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Volatility and growth: Governments are key

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ABSTRACT

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 not only 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 90 countries from 1961 to 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 0.52 percentage points in a democracy, but raises growth by 1.66 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.

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).[1] Finally, other papers argue that there exists no link at all between output volatility and growth (Solow, 1997; Dawson and Stephenson, 1997; 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 not only 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

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[1] 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, 2007) and Aghion et al. (2010) argue that volatility and growth could be related in various ways.

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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; Carmignani et al., 2011). 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; Bergh and Henrekson, 2011).[2] Theoretically, the sign of the net effect is then ambiguous, as summarized in Fig. 1. Using a balanced panel of annual observations for 90 countries from 1961 to 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 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.[3] 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.[4] 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 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 information for 90 countries with yearly data from 1961 to 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 order to address the latent reverse causality problem of the growth literature, growth determinants are lagged by one year, following suggestions by Temple (1999) and Durlauf et al. (2005). 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 (3SLS) framework, estimating growth and government size simultaneously. Finally, the empirical section also incorporates a GMM system estimation, which has been proposed to be a useful alternative to 3SLS (see Carmignani et al., 2011). 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:

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

where $vol_{i,t-1}$ stands for growth rate volatility, lagged by one year (calculation explained below in Section 2.2). Recently, Baker and Bloom (2011) provide evidence that volatility tends to affect growth and not vice versa, using an instrumental variables approach

[2] 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.

[3] Adam et al. (2011) find a positive and statistically significant relationship between democracy and public sector efficiency.

[4] 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.

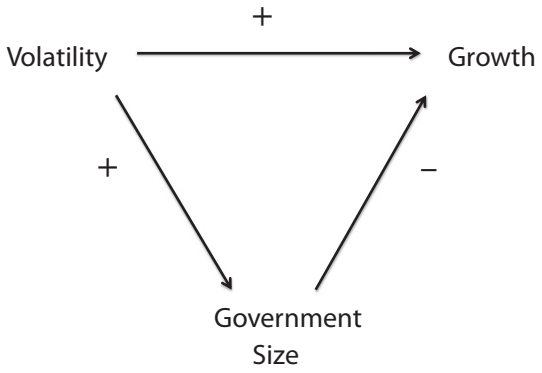


Fig. 1. Direct and indirect effects of volatility on growth.

based on natural disasters. Further, $lngov_{i,t}$ and $gr_{i,t-1}$ capture the logarithm of total government spending and the growth rate of the previous year.[5] Recently, Bergh and Henrekson (2011) provide a thorough survey of the literature on the effects from government size on growth. $X_{i,t-1}$ contains growth determinants suggested by Levine and Renelt (1992) and Mirestean and Tsangarides (2009). Specifically, $X_{i,t-1}$ includes investment (*lninv*), income (*lngdp*), population growth (*popgr*), life expectancy (*lnlife*), openness to trade (*lnopen*), and inflation (*lninfl*). Finally, $X_{i,t-1}$ also includes a measurement for capital account openness (*kaopen*), following Carmignani et al. (2011), who point out the intimate relationship between the freedom of capital movements, volatility, and government size. Including *kaopen* reduces the sample by about 20%, however all derived results are robust to the exclusion of *kaopen* and using the extended sample.

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 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%. Finally, λ_i and $\phi_{i,t}$ introduce country fixed effects and country-specific time trends, whereas $\delta_{i,t}$ stands for the usual error term.[6]

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.[7] Section 4.3 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 $vol_{i,t-1}$.

Beyond the HP filter, the paper then also employs several alternative measurements of volatility. First, I choose a different value of λ within the HP filter (in the spirit of Ravn and Uhlig, 2002) and consider the end-of-sample problem after which values close to the beginning and the end of the sample are naturally less precise (Watson, 2007). Second, I use an alternative detrending method by employing the Baxter–King filter (Baxter and King, 1999). Finally, I also employ a more traditional measurement of volatility by taking a country's variance of the growth rate over the previous three years (*variance*3).[8] These alternative techniques should provide more confidence in the derived results.

[5] Using government size as share of GDP does not change the implication of results, as discussed in Section 4.3.
[6] The Hausman test strongly rejects the use of random effects in favor of fixed effects.
[7] For the roots of the HP filter in general, consider Robert and Prescott (1997). For the relevant code in STATA, see Kowal (2005).
[8] This variance is divided by 100 to facilitate the comparability of magnitudes.

2.3. 3SLS estimations

After estimating Eq. (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 first moves to a 3SLS estimation system, where growth and government size are determined simultaneously. The government size regression takes the following form:

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

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*), population size (*lnpop*), plus the share of citizens under 15 (*pop*15) and over 65 years of age (*pop*65). 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.[9] The empirical section then also considers taking five and ten year averages of the data in order to answer the question whether the derived results can also be confirmed in a long run horizon.

Both Eqs. (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, total population size, and the shares of people in society, who are under 15 years of age or over 65 years. 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 (SUR) equations model implies raises in the efficiency of estimations by accounting for potential correlation of the error terms, extending the 2SLS to a 3SLS system.

2.4. Endogeneity

Naturally, almost all macroeconomic variables are subject to endogeneity concerns and these problems many times can only be addressed to a certain degree. This proves to be an issue in pure cross-country regressions, but the task becomes even more daunting when dealing with a panel of yearly data. For example, a variety of papers incorporate colonial history or geographical location as instruments for income levels or institutions, yet these variables by assumption do not change over time and thus lose their value in a panel data setting. Other factors, such as the ethnic or religious make-up of a country only change very slowly over time, thus making them poor candidates for panel data estimations using yearly data. Beyond that, many of these variables are not available on an annual basis for a broad sample of countries.

As a consequence, one needs to find other avenues of dealing with potential endogeneity problems, at least partially. The main form of endogeneity addressed in this paper circles around the growth-government size nexus and the idea that volatility may affect both variables, in addition to their intimate mutual relationship. In order to address any further endogeneity concerns, the main results are re-estimated not only for a variety of alternative specifications, but also within a GMM system in order to correct consistency problems of the parameter estimates (following Carmignani et al., 2011). In particular, this allows for potential heteroskedasticity in the error term and therefore provides a generalized estimation method of the system presented in Eqs. (1) and (2). Specifically, I estimate a GMM system, using current values of the explanatory variables and incorporating their lagged values as instruments. Although one can of course not completely eliminate endogeneity concerns in these types of estimations, these additional estimations give us some confidence about the derived results.

3. Data

All variables are displayed in Table 1 and mostly 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%.[10] Fig. 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 annual growth rates and volatility levels over the entire time span of 1961 to 2010. We notice that several African countries, but especially Southeast Asian economies experienced strong growth over the past 50 years. In fact, some of these aspiring nations also seem to have been highly volatile, like Gabon, Seychelles, or Oman. However, we also observe fast-growing countries with less volatility, such as Egypt or the Republic of Korea.[11] Further, Fig. 3 shows the world-wide average volatility over time and a breakdown by continents. We notice major spikes in the mid 60s and the late 90s, where the

[9] See for instance Acemoglu et al. (2003) or Klomp and de Haan (2009) for the argument of institutions in general influencing volatility.

[10] 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.

