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Economic Growth and Political Survival*

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Abstract

Using data for 162 countries for the period 1962-2006, this paper examines the importance of the national economic growth rate for the ability of a national leader to retain his or her position. To address the potential endogeneity of economic growth, I use commodity prices, export partner incomes, precipitation, and temperature to instrument for a country's growth rate. The results indicate that faster economic growth increases the short-run likelihood that leaders will remain in office. The results are robust to controlling for a host of leader-, party-, and country-level variables. The effect of growth on the likelihood of leader exits appears to be generally similar across both democracies and autocracies. Economic growth has the largest impact on the likelihood of regular leader exits rather than irregular exits such as coups. Evidence is also presented on whether economic growth affects the likelihood that leaders employ oppressive tactics against opponents.

KEYWORDS: economic growth, politics, political survival, political change, leader turnover

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1. Introduction

Does a strong economy increase the likelihood that national leaders will remain in office? The impact of the state of the economy on political survival is a question of fundamental importance in political economy, but one for which existing evidence is incomplete. Prior studies generally identify a positive relationship between economic growth and the electoral success of incumbents in democracies (see, for example, Palmer and Whitten 1999, Wolfers 2002, Leigh 2009). But many leaders lose their jobs outside of elections, and many countries do not have free and fair elections. Few studies examine the broad relationship between economic growth and political survival in both democracies and autocracies. In addition, prior studies on the effect of the economy on political outcomes generally ignore the potential endogeneity of economic growth.

The November 2011 resignations of the Prime Ministers of Greece and Italy are a reminder that times of falling growth are often times of leadership change. There are also notable instances of autocratic leaders being undermined by deteriorating economies: President Suharto of Indonesia, for instance, resigned during the economic turmoil of the Asian financial crisis of 1998. Despite these examples, the impact of a weakening economy on the underlying probability that national leaders will lose their jobs is not clear.

Leadership matters. National leaders have a significant influence over economic, social, and political developments in their countries, and commonly attempt to distinguish themselves from their predecessors (Jones and Olken 2005, 2009). Exits of national leaders are often associated with moments of substantive political change. Whether the rate of economic growth systematically affects the abilities of leaders to succeed in their positions is of considerable consequence, and of interest to policy makers, domestic participants in the political process, outsiders who wish to encourage or discourage leadership transitions, and others. Whether economic growth has differing implications for democratic leaders and autocratic leaders, and whether certain modes of leader exit are more dependent on the state of the economy, are also of relevance in informing both policy and theory.

This paper adopts an instrumental variable (IV) approach to identify the causal impact of economic growth on changes in the primary national leader. Four instruments for economic growth are employed: commodity export price movements, export partner growth rates, precipitation, and temperature. Estimations are carried out for a large country-level panel data set, and control for a host of variables that may affect leader exits, as well as country and year fixed effects. The results indicate that faster economic growth significantly improves the short-run political survival prospects of national leaders. Of particular interest is that the estimated effect of economic growth on political survival extends to

autocratic leaders. As far as I am aware, this is the first study to provide robust evidence of a broad causal impact of economic growth on national leader political survival. The paper also examines whether the state of the economy affects the likelihood of purges of those opposing the leader.

The remainder of this paper is organized as follows. Section 2 discusses theory and existing evidence on economic growth and leadership change. Sections 3 and 4 outline the empirical approach and discuss the data used in the study. Estimation results are presented in Section 5. The final section concludes.

2. Economic growth and short-term political survival prospects

There are a number of reasons why the political survival prospects of a national leader may be improved by a stronger economy – even if the stronger economy is the result of factors outside the leader's control (such as improvements in economic conditions in export markets). *Ex ante*, these reasons may apply to both democratic leaders and autocratic leaders. First, members of the selectorate (those with an influence over the choice of national leader, including voters, cabinet members, the military, and others) may use the economic growth rate as a proxy for leader competence and be more likely to support the incumbent leader if the economy is growing quickly. They might be particularly likely to do so if they have limited information on the workings of the economy and/or the incumbent leader's performance (Alesina et al. 1997). Second, a stronger economy may make it easier for an incumbent leader to pursue their political agenda, provide goods and services to the public, meet their political promises, maintain or build patronage networks, and buy-off real and potential opposition. Further, a stronger economy may lead to an improvement in the national government's fiscal balance, which is often electorally popular (Brender and Drazen 2008). By increasing the opportunity cost of time, a rapidly growing economy may also reduce the ability of political opponents to drum up support for their cause. Conversely, an economic slowdown that reduces the opportunity cost of time (by increasing the numbers of the unemployed, for instance) may make it easier for opponents to organize political resistance.

Counter-arguments exist. Olson (1963) and Huntington (1968, 1991) hold that stronger economic growth could increase inequality and strain the social fabric, potentially leading to political instability. Economic slowdowns may also favor the experience of the incumbent leader and see calls for political stability in the face of economic uncertainty. Or perhaps there is no systematic relationship between economic growth and leadership change. If members of the selectorate believe that national leaders have little impact on aggregate economic growth or if

they are able to directly judge the leader's performance, their support for the leader may be unrelated to the national economic growth rate.

Complicating the situation from an estimation point of view, there is evidence that political factors affect the economy, meaning that the direction of causality is unlikely to be one-way. Barro (1991), Alesina et al. (1996), Brunetti (1997), and Przeworski et al. (2000), for instance, find that political instability is harmful to the economy. Political instability may entail protests, uncertainty, and low investment, which are likely to hurt the economic growth rate. There is also evidence that leaders attempt to influence the economy with the aim of improving their electoral prospects (see Drazen 2000 on the political business cycle). National leaders with falling popularity may seek to artificially stimulate the economy through government spending, for example.

Further still, other variables may affect both political survival and the state of the economy. One such variable is leader competence: leaders can affect the health of the economy (Jones and Olken 2005), and voters, cabinet, and others are likely to reward competent leadership. Other variables affecting both political survival and the state of the economy may include institutions, regime type, government policies, global events such as the end of the Cold War, and expectations concerning political stability.

Existing evidence generally suggests that faster economic growth improves political survival prospects, although most prior studies have not had a strong focus on identifying a causal effect. As discussed, many papers have concluded that incumbents are more likely to win elections if the economy is strong. Studies such as those of Londregan et al. (1995), Londregan and Poole (1996), Carmignani (2002), Bueno de Mesquita et al. (2003), Marinov (2005), Bueno de Mesquita and Smith (2010), and Malone (2011) report a positive relationship between economic growth and political survival more generally. Lindenberg (1990) and Remmer (1991) find that economic slowdowns undermine incumbent leaders in Central America. Li and Zhou (2005) conclude that economic growth is also important for the short-term job security of Chinese provincial leaders. Londregan and Poole (1990) present evidence that lower incomes facilitate coups, although find no evidence that the economic growth rate affects the short-run likelihood of coups. Bienen and van de Walle (1991, 1992) find no evidence for a global sample that a country's average economic growth rate increases leadership duration, but do not look at whether the annual rate of economic growth affects short-term political survival. Besley and Kudamatsu (2008) identify leadership turnover as a characteristic of successful autocracies, yet there is little evidence on whether the state of the economy is important to the timing of the political exits of autocrats.

Only a limited number of studies have adopted estimation techniques that address the potential endogeneity of economic growth. Alesina et al. (1996) use a

simultaneous equation specification to model the relationship between economic growth and changes in national leaders. They find evidence that a weak economy increases the likelihood of coups but no statistically significant evidence that the economic growth rate affects other types of leadership change. But their practice of instrumenting economic growth with education is not convincing: education is slow moving, and may not be exogenous to political change. Deaton and Miller (1995) use a commodity price index to instrument for economic growth in sub-Saharan African countries, and find a negative but statistically insignificant effect of economic growth on political exits. Wolfers (2002) investigates whether gubernatorial election results in the United States are affected by shocks to state economies from the national economy and from oil prices, and finds that positive economic shocks increase the likelihood of incumbent re-election. Brender and Drazen (2008) and Leigh (2009) examine the impact of changes in world economic activity on the results of national elections. Only the latter of these two studies finds that a faster-growing global economy aids national leader re-election prospects. In reduced-form estimations, Dell et al. (2008) find that temperature increases raise the likelihood of coups in poor countries, but find no significant effect of temperature on other types of leader exits.

In a related literature, Burke and Leigh (2010) use several IV approaches to investigate the impact of economic growth on the short-term likelihood of institutional change. They find evidence that adverse economic shocks from the weather trigger democratic change but no evidence that such shocks affect the likelihood of democratic reversals, and also no evidence that shocks to the economy from commodity export prices affect the likelihoods of either democratic progress or democratic reversals.[1] The empirical approach adopted in this paper extends on that of Burke and Leigh.[2]

3. Empirical approach

3.1 Estimation model

The model for estimation is:

$$D_{c,t} = \alpha G_{c,t-1} + \mathbf{x}'_{c,t-j}\boldsymbol{\beta} + I_c + I_t + \varepsilon_{c,t} \qquad (1)$$

[1] Caselli and Tesei (2011) and Brückner et al. (forthcoming) present additional evidence on the effect of commodity price fluctuations on institutional development.

[2] In working papers that appeared subsequent to the initial version of this paper, Cáceres and Malone (2011) and Treisman (2011) also present IV evidence on the relationship between economic growth and leader exits. Their IV approaches are narrower than that employed here.

where the dependent variable is equal to 1 if there is an exit of the effective primary national leader during year *t* (excluding exits due to natural death or deposition by another state), and 0 otherwise. This dependent variable covers exits of leaders brought about by election loss, resignation, loss of cabinet support, loss of the support of the legislature, sickness, coup, popular revolt, assassination, domestic armed rebellion, and other means. $G_{c,t-1}$ is the real gross domestic product (GDP) per capita growth rate in year *t*-1.[3] $\mathbf{x}'_{c,t-j}$ is a vector of time-varying control variables, I_c is a vector of country fixed effects, I_t is a vector of year fixed effects, and $\varepsilon_{c,t}$ is an error term, with $E(\varepsilon_{c,t}) = 0$.

Equation 1 is initially estimated using a linear probability model (LPM), a logit model, and a Cox (1972) proportional hazard model. A probit model is not employed because it is not suited to a fixed effects treatment (Greene 2000). The inclusion of country fixed effects is important because unobserved time-invariant factors, such as difficult-to-measure characteristics of the electoral system, may affect both political stability and economic growth. Results are presented both with and without the time-varying controls. These time-varying controls include log GDP per capita, the secondary school enrollment rate, the percentage of people aged 65 years and above, the tenure of the leader in power at the start of year *t* in years, the age of the leader in power at the start of year *t*, a dummy equal to 1 for the years 1989-1992 for countries classed as transition economies by the Development Research Institute (DRI 2009) and 0 otherwise, a dummy for countries that are classed as democracies at the end of year *t*-1, dummies for elections that affect the effective primary national leader, and a dummy for the year of a legal term limit.[4] The first three of these controls are measured at *t*-2 so that they are not affected by year *t*-1 growth. Additional controls, such as party dummies, are included in robustness checks. Estimated standard errors are robust to heteroscedasticity and are clustered at the country level to account for possible serial correlation.

