	0.1930	0.7924	[0.4097, 0.9208]	0.0722	138	78
Religion Tensions	0.4120	0.8333	[0.5000, 0.9889]	0.0770	119	97
Financial Development						
BCBD	0.3600	0.8065	[0.5881, 1.3368]	0.0754	77	139
DBACBA***	0.0010	0.8446	[0.6175, 0.9793]	0.0731	105	111
Health						
Life Expectancy**	0.0400	4.2661	[3.9749,4.3373]	0.0754	134	82
Ethnic Fractionalization						
Language	0.1390	0.4427	[0.0468, 0.7679]	0.0769	125	91
Geography and Climate						
Tropics	0.2130	0.7079	[0.0000, 0.9926]	0.0765	140	76
LCR100KM**	0.0420	0.2201	[0.1031, 0.9922]	0.0738	66	150

Table A4: Threshold Regressions (posterior mode model)

This table presents regression coefficient estimates for threshold regression models using threshold variable q_i in equation (4.6). Panels (1)-(16) report the results for various threshold variables grouped by growth theory. The significance of the corresponding threshold effect is noted with star. Each panel refers to a threshold regression based on the corresponding threshold variable and shows the posterior inclusion probability (PIP), the posterior mean (PM), and the LS coefficient of the full model (Full) for the regression coefficients of Life Expectancy, Openness, Debt, Executive Constraints, and Ethnic Tensions in the low and high regimes. All models included a constant and a trend. ***, **, and * denote of the significance at 1%, 5%, and 10%, respectively.

Regression coefficients for the two regimes

	Openness		Life Expectancy		Debt		Exec. Constraints		Ethnic Tensions	
	Low	High	Low	High	Low	High	Low	High	Low	High
					Solow					
					*Panel 1: q_i = Population Growth**					
PIP	0.37667	0.17933	1.00000	0.97733	1.00000	0.10133	0.30100	0.95500	0.14033	0.90100
PM	0.00005	0.00001	-0.13444***	-0.04488***	0.00012***	0.00000	0.00704	-0.01702**	0.00061	0.02142**
Full	0.00010	0.00008*	-0.15817***	-0.04620***	0.00013***	0.00003	0.02151*	-0.01484**	0.00892	0.02327 ***
					*Panel 2: q_i = Schooling****					
PIP	0.43167	0.50367	0.74700	1.00000	0.99300	0.21500	0.62267	0.10800	0.51567	0.13533
PM	0.00006	0.00005	-0.03216	-0.08136***	0.00011***	-0.00001	-0.01109	-0.00047	0.01187	0.00067
Full	0.00016**	0.00009**	-0.04650**	-0.08142**	0.00010***	-0.00005	-0.01348*	-0.00163	0.02481**	0.00568
					*Panel 3: q_i = Initial Income***					
PIP	0.55633	0.63867	0.94467	0.93800	0.94033	0.13700	0.91267	0.22933	0.60933	0.09433
PM	0.00013	0.00006	-0.05519**	-0.05644**	0.00010**	0.00000	-0.02729**	-0.00255	0.01994	0.00032
Full	0.00023**	0.00010**	-0.06077***	-0.05133**	0.00009***	-0.00003	-0.02745***	-0.00721	0.03293**	0.00307
					*Panel 4: q_i = Investments***					
PIP	0.72033	0.43067	0.95600	0.99567	0.13800	1.00000	0.96167	0.20467	0.84267	0.11400
PM	0.00010	0.00005	-0.04530***	-0.07950***	0.00000	0.00012***	-0.02371***	-0.00128	0.02092*	0.00014
Full	0.00012***	0.00012**	-0.04863***	-0.07837***	0.00003	0.00011***	-0.02461***	-0.00333	0.02516***	0.00288
					Macroeconomic policy					
					*Panel 5: q_i = Inflation Volatility****					
PIP	0.99733	0.16400	0.96667	0.91233	0.08033	0.93367	0.12033	0.54333	0.09833	0.31067
PM	0.00015***	0.00002	-0.03770***	-0.04416**	0.00000	0.00009**	-0.00067	-0.01033	0.00058	0.00669
Full	0.00015***	0.00009	-0.03917**	-0.05017**	-0.00003	0.00009**	-0.00352	-0.01732**	0.00524	0.02460*
					*Panel 6: q_i = Inflation Rate***					
PIP	0.99800	0.18100	1.00000	0.40333	0.05800	0.84567	0.49900	0.72400	0.49433	0.14633
PM	0.00017***	0.00003	-0.06048***	-0.01666	0.00000	0.00008*	-0.00612	-0.01990	0.00753	0.00077
Full	0.00017***	0.00011	-0.05728***	-0.03858	0.00002	0.00008*	-0.01187*	-0.02515**	0.01504**	0.01352
					*Panel 7: q_i = Government**					
PIP	0.10200	0.98833	0.41800	1.00000	0.24933	0.98800	0.88767	0.20033	0.81633	0.06433
PM	0.00000	0.00018***	-0.01744	-0.07469***	0.00003	0.00008***	-0.02224**	-0.00169	0.02330	0.00017
Full	0.00004	0.00019***	-0.03584	-0.06894***	0.00013	0.00008***	-0.01641*	-0.00823	0.03367***	0.00344
					*Panel 8: q_i = Debt***					
PIP	0.93933	0.19300	1.00000	0.67900	0.08700	0.89433	0.17367	0.98000	0.34267	0.19367
PM	0.00013**	0.00002	-0.06022***	-0.03138	0.00000	0.00009**	-0.00148	-0.04218***	0.00462	0.00254
Full	0.00014***	0.00012	-0.05816***	-0.05315**	-0.00004	0.00010***	-0.00798	-0.04019***	0.01267*	0.02143