[11] 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
gr	3.98	5.83	4750	WDI	GDP growth in annual percent
vol	0.238	1.87	4750	Own	Using the Hodrick–Prescott filter with $\lambda_{HP} = 100$ for detrending
lngov	21.59	2.35	4470	WDI	Ln(GDP × government share / 100)
lninv	21.86	2.50	4668	PWT 7.1	Ln(GDP × investment share / 100)
lngdp	23.46	2.31	4750	WDI	Ln(total GDP in constant 2000 US$)
popgr	0.02	0.022	4750	PWT 7.1	$(pop_t – pop_{t-1}) / pop_t$
lnopen	4.02	0.63	4530	WDI	Ln(trade as percent of GDP)
lnlife	4.11	0.20	4671	WDI	Ln(life expectancy at birth)
lninfl	0.12	0.29	4750	WDI	Ln[1 + (annual inflation / 100)]
kaopen	−.04	1.50	3576	Chinn-Ito	Chinn–Ito index of capital account openness (higher values indicating more openness
lnpop	15.91	1.85	4750	WDI	Ln(total population)
*pop*15	36.30	9.97	4700	WDI	Population ages 0–14 (% of total)
*pop*65	6.04	4.23	4700	WDI	Population ages 65 and above (% of total)
*variance*3	0.253	1.324	4465	Own	Growth rate variance of the previous 3 years divided by 100
pol	1.73	7.24	4279	Polity IV	Variable *polity*2, ranging from −10 (totally autocratic) to +10 (total democracy)
$vol_{\lambda_{HP}=6.25}$	0.17	1.23	4750	Own	Using the Hodrick–Prescott filter with $\lambda_{HP} = 6.25$ for detrending
vol_{BK}	0.18	1.33	4180	Own	Using the Baxter–King filter for detrending
g	14.99	6.22	4470	WDI	Government share of GDP
inv	21.73	9.76	4668	PWT 7.1	Investment share of GDP
urbanrate	51.07	24.69	3354	WDI	Urban population (% of total)
KOFindex	47.48	18.37	3786	KOF	KOF index of globalization

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

former appears to be driven by African, Asian, and European economies. In general, Asian and European countries managed to tame their business cycles since the mid 70s, whereas African nations continue to incur strongly volatile periods. Noteworthy is also a comparison within 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 Eq. (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 specific fixed effects and country time trends, accounting for the individual characteristics of each economy. Specification (4) adds government size, following Barro and Lee (1994), Barro (2001), Afonso and Furceri (2010), and Bergh and Henrekson (2011). Column (5) adds the persistent growth determinants found by Levine and Renelt (1992) and Mirestean and Tsangarides (2009) and finally column (6) incorporates capital account openness following Carmignani et al. (2011).[12]

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 specifications 4 and 5). 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 for continents and OECD versus non-OECD displayed in Table A.1). 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.

[12] As an additional check, I also replicated all tables only using 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 do not seem to be driving the derived results.

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

Fig. 2. Average growth rates over time.

Table 2
Countries by average growth rate (*gr*) and volatility (*vol*) from 1961 to 2010.

Country	Average growth rate (mean = 3.98)	Average volatility (mean = 0.24)
Africa		
Congo, Dem. Rep.	0.85	0.23
Central African Republic	1.35	0.14
Madagascar	1.86	0.16
Niger	2.21	0.30
Zimbabwe	2.33	0.33
Zambia	2.57	0.17
Sierra Leone	2.61	0.34
Burundi	2.64	0.27
Senegal	2.73	0.13
Liberia	3.02	3.11
Ghana	3.20	0.13
South Africa	3.26	0.04
Chad	3.42	0.62
Cameroon	3.45	0.21
Benin	3.46	0.08
Cote d'Ivoire	3.71	0.17
Togo	3.74	0.30
Algeria	3.84	0.53
Mauritania	4.03	0.33
Nigeria	4.11	0.41
Sudan	4.19	0.25
Burkina Faso	4.25	0.09
Malawi	4.31	0.25
Morocco	4.33	0.18
Rwanda	4.37	1.03
Congo, Rep.	4.43	0.24
Gabon	4.47	0.77
Kenya	4.60	0.18
Lesotho	4.81	0.39
Egypt, Arab Rep.	5.36	0.06
Seychelles	6.37	1.95
Botswana	8.94	0.15
Asia		
Nepal	3.67	0.07
Bangladesh	3.89	0.12
Philippines	4.06	0.07
Japan	4.07	0.06
Turkey	4.51	0.14
Sri Lanka	4.73	0.03
India	5.15	0.08
Pakistan	5.36	0.04
Israel	5.45	0.09
Indonesia	5.62	0.10
Syrian Arab Republic	5.73	0.54
Thailand	6.39	0.10
Malaysia	6.45	0.10
Korea, Rep.	6.93	0.10
Singapore	7.99	0.14
China	8.24	0.35
Oman	9.33	1.77
Europe		
Denmark	2.42	0.04
United Kingdom	2.47	0.04
Sweden	2.62	0.03
Belgium	2.79	0.03
Italy	2.79	0.03
France	2.95	0.02
Austria	2.96	0.02
Netherlands	3.07	0.03
Finland	3.09	0.07
Norway	3.33	0.02
Greece	3.50	0.07
Hungary	3.61	0.28
Portugal	3.69	0.07
Luxembourg	3.76	0.09
Iceland	3.76	0.12
Spain	3.79	0.03

(continued on next page)

Table 2 *(continued)*

Country	Average growth rate (mean = 3.98)	Average volatility (mean = 0.24)
Oceania		
Fiji	3.10	0.18
Australia	3.60	0.03
Papua New Guinea	3.79	0.15
North America		
United States	3.15	0.04
Bermuda	3.20	0.11
Canada	3.38	0.03
St. Vincent and the Grenadines	3.38	0.35
Trinidad and Tobago	3.39	0.11
Bahamas, The	3.56	0.37
Honduras	4.03	0.08
Puerto Rico	4.05	0.05
Mexico	4.14	0.10
Panama	5.03	0.13
Dominican Republic	5.45	0.24
Belize	5.51	0.13
South America		
Guyana	1.87	0.19
Uruguay	2.23	0.15
Nicaragua	2.59	0.27
El Salvador	2.87	0.09
Venezuela, RB	2.88	0.24
Bolivia	2.91	0.09
Argentina	2.98	0.29
Peru	3.65	0.20
Guatemala	3.91	0.03
Ecuador	3.99	0.09
Colombia	4.24	0.03
Chile	4.30	0.17
Paraguay	4.35	0.11
Brazil	4.51	0.10
Costa Rica	4.80	0.08

4.2. 3SLS and GMM 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. In addition, the conventional tests concerning the quality of the instruments show no reason for particular concern.[13] For the lack of space, all coefficients, which are not the main focus of this paper are omitted, but available upon request. 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.[14]

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, and 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. What about the quantitative interpretation? The results from column (2) suggest that a one standard deviation of volatility (1.87) should raise growth by 1 percentage point.[15] Section 4.4 will provide a more detailed analysis on the prevalence of both effects in different settings.

