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**Working Paper**

## Volatility and Growth: Governments are Key

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IZA DP No. 7826

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Michael Jetter

December 2013

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and IZA*

Discussion Paper No. 7826  
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## ABSTRACT

### **Volatility and Growth: Governments are Key**

There exists a persistent disagreement in the literature over the effect of business cycles on economic growth. This paper offers a solution to this disagreement, suggesting that volatility carries a positive direct effect, but also a negative indirect effect, operating through the insurance mechanism of government size. Theoretically, the net growth effect of volatility is then ambiguous. The paper reveals the underlying endogeneity of government size in a balanced panel of 95 countries from 1961 - 2010. In practice, the negative indirect channel dominates in democracies, but with less power to choose public services in autocratic regimes the positive direct effect takes over. Consequently, volatile growth rates are detrimental to growth in democracies, but beneficial to growth in autocracies. The empirical results suggest that a one standard deviation increase of volatility lowers growth by up to 0.57 percentage points in a democracy, but raises growth by 1.74 percentage points in a total autocracy. These findings point to a crucial intermediating role of governments in the relationship between volatility and growth. Both the size of the public sector and the regime form assume key roles.

JEL Classification: E32, H11, O43, P16

Keywords: economic growth, volatility, business cycles, government size, regime form

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## NON-TECHNICAL SUMMARY

Whether business cycles are good or bad for economic growth is an evergreen in the economics profession. What has since been unrecognized however is the indirect channel from cycles on growth, operating through government size. Faced with a more volatile overall economic environment, people prefer a stronger public sector for security purposes – but bigger governments in turn lower growth in the short run. This leads to a negative growth externality from volatility.

Revealing this mechanism (volatility → public sector → growth) carries several implications:

(1) the consequences from business cycles might be easier to predict.

(2) past discrepancies on the net relationship between volatility and growth could be explained. There exists a positive direct effect from volatility on growth in the short run, presumably operating through precautionary savings or creative destruction (see Schumpeter). Disentangling the indirect effect through government size helps to isolate the true effects at work.

(3) the regime form of a country is important when evaluating growth consequences from business cycles. For instance, in autocratic regimes, where people cannot actively choose their extent of the public sector, the indirect channel is cut off. In this case, people cannot react to volatility by increasing their public safety net.

In summary, the relationship between business cycles and economic growth may not be as mysterious as previously thought. Taking into account both direct and indirect effects may allow us to estimate whether this connection is positive or negative in a given country.

## 1. Introduction

The global financial crisis of 2008 has once again magnified the importance of understanding possible connections between business cycles and economic growth. Ever since [Ramey and Ramey \(1995\)](#) proposed a causal relationship between growth volatility and growth itself, researchers have presented evidence for both negative and positive effects from volatility on growth, as summarized in [Döpke \(2004\)](#).<sup>1</sup> Finally, other papers argue that there exists no link at all between output volatility and growth ([Solow, 1997](#), [Dawson and Stephenson, 1997](#), and [Posch and Wälde, 2011](#)).

This paper provides an explanation for these deep disagreements, uncovering a hidden indirect channel, which needs to be accounted for in order to understand the total net effect. Volatility carries both a positive direct effect on economic growth, but also a negative indirect effect, operating through the size of the public sector. As both mechanisms push in opposite directions, estimating growth in a standard single equation framework can lead to misleading conclusions.

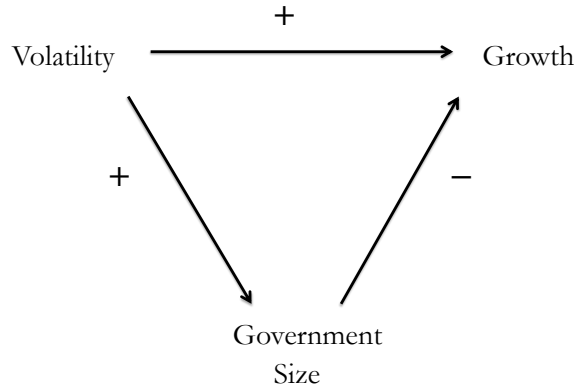
Theoretical foundations for a positive connection between volatility and growth include creative destruction ([Schumpeter and Fels, 1939](#); [Philippe and Peter, 1992](#)), an opportunity-cost effect of conducting research in recessions ([Saint-Paul, 1993](#); [Aghion and Saint-Paul, 1998](#)), and precautionary savings ([Mirman, 1971](#); [Devereux and Smith, 1994](#)). However, volatility also carries another consequence, which has been neglected in the growth context. In times of increased cyclical fluctuations, people turn to the public sector for security (see [Rodrik, 1998](#)). Specifically, people may call for a tighter public safety net and choose to pursue government sector jobs over more volatile private sector employment (see [Jetter et al., 2013](#)). This implies bigger governments in volatile times, which can in turn lower growth rates in the short run, as resources are being withdrawn from the private sector ([Barro and Lee, 1994](#); [Barro, 2001](#); [Afonso and Furceri, 2010](#)).<sup>2</sup> Theoretically, the sign of the net effect is then ambiguous, as summarized in figure 1.

Using a balanced panel of annual observations for 95 countries from 1961 – 2010, this paper presents evidence for the existence and the importance of the indirect channel of volatility on growth. Growth rate volatility is never a significant predictor of growth in a single equation framework, even after including the usual control variables found by [Levine and Renelt \(1992\)](#) and [Mirestean and Tsangarides \(2009\)](#). However, after addressing the underlying endogeneity of government size in a simultaneous estimation

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<sup>1</sup>Similar to [Ramey and Ramey \(1995\)](#), [Badinger \(2010\)](#) or [Wang and Wen \(2011\)](#) propose negative growth effects from volatility, whereas [Caporale and McKiernan \(1998\)](#), [Canton \(2002\)](#), or [Oikawa \(2010\)](#) suggest positive growth effects. [Imbs \(2002\)](#), [Imbs \(2007\)](#), and [Aghion et al. \(2010\)](#) argue that volatility and growth could be related in various ways.

<sup>2</sup>In a seminal paper, [Rodrik \(1998\)](#) introduces the thought of citizens demanding stronger public safety nets in the light of uncertainty. There exists an extensive discussion surrounding this theory, as [Rodrik \(1998\)](#) first relates trade openness to volatility, which then raises the demand for public goods. In this chain of arguments, the first link of openness leading causing volatility is heavily debated. The present paper only builds on the second effect of volatility causing people to demand more security from the public sector.



**Figure 1:** Direct and indirect effect of volatility on growth

framework, both the positive direct and the negative indirect effect receive strong statistical support.

In reality, the relative strength of the two effects varies substantially across countries. Especially the indirect channel of people being able to influence the extent of the public sector relies on the citizen's option to engage in the political process. People can only actively influence public goods provision if they have a say in politics. Indeed, the positive direct effect dominates in autocratic regimes, whereas the negative indirect effect is absent. Once a country evolves into a democratic society the indirect channel gains importance. Regarding growth, this translates to a positive net effect from volatility in autocratic societies, but a negative net effect in democracies.

These findings provide a coherent explanation why previous analyses could not agree on the net effect from volatility on growth. Depending on the mix of regimes in a specific sample, a single estimation framework can produce positive, negative, or no net effects on growth. Thus, taking into account both the indirect channel through government size and the political regime form is important when evaluating potential growth consequences from policies affecting the business cycle. This explains why some papers (Ramey and Ramey, 1995; Martin and Ann Rogers, 2000) find strong negative growth effects from volatility in OECD economies, as these countries are mostly democratic.

In general, these results emphasize the importance of heterogeneity within the determinants of growth, in this case along the lines of political regime form for the effects from volatility.<sup>3</sup> The surrounding conditions of a country can change sign and magnitudes of growth determinants. In a related context, the political regime form has been found to play an important role in the relationship between trade

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<sup>3</sup>See Masanjala and Papageorgiou (2008) for differences across regions, specifically Africa. Recently, several nonlinearities have been pointed out in the growth literature, e.g. Reinhart and Rogoff (2010) considering public debt or Henderson et al. (2013) in the context of financial development.

openness and government size (see Sáenz et al., 2013).

The paper proceeds with the methodological setup, followed by a description of the data in section 3. Section 4 presents the empirical findings and section 5 concludes.