[3] Specifications including GDP per capita growth in years *t*-2, *t*, and *t*+1 are also explored. Using growth in year *t*-1 has the advantage of ensuring examination of a temporally-prior effect (year-*t* growth covers calendar months subsequent to many year-*t* leader exits).

[4] The inclusion of log GDP per capita$_{t-2}$ in the regressions raises the issue of the potential endogeneity of *t*-2 GDP, but has little impact on the estimated coefficient for the explanatory variable of primary interest, GDP per capita growth$_{t-1}$. I control for elections in years *t* and *t*-1 as in some instances leaders leave office in the calendar year after elections are held. The timing of elections in some countries is affected by the national leader and/or legislature and so may be endogenous, but the inclusion of the election dummies does not substantially affect estimated coefficients on GDP per capita growth$_{t-1}$.

3.2 Instrumenting for economic growth

Despite the lagging of growth, it is possible that it is endogenous to the system. Times of political instability may be harmful for growth, as they may be characterized by uncertainty, the mobilization of protestors, low investment, and reduced tourism. Expectations of political change may also harm growth, and the competence of incumbent leaders and challengers may affect both current economic growth and the likelihood of leader change. The policies and actions of the incumbent government (and others) may also affect both the economy and the likelihood of the national leader remaining in office. Given the infeasibility of controlling for unobservable factors such as anticipation of upcoming leader change, leader competence, and all relevant policies, an IV approach is required to obtain a consistent estimate of the impact of economic growth on political survival, and to ensure that estimates represent causal impacts, rather than simply correlation. An IV approach also allows potential attenuation bias arising from measurement error in national accounts data, for which there is substantial evidence (Heston 1994), to be addressed.

Four strategies to instrument for economic growth are employed. The strategies involve using sources of variation in economic growth resulting from the international economy or the weather which are unlikely to be affected by political developments in any individual country. I am unaware of any other instruments for economic growth of relevance to this paper that have been used elsewhere in the literature.[5]

The first IV strategy is to instrument for economic growth using changes in commodity export prices following Burke and Leigh (2010). I employ a commodity export price index constructed using country-specific commodity weights based on the share of each commodity in a country's (50-commodity) commodity export bundle in 1995.[6] These weights are held fixed over time and applied to deflated world price indices to produce a country-specific arithmetically weighted index of world commodity prices. The differenced log of the index is multiplied by the share of exports of the 50 commodities in GDP in 1995 to allow the effect of commodity price fluctuations on economic growth to be larger for countries that are more dependent on commodity exports, which substantially improves the strength of the instrument. The most important commodities in the index in value terms are oil, fish, natural gas, and coal.

[5] The terms of trade has been used to instrument for five-yearly changes in income (see e.g. Pritchett and Summers 1996). Terms of trade data are unavailable for the majority of country-years in the estimation sample.

[6] Using fixed weights ensures that the within-country variation of the instrument only reflects year-to-year changes in global commodity prices and is not affected by (potentially endogenous) reorientations of export quantities. A similar point applies to the export partner growth instrument. 1995 weights allow broad country coverage.

The second IV strategy is to instrument for growth using a weighted export partner growth rate. This strategy follows evidence that economic growth is strongly affected by export partner growth, even in estimations that control for distance-weighted and world GDP growth rates (Arora and Vamvakidis 2005). Weights are based on the share of each export market in a country's total exports in 1995, using data from the International Monetary Fund's Direction of Trade Statistics. The weighted export partner growth rate is multiplied by the share of exports in GDP in 1995 to allow export partner growth to be of greater importance to economic growth in relatively more export-oriented economies. Related IV approaches have been used in different contexts by Acemoglu et al. (2008) and Brückner and Ciccone (2010).

The third IV strategy is to instrument for GDP growth using precipitation. I use log precipitation, employing country-level data from Dell et al. (2008) and, for five small countries, Mitchell et al. (2004). Log precipitation has the advantage of providing stronger first-stage identification than the year-to-year proportional change in precipitation (as used by Miguel et al. 2004 and Burke and Leigh 2010). It is also appropriate to use precipitation levels rather than growth rates due to the mean-reverting nature of annual precipitation (see Brückner and Ciccone 2011 and Ciccone 2011).[7]

The fourth IV strategy is to instrument for economic growth using temperature. Dell et al. (2008) and Burke and Leigh (2010) show that temperature variation is strongly correlated with economic growth at the country level. I instrument for economic growth using (1) temperature and (2) temperature interacted with a dummy for countries with an average temperature for the period 1960-1970 of less than 12ºC (to allow the impact of temperature on economic growth to differ for cold countries).[8] Temperature data are country averages from Dell et al. (2008) and Mitchell et al. (2004).

The use of the four IV strategies is appealing because the instruments provide different sources of plausibly exogenous variation in economic growth, allowing the estimation of different local average treatment effects (LATEs). Commodity export prices and the pace of growth in the economies of export partners are demand-side factors that are of primary relevance for export-oriented sectors, whereas precipitation and temperature are supply-side factors likely to be most strongly correlated with growth in agricultural output.[9] The weather

[7] Im-Pesaran-Shin unit-root tests (Im et al. 2003) suggest that temperature and precipitation are stationary series. GDP per capita growth is also a stationary series. Annual growth rates are used for the commodity price and export partner GDP instruments because commodity prices and export partner GDP are unit root processes.

[8] Results are similar if different "cold country" temperature cut-offs are used.

[9] Precipitation is also important for other water-intensive activities, such as hydroelectricity generation. There is also evidence that higher temperatures reduce labor productivity and industrial output (Dell et al. 2008, Hsiang 2010).

instruments reflect transitory shocks, whereas commodity prices and export partner GDP do not display rapid mean reversion.

The instruments are not without limitation. The weather instruments are fairly weak for the global sample, and so results are also presented for sub-samples of economies which are likely to be more weather-dependent (e.g. agricultural countries). World commodity prices and export partner incomes may also not always be exogenous, as they might in some instances be affected by in-country political developments, particularly in countries that are important commodity exporters or have large economies. Nevertheless, similar results are obtained in estimations that exclude large commodity producers or large economies, as will be discussed.

The exclusion restriction is that the instruments are orthogonal to the error term in equation 1, so that they are only correlated with leader exits via their impact on economic growth. One can imagine ways in which this assumption might be violated. For example, the weather may directly affect political rallies, or commodity prices may have a direct effect in the political sphere beyond any effect via output. Although the data suggest that the instruments operate via the growth channel in a quantitatively important manner, they do not allow the possibility that the instruments operate via other channels to be dismissed.[10] If the instruments do not in fact satisfy the exclusion restriction, the results nonetheless suggest a strong impact of commodity prices and export partner growth rates on the timing of leader exits.

4. Data

Effective primary national leader data are sourced from the Archigos dataset (Goemans et al. 2009). I have used Rulers.org (2011) to extend the Archigos data to cover years 2005 and 2006. GDP data are from the World Bank (2011a). The secondary school enrollment series is constructed using World Bank (2011b) and DRI (2009) data. The Dell et al. (2008) precipitation and temperature data are country averages constructed by weighting Matsuura and Willmott (2007) gridded weather data by the location of the population within each country. These data are not available for five small countries (Bahrain, Barbados, Singapore, Maldives, Malta), for which I have employed precipitation and temperature data from

[10] One way to investigate the direct impact of the instruments on protests is to estimate the reduced-form relationship between the instruments and anti-government protests, as measured by Databanks International (2008). There is some evidence that additional precipitation reduces the likelihood of protests in the next year. Nevertheless, tests of the impact of the set of instruments on the likelihood of protests in either the same or the next year fail to find statistically significant evidence of a joint effect.

Mitchell et al. (2004). A list of data sources and variable definitions is provided in the Appendix.

The estimation sample consists of 5,496 observations for 45 years (1962-2006) and 162 countries. Saudi Arabia is excluded from the sample given that it has a large influence over the price of oil (the most important commodity covered by the commodity price instrument). There is at least one leader exit (excluding natural deaths and foreign depositions of leaders) in 891 of the country-years (16%). Leader changes are more common in democracies (which have a mean of three leader changes each decade) than autocracies (one change per decade). Summary statistics are presented in Table 1.

Table 1. Summary statistics

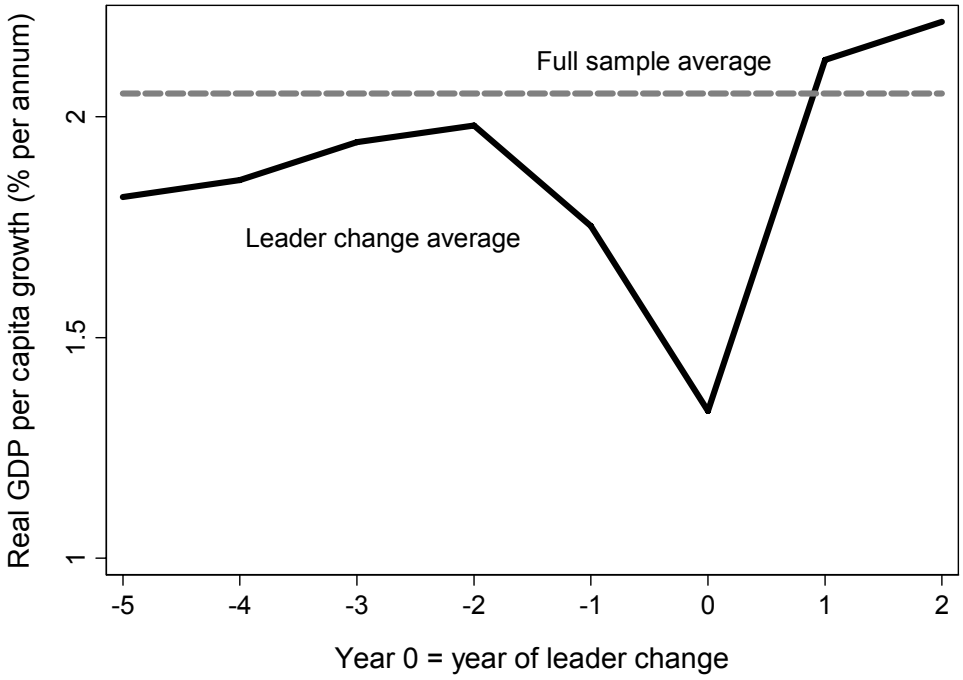
	Mean	(Standard deviation)
GDP per capita growth$_{t-1}$ (% per annum)	2.05	(6.01)
GDP per capita$_{t-2}$ (2000 US$ '000)	5.20	(7.83)
Secondary enrollment rate$_{t-2}$ (% gross)	49.92	(33.26)
Population aged 65 years and above$_{t-2}$ (%)	6.08	(4.16)
Tenure of leader in power at start of year$_t$ (years)	7.37	(7.74)
Age of leader in power at start of year$_t$ (years)	57.02	(11.02)
Transition dummy$_t$	0.00	(0.06)
Democracy dummy$_{t-1}$	0.46	(0.50)
Election dummy$_t$	0.19	(0.39)
Term limit dummy$_t$	0.03	(0.18)
Purge dummy$_t$	0.05	(0.21)
Commodity price instrument$_{t-1}$	0.06	(2.72)
Export partner growth instrument$_{t-1}$	126.88	(115.78)
Precipitation (ln mm)$_{t-1}$	6.83	(0.76)
Temperature$_{t-1}$ (ºC)	19.18	(7.28)
	Sum	
Years of at least one leader exit	891	
Countries	162	
Observations	5,496	

Data on major government crises and purges are available for 5,415 observations in the dataset.