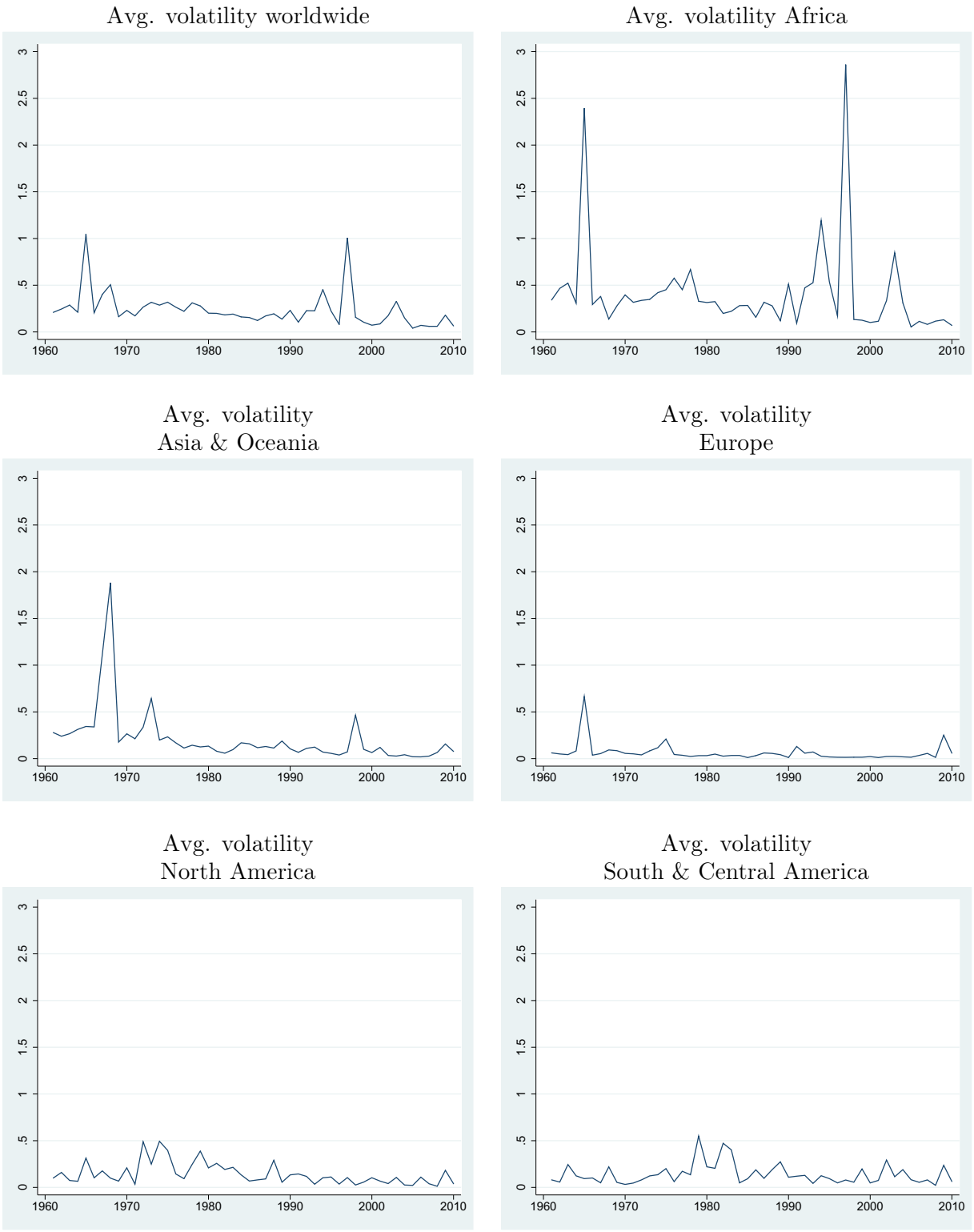
Drawing on the previous discussion about estimating volatility, and also about the methodology of estimating Eqs. (1) and (2) simultaneously, columns (3) and (4) provide alternatives. Specifically, I first use lagged variance (variance of the previous three years) as a measurement for volatility and second, I use a GMM structure to further address potential endogeneity.[16] The main

[13] 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). For the main regression, displayed in column (2), the underidentification test (Kleibergen–Paap rk LM statistic) rejects the null hypothesis of underidentification on the 1 percent level. Thus, the excluded instruments are relevant, as they are correlated with the endogenous regressors. Further, Hansen's J statistic produces a Chi-square value of 0.187, failing to reject the null hypothesis that the overidentifying restrictions are correct. All estimates are produced by using the *ivreg2* command in Stata, following Baum et al. (2011).

[14] 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).

[15] Calculation: *net effect* $= 1.87 \times 0.538 - 1.87 \times 0.009 \times 1.081$.

[16] The GMM system uses current values of the explanatory variables and their lagged values (by one year) as instruments.



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

Fig. 3. Average volatility over time.

Table 3
Basic 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)	0.586 (0.389)	0.545 (0.424)
$gr_{i,t-1}$	0.313*** (0.042)	0.263*** (0.043)	0.219*** (0.045)	0.173*** (0.040)	0.192*** (0.032)	0.213*** (0.036)
$lngov_{i,t}$				−1.514** (0.645)	1.979*** (0.592)	2.271*** (0.790)
$lninv_{i,t-1}$					0.966** (0.435)	1.155** (0.536)
$lngdp_{i,t-1}$					−14.455*** (1.722)	−20.044*** (2.153)
$lnlife_{i,t-1}$					15.820*** (5.019)	19.225*** (7.208)
$popgr_{i,t-1}$					0.950 (3.829)	−0.414 (4.364)
$lnopen_{i,t-1}$					2.230*** (0.487)	3.486*** (0.556)
$lninfl_{i,t-1}$					−0.917*** (0.314)	−0.823*** (0.319)
$kaopen_{i,t-1}$						0.511*** (0.111)
Country fixed effects		Yes	Yes	Yes	Yes	Yes
Country time trend			Yes	Yes	Yes	Yes
DWH-test[a]				62.40***	43.59***	26.99***
# of countries	95	95	95	93	93	90
N	4655	4655	4655	4387	4273	3359
R^2	0.100	0.135	0.168	0.206	0.261	0.315

Notes: Standard errors in parentheses.
[a] 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.
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

Table 4
Main results from simultaneous estimation.

			Using lagged variance	GMM[e]	5-year averages	10-year averages
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: $gr_{i,t}$						
$vol_{i,t-1}$	0.522***	0.538***	0.261**	0.019***	0.007***	0.791***
	(0.107)	(0.107)	(0.001)	(0.007)	(0.121)	(0.229)
$lngov_{i,t-1}$	−0.735	−1.081**	−1.336**	−20.145***	−2.530***	−1.061
	(0.551)	(0.551)	(0.555)	(0.230)	(0.790)	(2.260)
$gr_{i,t-1}$	0.192***	0.188***	0.171***		0.052	−.0239
	(0.017)	(0.017)	(0.017)		(0.038)	(0.053)
Country fixed effects	Yes	Yes	Yes			
Country specific time trends	Yes	Yes	Yes		Yes	Yes
Control sets[a]	Yes	Yes	Yes	Yes	Yes	Yes
F-test joint insignificance of IVs[b]	83.87***	48.84***	45.72***		3.63***	3.59**
Dependent variable: $lngov_{i,t}$						
$vol_{i,t-1}$	0.006**	0.009***	0.006*	0.029**	0	0.104***
	(0.003)	(0.003)	(0.000)	(0.003)	(0.004)	(0.014)
$gr_{i,t}$	0.004***	0.014***	0.013***	−1.394**	−0.001	−0.068***
	(0.001)	(0.002)	(0.002)	(0.562)	(0.007)	(0.025)
$lngov_{i,t-1}$	0.821***	0.751***	0.748***		0.463***	0.161***
	(0.011)	(0.012)	(0.012)		(0.040)	(0.025)
Country fixed effects	Yes	Yes	Yes			
Country specific time trends	Yes	Yes	Yes		Yes	Yes
Control set[c]		Yes	Yes	Yes	Yes	Yes
F-test joint insignificance of IVs[d]	14,209.09***	1918.59***	1750.56***		81.44***	5.55***
# of countries	90	90	90	90	93	95
N	3354	3354	3354	3354	735	449

Notes: Standard errors in parentheses.
[a] 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 ($lninfl_{i,t-1}$). In addition, capital account openness is added to the regressors because of its intimate relationship with volatility and government size (Carmignani et al., 2011).
[b] IVs are regressors exclusively used in the growth equation.
[c] Control set Shelton (2007): GDP ($lngdp_{i,t-1}$), trade openness ($lnopen_{i,t-1}$), population size ($lnpop_{i,t-1}$), the share of people under 15 ($pop15_{i,t-1}$) and over 65 ($pop65_{i,t-1}$).
[d] IVs are regressors exclusively used in the government size equation.
[e] Estimates the system with current values, using lagged values of the respective variables as instruments. Kleibergen–Paap test: $\chi_{(8)} = 306.26^{***}$ (Kleibergen and Paap, 2006) confirms the validity of the instruments.
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

conclusions remain consistent in both estimations: There exists a positive direct and a negative indirect effect (through government size) of volatility on growth.