## 2. Methodology

In order to test the effect of growth rate volatility on growth, I first estimate growth in a single estimation framework, including volatility as a regressor. Throughout the paper I use a balanced panel of 95 countries with yearly data from 1961 – 2010. As there exists an open-ended list of potential growth determinants (see Brock and Durlauf, 2001), I use two main reference papers to set up the growth regression: The variables from Levine and Renelt (1992) and Mirestean and Tsangarides (2009). In addition, the empirical analysis includes country fixed effects and country specific time trends, accounting for unique characteristics in terms of history, geography, climate, and development paths of every country. After showing the endogeneity of government size, the paper moves to the suggested three-stage least squares framework (3SLS), estimating growth and government size simultaneously. Throughout the paper, variables starting with *ln* imply the application of the natural logarithm.

### 2.1. OLS Estimation

The empirical section starts by estimating growth for country  $i$  at year  $t$ , including the volatility of economic growth as a regressor:

$$gr_{i,t} = \alpha_1 + \alpha_2 vol_{i,t-1} + \alpha_3 lngov_{i,t} + \alpha_4 gr_{i,t-1} + \alpha_5 \mathbf{X}_{i,t-1} + \alpha_6 \lambda_i + \alpha_7 \phi_{i,t} + \delta_{i,t}, \quad (1)$$

where  $vol_{i,t-1}$  stands for growth rate volatility, lagged by one year (calculation explained below in section 2.2). Further,  $lngov_{i,t}$  and  $gr_{i,t-1}$  capture the logarithm of total government spending and the growth rate of the previous year.<sup>4</sup>  $\mathbf{X}_{i,t-1}$  contains growth determinants suggested by Levine and Renelt (1992) and Mirestean and Tsangarides (2009). Specifically,  $\mathbf{X}_{i,t-1}$  includes investment ( $lninv$ ), income ( $lngdp$ ), population growth ( $popgr$ ), life expectancy ( $lnlife$ ), openness to trade ( $lnopen$ ), and inflation ( $lninfl$ ). In order to address the latent reverse causality problem of the growth literature,  $vol$  and  $\mathbf{X}$  are lagged by one year, following suggestions by Temple (1999) and Durlauf et al. (2005).<sup>5</sup>

Absent from the Levine and Renelt variables is only initial human capital, which in a panel setting with fixed effects and country-specific time trends may lose importance anyways. This goes along with

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<sup>4</sup>Using government size as share of GDP does not change the implication of results, as discussed in section 4.4.

<sup>5</sup>In terms of lagging the volatility component, Döpke (2004) cannot exclude a potential reverse causality problem in a growth regression. Although imperfect, using lagged values addresses this problem since future growth rates are unlikely to influence past growth volatility.



the more practical reason of data availability for human capital and education variables on a yearly basis. From [Mirestean and Tsangarides \(2009\)](#), the analysis does not include public debt, as missing data would reduce the sample by over 85 percent. Finally,  $\lambda_i$  and  $\phi_{i,t}$  introduce country fixed effects and country-specific time trends, whereas  $\delta_{i,t}$  stands for the usual error term.<sup>6</sup>

## 2.2. Estimating Volatility

A crucial aspect of this analysis is how to calculate volatility. For instance, [Ramey and Ramey \(1995\)](#) choose the standard deviation of a country’s growth rates over time. However, the problem of this method is that one is stuck with a single observation per country or at least fewer observations if one decides to split the sample. Recently, several filters have become prominent in detrending macroeconomic time series, such as the Hodrick-Prescott (HP) filter or the Baxter-King filter. For instance, [Baum \(2006\)](#) summarizes the discussion surrounding the HP filter, quoting [Ravn and Uhlig \(2002\)](#): “...the HP filter has become a standard method for removing trend movements in the business cycle literature.” Although the filter has been subject to heavy criticism, it “has withstood the test of time and the fire of discussion relatively well.”

Thus, I use the HP filter to detrend the annual growth rates of every country, following [Mills \(2000\)](#), [Döpke \(2004\)](#), and [Afonso and Furceri \(2010\)](#). To adjust for the sensitivity of the trend portion, the main analysis applies the benchmark value of  $\lambda_{HP} = 100$ , as suggested by [Backus and Kehoe \(1992\)](#) for annual data.<sup>7</sup> Section 4.4 provides alternatives. As I am only using countries for which all growth rates from 1961 to 2010 are available, each time series contains 50 data points. The result from applying the HP filter is an annual cycle term for each country. As we are interested in volatility in general, not just positive or negative deviations from the trend, I square this value to receive a measurement for the annual volatility component of a country’s growth rate (also see [Jetter et al., 2013](#)). Finally, in order to facilitate comparability, I divide this value by 100, which provides the variable  $vol_{i,t-1}$ .

## 2.3. 3SLS Estimation

After estimating equation 1, the empirical section presents evidence for the inconsistency of a simultaneous estimation framework, as the Durbin-Wu-Hausman test statistics (see [Davidson and MacKinnon, 2001](#)) confirm the endogeneity of government size. The paper then moves to a 3SLS estimation system, where growth and government size are determined simultaneously. The government size regression takes the following form:

$$lngov_{i,t} = \beta_1 + \beta_2 vol_{i,t-1} + \beta_3 gr_{i,t} + \beta_4 lngov_{i,t-1} + \beta_5 \mathbf{Z}_{i,t-1} + \beta_6 \lambda_i + \beta_7 \phi_{i,t} + \epsilon_{i,t}, \quad (2)$$

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<sup>6</sup>The Hausman test strongly rejects the use of random effects in favor of fixed effects.

<sup>7</sup>For the roots of the HP filter in general, consider [Robert and Prescott \(1997\)](#). For the relevant code in STATA, see [Kowal \(2005\)](#).

where  $gr_{i,t}$  captures the effect of growth on government size, following implications from Wagner’s Law (see section 2 in [Afonso and Furceri, 2010](#), for a brief discussion or [Peacock and Scott, 2000](#), for more detail).  $lngov_{i,t-1}$  accounts for government size of the previous year.  $Z_{i,t-1}$  is a vector containing the remaining control variables of the literature, as summarized by [Shelton \(2007\)](#). Among these are income ( $lngdp$ ), openness to trade ( $lnopen$ ), and population size ( $lnpop$ ). As in the growth regression, I choose lagged explanatory variables, both for consistency and in order to reduce potential issues from reverse causality, as future government size is unlikely to affect the explanatory variables today.<sup>8</sup>

Both equations 1 and 2 are identified by unique variables. For the growth regression, these are lagged growth, investment, population growth, life expectancy, and inflation. In the case of government size, these are lagged government size and total population size. Their suitability as identifying variables is comfortably validated by F-tests for joint insignificance of the unique dependent variables in all respective regressions. Finally, incorporating the seemingly unrelated regression equations model (SUR) accounts for potential correlation of the error terms, extending the 2SLS to a 3SLS system.

### 3. Data

All variables are displayed in table 1 and taken from one of three standard data sources in macroeconomics: The World Bank Development Indicators, the Penn World Tables, and the Polity IV index. On average, the 95 sample countries had an annual growth rate of almost 4 percent.<sup>9</sup> Figure 2 displays some general growth developments over time and across regions. Standing out as contractions are the oil crisis in the 70s (which especially hit North America and Europe), the Latin American debt crisis in the early 80s, Africa’s struggle around 1990, the 1997 Asian financial crisis, and of course the 2008 financial crisis. On the positive side, we observe the Asian boom between 1960 and 1995, driven by the Asian Tigers, and a growth spurt in Africa until the late 70s.

Table 2 sorts all sample countries by their average yearly volatility over the entire time span of 1961 – 2010. We notice that the core European countries, together with South Africa, Sri Lanka, Australia, Guatemala, and Colombia, experienced low volatility. Various African (such as Liberia, the Seychelles, or Rwanda) and some Asian economies (e.g. the Oman) on the other hand experienced many twists and turns.<sup>10</sup> Further, figure 3 shows the worldwide average volatility over time and a breakdown by continents. We notice major spikes in the mid 60s and the late 90s, where the former appears to be driven by African, Asian, and European economies. In general, Asian and European countries managed

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<sup>8</sup>See for instance [Acemoglu et al. \(2003\)](#) or [Klomp and de Haan \(2009\)](#) for the argument of institutions in general influencing volatility.