A negative association between economic growth and political exits is evident in Figure 1, which plots the average GDP per capita growth rate for countries in the estimation sample for the years adjacent to leader changes. A reduction in GDP per capita growth commencing in the year prior to leader changes can be seen: times of political change tend to be times of slow growth. This may be because a slowing economy harms the political survival prospects of

national leaders; and/or because leader change harms the economy; and/or because of the effect of other factors on both the economy and political survival. An IV approach is required to obtain a consistent estimate of the causal impact of economic growth on political survival.

Figure 1. GDP growth at times of leader change



Goemans et al. (2009) and World Bank (2011a) data. Five years of lagged data are not available for all leader changes in the estimation sample. The "full sample average" is for all country-years in the sample, and is independent of the *x*-axis.

5. Results

5.1 Linear probability, logit, and hazard model results

LPM results are presented in columns 1-2 of Table 2. The results indicate that GDP per capita growth has a negative impact on the likelihood of leader exits. The estimated impact of growth on the likelihood of leader exits is statistically significant at the 1% level in a linear estimation including year and country fixed effects (column 1), and at the 5% level once the set of leader and country

characteristics are controlled for (column 2). The estimate in column 2 indicates that a one percentage point increase in GDP per capita growth on average reduces the likelihood of a national leader exit in the next year by 0.2 percentage points, equal to a 1.1% reduction in the average likelihood of leader change.

Table 2. LPM, logit, and hazard model estimation results

Dependent variable (columns 1-4): Exit of leader in year *t*

	(1)	(2)	(3)	(4)	(5)	(6)
Estimation	LPM		Logit		Cox proportional hazard model	
	Coefficients		Odds ratios		Hazard ratios	
GDP per capita growth$_{t-1}$	-0.003***	-0.002**	0.973***	0.974**	0.976***	0.983**
	(0.001)	(0.001)	(0.008)	(0.011)	(0.006)	(0.007)
Log GDP per capita$_{t-2}$		-0.004		0.856		0.951
		(0.034)		(0.367)		(0.252)
Tenure of leader in power at start of year$_t$ (years)		-0.001		0.996		1.725
		(0.001)		(0.014)		(0.773)
Age of leader in power at start of year$_t$ (years)		0.003***		1.029***		1.015***
		(0.001)		(0.009)		(0.005)
Transition dummy$_t$		0.310**		4.272*		1.827*
		(0.135)		(3.230)		(0.605)
Democracy dummy$_{t-1}$		0.018		1.226		1.038
		(0.024)		(0.280)		(0.152)
Election dummy$_t$		0.250***		6.881***		3.309***
		(0.021)		(0.896)		(0.335)
Election dummy$_{t-1}$		0.019		1.181		1.204*
		(0.012)		(0.159)		(0.115)
Term limit dummy$_t$		0.769***		+		6.030***
		(0.029)		***		(1.080)
Country and year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.017	0.246	0.025	0.273	-	-
Observations	5,496	5,496	5,082	5,082	5,496	5,496
LPM estimate on GDP per capita growth$_{t-1}$ for logit sample	-	-	-0.003***	-0.002**	-	-
Years of at least one leader exit	891	891	846	846	880	880
Countries	162	162	141	141	162	162
Years: 1962-2006						

Robust standard errors clustered by country are in parentheses. The logit estimation sample is by necessity restricted to countries that experienced within-sample variation in the dependent variable. The estimated odds ratio for the term limit dummy in the logit specification is large, positive, and statistically significant at the 1% significance level. Estimates in columns 2, 4, and 6 control for the secondary school enrollment rate (% gross) and the share of the population aged 65 years and above in year *t*-2. The hazard model models the years to leader change, treats each leader-spell as an individual subject, and only includes leaders in power at the start of the calendar year. The hazard estimates include 11 fewer leader exits than the LPM estimates because instances of leader exits occurring within the same year as but subsequent to the natural death of the initial leader are coded as zero (they are coded as one for the other estimates). The R^2 terms reflect the explanatory power of the time-varying explanatory variables and year dummies. The R^2 in columns 1-2 is the within-R^2. The R^2 in columns 3-4 is the pseudo-R^2. * Significant at 10%. ** Significant at 5%. *** Significant at 1%.

Logit results are presented as odds ratios in columns 3-4 of Table 2. An odds ratio of 1 indicates that a conditional increase in the independent variable is not associated with any change in the dependent variable, while an odds ratio above 1 indicates that an increase in the independent variable raises the dependent variable. The odds ratio on GDP per capita growth is 0.97 in the logit estimates (significant at the 5% level and higher), indicating that a percentage point increase in the growth rate lowers the probability of leader change by 3%. There is at least one leader exit in 16.6% of years in the logit sample so, at the mean, a 3% drop in the probability of leader change is equivalent to a 0.4 percentage point reduction (i.e. from 16.6% to 16.2%). This suggests that the logit estimates are slightly larger than the linear estimates. Estimated hazard ratios from the Cox proportional hazard model (columns 5-6 of Table 2) identify a negative impact of economic growth on the likelihood of a leader exit in the next year, with a magnitude inbetween those obtained from the LPM and logit estimates.[11]

Results on the control variables indicate that a strong ageing effect exists: older leaders are statistically more likely to lose their jobs (even after controlling for tenure). All else equal, leaders of transition economies were more likely to lose office during 1989-1992. Unsurprisingly, leaders are more likely to lose office subsequent to elections, and upon reaching their term limit. Democracy also increases the likelihood of leader turnover, although this effect is reduced by the election and term limit dummies. (See section 5.4 for further evidence on the impact of democracy on leader exits.)

5.2 Instrumental variable results

LPM, logit, and hazard model results may suffer from bias due to endogeneity of economic growth. Prior to presenting the IV results, it is useful to examine the direct impact of the instruments on leader exits. These can be seen in Table 3, which presents reduced-form estimations controlling for (1) country and year fixed effects and (2) these fixed effects and the set of time-varying controls. The results suggest that higher commodity export prices and faster export-partner economic growth reduce the likelihood of a leader losing his or her job in the next year. The estimations provide no statistically significant evidence of any effect of the weather variables on the probability of a leader exiting office.

[11] Similar results are obtained for exponential, Weibull, or Gompertz survival models.

Table 3. Reduced-form results

Dependent variable: Exit of leader in year *t*

	(1)	(2)
	With no time-varying controls	With time-varying controls
Commodity price instrument$_{t-1}$/100	-0.248**	-0.221**
	(0.107)	(0.092)
Export partner growth instrument$_{t-1}$/100	-0.014*	-0.011*
	(0.007)	(0.006)
Precipitation instrument$_{t-1}$/100	-0.429	-2.270
	(2.414)	(1.927)
Temperature instrument$_{t-1}$/100	-0.529	-1.524
	(1.412)	(1.322)
Temperature instrument$_{t-1}$*Cold country dummy/100	-0.652	0.625
	(2.005)	(1.975)
Country and year fixed effects	Yes	Yes
R^2	0.016	0.246
Observations	5,496	5,496
Years of at least one leader exit	891	891
Countries	162	162
Years: 1962-2006		

Robust standard errors clustered by country are in parentheses. The instruments have been divided by 100 to reduce the number of decimal places. Estimates in column 2 include the full set of controls used in the estimate in column 2 of Table 2 (estimated coefficients not shown). The R^2 is the within-R^2 and reflects the explanatory power of the time-varying variables and year dummies. * Significant at 10%. ** Significant at 5%.

IV estimates of equation 1 without the time-varying country controls are shown in Table 4. IV estimates use each of the instruments separately (columns 3-6), and consider the instruments jointly (column 2). They use the Fuller 1 estimator (Fuller 1977), which is a bias-corrected version of the limited information maximum likelihood estimator, and provides the most unbiased estimates for inference purposes when instruments are potentially weak (Stock and Yogo 2005). (Two-stage least squares estimates are similar.) Partial *R*-squared and *F* statistics on the excluded instruments are presented. The *F* statistic on the excluded instruments is the Stock-Yogo weak instruments test statistic. 5% significance level critical values for Stock-Yogo tests of both 30% and 5% maximal Fuller relative bias are also shown.

Table 4. IV regression results

Dependent variable: Exit of leader in year *t*

	(1)	(2)	(3)	(4)	(5)	(6)
Estimation	LPM	IV (F1)	IV (F1)	IV (F1)	IV (F1)	IV (F1)
Instrument/s	None	All	Commodity price instrument$_{t-1}$	Export partner growth instrument$_{t-1}$	Precipitation instrument$_{t-1}$	Temperature instruments$_{t-1}$
GDP per capita growth$_{t-1}$	-0.003***	-0.010**	-0.024*	-0.010*	-0.001	-0.004
	(0.001)	(0.005)	(0.013)	(0.005)	(0.020)	(0.013)
Country and year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
First-stage coefficients						
Commodity price instrument$_{t-1}$	-	0.098***	0.094***	-	-	-
Export partner growth instrument$_{t-1}$	-	0.014***	-	0.014***	-	-
Precipitation instrument$_{t-1}$	-	0.861**	-	-	0.943**	-
Temperature instrument$_{t-1}$	-	-0.654**	-	-	-	-0.739**
Temperature instrument$_{t-1}$*Cold country dummy	-	1.241***	-	-	-	1.448***
F statistic on excluded instruments	-	14.75	8.59	30.87	6.75	5.14
Stock-Yogo critical value	-	4.03/6.42	12.71/24.09	12.71/24.09	12.71/24.09	7.49/13.46
Partial R^2 on excluded instruments	-	0.031	0.002	0.025	0.001	0.004
Wooldridge endogeneity test *p* value	-	0.06	0.08	0.09	0.96	0.88
Sargan overidentification test *p* value	-	0.68	-	-	-	-
Observations	5,496	5,496	5,496	5,496	5,496	5,496
Years of at least one leader exit	891	891	891	891	891	891
Countries	162	162	162	162	162	162
Years: 1962-2006						

Robust standard errors clustered by country are in parentheses. Stock-Yogo critical values are the 5% significance level critical values for weak instruments tests based on, respectively, 30% and 5% maximal Fuller relative bias. The null of weak instruments is rejected if the *F* statistic on the excluded instruments exceeds the Stock-Yogo critical value/s. Results in column 1 are identical to those in column 1 of Table 2. The endogeneity and overidentification tests are for two-stage least squares estimates with robust but unclustered standard errors. F1 is Fuller 1. * Significant at 10%. ** Significant at 5%. *** Significant at 1%.

The instruments, when considered jointly, safely pass the Stock-Yogo weak instrument test, and explain 3.1% of the variation in GDP per capita growth for the sample (after country and year fixed effects are controlled for). The strongest of the instruments is the export partner growth instrument, which passes the Stock-Yogo weak instrument test. While the other instruments do not obtain high individual strength for the global sample, they are more important explanators of economic growth in additional specifications explored in the robustness analysis (section 5.3). The coefficients on the instruments in the first-stage regressions are of the expected signs: increases in commodity prices, export partner GDP growth rates, and precipitation on average result in faster economic growth, whereas higher temperatures are on average bad for growth in all but the group of cold countries. Tests of endogeneity and overidentification using the full set of instruments suggest that economic growth is indeed not exogenous and provide no evidence that the null hypothesis that the instruments are valid can be rejected.