So far, the scope of the analysis centers around annual observations, which allows for conclusions regarding the short-term effect of volatility. One question is whether the derived relationships can also be observed over the long-run. Given the sample timeframe of 50 years (1961–2010), I now turn to using five (1961–1965, 1966–1970, etc.) and ten year averages (1961–1970, 1971–1980, etc.) in columns (5) and (6).[17] Thus, every country can enter up to ten times in the five year averages and up to five times in the ten year averages. However, since the annual data is unbalanced along the lines of several control variables, several countries enter with less observations. For the econometric framework this means that country fixed effects may become a rather strict constraint, leaving little within country variation. Therefore, columns (5) and (6) are estimated with country-specific time trends, but no country fixed effects.[18] These estimations also further address potential issues of potential reverse causality, as observations 5 or 10 years prior are unlikely to be affected by current growth rates. In addition, averaging over time reduces the impact of potential outliers and measurement error. We note that the main results are mostly confirmed. Only the indirect effect disappears in the five year averages, but is recuperated when considering decades. Notice that government size is suggested to be insignificant in predicting growth in the final estimation, but this seems to be driven by elevated standard errors, potentially owed to the restricted sample of ten year averages. In fact, using decades creates a sample of only 449 observations, which comes out to be less than 15% of the annual sample size. The following section will now discuss a variety of robustness checks.

4.3. Robustness checks

This section presents several alternative specifications, addressing the method of detrending growth rates, the definition of government size, and the potential effect of outliers. Table 5 displays the results of replicating the main specification of column (2) from Table 4 for each robustness check. First, a general criticism of the HP filter consists in 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 sample balanced along the lines of growth rates of 50 observations per country, specification (1) displays 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. If anything magnitudes are increased.

Second, 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 $\lambda_{HP} = 6.25$. Column (2) replicates the main regression 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. Even though signs and significance levels mostly confirm the earlier findings, magnitudes are smaller, potentially owed to the fact that a lower λ_{HP} translates to a smaller penalty for variations in the growth rate, i.e. the trend is given more flexibility.

Third, column (3) provides another alternative estimation method to derive volatility, this time using the Baxter–King (BK) filter (Baxter and King, 1999). This specification serves 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 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.

Specification (4) checks 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 total investment.[19] In this case, the direct effect is comfortably confirmed, whereas the link between volatility and government size just loses statistical significance on conventional levels. Notice that switching to shares changes the numerical interpretation of the coefficients associated with government size.

Column (5) considers further control variables found in the government size literature (see Carmignani et al., 2011), specifically adding life expectancy, capital account openness, and the urbanization rate. However, the main coefficients of interest once again allow for the same conclusions as before, both with respect to significance levels and magnitudes.

Finally, columns (6) and (7) focus on the potential impact of outliers on the main results. Specifically, I first exclude the five fastest growing economics (Botswana, Oman, China, Singapore, and the Republic of Korea) and then the ten fastest growing economies (adding Malaysia, Thailand, Seychelles, Syria, and Indonesia to the list). Notice that this also includes some of the most volatile economies with Seychelles and Oman. In terms of annual observations, some of these countries note growth rates under −50% or over 80% in a given year. However, the results remain virtually unchanged. Excluding individual observations here produces corresponding results.

Overall, the results from estimating growth and government size simultaneously provide a substantially revised view on the role of volatility, compared to the generic single estimation framework. Once the endogeneity of government size is addressed, volatility carries not only a positive direct effect on growth, but also a negative indirect effect, operating through the size of the public sector. The natural question arising from this finding now relates to the relative strength of both effects across different settings.

[17] To derive aggregated values by country and variable, I take broad averages, meaning that one annual observation is sufficient to enter the five and ten year sample.
[18] In fact, including country fixed effects renders the majority of coefficients as statistically insignificant, yet preserving their initial signs.
[19] Measuring government size as a fraction of GDP carries the caveat that exogenous changes in GDP can affect the size of the public sector, even though the public sector per se does not change. Econometrically, including both government spending and total GDP in both regressions allows for a more isolated interpretation of both variables.

Table 5
Robustness checks.

	1965–2005	$vol_{\lambda HP = 6.25}$	vol_{BK}[a]	Using shares	Further controls[e]	Excluding outliers[b]	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable: $gr_{i,t}$							
$vol_{i,t-1}$	0.570*** (0.113)	0.007*** (0.001)	1.490*** (0.039)	0.521*** (0.104)	0.535*** (0.107)	0.511*** (0.108)	0.519*** (0.109)
$lngov_{i,t}$	−2.449*** (0.635)	−1.098** (0.552)	1.566*** (0.468)	−0.094*** (0.036)	−1.087** (0.551)	−1.217** (0.560)	−1.391** (0.569)
$gr_{i,t-1}$	0.186*** (0.018)	0.187*** (0.017)	−0.207*** (0.017)	0.187*** (0.017)	0.185*** (0.017)	0.178*** (0.017)	0.178*** (0.018)
Country fixed effects & time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control sets[c]	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-test joint insignificance of IVs	41.85***	49.07***	30.33***	40.22***	48.84***	45.98***	44.74***
Dependent variable: $lngov_{i,t}$							
$vol_{i,t-1}$	0.009*** (0.003)	0.000** (0.000)	0.010*** (0.003)	0.067 (0.044)	0.009*** (0.003)	0.009*** (0.003)	0.009*** (0.003)
$gr_{i,t}$	0.014*** (0.002)	0.013*** (0.002)	−0.002 (0.003)	0.018 (0.027)	0.015*** (0.002)	0.014*** (0.002)	0.014*** (0.002)
$lngov_{i,t-1}$	0.751*** (0.013)	0.750*** (0.012)	0.767*** (0.013)	0.738*** (0.012)	0.752*** (0.012)	0.753*** (0.012)	0.753*** (0.013)
Country fixed effects & time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control set 1[d]	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control set 2[e]					Yes		
F-test joint insignificance of IVs	1355.61***	1926.92***	1557.71***	1527.99***	818.00***	1793.98***	1682.08***
# of countries	90	90	90	90	90	87	90
N	2934	3354	3193	3354	3354	3179	3008

Notes: Standard errors in parentheses.
[a] Baxter–King filter applied to detrend growth rates.
[b] (6) excludes the 5 countries with the highest average growth rates: Botswana, Oman, China, Singapore, and the Republic of Korea. (7) excludes the 10 strongest growing economies, adding Malaysia, Thailand, Seychelles, Syria, and Indonesia.
[c] 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 ($lninfl_{i,t-1}$).
[d] Control variables from Shelton (2007): GDP ($lngdp_{i,t-1}$), openness to trade ($lnopen_{i,t-1}$), population size ($lnpop_{i,t-1}$), the share of people under 15 ($pop15_{i,t-1}$) and over 65 ($pop65_{i,t-1}$).
[e] Adding control variables from Carmignani et al. (2011) to the government size equation: $kaopen_{i,t-1}$, $lnlife_{i,t-1}$, $urbanrate_{i,t-1}$.
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

4.4. The role of the political regime form

Let us consider the mechanism of the indirect effect in detail, especially the first leg of the relationship between volatility and government size. In this context, the link between the citizens' ability to articulate and enforce their wishes in terms of public goods provision is an essential component. Without the ability to engage in the political process, the citizens' options to respond to volatility are limited. Consequently, the prevailing political regime form of a country could naturally play an intermediating role for the indirect effect. Table 6 extends the basic analysis along the lines of considering the Polity IV index. Specifically, I incorporate the variable *polity*2 (*pol*), which ranks political regimes from −10 (totally autocratic) to +10 (perfect democracy). The first 2 columns simply divide countries into autocracies or closed anocracies ($pol < 0$) versus open anocracies and democracies ($pol > 0$). The former regimes are defined by a lack of political participation for citizens or situations in which citizens are subject to a ruling elite. The latter regimes are characterized by citizens receiving the opportunity to engage in the political process.