<sup>9</sup>The augmented Dickey-Fuller test shows no signs of unit roots being present for most countries, with the exceptions of Greece, Puerto Rico, and Trinidad and Tobago (using one lag and a constant term). Results are available upon request.

<sup>10</sup>See [Koren and Tenreyro \(2007\)](#) for an explanation of why poor countries might have more volatility than rich ones.

**Table 1:** Summary statistics

Variable	Mean	Std. Dev.	N	Source	Description
<i>gr</i>	3.98	5.83	4,750	WDI	GDP growth in annual percent
<i>vol</i>	0.238	1.87	4,750	Own	Using the Hodrick-Prescott filter with $\lambda_{HP} = 100$ for detrending
<i>lngov</i>	21.59	2.35	4,470	WDI	Ln(GDP $\times$ government share/100)
<i>lninv</i>	21.86	2.50	4,668	PWT 7.1	Ln(GDP $\times$ investment share/100)
<i>lngdp</i>	23.46	2.31	4,750	WDI	Ln(total GDP in constant 2000 US\$)
<i>popgr</i>	0.02	0.022	4,750	PWT 7.1	$(pop_t - pop_{t-1})/pop_t$
<i>lnopen</i>	4.02	0.63	4,530	WDI	Ln(trade as percent of GDP)
<i>lnlife</i>	4.11	0.20	4,671	WDI	Ln(life expectancy at birth)
<i>lninfl</i>	0.12	0.29	4,750	WDI	Ln[1 + (annual inflation/100)]
<i>lnpop</i>	15.91	1.85	4,750	WDI	Ln(total population)
<i>pol</i>	1.73	7.24	4,279	Polity IV	Variable <i>polity2</i> , ranging from $-10$ (totally autocratic) to $+10$ (total democracy)
<i>vol</i> $_{\lambda_{HP}=6.25}$	0.17	1.23	4,750	Own	Using the Hodrick-Prescott filter with $\lambda_{HP} = 6.25$ for detrending
<i>vol</i> $_{BK}$	0.18	1.33	4,180	Own	Using the Baxter-King filter for detrending
<i>g</i>	14.99	6.22	4,470	WDI	Government share of GDP
<i>inv</i>	21.73	9.76	4,668	PWT 7.1	Investment share of GDP

Notes: WDI = World Development Indicators (World Bank).  
PWT 7.1 = Penn World Table Version 7.1.



Notes: x-axis = year, y-axis = average growth rate (*gr*).

**Figure 2:** Average growth rates over time

to tame their business cycles since the mid 70s, whereas African nations continue to incur strongly volatile periods. Noteworthy is also a comparison between the richest nations, as cycles generally appear more prevalent in North America with the oil crisis in the early 70s standing out. Finally, the 2008 global financial crisis is especially visible in the Americas and Europe, as for the average European country volatility reached its highest level since the mid 60s.

## 4. Empirical Findings

### 4.1. OLS Results

Table 3 displays results from the generic growth regression of equation 1, gradually adding explanatory variables. Column (1) starts with the most basic model, only using volatility and the growth rate of the previous year as regressors. Columns (2) and (3) add country fixed effects and country time trends, accounting for the individual characteristics of each country. Specification (4) adds government size, following Barro and Lee (1994), Barro (2001), and Afonso and Furceri (2010). Finally, (5) and (6) add the growth determinants used by Levine and Renelt (1992) and Mirestean and Tsangarides (2009).

As for the coefficient of interest, we find no evidence for the importance of volatility. The coefficient on *vol* is mostly positive, but insignificant in all specifications (although close to the ten percent significance level in the final specifications). Estimates for the effects of other control variables confirm prevailing conclusions in the literature. Investment, life expectancy, and openness to trade have positive and significant effects on growth, whereas income and inflation carry negative growth effects.

Were one to stop here, the conclusion would be that either the business cycle does not affect economic growth at all or that there exists a weak positive relationship. In fact, distinguishing by continents, population size, time frames, or OECD and non-OECD produces an insignificant coefficient for *vol* as well (results displayed in tables A.1 and A.2). However, a closer look reveals that including government size in column (4) changes the coefficient on volatility remarkably, suggesting potential problems of endogeneity. In fact, Durbin-Wu-Hausman (DWH) test statistics reveal that the regressions are problematic and government size is endogenous. The significance of the F-values, displayed at the bottom of each regression, indicates that OLS estimates are not consistent.

### 4.2. 3SLS Results

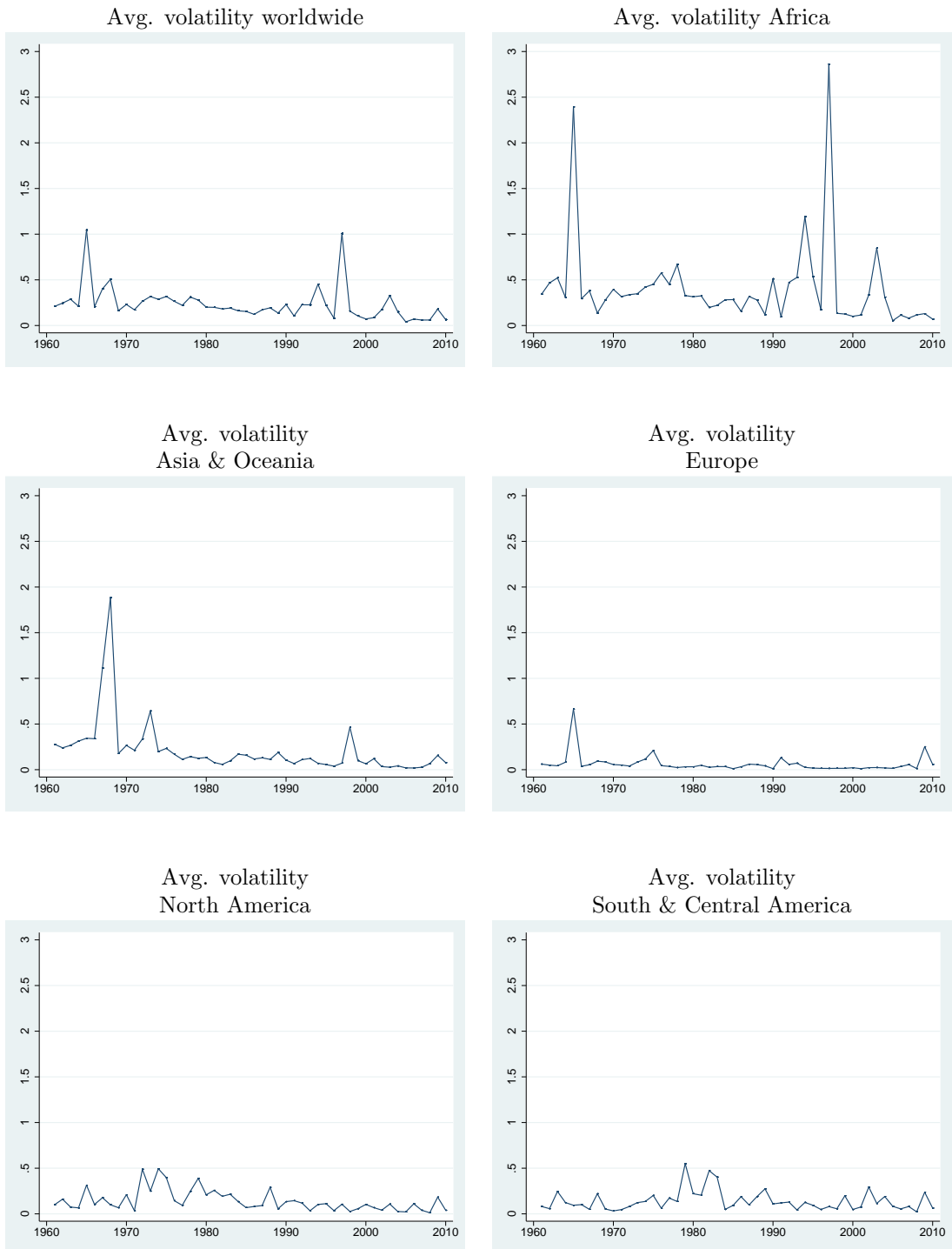
Table 4 proceeds to results from estimating growth and government size simultaneously, displaying F-tests for the joint insignificance of the respective instruments under each regression.<sup>11</sup> For lack of space, all

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<sup>11</sup>Values of F-tests in all but one regression are substantially higher than ten, clearing the threshold level for weak instruments identified by Staiger and Stock (1997). Only in the subsamples of autocracies and anocracies, displayed in columns (3) and (4), does the value not exceed ten.