Table continued on next page ...

Table A4 continued

Regression coefficients for the two regimes

	Openness		Life Expectancy		Debt		Exec. Constraints		Ethnic Tensions	
	Low	High	Low	High	Low	High	Low	High	Low	High
*Panel 9: q_i = Openness**										
PIP	0.10767	0.65733	1.00000	0.95933	0.11933	0.97700	0.99433	0.14767	0.99233	0.24433
PM	0.00001	0.00014	-0.05932***	-0.07983***	0.00001	0.00011***	-0.02214***	0.00073	0.02935***	-0.00414
Full	0.00002	0.00023***	-0.05758***	-0.08594**	0.00004*	0.00009***	-0.02313***	0.00679	0.02945***	-0.01475
Institutions										
*Panel 10: q_i = Executive Constraints***										
PIP	0.20933	0.90167	0.99633	0.29333	1.00000	0.20667	0.70700	0.96933	0.78300	0.14367
PM	0.00002	0.00013**	-0.05386***	-0.00897	0.00012***	-0.00001	-0.01419	-0.17665***	0.02177	-0.00089
Full	0.00010*	0.00015***	-0.05720***	-0.02721	0.00011***	-0.00005	-0.01815**	-0.16272***	0.02889***	-0.00198
*Panel 11: q_i = Bureaucratic Quality***										
PIP	0.10900	0.99567	0.94200	0.98500	1.00000	0.18533	0.42967	0.48833	0.67133	0.16333
PM	0.00000	0.00018***	-0.04504**	-0.07640***	0.00012***	-0.00001	-0.00642	-0.00860	0.01807	0.00150
Full	0.00003	0.00016***	-0.04766***	-0.07570***	0.00012***	-0.00005	-0.01292*	-0.01656*	0.02774**	0.00742
*Panel 12: q_i = Law and Order****										
PIP	0.35367	0.47567	0.94133	0.99667	0.98967	0.13467	0.67933	0.29767	0.74467	0.14067
PM	0.00004	0.00005	-0.04548**	-0.19590***	0.00010***	0.00000	-0.01107	0.00443	0.01787	-0.00087
Full	0.00011**	0.00008	-0.05032***	-0.24105***	0.00009***	-0.00003	-0.01309**	0.01492	0.02455***	-0.00531
Panel 13: q_i = Internal Conflict (5%)										
PIP	0.66433	0.14500	0.96900	1.00000	0.98700	0.16967	0.81000	0.17167	0.58133	0.20800
PM	0.00009	0.00001	-0.04688***	-0.21654***	0.00010***	-0.00001	-0.01358	0.00123	0.01115	0.00248
Full	0.00014***	0.00003	-0.05063***	-0.24582***	0.00009***	-0.00006	-0.01474**	0.00931	0.01962**	0.01280
Financial Development										
*Panel 14: q_i = DBACBA****										
PIP	0.24533	0.91367	0.99533	0.84433	0.99967	0.40867	0.96200	0.23433	0.97900	0.17967
PM	0.00003	0.00012**	-0.05931***	-0.04101*	0.00011***	-0.00004	-0.02215***	-0.00276	0.03819***	-0.00207
Full	0.00012*	0.00013***	-0.06338***	-0.02623	0.00010***	-0.00011**	-0.02167***	-0.00738	0.03977***	-0.01077
Health										
*Panel 15: q_i = Life Expectancy***										
PIP	0.67700	0.14900	0.93933	1.00000	0.96200	0.08133	0.68000	0.28133	0.36267	0.13600
PM	0.00011	-0.00001	-0.04708**	-0.26111***	0.00009***	0.00000	-0.01162	0.00526	0.00689	0.00093
Full	0.00017***	-0.00004	-0.05264***	-0.32469***	0.00009***	0.00001	-0.01326**	0.01931	0.01908*	0.00550
Geography										
*Panel 16: q_i = LCR100KM****										
PIP	0.12900	0.78367	0.99800	0.95333	1.00000	0.05067	0.68967	0.38567	0.93200	0.10733
PM	0.00001	0.00009	-0.07423***	-0.05021***	0.00016***	0.00000	-0.01459	-0.00550	0.04786**	0.00069
Full	0.00008	0.00011***	-0.07355***	-0.04710**	0.00015***	0.00002	-0.01793**	-0.01249	0.05473***	0.00639