Notice that once we consider undemocratic regimes in column (1) the magnitude of the positive direct effect is increased by over 50% from the baseline regression (column 2, Table 4). The indirect effect however shrinks to about one half of its original size, rendering a statistically insignificant estimate. Thus, volatility does not seem to affect government size in non-democratic regimes. 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. However, this result is reversed for democratic nations, as displayed in column (2). Volatility now raises the size of the public sector and this result is significant on the 5% level. 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 gains strength, presumably operating through an insurance mechanism of the public sector.

Table 6
3SLS results adding political regime form.

	$pol_{i,t-1} < 0$	$pol_{i,t-1} > 0$	Full sample		Considering exchange rate regimes		OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable: $gr_{i,t}$							
$vol_{i,t-1}$	0.823*** (0.161)	0.313* (0.174)	0.325** (0.143)	0.332** (0.143)	0.428*** (0.155)	0.421*** (0.154)	0.357 (0.413)
$lngov_{i,t}$	−1.963 (1.295)	−1.006 (0.747)	−1.259** (0.558)	−1.402** (0.564)	−1.241*** (0.242)	−1.232*** (0.241)	2.201*** (0.807)
$gr_{i,t-1}$	0.103*** (0.028)	0.284*** (0.022)	0.176*** (0.017)	0.175*** (0.017)	0.259*** (0.019)	0.260*** (0.019)	0.198*** (0.037)
$vol_{i,t-1} \times pol_{i,t-1}$			−0.057** (0.024)	−0.058** (0.024)	0.038 (0.028)	−0.054 (0.028)	−0.057 (0.069)
$pol_{i,t-1}$			0.058** (0.026)	0.056** (0.026)	0.003 (0.017)	0.003 (0.017)	0.050* (0.028)
$KOFindex_{i,t-1}$				0.111*** (0.027)			
$excharr_{i,t-1}$					−0.022 (0.021)		
Country fixed effects & time trends	Yes	Yes	Yes	Yes			Yes
Control sets[a]	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-test joint insignificance of IVs[b]	14.06***	19.40***	44.98***	40.05***	38.14***	45.96***	
Dependent variable: $lngov_{i,t}$							
$vol_{i,t-1}$	0.004 (0.004)	0.012** (0.005)	0.014*** (0.004)	0.014*** (0.004)	0.023*** (0.004)	0.023*** (0.004)	
$gr_{i,t}$	0.009*** (0.003)	0.008*** (0.002)	0.014*** (0.002)	0.014*** (0.002)	0.017*** (0.002)	0.017*** (0.002)	
$lngov_{i,t-1}$	0.663*** (0.022)	0.691*** (0.015)	0.752*** (0.012)	0.751*** (0.012)	0.950*** (0.007)	0.949*** (0.007)	
$vol_{i,t-1} \times pol_{i,t-1}$			0.001* (0.001)	0.001* (0.001)	0.001 (0.001)	0.001 (0.001)	
$pol_{i,t-1}$			−0.000 (0.001)	−0.000 (0.001)	0.000 (0.000)	0.000 (0.000)	
Country fixed effects & time trends	Yes	Yes	Yes	Yes			
Control set[c]	Yes	Yes	Yes	Yes	Yes	Yes	
F-test joint insignificance of IVs[d]	269.53***	541.14***	982.72***	965.47***	5947.44***	5947.44***	
# of countries	61	79	85	85	67	67	90
N	1253	2048	3222	3194	2744	2744	3222

Notes: Standard errors in parentheses.
[a] 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 ($lninfl_{i,t-1}$).
[b] IVs are regressors exclusively used in the growth equation.
[c] Control set Shelton (2007): GDP ($lngdp_{i,t-1}$), trade openness ($lnopen_{i,t-1}$), population size ($lnpop_{i,t-1}$), the share of people under 15 ($pop15_{i,t-1}$) and over 65 ($pop65_{i,t-1}$).
[d] IVs are regressors exclusively used in the government size equation.
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

One downfall of this analysis is the arbitrary distinction into positive and negative values of polity. Thus, column (3) 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 seems to diminish, but the indirect effect gains importance.[20] Following this final and most complete specification, a one standard deviation of volatility is suggested to lower the growth rate of GDP by 0.52 percentage points in a country with a perfect polity score of +10.[21] 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 1.66 percentage points.

From there, column (4) incorporates the *KOF* globalization index in order to check whether the derived result can indeed be traced back to regime forms and does not just pick up any other development effects. Previously, Kose et al. (2006) have pointed out that globalization can influence the growth–volatility relationship. However, we see virtually no changes in the coefficients and standard errors after including *KOFindex*.

[20] 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.
[21] Calculation: $\Delta gr = 1.87[0.325 - 10 \times 0.057 - 1.259(0.014 + 10 \times 0.001)]$.

Further, the exchange rate regime has been pointed out to be closely related to volatility, as more stable exchange rate regimes are suggested to experience less volatility. Column (5) adds this variable (from Reinhart and Rogoff, 2011) to the list of potential growth determinants.[22] Indeed, we find that the intermediating role of the political regime form becomes weaker, even though the suggested signs are maintained. However, missing data on exchange rate regimes leads to a loss of 478 observations from 18 different countries and with 8 countries exiting the sample entirely.[23] In order to test whether the change in coefficients can be traced back to the inclusion of the exchange rate regime or the loss of observations, column (6) uses the same number of observations (2744), but excludes *excharr* from the estimation. Indeed, we find that the coefficients are virtually identical to column (5), which leads me to believe that the selection of observations drives the non-significance of the interaction terms with the political regime in column (5). Another indication of this is provided by the insignificance of *excharr* in column (5). Thus, it does not appear as if the exchange rate regime is driving the importance of the political regime form.

Finally, column (7) re-estimates the basic single equation framework for growth, this time including the political regime form 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. Thus, one needs the simultaneous equation structure and the incorporation of the political regime to carve out the entire dynamics of volatility and its net effect on growth.

In summary, I find evidence that especially the indirect effect of volatility on growth is influenced by the political regime form of the country. In alternative specifications, I also estimated the system by continents and OECD versus non-OECD nations, as Aguiar and Gopinath (2007) note that volatility may operate differently in emerging markets. These results are displayed in Table A.2. However, it appears difficult to draw a precise conclusion as both the direct and the indirect effect appear scattered throughout continents. For instance, the positive direct effect seems to be particularly prevalent in Asia, Oceania, and Europe, whereas the indirect effect emerges with force for African and European countries. Given less variation of political regime forms in countries within continents, it becomes difficult to interpret the coefficients on the interaction term ($vol \times polity$). In general, we can see that the direct effect seems to dominate in richer countries (OECD), but the negative effect emerges stronger in the developing world (non-OECD).

4.5. Development over time and country examples

In fact, the results from column (3) (Table 6) suggest a threshold level of a country's polity score of +5.3, over which the net effect of volatility on growth becomes negative.[24] 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.

Fig. 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 6, column (3). 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% between 1970 and 1974), but jumped from 15.4% in 1986 to 18.8% in 1993. Severe changes in political regime form can be observed in numerous other countries, such as Brazil, Ghana, Portugal, or Thailand.