Using all of the instruments (column 2 of Table 4), an estimate of the impact of growth on leader change that is more than three times larger than the LPM result (column 1 of Table 4) is obtained. The estimate indicates that an additional percentage point of per capita GDP growth reduces the likelihood of a change in national leader in the next year by a percentage point. This equals a 6% reduction in this likelihood, which is quite a large effect. The IV result implies that an additional percentage point of per capita GDP growth has a similar effect on the short-run likelihood of a change in national leader as having a leader who is three years younger.

The IV result on per capita GDP growth, significant at the 5% level, is driven primarily by the impact of fluctuations in commodity export prices and export partner growth rates. The estimated coefficients on growth using the commodity price variation and export partner growth instruments in columns 3-4 of Table 4 are each negative and statistically significant at the 10% level. That negative coefficient estimates are obtained instrumenting with either international commodity price movements or export partner growth rates provides reassurance against the concern that the results are a product of a violation of the exclusion restriction in either estimation. Estimates using the weather instruments (columns 5-6 of Table 4) suggest a negative effect of economic growth on leader exits, but one which is not statistically significant.

In Table 5, additional controls are added to the IV estimates. The results on the effect of growth on leader change are similar to those in Table 4 (although are slightly weaker in statistical terms), and results on the control variables are similar to those in the LPM specification.

Table 5. IV estimation results with additional controls

Dependent variable: Exit of leader in year t

	(1)	(2)	(3)	(4)	(5)	(6)
Estimation	LPM	IV (F1)	IV (F1)	IV (F1)	IV (F1)	IV (F1)
Instrument/s	None	All	Commodity price instrument$_{t-1}$	Export partner growth instrument$_{t-1}$	Precipitation instrument$_{t-1}$	Temperature instruments$_{t-1}$
GDP per capita growth$_{t-1}$	-0.002**	-0.008*	-0.022*	-0.008	-0.015	0.003
	(0.001)	(0.005)	(0.012)	(0.005)	(0.015)	(0.011)
Log GDP per capita$_{t-2}$	-0.004	-0.020	-0.058	-0.022	-0.039	0.010
	(0.034)	(0.036)	(0.051)	(0.037)	(0.052)	(0.044)
Tenure of leader in power at start of year$_t$ (years)	-0.001	-0.001	-0.001	-0.001	-0.001	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Age of leader in power at start of year$_t$ (years)	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Transition dummy$_t$	0.310**	0.268*	0.168	0.263*	0.218	0.347**
	(0.135)	(0.143)	(0.178)	(0.146)	(0.178)	(0.148)
Democracy dummy$_{t-1}$	0.018	0.019	0.022	0.019	0.021	0.016
	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
Election dummy$_t$	0.250***	0.248***	0.244***	0.248***	0.246***	0.251***
	(0.021)	(0.021)	(0.022)	(0.021)	(0.022)	(0.021)
Election dummy$_{t-1}$	0.019	0.020	0.022	0.020	0.021*	0.018
	(0.012)	(0.012)	(0.013)	(0.012)	(0.013)	(0.012)
Term limit dummy$_t$	0.769***	0.767***	0.762***	0.767***	0.764***	0.771***
	(0.029)	(0.029)	(0.033)	(0.029)	(0.031)	(0.030)
Country and year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
First-stage coefficients						
Commodity price instrument$_{t-1}$	-	0.097***	0.091***	-	-	-
Export partner growth instrument$_{t-1}$	-	0.013***	-	0.013***	-	-
Precipitation instrument$_{t-1}$	-	0.946***	-	-	1.052***	-
Temperature instrument$_{t-1}$	-	-0.766***	-	-	-	-0.864***
Temperature instrument$_{t-1}$* Cold country dummy	-	1.543***	-	-	-	1.743***
F statistic on excluded instruments	-	14.51	7.94	25.54	9.28	8.83
Stock-Yogo critical value	-	4.03/6.42	12.71/24.09	12.71/24.09	12.71/24.09	7.49/13.46
Partial R^2 on excluded instruments	-	0.029	0.002	0.021	0.001	0.006
Wooldridge endogeneity test p value	-	0.11	0.09	0.11	0.41	0.59
Sargan overidentification test p value	-	0.27	-	-	-	-
Observations	5,496	5,496	5,496	5,496	5,496	5,496
Years of at least one leader exit	891	891	891	891	891	891
Countries	162	162	162	162	162	162
Years: 1962-2006						

Robust standard errors clustered by country are in parentheses. Stock-Yogo critical values are the 5% significance level critical values for weak instruments tests based on, respectively, 30% and 5% maximal Fuller relative bias. The null of weak instruments is rejected if the F statistic on the excluded instruments exceeds the Stock-Yogo critical value/s. Estimates control for the secondary school enrollment rate (% gross) and the share of the population aged 65 years and above in year t-2. Results in column 1 are identical to those in column 2 of Table 2. The endogeneity and overidentification tests are for two-stage least squares estimates with robust but unclustered standard errors. F1 is Fuller 1. * Significant at 10%. ** Significant at 5%. *** Significant at 1%.

There are several potential explanations for why the IV estimates of the impact of per capita GDP growth on the likelihood of leader exits are larger (in absolute value terms) than the LPM estimates. One is that the political implications of changes in export-sector growth rates are indeed particularly large, perhaps because political elites are disproportionately involved in export activities. Another is that the LPM estimates suffer from attenuation bias due to measurement error in the GDP data. A further possibility is that leaders in crisis put pressure on their statistical offices to inflate growth figures (i.e. measurement error in economic data may be a function of political instability). Finally, it might be that in some instances the dismissal of incompetent leaders is foreseen, and that this has a positive impact on the economy.

5.3 Robustness analysis

To further explore the exclusion restriction, Table 6 presents IV specifications in which the instruments are used individually and the unused instruments are included directly in the second-stage estimations. The results provide no indication that the instruments have a direct effect on the likelihood of leader exits over and above the effect of economic growth, either individually or jointly.

Table 7 presents estimates for a specification which controls for leader exits in year *t*-1. Results on the *t*-1 GDP per capita growth term remain statistically significant. Table 7 also includes specifications using data on growth in (1) GDP and (2) gross domestic income (GDI), from the Penn World Table (Heston et al. 2011). Results are similar. Of particular note is that commodity price movements provide very strong first-stage identification for growth in GDI, safely passing the strictest Stock-Yogo weak instrument test. Using the full instrument set, a percentage point increase in the GDI growth rate is estimated to reduce the likelihood of a leader exit in the next year by 0.5 percentage points, an impact which is statistically significant at the 1% level.

The timing of the effect warrants examination. Table 8 presents IV results for GDP per capita growth in years *t*-2, *t*, and *t*+1 in addition to year *t*-1 (the year of focus to this point). The estimates fail to identify a significant impact of same-year growth on the probability of a leader exit. There is also no evidence that growth in year *t*-2 significantly affects year-*t* leader exits, or that leaders are replaced in anticipation of the state of the economy in year *t*+1. It is the impact of economic growth on the likelihood of next-year leader changes that remains the largest in magnitude across the specifications in Table 8. The reduction in the probability of a leader losing his or her job as a result of an increase in economic growth thus appears to be realized over the subsequent twelve months.

Table 6. Exploring the exclusion restriction

Dependent variable: Exit of leader in year *t*

	(1)	(2)	(3)	(4)
Estimation	IV (F1)	IV (F1)	IV (F1)	IV (F1)
Instrument/s included in first stage (all /100)	Commodity price instrument$_{t-1}$	Export partner growth instrument$_{t-1}$	Precipitation instrument$_{t-1}$	Temperature instruments$_{t-1}$
GDP per capita growth$_{t-1}$	-0.023*	-0.010*	-0.005	-0.004
	(0.013)	(0.006)	(0.023)	(0.016)
Commodity price instrument$_{t-1}$/100		-0.152	-0.203	-0.210
		(0.129)	(0.252)	(0.195)
Export partner growth instrument$_{t-1}$/100	0.019		-0.007	-0.009
	(0.021)		(0.033)	(0.023)
Precipitation instrument$_{t-1}$/100	1.588	0.412		0.152
	(2.575)	(2.437)		(2.780)
Temperature instrument$_{t-1}$/100	-2.058	-1.167	-0.820	
	(1.872)	(1.463)	(2.345)	
Temperature instrument$_{t-1}$*Cold country dummy/100	2.253	0.560	-0.093	
	(2.925)	(2.169)	(3.560)	
Country and year fixed effects	Yes	Yes	Yes	Yes
p value for joint significance of instruments included in second stage only	0.78	0.62	0.58	0.58
F statistic on excluded instruments	8.62	30.15	5.92	4.50
Stock-Yogo critical value	12.71/24.09	12.71/24.09	12.71/24.09	7.49/13.46
Partial R^2 on excluded instruments	0.002	0.024	0.001	0.003
Observations	5,496	5,496	5,496	5,496
Years of at least one leader exit	891	891	891	891
Countries	162	162	162	162
Years: 1962-2006				

Robust standard errors clustered by country are in parentheses. The instruments have been divided by 100. Stock-Yogo critical values are the 5% significance level critical values for weak instruments tests based on, respectively, 30% and 5% maximal Fuller relative bias. The null of weak instruments is rejected if the *F* statistic on the excluded instruments exceeds the Stock-Yogo critical value/s. F1 is Fuller 1. * Significant at 10%.

Table 7. Lagged leader exits and alternative growth measures

Dependent variable: Exit of leader in year *t*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Source for GDP/GDI growth data	World Bank		Penn World Table (columns 3-7)				
Estimation	LPM	IV (F1)	LPM	IV (F1)	LPM	IV (F1)	IV (F1)
Instrument/s	None	All	None	All	None	All	Commodity price instrument$_{t-1}$
GDP per capita growth$_{t-1}$	-0.003***	-0.010**	-0.002***	-0.009**			
	(0.001)	(0.005)	(0.001)	(0.004)			
GDI per capita growth$_{t-1}$					-0.002***	-0.005***	-0.004**
					(0.001)	(0.002)	(0.002)
Leader change dummy$_{t-1}$	-0.011	-0.021	-0.013	-0.019	-0.013	-0.016	-0.015
	(0.021)	(0.022)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Country and year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
First-stage coefficients							
Commodity price instrument$_{t-1}$	-	0.099***	-	0.125***	-	0.677***	0.674***
Export partner growth instrument$_{t-1}$	-	0.014***	-	0.014***	-	0.014***	-
Precipitation instrument$_{t-1}$	-	0.823**	-	1.428***	-	1.243**	-
Temperature instrument$_{t-1}$	-	-0.651**	-	-0.665**	-	-0.781***	-
Temperature instrument$_{t-1}$* Cold country dummy	-	1.263***	-	0.941***	-	1.163***	-
F statistic on excluded instruments	-	14.92	-	18.19	-	23.38	56.36
Stock-Yogo critical value	-	4.03/6.42	-	4.03/6.42	-	4.03/6.42	12.71/24.09
Partial R^2 on excluded instruments	-	0.031	-	0.020	-	0.063	0.048
Observations	5,496	5,496	5,402	5,402	5,407	5,407	5,407
Years of at least one leader exit	891	891	880	880	880	880	880
Countries	162	162	162	162	162	162	162
Years: 1962-2006							

Robust standard errors clustered by country are in parentheses. The set of 'All' instruments includes the commodity price instrument$_{t-1}$, export partner growth instrument$_{t-1}$, precipitation instrument$_{t-1}$, and temperature instruments$_{t-1}$. Stock-Yogo critical values are the 5% significance level critical values for weak instruments tests based on, respectively, 30% and 5% maximal Fuller relative bias. The null of weak instruments is rejected if the F statistic on the excluded instruments exceeds the Stock-Yogo critical value/s. F1 is Fuller 1. ** Significant at 5%. *** Significant at 1%.