Table A5: Sample means of the growth volatility regimes (posterior mode model)

This table presents the sample means for Growth Volatility, Openness, Life Expectancy, Debt, Exec. Constraints, and Ethnic Tensions in the low and high regimes that were identified by the various threshold regression models.

	Growth Vol.		Openness		Life Expectancy		Debt		Exec. Con.		Ethnic Tensions	
	Low	high	Low	high	Low	high	Low	high	Low	high	Low	high
Solow												
Population Growth	0.0332	0.0407	68.207	65.671	4.2864	4.1393	84.711	68.903	0.9099	0.6136	0.7939	0.6218
Investments	0.0385	0.0397	61.687	78.041	4.1723	4.1858	71.740	75.686	0.7347	0.5683	0.6720	0.6467
Schooling	0.0468	0.0292	63.730	69.407	4.0903	4.2794	80.544	63.597	0.5407	0.8646	0.5994	0.7436
Initial Income	0.0506	0.0323	62.636	68.337	4.0150	4.2654	97.911	58.975	0.4415	0.8240	0.5359	0.7363
Macroeconomic policy												
Inflation Volatility	0.0288	0.0523	66.464	66.091	4.2358	4.0956	60.852	89.032	0.8164	0.5142	0.6923	0.6278
Openness	0.0374	0.0433	49.947	115.38	4.1618	4.2189	68.217	86.769	0.6828	0.7024	0.6708	0.6470
Government	0.0410	0.0371	63.732	68.364	4.1745	4.1774	57.261	85.329	0.6396	0.7261	0.6539	0.6736
Inflation Rate	0.0343	0.0536	69.884	54.724	4.1952	4.1145	64.854	98.739	0.7154	0.5981	0.6661	0.6606
Debt	0.0356	0.0537	64.930	72.546	4.1960	4.0857	54.245	157.32	0.7158	0.5599	0.6709	0.6372
Institutions												
Bureaucratic Quality	0.0445	0.0325	67.541	64.925	4.1066	4.2538	82.875	61.655	0.5416	0.8510	0.6235	0.7110
Executive Constraints	0.0462	0.0288	68.134	63.793	4.0956	4.2867	79.430	63.824	0.4652	0.9932	0.6148	0.7336
Internal Conflict	0.0423	0.0269	66.421	65.902	4.1367	4.3142	76.544	59.942	0.6229	0.9146	0.6155	0.8377
Law and Order	0.0445	0.0250	67.789	62.702	4.1146	4.3255	78.291	59.652	0.5881	0.9296	0.6052	0.8097
Financial Development												
DBACBA	0.0470	0.0312	63.803	68.672	4.0844	4.2628	91.572	55.150	0.5411	0.8264	0.6246	0.7029
Health												
Life Expectancy	0.0459	0.0274	65.423	67.747	4.0850	4.3249	79.762	61.568	0.5380	0.9323	0.5807	0.8024
Geography												
LCR100KM	0.0481	0.0348	60.817	68.720	4.0572	4.2284	88.544	65.952	0.4753	0.7811	0.5709	0.7062