Fig. 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 overall sample countries are suggested to have enjoyed 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.

5. Conclusion

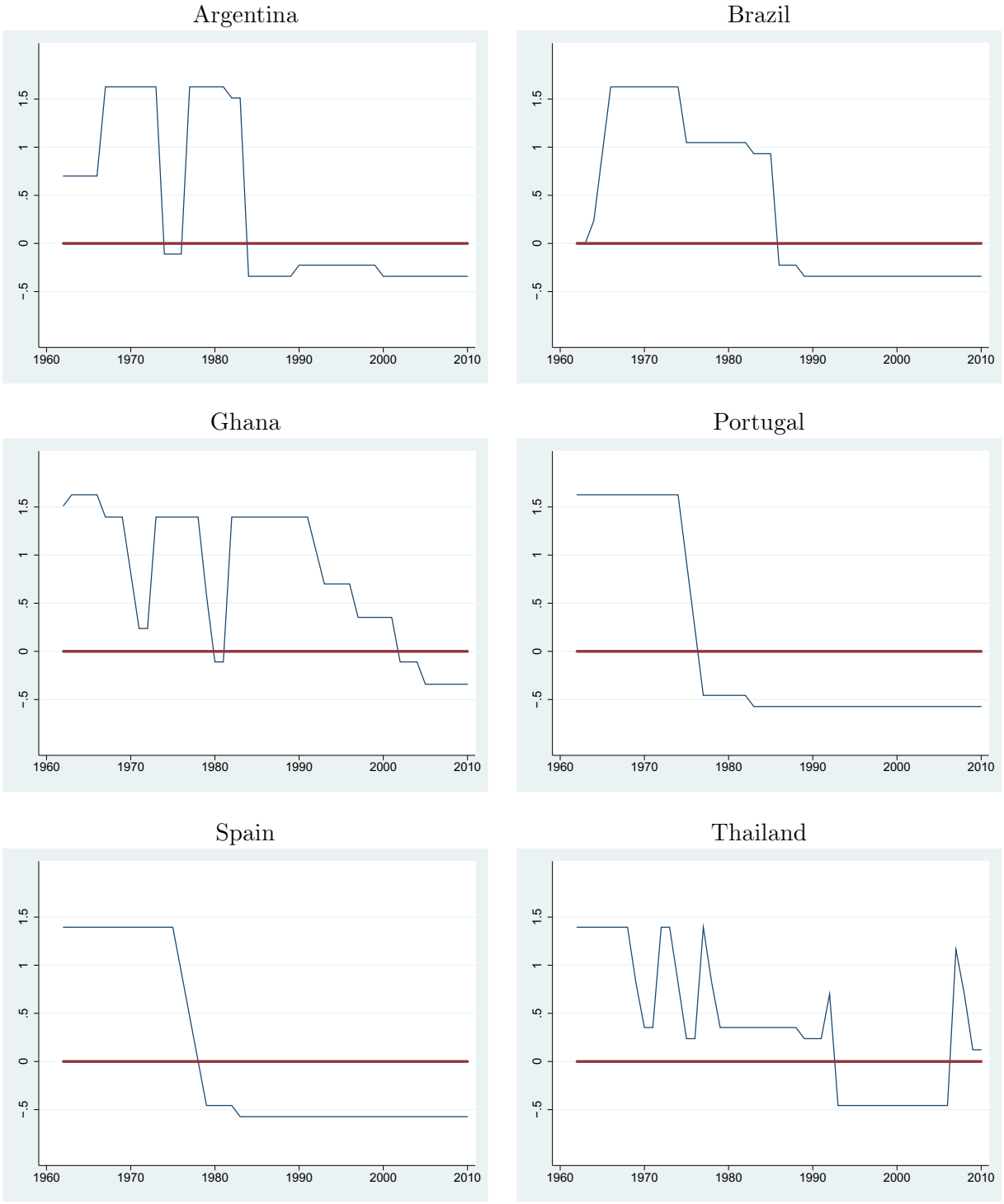
This paper analyzes the relationship between business cycles and economic growth in a new light, suggesting both a positive direct and a negative indirect effect from volatile growth rates on growth. A positive direct effect has previously been proposed by several theories (e.g., creative destruction 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

[22] For a deeper discussion about the choice of exchange rate regimes, one may consider Carmignani et al. (2008).

[23] These countries are the Central African Republic, the Democratic Republic of the Congo, the Republic of the Congo, Egypt, Rwanda, South Korea, Trinidad and Tobago, and Venezuela.

[24] Calculation for the threshold level: $0.325 - pol \times 0.057 - 1.259 \times (0.014 + pol \times 0.001) = 0$.



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.

Fig. 4. Net effects from volatility on growth.

suggest that a one standard deviation of growth rate volatility may lower growth by as much as 0.52 percentage points in a perfect democracy. In a total autocracy however, a one standard deviation can raise growth by up to 1.66 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.