Table 8. Timing of the effect

Dependent variable: Exit of leader in year *t*

	(1)	(2)	(3)	(4)	(5)	(6)
Estimation	IV (F1)	IV (F1)	IV (F1)	IV (F1)	IV (F1)	IV (F1)
Instruments	All_{t+1}	All_{t}	All_{t-2}	$All_{t-2,\, t-1}$	$All_{t,t-1}$	$All_{t-2,\, t-1,\, t,\, t+1}$
GDP per capita growth$_{t+1}$	-0.005					-0.007
	(0.006)					(0.006)
GDP per capita growth$_{t}$		-0.002			0.001	0.006
		(0.005)			(0.006)	(0.008)
GDP per capita growth$_{t-1}$				-0.011*	-0.010	-0.014*
				(0.006)	(0.006)	(0.007)
GDP per capita growth$_{t-2}$			-0.002	0.004		0.007
			(0.003)	(0.005)		(0.006)
Country and year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
F statistic on excluded instruments (across all first-stage equations)	10.98	12.37	15.88	5.75	5.49	2.62
Stock-Yogo critical value	4.03/6.42	4.03/6.42	4.03/6.42	3.02/4.41	3.02/4.41	n.a.
Observations	5,329	5,491	5,376	5,376	5,491	5,209
Years of at least one leader exit	864	891	880	880	891	853
Countries	162	162	162	162	162	162
Years: 1962-2006						

Robust standard errors clustered by country are in parentheses. The set of instruments includes the commodity price instrument, export partner growth instrument, precipitation instrument, and temperature instruments. The number of first-stage equations is equal to the number of growth terms. Stock-Yogo critical values are the 5% significance level critical values for weak instruments tests based on, respectively, 30% and 5% maximal Fuller relative bias. The null of weak instruments is rejected if the *F* statistic on the excluded instruments exceeds the Stock-Yogo critical value/s. F1 is Fuller 1. n.a. is not available. * Significant at 10%.

To allow for the possibility that the effect of *t*-1 economic growth on political survival depends on whether growth is positive or negative, I test $\alpha_0 = \alpha_1$ in the equation:

$$D_{c,t} = \alpha_0 \overline{G}_{c,t-1} + \alpha_1 \underline{G}_{c,t-1} + I_c + I_t + \varepsilon_{c,t} \quad (2)$$

where $\overline{G}$ equals GDP per capita growth when this is positive (0 otherwise), and $\underline{G}$ equals GDP per capita growth when this is negative (0 otherwise). (Results available on request.) An LPM estimation indicates that α_1 is more negative than α_2, with the difference significant at the 5% level. This suggests that the impact of economic growth on the next-year likelihood of leader exits might be asymmetric: i.e. contractions in output have particularly important implications for the odds of political survival. The IV estimation provides no statistically significant evidence of such asymmetry, however, as the instrumented growth terms are estimated with large standard errors.

The weather variables are relatively weak instruments for economic growth in the global sample. Temperature and precipitation are likely to be much more important for the economies of poor agricultural countries than they are for modern economies (Dell et al. 2008). To allow these instruments to obtain larger first-stage identification strength, Table 9 presents IV estimates for the impact of economic growth on next-year leader exits for three sub-samples of countries: (1) agricultural countries; (2) poor and hot countries, and (3) sub-Saharan African countries. Precipitation and temperature are indeed generally much stronger instruments for these sub-samples, as identified by the generally larger first-stage *F* statistics on the instrumental variables. The second-stage results across these specifications indicate a negative impact of economic growth on the likelihood of a leader exit in the next year, although this effect is only statistically significant for the case of precipitation shocks to the economies of agricultural countries. Altogether, the impact of economic shocks from the weather on political survival is not precisely estimated (even when these shocks provide sufficiently strong first-stage identification strength).

Table 9. Instrumenting with the weather instruments for relevant country sub-samples

Dependent variable: Exit of leader in year *t*

	(1)	(2)	(3)	(4)	(5)	(6)
Sub-sample	Agricultural countries		Poor and hot countries		Sub-Saharan Africa	
Estimation	IV (F1)	IV (F1)	IV (F1)	IV (F1)	IV (F1)	IV (F1)
Instrument/s	Precipitation instrument$_{t-1}$	Temperature instruments$_{t-1}$	Precipitation instrument$_{t-1}$	Temperature instrument$_{t-1}$	Precipitation instrument$_{t-1}$	Temperature instruments$_{t-1}$
GDP per capita growth$_{t-1}$	-0.019*	-0.004	-0.012	-0.012	-0.020	-0.021
	(0.011)	(0.224)	(0.014)	(0.020)	(0.018)	(0.014)
Country and year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
First-stage coefficients						
Precipitation instrument$_{t-1}$	5.283***	-	3.306***	-	2.196**	-
Temperature instrument$_{t-1}$	-	-2.358***	-	-1.809***	-	-1.654***
Temperature instrument$_{t-1}$*Cold country dummy	-	2.086**	-	-	-	-1.054**
F statistic on excluded instruments	17.20	4.60	11.73	15.11	4.43	17.88
Stock-Yogo critical value	12.71/24.09	7.49/13.46	12.71/24.09	12.71/24.09	12.71/24.09	7.49/13.46
Partial R^2 on excluded instruments	0.009	0.006	0.006	0.006	0.002	0.006
Observations	928	928	1,457	1,457	1,589	1,589
Years of at least one leader exit	124	124	174	174	153	153
Countries	28	28	41	41	44	44
Years: 1962-2006						

Robust standard errors clustered by country are in parentheses. Agricultural countries are those in which the agricultural share of gross value added in 1995 exceeded one-third (using data from the United Nations 2011). Poor countries are those in which the panel-average *t*-2 GDP per capita is less than US$600 in year-2000 prices. Hot countries are those with an average temperature for the period 1960-1970 of more than 12ºC (using Mitchell et al. 2004). Stock-Yogo critical values are the 5% significance level critical values for weak instruments tests based on, respectively, 30% and 5% maximal Fuller relative bias. The null of weak instruments is rejected if the *F* statistic on the excluded instruments exceeds the Stock-Yogo critical value/s. F1 is Fuller 1. * Significant at 10%. ** Significant at 5%. *** Significant at 1%.

Many additional robustness checks were carried out (available on request). The estimates for *t*-1 GDP per capita growth are similar and remain statistically significant in specifications that control for (country-specific) party dummies. The impact of economic growth on the next-year likelihood of political survival estimated in column 2 of Table 5 remains statistically significant in estimations that control for additional leader characteristics, such as the leader's gender, whether the leader entered office legally, whether the leader served earlier terms in office, and whether the leader was the first leader of their country post-independence. Results are also similar in specifications that control for the inflation rate, the percentage of the population under 15 years of age, the urbanization rate, the infant mortality rate, the logged size of the population, exports as a share of GDP, the number of anti-government demonstrations (from Databanks International 2008), internal armed conflicts (Gleditsch et al. 2002), and whether a country is subject to economic sanctions (Marinov 2005). The Arab Spring of 2011 suggests that regional political change contagion effects might be important to consider. The estimated impact of economic growth on the odds of leader change remains similar if the share of other countries in the region experiencing leadership change in year *t* is controlled for.[12]

Similar results are obtained using aggregate rather than per capita GDP growth. Results are also similar if a dependent variable measuring the number of changes in national leader is used (instead of the dummy for leader change). Overall results are not affected by using a dependent variable coded as zero for instances of leader exit due to sickness, or if data on national leaders from Cheibub et al. (2010) or Databanks International (2008) are used to code the dependent variable.

An issue of concern is that the commodity price and export partner growth instruments may be affected by political developments in large countries or important commodity producers. Nevertheless, IV results are similar if the 20 largest economies in 1995 (which together accounted for 85% of global GDP in US dollar terms) are excluded from the sample. Results are also similar if members of the Organization of the Petroleum Exporting Countries are excluded or if exports of commodities for which a country contributed more than 15% of global exports in 1995 are excluded from that country's commodity export bundle.

To explore whether the IV results are sensitive to the choice of 1995 as weight year for the commodity export price and export partner growth instruments, I carried out additional IV regressions using an instrument weight year of 1975. The results are generally similar, although estimation sample sizes are smaller and estimated coefficients have lower statistical significance. The IV result using a 1975-weighted commodity export price instrument indicates that

[12] The seven World Bank (2011a) regions were used in the construction of this variable.

economic growth has a negative impact on next-year leader exits (significant at the 10% level). A 1975-weighted export partner growth instrument provides an estimate on *t*-1 growth which is similar to that using 1995 weights, but which is not statistically significant.[13]

5.4 The roles of institutions and development level

The importance of economic growth for the political survival of national leaders may differ for countries with different governance institutions. Table 10 presents LPM and IV estimates in which *t*-1 economic growth per capita is interacted with two measures of democracy in *t*-1: the Cheibub et al. (2010) binary democracy indicator, and the Marshall et al. (2010) POLITY2 measure (which I have rescaled to range from -1 [full autocracy] to +1 [full democracy] to aid coefficient interpretation).[14] Given that the commodity price and export partner growth instruments have the most important impact on political survival, IV estimates are also provided using these "external economy" instruments. The implied growth coefficients for full democracies and full autocracies are shown.

The LPM estimates in Table 10 provide no evidence that the short-run impact of economic growth on political survival differs between democracies and autocracies. Interestingly, the IV estimates suggest that the impact of the growth rate on next-year leader exit odds is smaller in democracies than autocracies, although the difference is only significant in the estimate in column 2 (and only at the 10% level). The IV estimates in columns 3 and 5-6 indicate that the short-run impact of growth on leader exits remains negative in democracies, albeit smaller (in absolute value terms) than that for autocracies.

The estimates in Table 10 provide strong evidence that an additional percentage point of GDP per capita growth reduces the likelihood of incumbent autocrats exiting office in the next year (significant at the 5% level and higher). As far as I am aware, this is the first estimate of the importance of economic growth for the political survival of leaders in autocratic countries.

[13] The significant IV result using the export partner growth instrument is not solely a product of using 1995 weights. A similar result is obtained using 2000 weights.

[14] Results using the binary democracy measure of Boix et al. (forthcoming) are similar to those using the Cheibub et al. measure.