Table A6: BMA results of the multiple threshold regression (posterior mode model)

This table presents posterior probabilities (PIP's) of theory or group of variables, which is the sum of posterior model probabilities over all those models that contain at least one variable of the underlying group. We present PPIs for individuals indicator variables, PPIs for groups of threshold variables, where the group includes all the indicator variables for each threshold variable, and PPIs for theories of threshold variables, where the group includes all the indicator variables for the threshold variables of the same theory. x_i includes intercept, Debt, Openness, Life Expectancy, Executive Constraints, and Ethnic Tensions.

Panel A: Individual Indicator Variables	
$Debt \cdot I(Population\ Growth \leq \widehat{\gamma}_{Population\ Growth})$	0.81
$Ethnic\ Tensions \cdot I(Government \leq \widehat{\gamma}_{Government})$	0.82
$Exec.\ Constraints \cdot I(Debt \leq \widehat{\gamma}_{Debt})$	0.77
$Ethnic\ Tensions \cdot I(Debt \leq \widehat{\gamma}_{Debt})$	0.77
$Openness \cdot I(Bureaucratic\ Quality \leq \widehat{\gamma}_{Bureaucratic\ Quality})$	0.68
$Constant \cdot I(Inflation\ Volatility \leq \widehat{\gamma}_{Inflation\ Volatility})$	0.56
$Ethnic\ Tensions \cdot I(DBACBA \leq \widehat{\gamma}_{DBACBA})$	0.54
$Life\ Expectancy \cdot I(DBACBA \leq \widehat{\gamma}_{DBACBA})$	0.52
Panel B: Threshold Variables	
$x_i \cdot I(Population\ Growth \leq \widehat{\gamma}_{Population\ Growth})$	0.43
$x_i \cdot I(Investments \leq \widehat{\gamma}_{Investments})$	0.43
$x_i \cdot I(Schooling \leq \widehat{\gamma}_{Schooling})$	0.10
$x_i \cdot I(Initial\ Income \leq \widehat{\gamma}_{Initial\ Income})$	0.95
$x_i \cdot I(Inflation\ Volatility \leq \widehat{\gamma}_{Inflation\ Volatility})$	1.00
$x_i \cdot I(Inflation\ Rate \leq \widehat{\gamma}_{Inflation\ Rate})$	1.00
$x_i \cdot I(Government \leq \widehat{\gamma}_{Government})$	0.87
$x_i \cdot I(Openness \leq \widehat{\gamma}_{Openness})$	0.03
$x_i \cdot I(Debt \leq \widehat{\gamma}_{Debt})$	0.23
$x_i \cdot I(Executive\ Constraints \leq \widehat{\gamma}_{Executive\ Constraints})$	0.90
$x_i \cdot I(Bureaucratic\ Quality \leq \widehat{\gamma}_{Bureaucratic\ Quality})$	0.45
$x_i \cdot I(Internal\ Conflict \leq \widehat{\gamma}_{Internal\ Conflict})$	0.10
$x_i \cdot I(Law\ and\ Order \leq \widehat{\gamma}_{Law\ and\ Order})$	0.34
$x_i \cdot I(DBACBA \leq \widehat{\gamma}_{DBACBA})$	0.22
$x_i \cdot I(Life\ Expectancy \leq \widehat{\gamma}_{Life\ Expectancy})$	0.59
$x_i \cdot I(LCR100KM \leq \widehat{\gamma}_{LCR100KM})$	0.03
Panel C: Theories of Threshold Variables	
$x_i \cdot I(Solow \leq \widehat{\gamma}_{Solow})$	0.99
$x_i \cdot I(Macroeconomic\ Policy \leq \widehat{\gamma}_{Macroeconomic\ Policy})$	1.00
$x_i \cdot I(Institutions \leq \widehat{\gamma}_{Institutions})$	1.00
$x_i \cdot I(Financial\ Development \leq \widehat{\gamma}_{Financial\ Development})$	0.22
$x_i \cdot I(Health \leq \widehat{\gamma}_{Health})$	0.36
$x_i \cdot I(Geography \leq \widehat{\gamma}_{Geography\ and\ Climate})$	0.03