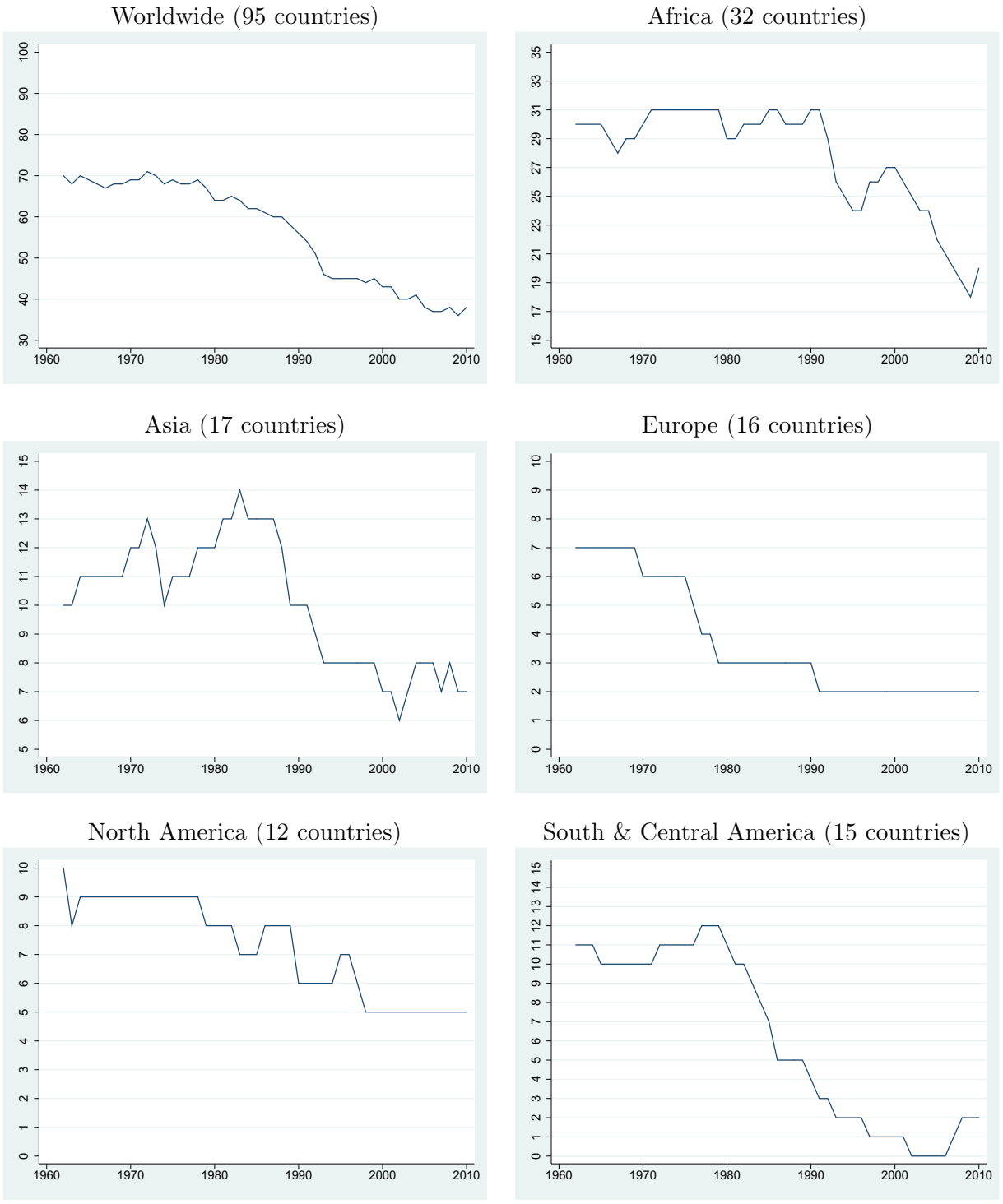


Fig. 5. Amount of countries with predicted positive net growth effect from volatility over time.

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 A

Table A.1
Main OLS regressions (Table 3, column 6) by continents and OECD versus non-OECD.

	Africa	Asia & Oceania	Europe	North & South America	OECD	non-OECD
	(1)	(2)	(3)	(4)	(5)	
Dependent variable: $gr_{i,t}$						
$vol_{i,t-1}$	0.473 (0.438)	0.669 (1.319)	3.919** (1.641)	0.306 (0.764)	3.185** (1.589)	0.504 (0.420)
$gr_{i,t-1}$	0.145*** (0.053)	0.162** (0.082)	0.466*** (0.069)	0.409*** (0.044)	0.436*** (0.064)	0.201*** (0.038)
$lngov_{i,t-1}$	3.170** (1.388)	4.165*** (1.517)	−1.074 (1.592)	0.222 (0.750)	−0.939 (1.370)	2.374*** (0.829)
$lninv_{i,t-1}$	2.059*** (0.729)	0.226 (0.950)	−3.316*** (1.209)	−1.837** (0.845)	−2.897** (1.162)	1.215** (0.563)
$lngdp_{i,t-1}$	−23.554*** (3.443)	−19.733*** (3.210)	−8.786*** (3.078)	−12.153*** (2.438)	−8.376*** (2.884)	−20.936*** (2.326)
$lnlife_{i,t-1}$	19.806** (7.995)	33.986*** (11.244)	26.681 (25.048)	−16.518 (11.562)	18.884 (26.051)	19.774*** (7.310)
$popgr_{i,t-1}$	0.816 (8.130)	−1.200 (5.636)	4.528 (6.618)	0.335 (6.683)	1.450 (5.792)	−1.032 (5.089)
$lnopen_{i,t-1}$	3.840*** (0.936)	1.692* (0.989)	−0.479 (1.251)	3.418*** (0.901)	−1.609* (0.951)	4.148*** (0.637)
$lninfl_{i,t-1}$	−0.293 (0.844)	−1.974 (1.378)	−6.115* (3.456)	−0.418 (0.333)	−1.250 (1.668)	−0.726** (0.328)
$kaopen_{i,t-1}$	0.089 (0.298)	0.621*** (0.214)	0.425** (0.175)	0.370** (0.171)	0.350** (0.137)	0.574*** (0.146)
N	1093	751	578	937	898	2461
R^2	0.297	0.332	0.375	0.345	0.383	0.311

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

Table A.2
Basic 3SLS results by continents and OECD/non-OECD.

	Africa	Asia & Oceania	Europe	North & South America	OECD	non-OECD
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: $gr_{i,t}$						
$vol_{i,t-1}$	−0.084 (0.205)	0.970* (0.550)	3.009** (1.470)	0.675 (0.580)	3.290*** (0.721)	0.245 (0.161)
$lngov_{i,t-1}$	−1.102 (1.158)	0.455 (1.487)	0.078 (1.678)	−3.252*** (0.775)	−2.682* (1.491)	−1.281** (0.640)
$vol_{i,t-1} \times pol_{i,t-1}$	−0.132*** (0.036)	0.122* (0.070)	0.335* (0.185)	0.238*** (0.078)	0.153* (0.080)	−0.067** (0.028)
$pol_{i,t-1}$	0.186*** (0.058)	−0.050 (0.042)	0.041 (0.058)	−0.020 (0.044)	0.018 (0.041)	0.053* (0.031)
$gr_{i,t-1}$	0.089*** (0.029)	0.184*** (0.037)	0.470*** (0.053)	0.419*** (0.036)	0.446*** (0.042)	0.166*** (0.020)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country specific time trends	Yes	Yes	Yes	Yes	Yes	Yes
Control sets[a]	Yes	Yes	Yes	Yes	Yes	Yes
Dependent variable: $lngov_{i,t}$						
$vol_{i,t-1}$	0.019*** (0.006)	0.009 (0.012)	0.071** (0.032)	−0.012 (0.019)	−0.011 (0.013)	0.014*** (0.005)
$vol_{i,t-1} \times pol_{i,t-1}$	0.003** (0.001)	0.001 (0.002)	−0.011*** (0.004)	−0.007*** (0.003)	0.002 (0.002)	0.001 (0.001)
$pol_{i,t-1}$	−0.004** (0.002)	0.003*** (0.001)	0.005*** (0.001)	−0.001 (0.002)	0.003*** (0.001)	−0.001 (0.001)
$gr_{i,t}$	0.015*** (0.003)	0.010** (0.004)	−0.002 (0.002)	0.017*** (0.003)	0.002 (0.002)	0.015*** (0.002)
$lngov_{i,t-1}$	0.682*** (0.023)	0.717*** (0.027)	0.718*** (0.027)	0.833*** (0.023)	0.715*** (0.023)	0.748*** (0.014)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country specific time trends	Yes	Yes	Yes	Yes	Yes	Yes
Control set[c]	Yes	Yes	Yes	Yes	Yes	Yes
# of countries	31	20	16	26	24	69
N	1090	750	578	936	898	2456

Notes: Standard errors in parentheses.
[a] 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 ($lninfl_{i,t-1}$).
[b] IVs are regressors exclusively used in the growth equation.
[c] Control set Shelton (2007): GDP ($lngdp_{i,t-1}$), trade openness ($lnopen_{i,t-1}$), population size ($lnpop_{i,t-1}$), the share of people under 15 ($pop15_{i,t-1}$) and over 65 ($pop65_{i,t-1}$).
[d] IVs are regressors exclusively used in the government size equation.
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