Table 10. Interaction of GDP growth with democracy measures

Dependent variable: Exit of leader in year *t*

	(1)	(2)	(3)	(4)	(5)	(6)
Estimation	LPM	IV (F1)	IV (F1)	LPM	IV (F1)	IV (F1)
Instrument/s	None	All	External economy instruments	None	All	External economy instruments
GDP per capita growth$_{t-1}$	-0.003***	-0.013**	-0.014**	-0.002**	-0.006	-0.010*
	(0.001)	(0.006)	(0.006)	(0.001)	(0.006)	(0.005)
GDP per capita growth$_{t-1}$*Democracy dummy$_{t-1}$	0.000	0.016*	0.010			
	(0.002)	(0.008)	(0.008)			
GDP per capita growth$_{t-1}$*POLITY2 (rescaled)$_{t-1}$				-0.001	0.002	0.003
				(0.001)	(0.005)	(0.006)
Democracy dummy$_{t-1}$	0.063***	0.038	0.047*			
	(0.023)	(0.026)	(0.027)			
POLITY2 (rescaled)$_{t-1}$				0.053***	0.047**	0.045**
				(0.017)	(0.021)	(0.022)
Country and year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Implied growth coefficient for (full) democracy	-0.003	0.002	-0.003	-0.003	-0.004	-0.007
Implied growth coefficient for (full) autocracy	-0.003	-0.013	-0.014	-0.002	-0.008	-0.013
F statistic on excluded instruments (across two first-stage equations)	-	11.97	9.19	-	11.62	7.42
Stock-Yogo critical value	-	3.02/4.41	5.10/8.53	-	3.02/4.41	5.10/8.53
Observations	5,496	5,496	5,496	5,148	5,148	5,148
Years of at least one leader exit	891	891	891	845	845	845
Countries	162	162	162	152	152	152
Years: 1962-2006						

Robust standard errors clustered by country are in parentheses. POLITY2 has been rescaled to range from -1 (full autocracy) to 1 (full democracy), rather than -10 to 10. POLITY2 is not available for all country-years in the sample. The set of 'All' instruments includes (1) the commodity price instrument$_{t-1}$, export partner growth instrument$_{t-1}$, precipitation instrument$_{t-1}$, and temperature instruments$_{t-1}$ and (2) these instruments multiplied by the term with which GDP per capita growth$_{t-1}$ is interacted with. The 'External economy' instruments are the commodity price and export partner growth instruments, and their relevant interaction terms. The number of first-stage equations is equal to two (the number of growth terms). Stock-Yogo critical values are the 5% significance level critical values for weak instruments tests based on, respectively, 30% and 5% maximal Fuller relative bias. The null of weak instruments is rejected if the *F* statistic on the excluded instruments exceeds the Stock-Yogo critical value/s. F1 is Fuller 1. * Significant at 10%. ** Significant at 5%. *** Significant at 1%.

That (instrumented) growth might be more important for the short-run political survival of autocrats than of democrats is surprising, and could be attributable to two factors. First, sub-sample estimations (available on request) indicate that the instruments are more strongly correlated with economic growth in autocracies. As a result, the estimates in Table 10 could reflect a stronger LATE arising from external economy and weather shocks in autocracies than in democracies. Second, the impact of economic growth on the odds of a leader exit in the next year in democracies might be reduced by the rigidity of leader replacement timings in some democratic systems (e.g. those with fixed terms).

That the political survival odds of autocrats are affected by the economy relates to the argument of Londregan and Poole (1996) that even autocratic countries generally have in-built accountability criteria for leaders which make them more likely to be replaced if they perform poorly.[15] Slow growth also likely provides an opportune time for opponents to grab power off an autocrat.

My overall interpretation of the results in Table 10 is that, although imprecisely estimated, economic growth likely has a negative effect on the odds of a next-year leader exit in democracies. Such a conclusion is supported by the statistical insignificance of the interaction terms (other than that in column 2), and the implied growth coefficients for full democracies, which are -0.003 to -0.007 in the POLITY2 IV interaction specifications. That growth reduces the likelihood of a democrat exit is also supported by an IV estimation for the democracy sub-sample (available on request), which indicates that a percentage point increase in growth reduces the likelihood of a democrat's exit in the next year by 1.1 percentage points. This estimate is similar to the overall effect for the full sample (Table 4), although remains outside standard statistical significance ($p = 0.27$).

To explore whether the impact of economic growth on political survival varies by development level, Table 11 presents estimates for specifications with interaction terms between the economic growth rate in t-1 and either (1) the t-2 log GDP per capita level or (2) a dummy variable for "poor" countries, defined as countries with below-median per capita GDP in their first year in the sample (following an approach similar to that of Dell et al. 2008). The estimates in columns 1-2 provide some indication that higher per capita GDP makes leaders less sensitive to short-run economic growth (significant at the 10% level). But most of the coefficient estimates in Table 11 have high standard errors, and they together provide little evidence that the short-run growth effect varies systematically across countries at different development levels. The overall results thus suggest that the underlying nature of support coalitions may be broadly similar across countries at different levels of economic development as well as across countries with different institutions.

[15] Londregan and Poole refer to the "underlying similarity of support coalitions" in autocracies and democracies (p. 27).

Table 11. Interaction of GDP growth with measures of development level

Dependent variable: Exit of leader in year *t*

	(1)	(2)	(3)	(4)	(5)	(6)
Estimation	LPM	IV (F1)	IV (F1)	LPM	IV (F1)	IV (F1)
Instrument/s	None	All	External economy instruments	None	All	External economy instruments
GDP per capita growth$_{t-1}$	-0.009***	-0.045**	-0.036	-0.001	-0.014	-0.015
	(0.003)	(0.022)	(0.024)	(0.002)	(0.010)	(0.009)
GDP per capita growth$_{t-1}$*Log GDP per capita$_{t-2}$	0.001*	0.005*	0.003			
	(0.000)	(0.003)	(0.003)			
GDP per capita growth$_{t-1}$*Poor country dummy				-0.002	0.011	0.006
				(0.002)	(0.009)	(0.008)
Log GDP per capita$_{t-2}$	0.003	-0.031	-0.030			
	(0.030)	(0.040)	(0.041)			
Country and year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
F statistic on excluded instruments (across two first-stage equations)	-	5.57	5.92	-	9.06	11.58
Stock-Yogo critical value	-	3.02/4.41	5.10/8.53	-	3.02/4.41	5.10/8.53
Observations	5,496	5,496	5,496	5,496	5,496	5,496
Years of at least one leader exit	891	891	891	891	891	891
Countries	162	162	162	162	162	162
Years: 1962-2006						

Robust standard errors clustered by country are in parentheses. The set of 'All' instruments includes (1) the commodity price instrument$_{t-1}$, export partner growth instrument$_{t-1}$, precipitation instrument$_{t-1}$, and temperature instruments$_{t-1}$ and (2) these instruments multiplied by the term with which GDP per capita growth$_{t-1}$ is interacted with. The 'External economy' instruments are the commodity price and export partner growth instruments, and their relevant interaction terms. The number of first-stage equations is equal to two (the number of growth terms). Stock-Yogo critical values are the 5% significance level critical values for weak instruments tests based on, respectively, 30% and 5% maximal Fuller relative bias. The null of weak instruments is rejected if the *F* statistic on the excluded instruments exceeds the Stock-Yogo critical value/s. F1 is Fuller 1. * Significant at 10%. ** Significant at 5%. *** Significant at 1%.

5.5 Economic growth and modes of leader exits

To explore what types of leader exits are affected most strongly by economic growth, I categorize leader exits by mode using the EXIT variable in Archigos. Regular exits occur when a leader leaves office according to the prevailing rules, provisions, conventions and norms of the country, for reasons including loss of an election, end of term, voluntary retirement, losing cabinet support, losing the support of parliament, or ill health.[16] Irregular exits occur when a leader is removed from office in contravention of rules and conventions (for example, by coups, assassinations, military power struggles, or removal by domestic rebel forces or revolts). In 719 of the 891 years of leader exits, the first exit during the year was for regular reasons. The other 172 exits in the sample were irregular. Regular exits make up the majority of the first leader exits in the year in both democracies (91%) and autocracies (58%).

LPM, multinomial logit, and IV results for the two different modes of leader exit are presented in Table 12. The results in columns 1-3 indicate that faster economic growth reduces the short-run likelihood of a regular leader exit, with the IV result suggesting that each percentage point of growth reduces the likelihood of a regular exit in the subsequent year by 0.8 percentage points.

The LPM and multinomial results in columns 4-5 of Table 12 indicate that growth tends to be slower in the lead-up to irregular leader exits, yet this may reflect reverse causality. The IV estimate in column 6 suggests a negative effect of growth on irregular exits, although one that is outside the standard significance level. Unreported specifications in which growth is interacted with the democracy variable do not indicate that the overall impact of growth on irregular leader exits differs between democracies and autocracies.

Separate (unreported) estimates instrumenting only with precipitation suggest slower growth caused by low rainfall increases the short-run likelihood of an irregular leader exit, particularly in autocratic countries (significant at the 1% level for an autocracy sub-sample, and at 10% for the full sample).[17] A statistically significant estimate [-0.003] of the impact of growth on irregular leader exits is also obtained using the full instrument set and the Heston et al. GDP growth data. There is thus some evidence that irregular leader transitions are affected by growth shocks (especially those from precipitation), although the overall average effect of growth on the likelihood of irregular leader exits appears to be small.

[16] Leaders exiting due to ill health have been added to the Archigos coding of regular exits.

[17] This result relates to the finding that falls in precipitation often trigger autocratic countries to transition toward democracy (Burke and Leigh 2010, Brückner and Ciccone 2011).

Table 12. Impact of economic growth on different modes of leader exits

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: First exit of leader in year *t* is due to …		Regular leader exit (columns 1-3)			Irregular leader exit (columns 4-6)	
Estimation	LPM	Multinomial logit (relative risk ratios)	IV (F1)	LPM	Multinomial logit (relative risk ratios)	IV (F1)
Instrument/s	None	None	All	None	None	All
GDP per capita growth$_{t-1}$	-0.002**	0.979**	-0.008**	-0.001**	0.967**	-0.002
	(0.001)	(0.009)	(0.004)	(0.000)	(0.014)	(0.002)
Country and year fixed effects	Yes	Country only	Yes	Yes	Country only	Yes
F statistic on excluded instruments	-	-	14.75	-	-	14.75
Stock-Yogo critical value	-	-	4.03/6.42	-	-	4.03/6.42
p value: test of equality with corresponding coefficient for regular exits	-	-	-	0.51	0.44	0.13
Observations	5,496	5,082	5,496	5,496	5,082	5,496
Observations for which dependent variable equals 1	719	674	719	172	172	172
Countries	162	141	162	162	141	162
Years: 1962-2006						

Robust standard errors clustered by country are in parentheses. The set of instruments includes the commodity price instrument$_{t-1}$, export partner growth instrument$_{t-1}$, precipitation instrument$_{t-1}$, and the temperature instruments$_{t-1}$. Stock-Yogo critical values are the 5% significance level critical values for weak instruments tests based on, respectively, 30% and 5% maximal Fuller relative bias. The null of weak instruments is rejected if the *F* statistic on the excluded instruments exceeds the Stock-Yogo critical value/s. The IV test of parameter restrictions is for two-stage least squares estimates. The multinomial logit estimates are from a single estimation and control for a time trend instead of the year dummies to allow convergence. Regular exits occur when a leader leaves office according to the prevailing rules, provisions, conventions and norms of the country, for reasons including loss of an election, end of term, voluntary retirement, losing cabinet support, losing the support of parliament, or ill health. Irregular exits occur when a leader is removed from office in contravention of rules and conventions (for example, by coups, assassinations, military power struggles, or removal by domestic rebel forces or popular revolts). Dependent variables are for the first leader exit in the calendar year for reasons other than natural death or foreign deposition. F1 is Fuller 1. * Significant at 10%. ** Significant at 5%. *** Significant at 1%.