**Table 2:** Countries by average volatility (*vol*) from 1961 – 2010.

Country	Avg. volatility	Country	Avg. volatility
<b>Africa</b>		<b>Europe</b>	
South Africa	0.039	France	0.018
Egypt, Arab Rep.	0.061	Norway	0.020
Benin	0.080	Austria	0.024
Burkina Faso	0.092	Belgium	0.026
Senegal	0.126	Spain	0.028
Ghana	0.129	Netherlands	0.030
Central African Republic	0.137	Italy	0.033
Botswana	0.150	Sweden	0.034
Madagascar	0.158	United Kingdom	0.035
Cote d'Ivoire	0.173	Denmark	0.041
Zambia	0.174	Portugal	0.072
Morocco	0.182	Greece	0.073
Kenya	0.182	Finland	0.073
Cameroon	0.210	Luxembourg	0.091
Congo, Dem. Rep.	0.232	Iceland	0.123
Congo, Rep.	0.242	Hungary	0.282
Malawi	0.246		
Sudan	0.249	<b>Oceania</b>	
Burundi	0.272	Australia	0.025
Togo	0.295	Papua New Guinea	0.149
Niger	0.298	Fiji	0.176
Zimbabwe	0.327	<b>North America</b>	
Mauritania	0.335	Canada	0.032
Sierra Leone	0.339	United States	0.038
Lesotho	0.386	Puerto Rico	0.051
Nigeria	0.414	Honduras	0.080
Algeria	0.531	Mexico	0.095
Chad	0.621	Bermuda	0.105
Gabon	0.774	Trinidad and Tobago	0.112
Rwanda	1.033	Belize	0.129
Seychelles	1.947	Panama	0.132
Liberia	3.112	Dominican Republic	0.238
		St. Vincent and the Grenadines	0.353
		Bahamas, The	0.371
<b>Asia</b>		<b>South &amp; Central America</b>	
Sri Lanka	0.031	Guatemala	0.031
Pakistan	0.042	Colombia	0.034
Japan	0.060	Costa Rica	0.083
Philippines	0.065	Bolivia	0.087
Nepal	0.066	Ecuador	0.087
India	0.077	El Salvador	0.090
Israel	0.093	Brazil	0.098
Korea, Rep.	0.096	Paraguay	0.109
Thailand	0.097	Uruguay	0.154
Malaysia	0.099	Chile	0.174
Indonesia	0.102	Guyana	0.190
Bangladesh	0.121	Peru	0.199
Singapore	0.137	Venezuela, RB	0.240
Turkey	0.143	Nicaragua	0.267
China	0.354	Argentina	0.286
Syrian Arab Republic	0.543		
Oman	1.772		



Notes: x-axis = year, y-axis = average volatility (*vol*).

**Figure 3:** Average volatility over time

**Table 3:** OLS results

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: $gr_{i,t}$						
$vol_{i,t-1}$	0.008 (0.184)	0.029 (0.180)	-0.003 (0.181)	0.585 (0.370)	0.516 (0.361)	0.586 (0.389)
$gr_{i,t-1}$	0.313*** (0.042)	0.263*** (0.043)	0.219*** (0.045)	0.173*** (0.040)	0.200*** (0.031)	0.192*** (0.032)
$lngov_{i,t}$				-1.514** (0.645)	2.678*** (0.624)	1.979*** (0.592)
$lninv_{i,t-1}$					1.343*** (0.432)	0.966** (0.435)
$lngdp_{i,t-1}$					-13.215*** (1.593)	-14.455*** (1.722)
$popgr_{i,t-1}$					3.333 (4.546)	0.950 (3.829)
$lnlife_{i,t-1}$						15.820*** (5.019)
$lnopen_{i,t-1}$						2.230*** (0.487)
$lninfl_{i,t-1}$						-0.917*** (0.314)
Country fixed effects		yes	yes	yes	yes	yes
Country time trend			yes	yes	yes	yes
DWH-test <sup>a</sup>				62.40***	36.66***	43.59***
$N$	4,655	4,655	4,655	4,387	4,346	4,273
$R^2$	0.100	0.135	0.168	0.219	0.225	0.255

*Notes:* Standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .  
<sup>a</sup>Testing for the endogeneity of government size, where the government size equation contains  $lngov_{i,t-1}$ ,  $lnopen_{i,t-1}$ ,  $lngdp_{i,t-1}$ ,  $lnpop_{i,t-1}$ , country fixed effects, and country specific time trends.



coefficients, which are not the main focus of this paper are referred to table A.3.<sup>12</sup> The remaining growth coefficients show no surprises compared to table 3 and neither do the coefficients on the control variables predicting government size, compared to the prevailing conclusions in the corresponding literature.<sup>13</sup>

Columns (1) and (2) use the entire sample and we notice a remarkable difference relative to the single estimation framework above. Volatility is positive and highly significant in affecting growth directly, but also increases government size, which in turn lowers growth. Although the quantitative interpretation on the volatility coefficient in the growth regression is remarkably stable compared to the final single estimation in table 3, the accuracy of the 3SLS system is highly improved. In fact, the standard error shrinks to almost one fourth of its OLS counterpart. Thus, even though the magnitude of the indirect effect in the total sample is low compared to the direct channel, accounting for the indirect channel improves the statistical accuracy substantially.

As a next step, it is important to analyze the indirect mechanism in more detail. Especially the link between the citizens' ability to articulate their wishes in terms of public goods provision is an essential component here. Without the ability to engage in the political process, the citizens' options to respond to volatility are limited. Thus, the final columns of table 4 distinguish by political regime form.

Column (3) only considers countries, which at the time of observation are marked as autocracies or closed anocracies ( $pol < 0$ ). These regimes are defined by a lack of political participation for citizens or that citizens are subject to a ruling elite. The positive direct effect is strengthened with its magnitude increasing by about 50 percent. However, volatility does not seem to affect government size in autocracies. This result seems quite intuitive as the citizens' options to influence the provision and extent of public services is by definition limited in autocratic regimes.

These results are reversed in regimes, where citizens receive the opportunity to engage in the political process, displayed in column (4). Regimes with a positive  $pol$  score are denoted as open anocracies or democracies. We note a stark difference to autocracies, as the direct effect shrinks to almost one third of its initial magnitude and becomes insignificant. The indirect channel through government size on the other hand becomes important, as volatility raises the public sector, which in turn continues to lower growth. This suggests a shift in response to volatility shocks, depending on the political regime: In autocracies the positive direct effect dominates, whereas in democracies the negative indirect effect takes over, presumably operating through an insurance mechanism of the public sector.

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<sup>12</sup>As an additional check, table A.4 only uses observations, for which information on the full set of variables is available. The qualitative interpretation remains the same, with only very minor changes in magnitudes. Thus, observations which are lost when including additional variables are not driving the results displayed in table 4.

<sup>13</sup>Wagner's Law receives support as richer countries are associated with bigger governments. In addition, bigger populations seem to have smaller governments in relative terms, although this result is weaker – an artifact potentially due to low variation in population size from year to year (see Alesina and Wacziarg, 1998, who average over multiple years). Further, I find mixed evidence for the effect from openness to trade (a relationship heavily discussed since Rodrik, 1998).