References

Acemoglu, D., Johnson, S., Robinson, J., Thaicharoen, Y., 2003. Institutional causes, macroeconomic symptoms: volatility, crises and growth. J. Monet. Econ. 50 (1), 49–123.
Adam, A., Delis, M.D., Kammas, P., 2011. Are democratic governments more efficient? Eur. J. Polit. Econ. 27 (1), 75–86.
Afonso, A., Furceri, D., 2010. Government size, composition, volatility and economic growth. Eur. J. Polit. Econ. 26 (4), 517–532.
Aghion, P., Saint-Paul, G., 1998. Virtues of bad times interaction between productivity growth and economic fluctuations. Macroecon. Dyn. 2 (03), 322–344.
Aghion, P., Angeletos, G.M., Banerjee, A., Manova, K., 2010. Volatility and growth: credit constraints and the composition of investment. J. Monet. Econ. 57 (3), 246–265.
Aguiar, M., Gopinath, G., 2007. Emerging market business cycles: the cycle is the trend. J. Polit. Econ. 115 (1).
Alesina, A., Wacziarg, R., 1998. Openness, country size and government. J. Public Econ. 69 (3), 305–321.
Backus, D., Kehoe, P., 1992. International evidence on the historical properties of business cycles. Am. Econ. Rev. 864–888.
Badinger, H., 2010. Output volatility and economic growth. Econ. Lett. 106 (1), 15–18.
Baker, S., Bloom, N., 2011. Does uncertainty reduce growth? Using disasters as a natural experiment. Technical Report. Stanford University Working Paper (Palo Alto, California).
Barro, R.J., 2001. Human capital and growth. Am. Econ. Rev. 91 (2), 12–17.
Barro, R.J., Lee, J.W., 1994. Sources of economic growth. Carnegie-Rochester Conference Series on Public Policy. vol. 40. Elsevier, pp. 1–46.
Baum, C.F., 2006. Time series filtering techniques in Stata. Technical Report. Stata Users Group.
Baum, C.F., Schaffer, M.E., Stillman, S., 2011. Ivreg29: Stata Module for Extended Instrumental Variables/2SLS and GMM Estimation (v9). Statistical Software Components.
Baxter, M., King, R.G., 1999. Measuring business cycles: approximate band-pass filters for economic time series. Rev. Econ. Stat. 81 (4), 575–593.
Bergh, A., Henrekson, M., 2011. Government size and growth: a survey and interpretation of the evidence. J. Econ. Surv. 25 (5), 872–897.
Brock, W.A., Durlauf, S.N., 2001. What have we learned from a decade of empirical research on growth? Growth empirics and reality. World Bank Econ. Rev. 15 (2), 229–272.
Canton, E., 2002. Business cycles in a two-sector model of endogenous growth. Economic Theory 19 (3), 477–492.
Caporale, T., McKiernan, B., 1998. The Fischer Black hypothesis: some time-series evidence. South. Econ. J. 64 (3), 765–771.
Carmignani, F., Colombo, E., Tirelli, P., 2008. Exploring different views of exchange rate regime choice. J. Int. Money Financ. 27 (7), 1177–1197.
Carmignani, F., Colombo, E., Tirelli, P., 2011. Macroeconomic risk and the (de)stabilising role of government size. Eur. J. Polit. Econ. 27 (4), 781–790.
Davidson, R., MacKinnon, J.G., 2001. Estimation and inference in econometrics. OUP Catalogue.
Dawson, J.W., Stephenson, E.F., 1997. The link between volatility and growth: evidence from the States. Econ. Lett. 55 (3), 365–369.
Devereux, M.B., Smith, G.W., 1994. International risk sharing and economic growth. Int. Econ. Rev. 35 (3), 535–550.
Döpke, J., 2004. How robust is the empirical link between business-cycle volatility and long-run growth in OECD countries? Int. Rev. Appl. Econ. 18 (1), 103–121.
Durlauf, S., Johnson, P., Temple, J., 2005. Growth econometrics. Handb. Econ. Growth 1, 555–677.
Henderson, D.J., Papageorgiou, C., Parmeter, C.F., 2013. Who benefits from financial development? New methods, new evidence. Eur. Econ. Rev. 63 (0), 47–67.
Imbs, J., 2002. Why the link between volatility and growth is both positive and negative. CEPR Discussion Paper.
Imbs, J., 2007. Growth and volatility. J. Monet. Econ. 54 (7), 1848–1862.
Jetter, M., Nikolsko-Rzhevskyy, A., Smith, W.T., 2013. The effects of wage volatility on growth. J. Macroecon. 37 (0), 93–109.
Kleibergen, F., Paap, R., 2006. Generalized reduced rank tests using the singular value decomposition. J. Econ. 133 (1), 97–126.
Klomp, J., de Haan, J., 2009. Political institutions and economic volatility. Eur. J. Polit. Econ. 25 (3), 311–326.
Koren, M., Tenreyro, S., 2007. Volatility and development. Q. J. Econ. 122 (1), 243–287.
Kose, M.A., Prasad, E.S., Terrones, M.E., 2006. How do trade and financial integration affect the relationship between growth and volatility? J. Int. Econ. 69 (1), 176–202.
Kowal, P., 2005. Matlab implementation of commonly used filters. Computer Programs.
Levine, R., Renelt, D., 1992. A sensitivity analysis of cross-country growth regressions. Am. Econ. Rev. 82 (4), 942–963.
Martin, P., Ann Rogers, C., 2000. Long-term growth and short-term economic instability. Eur. Econ. Rev. 44 (2), 359–381.
Masanjala, W.H., Papageorgiou, C., 2008. Rough and lonely road to prosperity: a reexamination of the sources of growth in Africa using Bayesian model averaging. J. Appl. Econ. 23 (5), 671–682.
Mills, T.C., 2000. Business cycle volatility and economic growth: a reassessment. J. Post Keynesian Econ. 23 (1), 107–116.
Mirestean, A., Tsangarides, C., 2009. Growth Determinants Revisited, vol. 9. International Monetary Fund.
Mirman, L.J., 1971. Uncertainty and optimal consumption decisions. Econometrica 39 (1), 179–185.
Oikawa, K., 2010. Uncertainty-driven growth. J. Econ. Dyn. Control. 34 (5), 897–912.
Peacock, A., Scott, A., 2000. The curious attraction of Wagner's law. Public Choice 102 (1-2), 1–17.
Philippe, A., Peter, H., 1992. A model of growth through creative destruction. Econometrica 60, 323–351.
Posch, O., Wälde, K., 2011. On the link between volatility and growth. J. Econ. Growth 16 (4), 285–308.
Ramey, G., Ramey, V.A., 1995. Cross-country evidence on the link between volatility and growth. Am. Econ. Rev. 85 (5), 1138–1151.
Ravn, M.O., Uhlig, H., 2002. On adjusting the Hodrick–Prescott filter for the frequency of observations. Rev. Econ. Stat. 84 (2), 371–376.
Reinhart, C.M., Rogoff, K.S., 2010. Growth in a time of debt. Am. Econ. Rev. 100 (2), 573–578.
Reinhart, C.M., Rogoff, K.S., 2011. From financial crash to debt crisis. Am. Econ. Rev. 101 (5), 1676–1706.
Robert, H., Prescott, E., 1997. Post-war US business cycles: an empirical investigation. J. Money Credit Bank. 29 (1), 1–16.
Rodrik, D., 1998. Why do more open economies have bigger governments? J. Polit. Econ. 106 (5), 997–1032.
Sáenz, E., Sabaté, M., Gadea, M.D., 2013. Trade openness and public expenditure. The Spanish case, 1960–2000. Public Choice 154 (3-4), 173–195.
Saint-Paul, G., 1993. Productivity growth and the structure of the business cycle. Eur. Econ. Rev. 37 (4), 861–883.
Schumpeter, J.A., Fels, R., 1939. Business Cycles, vol. 1. Cambridge Univ Press.
Shelton, C., 2007. The size and composition of government expenditure. J. Public Econ. 91 (11), 2230–2260.
Solow, R.M., 1997. Is there a core of usable macroeconomics we should all believe in? Am. Econ. Rev. 87 (2), 230–232.
Staiger, D., Stock, J.H., 1997. Instrumental variables regression with weak instruments. Econometrica 65 (3), 557–586.
Temple, J., 1999. The new growth evidence. J. Econ. Lit. 37 (1), 112–156.
Wang, P.F., Wen, Y., 2011. Volatility, growth, and welfare. J. Econ. Dyn. Control. 35 (10), 1696–1709.
Watson, M., 2007. How accurate are real-time estimates of output trends and gaps? FRB Richmond Econ. Q. 93 (2), 143–161.