5.6 Leader reactions to growth shocks

National leaders differ substantially in their political longevity. Some, such as President Mobutu Sese Seko of the former Zaire (in office 1965-1997), have stayed in power for long periods of time, despite poor economic records. One potential factor in explaining the longevity of these leaders is that they employ oppressive tactics to circumvent rising political opposition at times of weak economic growth. There is little evidence on whether national leaders are more likely to engage in crackdowns on opponents when the economy is weak.[18]

To explore the impact of growth on political oppression, I utilize data from Databanks International (2008) on "purges", defined as any systematic elimination by jailing or execution of opponents within the ranks of the regime or the opposition. I regress a dummy for whether a country had a political purge on economic growth and year dummies in the fixed-effects LPM and IV model frameworks. The Databanks International data are constructed primarily from reports in the *New York Times*. They may be subject to geographic and other biases, but provide the best available data coverage for these variables.

The results on the impact of economic growth (both current and lagged) on purges are presented in Table 13. The LPM estimate in column 1 indicates that political purges tend to occur during years of slower growth. The IV estimates indicate a negative impact of growth on the likelihood of purges, yet these estimates are imprecise (and do not pass the standard statistical significance criteria). Accordingly, the results do not provide strong evidence on whether slow growth increases the likelihood of oppression. I also did not find strong evidence of a causal impact of economic growth on purges in unreported specifications using the instruments individually and/or using the Heston et al. GDP growth data. Whether and how leaders respond to negative economic shocks to attempt to improve their likelihood of remaining in office may be a fruitful line for further research.

[18] Henderson (1991) reports that stronger long-run economic growth reduces political repression, but does not look at the importance of the economic growth rate for political repression in the short term.

Table 13. Economic growth and the likelihood of political purges
Dependent variable: Purge dummy$_t$

	(1)	(2)	(3)	(4)
Estimation	LPM	IV (F1)	LPM	IV (F1)
Excluded instrument/s	None	All$_t$	None	All$_{t-1}$
GDP per capita growth$_t$	-0.001**	-0.003		
	(0.001)	(0.003)		
GDP per capita growth$_{t-1}$			0.000	-0.003
			(0.001)	(0.003)
Country and year fixed effects	Yes	Yes	Yes	Yes
F statistic on excluded instruments	-	11.92	-	13.26
Stock-Yogo critical value	-	4.03/6.42	-	4.03/6.42
Partial R^2 on excluded instruments	-	0.028	-	0.033
Observations	5,410	5,410	5,415	5,415
Years of one or more purge	251	251	251	251
Countries	162	162	162	162
Years: 1962-2006				

Robust standard errors clustered by country are in parentheses. The set of instruments includes the commodity price instrument, export partner growth instrument, precipitation instrument, and temperature instruments. Stock-Yogo critical values are the 5% significance level critical values for weak instruments tests based on, respectively, 30% and 5% maximal Fuller relative bias. The null of weak instruments is rejected if the *F* statistic on the excluded instruments exceeds the Stock-Yogo critical value/s. A purge is any systematic elimination by jailing or execution of political opponents within the ranks of the regime or the opposition. F1 is Fuller 1. ** Significant at 5%.

6. Conclusion

This paper explores whether a nation's rate of economic growth affects the short-run political survival prospects of that nation's leader. The identification strategy exploits variation in economic growth due to shocks from the global economy and the weather to obtain an internally-valid estimate of the effect of economic growth on the likelihood of leader exits. The results provide evidence that faster economic growth increases the likelihood that national leaders will retain their positions. Shocks from the global economy (commodity prices and export partner incomes) have a particularly important effect on the ability of national leaders to remain in office. While growth slowdowns do not invariably result in leadership change, the findings suggest that hard economic times make national leaders more likely to lose their jobs, particularly via regular means such as resignations and election losses. That the state of the economy has a systematic effect on the likelihood of leader survival provides evidence of a broad *economic political*

cycle (with causality from the economy to politics) that mirrors the much-studied *political business cycle* (which results from leaders' actions to manipulate the economic cycle to maximize their chances of retaining office).

Existing studies have typically examined the effect of economic growth on democratic election results, and have normally ignored the potential endogeneity of economic growth. This paper provides causal evidence of a relationship between economic growth and political survival that extends beyond the ballot box. Of most interest is the finding that even leaders in autocratic countries are more likely to lose their positions when the economy is weak.

The magnitude of the estimated impact of GDP growth on political survival is quite large. The IV estimate in column 2 of Table 5 indicates that a standard deviation increase in the rate of economic growth reduces the probability of leader change in the next year by almost 5 percentage points. This is equal to 29% of the underlying probability of leader change.

The results speak to the importance of economic fortunes for the political longevity of national leaders. Shocks to the economy from commodity prices and external demand for exports are outside the control of individual leaders, but affect the probability that they will keep their jobs. The evidence indicates that many leaders who have served short terms may be able to cite bad luck. Similarly, many long-lasting leaders may have fortuitous economic times to thank.

The IV finding that stronger GDP growth caused by exogenous factors (e.g. increasing prices for commodity exports) improves political survival prospects does not necessarily imply that stronger GDP growth caused by leader policies also improves political survival prospects. Unfortunately, I do not have an identification strategy to obtain an internally-valid estimate of the effect of leader-affected changes in economic growth on the likelihood of that leader's political survival. Reason would suggest, however, that if at least some of the impact of a leader's actions on the economy is measurable by at least some members of the selectorate, the leader should be held more accountable for these outcomes than outcomes over which he/she has no control. If this is the case, the IV estimates may represent the lower bound of the impact of leader-affected economic growth on that leader's short-run political survival prospects.

The findings have important policy implications. They suggest that national leaders should not neglect the economy, for the sake of their own careers at least. Leaders in countries with flexible election terms are well advised to time elections for when the economy is strong so as to maximise their likelihood of re-election. Another implication is that government interventions to bolster economic growth, where effective, have positive externalities for incumbent national leaders of trade-linked partners, including autocratic leaders. Finally, economic slowdowns place external actors in a unique position to influence political change. Crisis assistance conditioned on the benevolence of national leaders may be

valuable in shoring up the positions of benevolent leaders during times of economic hardship, while ensuring that corrupt or autocratic leaders do not receive relief from domestic political pressures at the very moment when these pressures are building in strength.

Appendix: Variable definitions

Exit of leader in year: Binary variable, =1 if there are one or more exits of the effective primary national leader during the year for reasons other than natural death or foreign deposition; 0 otherwise. Goemans et al. (2009). Extended to cover 2005 and 2006 using Rulers.org (2011).

GDP per capita growth: Annual percentage growth rate of GDP per capita based on constant local currency. Scaled so that one percentage point of growth is 1, not 0.01. World Bank (2011a).

Log GDP per capita: Log GDP per capita based on constant 2000 GDP in United States dollars (US$). World Bank (2011a).

Secondary enrollment rate (% gross): Number of pupils enrolled in secondary education, regardless of age, expressed as a percentage of the population in the theoretical age group for secondary education. Data from the World Bank (2011b) and DRI (2009). Data are interpolated (linear) and extrapolated (constant).

Population aged 65 years and above (%): Percentage of the total population aged 65 years or older. World Bank (2011a).

Tenure of leader in power at start of year (years): Sum of 31 Decembers that the leader has been in office during current tenure. Calculated for leader in office on 1 January using Goemans et al. (2009). Extended to cover 2005 and 2006 using Rulers.org (2011).

Age of leader in power at start of year (years): Calendar year minus birth year of leader in office on 1 January, calculated using Goemans et al. (2009). Extended to cover 2005 and 2006 using Rulers.org (2011).

Transition dummy: Binary variable, =1 for the years 1989-1992 for transition economies; 0 otherwise. DRI (2009).

Democracy dummy: Binary variable, =1 if country is classed as a democracy at year end; 0 otherwise. Cheibub et al. (2010). Data are unavailable for 1% of country-years in the sample. Countries are coded as autocracies for these years (an operation that does not affect the results).

Election dummy: Binary variable, =1 if an election affecting the effective national leader occurred during the year; 0 otherwise. Constructed with election data from Goemans (2009) using the following operation on six binary variables: Presidential election (0,1)*Leader subject to presidential elections (0,1) + Parliamentary election (0,1)*Leader subject to parliamentary elections (0,1) + Presidential or parliamentary election (0,1)*Assembly-elected president (0,1). Beck et al. (2001) and other sources used to allocate leaders to elections.

Term limit dummy: Binary variable, =1 if national leader left office due to legal requirement during year; 0 otherwise. Author construction. Does not include cases in which a national leader avoided a requirement to leave office.

GDP per capita growth (Penn World Table): Annual percentage growth rate of GDP per capita based on constant-price purchasing power parity-converted GDP (chain series). Scaled so that one percentage point of growth is 1, not 0.01. Heston et al. (2011).

GDI per capita growth (Penn World Table): Annual percentage growth rate of real gross domestic income per capita. GDI is constructed via terms-of-trade adjustments to constant-price purchasing power parity-converted GDP (Laspeyres). Scaled so that one percentage point of growth is 1, not 0.01. Heston et al. (2011).

POLITY2 (rescaled): Revised Combined Polity Score of the Polity IV Project. Marshall et al. (2010). Rescaled so it ranges from -1 (full autocracy) to +1 (full democracy).

Purge dummy: Binary variable, =1 if there is an instance of systematic elimination by jailing or execution of political opposition within the ranks of the regime or the opposition. Databanks International (2008).

Commodity price instrument: Differenced logarithm of a country-specific commodity export price index for 50 commodities, using 1995 commodity

export basket weights and interacted with the 1995 share of exports of the 50 commodities in GDP. Burke and Leigh (2010).

Export partner growth instrument: Weighted average of export partners' GDP growth rates multiplied by the 1995 share of exports in GDP (capped at 100% of GDP). Data for 1995 are used for export partner weights. Constructed using World Bank (2011a) and International Monetary Fund (IMF, 2009) data. In the case of missing export partner GDP growth data, data from Heston et al. (2011) are used. If export partner GDP data are still missing, the world GDP growth rate is used. Similar results are obtained using alternative approaches to dealing with missing export partner growth data. For five countries, data on the export share of GDP for 1995 are not available. Data available for the year closest to 1995 are used. For three countries (Belgium, Luxembourg, South Africa), data on exports by partner for 1995 are not available from the IMF; data for 1998 are used. For six countries, data on exports by partner are not available for any year. For the four small members of the Southern Africa Customs Union, the export partner weight is set equal to 1 for South Africa and 0 for other partners. For Bhutan and Eritrea, the export weight is set equal to 1 for the largest export market as listed by the Central Intelligence Agency (2009). Results are similar if these countries are excluded from the estimations.