**Table 4:** 3SLS results

	Full sample		$pol_{i,t-1} < 0$	$pol_{i,t-1} > 0$	Full sample
	(1)	(2)	(3)	(4)	(5)
Dependent variable: $gr_{i,t}$					
$vol_{i,t-1}$	0.587*** (0.100)	0.603*** (0.100)	0.897*** (0.145)	0.211 (0.177)	0.329** (0.141)
$lngov_{i,t}$	-0.929** (0.438)	-1.236*** (0.438)	-1.623* (0.913)	-1.590** (0.630)	-1.439*** (0.454)
$gr_{i,t-1}$	0.173*** (0.015)	0.169*** (0.015)	0.087*** (0.024)	0.280*** (0.020)	0.142*** (0.016)
$vol_{i,t-1} \times pol_{i,t-1}$					-0.060*** (0.023)
$pol_{i,t-1}$					0.041* (0.022)
Country fixed effects & time trends	yes	yes	yes	yes	yes
Control sets <sup>a</sup>	yes	yes	yes	yes	yes
F-test joint insignificance of IVs <sup>b</sup>	26.29***	17.02***	4.23***	20.20***	13.86***
Dependent variable: $lngov_{i,t}$					
$vol_{i,t-1}$	0.006** (0.003)	0.006** (0.003)	-0.001 (0.004)	0.012** (0.005)	0.012*** (0.004)
$gr_{i,t}$	0.004*** (0.001)	0.013*** (0.002)	0.012*** (0.003)	0.006*** (0.002)	0.014*** (0.002)
$lngov_{i,t-1}$	0.868*** (0.008)	0.795*** (0.010)	0.728*** (0.017)	0.735*** (0.013)	0.792*** (0.010)
$vol_{i,t-1} \times pol_{i,t-1}$					0.001** (0.001)
$pol_{i,t-1}$					-0.001 (0.001)
Country fixed effects & time trends	yes	yes	yes	yes	yes
Control set <sup>c</sup>		yes	yes	yes	yes
F-test joint insignificance of IVs <sup>d</sup>	1,877.11***	571.41***	191.45***	220.03***	517.92***
$N$	4,266	4,266	1,651	2,536	3,974

Notes: Standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

<sup>a</sup>Control variables from [Levine and Renelt \(1992\)](#) and [Mirestean and Tsangarides \(2009\)](#): investment ( $lninv_{i,t-1}$ ), GDP ( $lngdp_{i,t-1}$ ), population growth ( $popgr_{i,t-1}$ ), life expectancy ( $lnlife_{i,t-1}$ ), openness to trade ( $lnopen_{i,t-1}$ ), and inflation ( $lninfl_{i,t-1}$ ).

<sup>b</sup>IVs are regressors exclusively used in the growth equation.

<sup>c</sup>Control set [Shelton \(2007\)](#): GDP ( $lngdp_{i,t-1}$ ), trade openness ( $lnopen_{i,t-1}$ ), and population size ( $lnpop_{i,t-1}$ ).

<sup>d</sup>IVs are regressors exclusively used in the government size equation.

One downfall of this analysis is the arbitrary distinction into positive and negative values of polity. Thus, column (5) uses the entire sample, including an interaction term between volatility and the polity score. We note that the interaction term is negative and significant in determining growth, but positive and significant in determining government size. Thus, as the democratic system rises, the direct effect of volatility on growth diminishes, but the indirect effect gains importance.<sup>14</sup> Following this final and most complete specification, a one standard deviation of volatility is suggested to lower the growth rate of GDP by 0.57 percentage points in a country with a perfect polity score of +10.<sup>15</sup> On the other end of the spectrum, a totally autocratic regime (polity score of -10) would enjoy an increase in the rate of economic growth by as much as 1.74 percentage points.

#### 4.3. Development Over Time and Country Examples

In fact, the results suggest a threshold level of a country's polity score of +5.4, over which the net effect of volatility on growth becomes negative.<sup>16</sup> Interestingly, the Polity *IV* project's definition of democracy starts precisely at a score of +6. As a reference point, Bangladesh and Ecuador received a score of +5 in the 2010 Polity report, whereas countries like Malaysia or Pakistan would be slightly above the threshold value with a score of +6.

Figure 4 displays several sample countries, which incurred substantial switches in regime form since the 1960s. All graphs show how a one standard deviation of volatility would affect the rate of economic growth, according to the main results from table 4, column (5).

In Argentina, the collapse of the military government and the subsequent "New Democracy" pushed the country to polity scores over 5.4, which would then suggest detrimental consequences of volatility on growth. In Spain, a period of relatively high volatility in the early 70s spurred growth, as the country received a polity score of -7 under the dictatorship of Franco. However, times of strong volatility in the late 80s and early 90s, as well as in 2009, should have had negative growth effects, as the country was considered a perfect democracy. Indeed, Spain's government size remained relatively stable in the early 70s (10.1 – 10.6 percent between 1970 and 1974), but jumped from 15.4 percent in 1986 to 18.8 percent in 1993. Severe changes in political regime form can be observed in numerous other countries, such as Brazil, Ghana, Portugal, or Thailand.

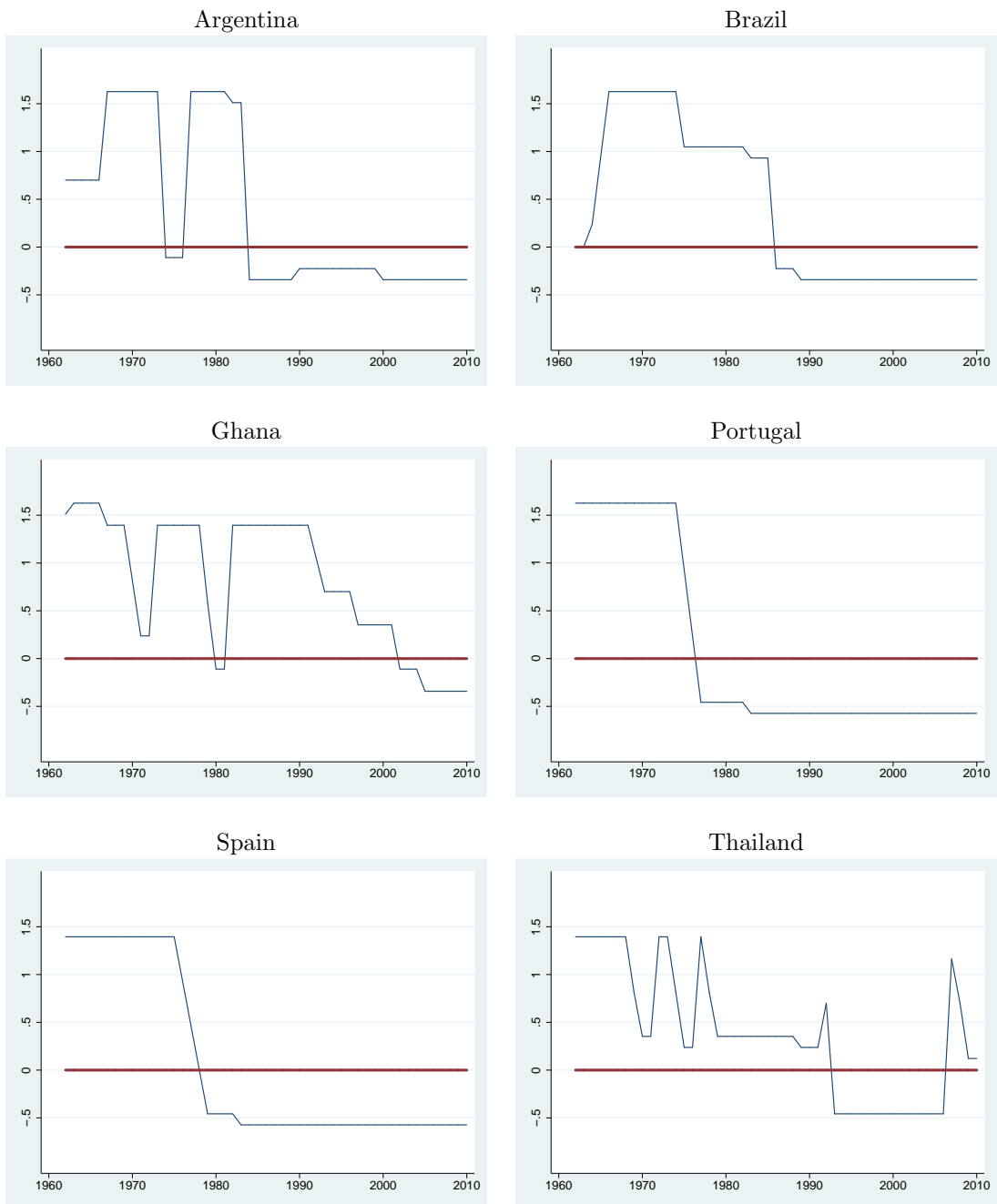
Figure 5 shows the amount of countries, which are suggested to have had positive net growth effects from volatility over time. In general, this number decreases especially since the 1980s, as countries moved towards democracies. Until then, about 70 of the 95 sample countries are suggested to have enjoyed

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<sup>14</sup>Including an interaction term of government size with *pol* in the growth regression did not produce significant results. Thus, I do not find evidence that the negative effect of government size on growth varies by level of democracy.