Precipitation instrument: Natural logarithm of yearly precipitation in millimeters (mm). Data are country averages using 1990 within-country population weights from Dell et al. (2008). Data for five small countries (Bahrain, Barbados, Singapore, Maldives, Malta) are not available from Dell et al. (2008); data from Mitchell et al. (2004) are used. The Mitchell et al. data are not population weighted.

Temperature instruments: (1) Temperature (ºC); and (2) temperature (ºC) multiplied by a dummy for countries with an average temperature for the period 1960-1970 of less than 12ºC. Data are country averages using 1990 within-country population weights from Dell et al. (2008). Data for Bahrain, Barbados, Singapore, Maldives, and Malta are not available from Dell et al. (2008); data from Mitchell et al. (2004) are used (which are not population-weighted). The 1960-1970 temperature average is from Mitchell et al. (2004).

References

Acemoglu, D., Johnson, S., Robinson, J.A. and Yared P. (2008). 'Income and democracy', *American Economic Review*, 98, 808–842.

Alesina, A., Özler, S., Roubini, N. and Swagel, P. (1996). 'Political instability and economic growth', *Journal of Economic Growth*, 1, 189–211.

Alesina, A., Roubini, N. and Cohen, G.D. (1997). *Political Cycles and the Macroeconomy*, MIT Press, Cambridge, MA.

Arora, V. and Vamvakidis, A. (2005). 'How much do trading partners matter for economic growth?', *IMF Staff Papers*, 52, 24–40.

Barro, R.J. (1991). 'Economic growth in a cross section of countries', *Quarterly Journal of Economics*, 106, 407–443.

Beck, T., Clarke, G., Groff, A., Keefer, P. and Walsh, P. (2001). 'New tools in comparative political economy: The database of political institutions', *World Bank Economic Review*, 15, 165–176.

Besley, T. and Kudamatsu, M. (2008). 'Making autocracy work', in E. Helpman (ed.) *Institutions and Economic Performance*, Harvard University Press, Cambridge, MA.

Bienen, H. and van de Walle, N. (1992). 'A proportional hazard model of leadership duration', *Journal of Politics*, 54, 685–717.

Bienen, H.S. and van de Walle, N. (1991). *Of Time and Power: Leadership Duration in the Modern World*, Stanford University Press, Stanford, CA.

Boix, C., Miller, M. and Rosato, S. (Forthcoming). 'A complete dataset of political regimes, 1800-2007', *Comparative Political Studies*.

Brender, A. and Drazen, A. (2008). 'How do budget deficits and economic growth affect reelection prospects? Evidence from a large panel of countries', *American Economic Review*, 98, 2203–2220.

Brückner, M. and Ciccone, A. (2010). 'International commodity prices, growth and the outbreak of civil war in sub-Saharan Africa', *Economic Journal*, 120, 519–534.

Brückner, M. and Ciccone, A. (2011). 'Rain and the democratic window of opportunity', *Econometrica*, 79, 923–947.

Brückner, M., Ciccone, A., and Tesei, A. (Forthcoming). 'Oil price shocks, income, and democracy', *Review of Economics and Statistics*.

Brunetti, A. (1997). *Politics and Economic Growth: A Cross-Country Data Perspective*, Development Centre of the Organisation for Economic Co-operation and Development, Paris.

Bueno de Mesquita, B., Smith, A., Siverson, R.M. and Morrow, J.D. (2003). *The Logic of Political Survival*, MIT Press, Cambridge, MA.

Bueno de Mesquita, B. and Smith, A. (2010). 'Leader survival, revolutions, and the nature of government finance', *American Journal of Political Science*, 54, 936–950.

Burke, P.J. and Leigh, A. (2010). 'Do output contractions trigger democratic change?', *American Economic Journal: Macroeconomics*, 2, 124–157.

Cáceres, N. and Malone, S. (2011). 'Economic growth, political institutions, and leadership transitions', mimeo. University of the Andes School of Management.

Carmignani, F. (2002). 'New evidence on the politics and economics of multiparty cabinets duration', *Scottish Journal of Political Economy*, 49, 249–279.

Caselli, F. and Tesei, A. (2011). 'Resource windfalls, political regimes, and political stability', CEPR Discussion Paper 8662.

Central Intelligence Agency (2009). *The World Factbook*, https://www.cia.gov/library/publications/the-world-factbook/.

Cheibub, J.A., Gandhi, J. and Vreeland, J.R. (2010). 'Democracy and dictatorship revisited', *Public Choice*, 143, 67–101.

Ciccone, A. (2011). 'Economic shocks and civil conflict: A comment', *American Economic Journal: Applied Economics*, 3, 215–227

Cox, D. (1972). 'Regression models and life tables', *Journal of the Royal Statistical Society*, Series B, 34, 187–220.

Databanks International (2008). *Cross-National Time-Series Data Archive*, http://www.databanksinternational.com.

Deaton, A.S. and Miller, R.I. (1995). 'International commodity prices, macroeconomic performance, and politics in sub-Saharan Africa', *Princeton Studies in International Finance*, 79.

Dell, M., Jones, B.F. and Olken, B.A. (2008). 'Climate change and economic growth: Evidence from the last half century', National Bureau of Economic Research Working Paper 14132.

Development Research Institute (2009). *Global Development Network Growth Database*, http://nyudri.org/resources/global-development-network-growth-database/.

Drazen, A. (2000). 'The political business cycle after 25 years', *NBER Macroeconomics Annual*, 15, 75–117.

Fuller, W.A. (1977). 'Some properties of a modification of the limited information estimator', *Econometrica*, 45, 939–953.

Gleditsch, N.P., Wallensteen, P., Eriksson, M., Sollenberg, M. and Strand, H. (2002). 'Armed conflict 1946–2001: A new dataset', *Journal of Peace Research*, 39, 615–637.

Goemans, H.E. (2009). *Election Dates*, http://www.rochester.edu/college/faculty/hgoemans/data.htm.

Goemans, H.E., Gleditsch, K.S. and Chiozza, G. (2009). 'Introducing Archigos: A dataset of political leaders', *Journal of Peace Research*, 46, 269–283.

Greene, W.H. (2000). *Econometric Analysis*, 4th ed., Prentice Hall, Upper Saddle River, NJ.

Henderson, C.W. (1991). 'Conditions affecting the use of political repression', *Journal of Conflict Resolution*, 35, 120–142.

Heston, A. (1994). 'A brief review of some problems in using national accounts data in level of output comparisons and growth studies', *Journal of Development Economics*, 44, 29–52.

Heston, A., Summers, R. and Aten, B. (2011). *Penn World Table Version 7*. Center for International Comparisons at the University of Pennsylvania.

Hsiang, S.M. (2010). 'Temperatures and cyclones strongly associated with economic production in the Caribbean and Central America', *Proceedings of the National Academy of Sciences*, 107, 15367–15372.

Huntington, S.P. (1968). *Political Order in Changing Societies*, Yale University Press, New Haven, CT.

Huntington, S.P. (1991). *The Third Wave: Democratization in the Late Twentieth Century*, University of Oklahoma Press, Norman, OK.

Im, K.S., Pesaran, M.H. and Shin, Y. (2003). 'Testing for unit roots in heterogeneous panels', *Journal of Econometrics* 115, 53–74.

International Monetary Fund (2009). *Direction of Trade Statistics*, http://www.imf.org/external/data.htm.

Jones, B.F. and Olken, B.A. (2005). 'Do leaders matter? National leadership and growth since World War II', *Quarterly Journal of Economics*, 120, 835–864.

Jones, B.F. and Olken, B.A. (2009). 'Hit or miss? The effect of assassinations on institutions and war', *American Economic Journal: Macroeconomics*, 1, 55–87.

Leigh, A. (2009). 'Does the world economy swing national elections?', *Oxford Bulletin of Economics and Statistics*, 71, 163–181.

Li, H. and Zhou, L.-A. (2005). 'Political turnover and economic performance: The incentive role of personnel control in China', *Journal of Public Economics*, 89, 1743–1762.

Lindenberg, M. (1990). 'World economic cycles and Central American political instability', *World Politics*, 42, 397–421.

Londregan, J., Bienen, H. and van de Walle, N. (1995). 'Ethnicity and leadership succession in Africa', *International Studies Quarterly*, 39, 1–25.

Londregan, J.B. and Poole, K.T. (1990). 'Poverty, the coup trap, and the seizure of executive power', *World Politics*, 42, 151–183.

Londregan, J.B. and Poole, K.T. (1996). 'Does high income promote democracy?' *World Politics,* 49, 1–30.

Malone, S.W. (2011). 'Sovereign indebtedness, default, and gambling for redemption', *Oxford Economic Papers*, 63, 331–354.

Marinov, N. (2005). 'Do economic sanctions destabilize country leaders?', *American Journal of Political Science*, 49, 564–576.

Marshall, M.G., Jaggers, K. and Gurr, T.R. (2010). *Polity IV Project: Political Regime Characteristics and Transitions, 1800-2010*, http://www.systemicpeace.org/polity.htm.

Matsuura, K. and Willmott, C. (2007). *Terrestrial Air Temperature and Precipitation: 1900-2006 Gridded Monthly Time Series*, Version 1.01, University of Delaware, http://climate.geog.udel.edu/~climate/.

Miguel, E., Satyanath, S. and Sergenti, E. (2004). 'Economic shocks and civil conflict: An instrumental variables approach', *Journal of Political Economy*, 112, 725–753.

Mitchell, T.D., Carter, T.R., Jones, P.D., Hulme, M. and New, M. (2004). 'A comprehensive set of high-resolution grids of monthly climate for Europe and the globe: The observed record (1901–2000) and 16 scenarios (2001–2100)', Tyndall Centre for Climate Change Research Working Paper 55.

Olson, M. Jr. (1963). 'Rapid growth as a destabilizing force', *Journal of Economic History*, 23, 529–552.

Palmer, H.D. and Whitten, G.D. (1999). 'The electoral impact of unexpected inflation and economic growth', *British Journal of Political Science*, 29, 623–639.

Pritchett, L. and Summers, L.H. (1996). 'Wealthier is healthier', *Journal of Human Resources*, 31, 841–868.

Przeworski, A., Alvarez, M.E., Cheibub, J.A. and Limongi, F. (2000). *Democracy and Development: Political Institutions and the Well-Being of the World, 1950–1990*, Cambridge University Press, Cambridge, UK.

Remmer, K.L. (1991). 'The political impact of economic crisis in Latin America in the 1980s', *American Political Science Review*, 85, 777–800.

Rulers.org (2011). *Rulers*, http://rulers.org/.

Stock, J.H. and Yogo, M. (2005). 'Testing for weak instruments in linear IV regression', in D.W.K. Andrews and J.H. Stock (eds) *Identification and Inference for Econometric Models: Essays in Honor of Thomas Rothenberg*, Cambridge University Press, Cambridge, UK.

Triesman, D. (2011). 'Income, democracy, and the cunning of reason', NBER Working Paper 17132.

United Nations (2011). *UNdata*, http://data.un.org/.

Wolfers, J. (2002). 'Are voters rational? Evidence from gubernatorial elections', Stanford GSB Working Paper No. 1730.

World Bank (2011a). *World Development Indicators*, http://go.worldbank.org/U0FSM7AQ40.

World Bank (2011b). *Education Statistics*, http://www.worldbank.org/education/edstats.