<sup>15</sup>Calculation:  $\Delta gr = 1.87[0.329 - 10 \times 0.060 - 1.439(0.012 + 10 \times 0.001)]$ .

<sup>16</sup>Calculation for the threshold level:  $0.329 - pol \times 0.060 - 1.439 \times (0.012 + pol \times 0.001) = 0$ .



Notes: x-axis = year; y-axis = Suggested net effect of a one standard deviation increase of  $vol_{i,t-1}$  on economic growth in percentage points.

Figure 4: Net effects from volatility on growth

positive net growth effects from volatility due to a lack of democratic institutions. In 2010 however, less than 40 countries would fall into this category. The remaining graphs show that this move towards democracy is not specific to selected regions, but rather a worldwide phenomenon.

#### 4.4. Robustness Checks

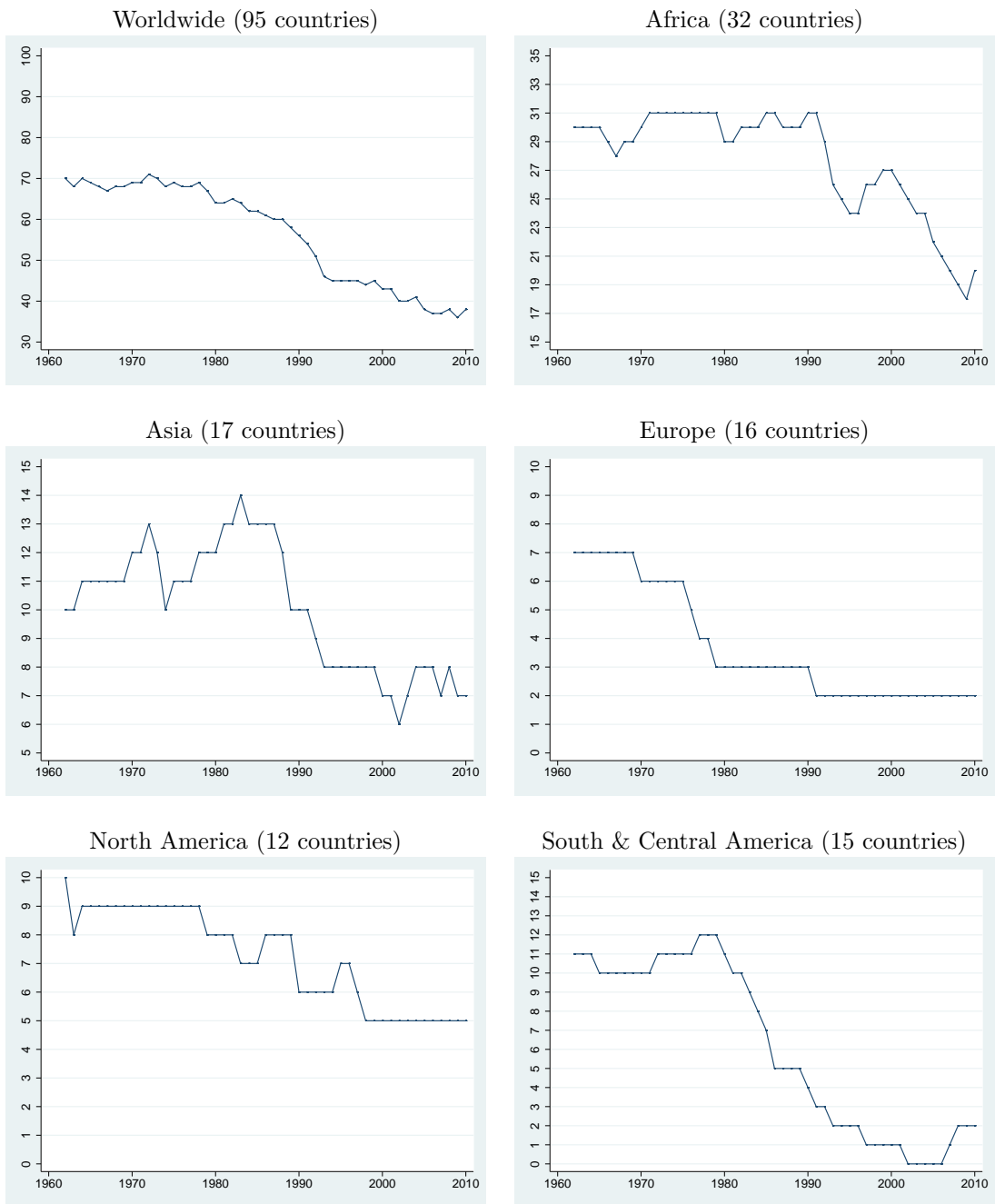
This section presents several alternative specifications, addressing the method of detrending growth rates, the definition of government size, and the possibility of the political regime being sufficient to explain the results, i.e. the indirect effect being redundant. Table 5 displays the results of replicating the two main specifications (2) and (5) from table 4 for each robustness check. Finally, table 6 replicates the initial single regression results, this time including *pol* and its interaction term with volatility.

First, the benchmark value of  $\lambda_{HP} = 100$  for annual data has been subject to criticism in the econometrics literature, where most notably [Ravn and Uhlig \(2002\)](#) suggest a value of  $\lambda_{HP} = 6.25$ . Columns (1) and (2) in table 5 show the results when detrending growth rates with  $\lambda_{HP} = 6.25$ . The implications of the main results are confirmed, as we observe both a positive direct and a negative indirect effect, where the polity score plays the same key role as before: Democracies tend to have negative net effects. Even though signs and significance levels mostly confirm the earlier findings, magnitudes are smaller, potentially owed to the fact that a lower  $\lambda_{HP}$  translates to a smaller penalty for variations in the growth rate, i.e. the trend is given more flexibility.

Second, there exists a general criticism of the HP filter: The end of sample problem ([Watson, 2007](#)). Specifically, towards the beginning (the end) of a sample detrending can lose accuracy, as reference points in the past (the future) are missing. With a balanced sample of 50 observations per country, specifications (3) and (4) in table 5 display the main results after cutting off the first and final five years of the sample. This means that the volatility term is still estimated using the entire 50 years per country, but only the 40 years in the middle are used for regressions. A look at the results reveals no change in significance levels and only minor deviations in terms of magnitudes.

Third, columns (5) and (6) provide alternative results when using the Baxter-King (BK) filter to detrend growth rates ([Baxter and King, 1999](#)). These specifications serve as a check on whether the main results could be driven by any particular characteristic of the HP filter. We notice that significance levels are generally in line with the main results and the same pattern can be observed: There exists a positive direct and a negative indirect effect of volatility on growth. Once again, democracies tend to weaken the direct effect. However, in this case the negative indirect effect does not seem to be altered significantly by the *pol* score, although we observe the predicted sign.

Specifications (7) and (8) check whether the results are robust to using shares of government spending and investment in GDP. In the main estimations, I use the logarithm of total government spending and



Notes: x-axis = year; y-axis = # of countries

Figure 5: Amount of countries with predicted positive net growth effect from volatility over time.

**Table 5:** Robustness checks

	$vol_{\lambda_{HP}=6.25}$		1965 – 2005		$vol_{BK}^a$		Using shares	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: $gr_{i,t}$								
$vol_{i,t-1}$	0.008*** (0.001)	0.003 (0.002)	0.725*** (0.108)	0.375** (0.157)	0.848*** (0.133)	0.192 (0.214)	0.572*** (0.078)	0.281** (0.139)
$lngov_{i,t}$	-1.261*** (0.438)	-1.484*** (0.455)	-2.446*** (0.533)	-2.694*** (0.551)	-1.627*** (0.469)	-1.885*** (0.485)	-0.111*** (0.029)	-0.122*** (0.029)
$gr_{i,t-1}$	0.167*** (0.015)	0.140*** (0.016)	0.181*** (0.017)	0.168*** (0.017)	0.190*** (0.016)	0.174*** (0.016)	0.174*** (0.015)	0.146*** (0.016)
$vol_{i,t-1} \times pol_{i,t-1}$		-0.001*** (0.000)		-0.001*** (0.000)		-0.138*** (0.034)		-0.045** (0.018)
$pol_{i,t-1}$		0.043** (0.022)		0.053** (0.025)		0.054** (0.023)		0.032 (0.022)
Country fixed effects & time trends	yes	yes	yes	yes	yes	yes	yes	yes
Control sets <sup>b</sup>	yes	yes	yes	yes	yes	yes	yes	yes
Dependent variable: $lngov_{i,t}$								
$vol_{i,t-1}$	0.000* (0.000)	0.000** (0.000)	0.006** (0.003)	0.015*** (0.004)	0.004 (0.004)	0.011* (0.006)	-0.050 (0.033)	0.064 (0.055)
$gr_{i,t}$	0.012*** (0.002)	0.014*** (0.002)	0.014*** (0.002)	0.015*** (0.002)	0.012*** (0.002)	0.014*** (0.002)	-0.021 (0.024)	0.008 (0.028)
$lngov_{i,t-1}$	0.794*** (0.010)	0.791*** (0.010)	0.781*** (0.012)	0.781*** (0.012)	0.804*** (0.010)	0.802*** (0.011)	0.794*** (0.009)	0.795*** (0.010)
$vol_{i,t-1} \times pol_{i,t-1}$		0.000 (0.000)		0.000*** (0.000)		0.001 (0.001)		0.021*** (0.008)
$pol_{i,t-1}$		-0.001 (0.001)		-0.001* (0.001)		-0.001 (0.001)		-0.016* (0.009)
Country fixed effects & time trends	yes	yes	yes	yes	yes	yes	yes	yes
Control set <sup>c</sup>	yes	yes	yes	yes	yes	yes	yes	yes
$N$	4,266	3,974	3,531	3,314	3,874	3,628	4,306	4,009

Notes: Standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

<sup>a</sup>Baxter-King filter applied to detrend growth rates.

<sup>b</sup>Control variables from [Levine and Renelt \(1992\)](#) and [Mirestean and Tsangarides \(2009\)](#):

Investment ( $lninv_{i,t-1}$ ), GDP ( $lngdp_{i,t-1}$ ), population growth ( $popgr_{i,t-1}$ ), life expectancy ( $lnlife_{i,t-1}$ ), openness to trade ( $lnopen_{i,t-1}$ ), and inflation ( $lninfl_{i,t-1}$ )

<sup>c</sup>Control variables from [Shelton \(2007\)](#): GDP ( $lngdp_{i,t-1}$ ), openness to trade ( $lnopen_{i,t-1}$ ), and population size ( $lnpop_{i,t-1}$ ).

total investment. In these specifications, the direct effect remains positive and significant, yet the indirect effect turns negative and insignificant in column (7). However, including the interaction with  $pol$  in column (8) recovers the main results. Notice that switching to shares changes the numerical interpretation of the coefficients associated with government size.

**Table 6:** OLS results, including  $pol_{i,t-1}$  and interaction term between  $vol_{i,t-1}$  and  $pol_{i,t-1}$

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: $gr_{i,t}$						
$vol_{i,t-1}$	0.021 (0.104)	0.071 (0.103)	0.056 (0.110)	0.406 (0.397)	0.320 (0.361)	0.343 (0.405)
$gr_{i,t-1}$	0.313*** (0.040)	0.262*** (0.041)	0.217*** (0.043)	0.156*** (0.038)	0.183*** (0.033)	0.169*** (0.034)
$lngov_{i,t}$				-1.672** (0.688)	2.537*** (0.646)	1.871*** (0.610)
$vol_{i,t-1} \times pol_{i,t-1}$	-0.079 (0.060)	-0.074 (0.060)	-0.071 (0.059)	-0.029 (0.068)	-0.041 (0.058)	-0.052 (0.063)
$pol_{i,t-1}$	-0.014 (0.014)	-0.001 (0.019)	0.052** (0.026)	0.034 (0.026)	0.023 (0.024)	0.044* (0.026)
Country fixed effects		yes	yes	yes	yes	yes
Country time trend			yes	yes	yes	yes
Control set 1 <sup>a</sup>					yes	yes
Control set 2 <sup>b</sup>						yes
$N$	4,192	4,192	4,192	4,050	4,014	3,980
$R^2$	0.129	0.165	0.194	0.215	0.249	0.271

Notes: Standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

<sup>a</sup>Variables from [Levine and Renelt \(1992\)](#): Investment ( $lninv_{i,t-1}$ ), GDP ( $lngdp_{i,t-1}$ ), and population growth ( $popgr_{i,t-1}$ ).

<sup>b</sup>Control set [Mirestean and Tsangarides \(2009\)](#): GDP ( $lngdp_{i,t-1}$ ), life expectancy ( $lnlife_{i,t-1}$ ), population growth ( $popgr_{i,t-1}$ ), openness to trade ( $lnopen_{i,t-1}$ ), and inflation ( $lninfl_{i,t-1}$ ).

Finally, the results presented in this paper emphasize the importance of accounting for both the indirect effect *and* the political regime form. So far, it is not clear whether distinguishing by regime form alone might be able to explain this relationship. Thus, table 6 replicates the basic OLS table 3, this time including  $pol$  and its interaction term with volatility. If the indirect channel did not matter,



then we should be able to observe similar results to the 3SLS estimations. However, these results are as inconclusive as before, showing that the indirect effect needs to be accounted for in order to explain the relationship between volatility and growth.

Overall, these robustness checks further strengthen the main findings. It does not seem likely that the results are driven by any particularities of the HP filter, the measurement of government size, or a simple distinction along the lines of regime form.

## 5. Conclusion

This paper analyzes the relationship between business cycles and economic growth in a new light, suggesting both a positive direct and a negative indirect effect from volatile growth rates on growth. A positive direct effect has previously been proposed by several theories (e.g., creative destruction or precautionary savings), but the paper's main contribution lies in revealing and accounting for the indirect channel. As public services act as an insurance mechanism in volatile times, volatility also increases the size of the public sector (after [Rodrik, 1998](#)). A bigger government can in turn lower growth in the short run. The paper shows that the importance of business cycles for economic growth could be dismissed if this indirect channel is not accounted for.

Whether the positive or the negative effect on growth dominates depends on a country's form of government. In autocratic regimes, the indirect channel is shut down, as people do not have the political power to determine their desired level of public services. The more democratic a country, the more likely it is that volatility carries negative net growth effects. Empirical estimates suggest that a one standard deviation of growth rate volatility may lower growth by as much as 0.57 percentage points in a perfect democracy. In a total autocracy however, a one standard deviation can raise growth by up to 1.74 percentage points. The main results suggest a threshold level of about +5.4 on the polity scale, although one should of course keep in mind possible data limitations.

In general, these findings strengthen the argument that business cycles *do* matter in the growth context. The implementation of policies aimed at limiting or unleashing volatility should keep in mind both the size of the public sector and the country's regime form. Governments could play a key role in the net relationship between business cycles and economic growth.

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## Appendix

**Table A.1:** Main OLS regressions (table 3, column 6) by continents.

	Africa (1)	Asia & Oceania (2)	Europe (3)	North America (4)	South & Central America (5)
Dependent variable: $gr_{i,t}$					
$vol_{i,t-1}$	0.577 (0.423)	0.277 (0.770)	2.053 (1.300)	0.435 (1.117)	0.562 (0.853)
$gr_{i,t-1}$	0.146*** (0.049)	0.108* (0.065)	0.361*** (0.058)	0.356*** (0.065)	0.390*** (0.052)
$lngov_{i,t}$	2.744*** (1.023)	4.717*** (1.029)	1.976* (1.155)	2.505 (1.580)	-1.270* (0.720)
$lninv_{i,t-1}$	1.481** (0.604)	0.983 (0.751)	-2.070** (1.018)	-0.480 (0.922)	-1.029 (0.961)
$lngdp_{i,t-1}$	-16.795*** (2.821)	-16.989*** (2.419)	-6.160*** (2.027)	-14.045*** (3.345)	-7.294*** (2.625)
$popgr_{i,t-1}$	4.782 (7.187)	-2.891 (5.159)	4.250 (5.786)	12.454 (11.733)	-5.837 (6.500)
$lnlife_{i,t-1}$	17.952*** (6.174)	7.895 (7.338)	25.959 (17.276)	-8.034 (16.588)	-11.533 (10.652)
$lnopen_{i,t-1}$	1.821** (0.854)	1.509** (0.712)	0.354 (1.184)	0.901 (1.285)	3.174*** (1.006)
$lninfl_{i,t-1}$	-0.574 (0.830)	-0.548 (1.180)	-7.055** (2.928)	4.486** (2.127)	-0.535 (0.335)
Country fixed effects	yes	yes	yes	yes	yes
Country time trend	yes	yes	yes	yes	yes
$N$	1,410	930	775	453	705
$R^2$	0.233	0.282	0.358	0.301	0.290

Standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

**Table A.2:** Main OLS regressions (table 3, column 6) by population, time frame, and OECD vs. non-OECD.

	<i>pop</i> < 9.2M (1)	<i>pop</i> ≥ 9.2M (2)	<i>year</i> < 1986 (3)	<i>year</i> > 1985 (4)	OECD (5)	non-OECD (6)
Dependent variable: $gr_{i,t}$						
$vol_{i,t-1}$	0.577 (0.433)	0.894 (0.762)	0.400 (0.428)	0.687 (0.532)	1.400 (1.201)	0.565 (0.389)
$gr_{i,t-1}$	0.218*** (0.040)	0.127** (0.048)	0.130*** (0.041)	0.227*** (0.045)	0.302*** (0.043)	0.184*** (0.035)
$lngov_{i,t}$	2.148** (0.994)	2.669*** (0.720)	5.136*** (0.942)	3.484*** (1.175)	1.418 (1.017)	2.014*** (0.629)
$lninv_{i,t-1}$	1.031 (0.647)	0.880 (0.596)	1.331 (0.871)	0.848 (0.856)	-1.035 (0.874)	1.022** (0.463)
$lngdp_{i,t-1}$	-19.740*** (2.767)	-12.431*** (1.901)	-23.671*** (3.304)	-24.958*** (3.289)	-7.275*** (2.155)	-15.187*** (1.938)
$popgr_{i,t-1}$	14.233 (9.051)	-4.768 (3.567)	-2.361 (5.072)	1.145 (4.846)	4.053 (4.908)	0.420 (4.501)
$lnlife_{i,t-1}$	18.544*** (6.773)	14.852*** (5.030)	31.900** (14.442)	29.564*** (11.336)	20.968 (14.220)	16.543*** (5.209)
$lnopen_{i,t-1}$	2.580*** (0.823)	1.957*** (0.642)	1.723 (1.188)	3.871*** (0.823)	0.388 (0.747)	2.599*** (0.564)
$lninfl_{i,t-1}$	-0.980** (0.450)	-0.928* (0.481)	1.857 (1.395)	-0.627* (0.370)	-3.143** (1.487)	-0.798** (0.320)
Country fixed effects	yes	yes	yes	yes	yes	yes
Country time trend	yes	yes	yes	yes	yes	yes
$N$	2,131	2,142	2,017	2,256	1,164	3,109
$R^2$	0.270	0.324	0.323	0.380	0.385	0.247

Standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

**Table A.3:** 3SLS results from table 4, displaying remaining coefficients.

	Full sample		$pol < 0$	$pol > 0$	Full sample
	(1)	(2)	(3)	(4)	(5)
Dependent variable: $gr_{i,t}$					
$lninv_{i,t-1}$	1.014*** (0.284)	1.176*** (0.278)	2.389*** (0.523)	-0.776** (0.362)	1.350*** (0.289)
$lngdp_{i,t-1}$	-11.738*** (0.849)	-11.352*** (0.846)	-16.168*** (1.551)	-5.513*** (1.271)	-11.801*** (0.862)
$popgr_{i,t-1}$	0.781 (3.278)	1.983 (3.210)	-1.094 (5.560)	0.411 (3.506)	2.226 (3.189)
$lnlife_{i,t-1}$	17.315*** (1.962)	17.950*** (1.935)	26.666*** (3.225)	13.936*** (2.896)	17.601*** (1.984)
$lnopen_{i,t-1}$	2.609*** (0.379)	2.726*** (0.380)	3.278*** (0.702)	1.676*** (0.467)	3.000*** (0.386)
$lninfl_{i,t-1}$	-0.983*** (0.257)	-1.137*** (0.252)	0.150 (0.695)	-0.574** (0.286)	-1.190*** (0.250)
Country fixed effects & time trends	yes	yes	yes	yes	yes
$vol_{i,t-1}$ , $lngov_{i,t}$ , $gr_{i,t-1}$	yes	yes	yes	yes	yes
$vol_{i,t-1} \times pol_{i,t-1}$ , $pol_{i,t-1}$					yes
Dependent variable: $lngov_{i,t}$					
$lngdp_{i,t-1}$		0.309*** (0.023)	0.375*** (0.048)	0.396*** (0.027)	0.325*** (0.026)
$lnopen_{i,t-1}$		0.028** (0.012)	0.045** (0.022)	-0.006 (0.013)	0.022* (0.013)
$lnpop_{i,t-1}$		-0.044 (0.043)	-0.045 (0.075)	-0.125** (0.062)	-0.056 (0.045)
Country fixed effects & time trends	yes	yes	yes	yes	yes
$vol_{i,t-1}$ , $gr_{i,t}$ , $lngov_{i,t-1}$	yes	yes	yes	yes	yes
$vol_{i,t-1} \times pol_{i,t-1}$ , $pol_{i,t-1}$					yes
$N$	4,266	4,266	1,651	2,536	3,974

Standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

**Table A.4:** 3SLS results, only using observations for which information for all variables is available.

	Full sample		<i>pol</i> < 0	<i>pol</i> > 0	Full sample
	(1)	(2)	(3)	(4)	(5)
Dependent variable: $gr_{i,t}$					
$vol_{i,t-1}$	0.567*** (0.100)	0.584*** (0.100)	0.901*** (0.144)	0.286 (0.177)	0.324** (0.141)
$lngov_{i,t}$	-1.095** (0.452)	-1.431*** (0.452)	-1.891** (0.912)	-1.403** (0.648)	-1.472*** (0.452)
$gr_{i,t-1}$	0.148*** (0.016)	0.142*** (0.016)	0.080*** (0.024)	0.243*** (0.021)	0.138*** (0.016)
$vol_{i,t-1} \times pol_{i,t-1}$					-0.061*** (0.023)
$pol_{i,t-1}$					0.039* (0.022)
Country fixed effects & time trends	yes	yes	yes	yes	yes
Control sets <sup>a</sup>	yes	yes	yes	yes	yes
F-test joint insignif- icance of IVs <sup>b</sup>	27.74***	13.98***	3.94***	14.30***	13.55***
Dependent variable: $lngov_{i,t}$					
$vol_{i,t-1}$	0.005* (0.003)	0.005* (0.003)	-0.001 (0.004)	0.014*** (0.005)	0.011*** (0.004)
$gr_{i,t}$ 0.004***	0.014*** (0.001)	0.012*** (0.002)	0.008*** (0.003)	0.015*** (0.002)	(0.002)
$lngov_{i,t-1}$	0.861*** (0.009)	0.792*** (0.010)	0.730*** (0.018)	0.724*** (0.014)	0.793*** (0.010)
$vol_{i,t-1} \times pol_{i,t-1}$					0.001** (0.001)
$pol_{i,t-1}$					-0.001 (0.001)
Country fixed effects & time trends	yes	yes	yes	yes	yes
Control set <sup>c</sup>		yes	yes	yes	yes
F-test joint insignif- icance of IVs <sup>d</sup>	1,413.57***	468.64***	168.70***	162.73***	478.13***
<i>N</i>	3,974	3,974	1,650	2,244	3,974

Notes: Standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

<sup>a</sup>Control variables from [Levine and Renelt \(1992\)](#) and [Mirestean and Tsangarides \(2009\)](#): investment ( $lninv_{i,t-1}$ ), GDP ( $lngdp_{i,t-1}$ ), population growth ( $popgr_{i,t-1}$ ), life expectancy, ( $lnlife_{i,t-1}$ ), openness to trade ( $lnopen_{i,t-1}$ ), and inflation ( $lninfl_{i,t-1}$ ).

<sup>b</sup>IVs are regressors exclusively used in the growth equation.

<sup>c</sup>Control variables from [Shelton \(2007\)](#): GDP ( $lngdp_{i,t-1}$ ), trade openness ( $lnopen_{i,t-1}$ ), and population size ( $lnpop_{i,t-1}$ ).

<sup>d</sup>IVs are regressors exclusively used in the government size equation.