How Much Do Leaders Explain Growth? An Exercise in Growth Accounting

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Preliminary – comments welcome.

High average rates of economic growth are often seen as evidence of good national leadership. This commonly-used metric substantially upward biases the growth contribution of leaders because transitory shocks also affect average growth rates. The bias is much larger in autocratic countries, because the transitory component of their growth rates tends to be much more volatile. Even identification of the best and worst leaders is prone to error due to differences in growth rates across data sources. Assuming a contemporaneous relationship between leader quality and growth, we decompose growth into a leader-specific component, a country-specific component and a (possibly auto-correlated) random component using four growth datasets and two leader datasets over 50 years and more than 100 countries. We find a very small variance in leader effects, even in autocracies. We find that only a small fraction of the variation in growth in autocracies can be explained by variation in leader quality.

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Introduction

High economic growth is often seen as evidence of good national leadership. Leaders who presided over periods of high growth — like Deng Xiaoping in China, Lee Kuan Yew in Singapore, Park Chung Hee in South Korea, or, more recently, Paul Kagame in Rwanda — are often given credit for these "growth miracles". Many rapid growth episodes like these feature autocrats, which has influenced the debate on democracy and development.

Examples of this kind of "leader growth accounting" — in which average growth during a leader's tenure is attributed to that government's leadership — are prevalent in policy discussions, and often in academia too. Most recently, countries that grew quickly during the few years of the financial crisis were credited with decisive leadership and prudent policies. This ranges from middle income countries such as China, where commentators praised China's "tightly managed, top-down policymaking machine that could avoid the delays of a messy democratic process" (Birdsall and Fukuyama 2011),[2] to the least developed economies such as Democratic Republic of the Congo (DRC) where the World Bank praised the DRC's "implementation of sound macroeconomic priorities" and noted "the DRC's economic growth [over 2010-12] has exceeded the average for Sub-Saharan Africa by 2 percentage points" (World Bank 2013).

The most explicit connection between leadership and growth is a report of the same name published by the World Bank's Commission on Growth and Development. The report singles out 13 economies that have achieved high growth over 25 years or more and suggests that "making the right choices over this set of components [growth strategy and institutions]…is what leaders in the high-growth economies have done" (Brady and Spence 2010 p4). An earlier report in 2008 by the same commission finds that "Successful cases share a further characteristic: an increasingly capable, credible, and committed government. Growth at such a quick pace, over such a long period, requires strong political leadership" (CGD 2008 p3).

In the academic literature, many authors argue that there is a strong connection between quality of autocratic leadership and contemporaneous economic growth.[3] This connection (sometimes implicit) justifies the stylized fact that the *variability* of growth (in both good and bad directions) is higher under autocracies than democracies, because "personal inclinations of autocrats might matter much more than personality differences between democratic rulers" (Weede 1996) and "visionary leaders … in autocratic [governments] need not heed legislative, judicial, or media constraints" (Becker 2010). Evidence presented usually contrasts the growth performance of "good" and "bad" leaders: "Highly centralized societies … may get a preceptor like Lee Kwan Yew of Singapore or a preceptor like Idi Amin of Uganda…" Sah (1991);"Singapore…has managed through benevolent dictatorship to produce a high quality of material life for its citizens, albeit without many of the freedoms that others hold dear." Bueno de Mesquita and Smith (2011, Kindle location 2006). Rodrik (2000) summarizes the academic consensus: "living under an authoritarian regime is a riskier gamble than living under a democracy." But autocracies are only a "risky gamble" for growth if autocratic leader quality has some effect on growth. If growth variability is due to idiosyncratic factors such as commodity price shocks, or country-

[2] Birdsall and Fukuyama (2011) make clear they are summarizing a consensus and not stating their own opinions.

[3] See for example: Weede (1996); Quinn and Woolley (2001); Almeida and Ferreira (2002), Acemoglu et al. (2003); Glaeser et. al. (2004); Mobarak (2005), and Yang (2008).

specific factors like institutions, the correlation between growth variability and autocratic government could have little or nothing to do with variability in quality of autocratic leaders.[4]

The most rigorous study is Jones and Olken (2005) who find that economic growth changes (in either direction) when a leader dies unexpectedly in office (such as by illness or accident) — with the results driven by autocracies. JO's test statistic implies that variation in leader quality explains a sizable 1.5 percentage points of variation in economic growth.[5]

However, natural or accidental deaths in office are extremely rare (Jones and Olken 2005 have 57 examples in 50 years across 100 countries), and identifying their effects relies on relatively poor quality annual growth data. Johnson et al (2013) re-estimate Jones and Olken's main results using a revised version of the Penn World Tables (PWT 6.2 rather than 6.1 as used by JO2005), and find that it is now *democratic* leaders, rather than autocratic leaders, which influence growth. In Appendix 3, we revisit JO 2005 using PWT 7.1 and corroborate Johnson et al (2013)'s findings. We also show that the most "influential" leader transitions change from dataset to dataset, and are often driven by periods of war, or small countries.

A more subtle concern is the generalizability of results drawn from a small number of leader transitions in a particular context (deaths due to accident or illness for example).[6] If the way a leader is selected affects the leader's characteristics of their ability to govern, then there is no reason to expect that other types of leader transitions would have a similar effect on growth — a point that has been lost in the policy and academic discussion.[7]

To illustrate this point, we revisit random leader transitions in another context — assassinations. Jones and Olken (2009) argue that within the set of "serious" assassination attempts, whether a leader is killed (a "hit") or not (a "miss") is essentially random.[8] In Appendix 2 we find that there is no significant difference in the change in growth following "hits" (which result in a change of leader) and "misses" (which do not).

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[4] Rodrik (2000) finds that the within-country variability of growth is higher under autocracies, which is consistent with strong autocratic leader effects (though he does not test leader effects themselves).

[5] Besley, Montalvo, and Reynal-Querol (2011) extend these findings to show also a positive effect on growth of the leader's educational attainment. Besley et al (2011) also find evidence of leader deaths on growth (and across their whole sample), but don't report an estimate of the contribution of leaders to growth. Because Besley et al's sample starts in the late 1800s, it is not possible to replicate their results other growth datasets (which starts in 1950 or 1960).

[6] Two studies, in other contexts, find mixed results of leader transitions on growth. Meyersson (2014) examines coups, and finds that while successful coups in autocracies have an "imprecise" effect on growth, coups in a democracies tend to reduce growth rates. Yao and Zhang (2014) examine the effect city leaders on local economic growth, and they find mixed results depend on the test considered.

[7] While leader transitions in democracies are similar (at the ballot box), in autocracies they are highly heterogeneous – such as coups, popular uprisings, transfers of power to relatives or to supporters in the same party faction/ ethnic group.

[8] Jones and Olken (2009) examine the effect of these successful assassinations on democracy and wars, but not economic growth.

Our leader growth accounting approach

In this paper take an alternative approach which allows us to produce stylized facts covering *all* types of leader transitions: leader growth accounting. Specifically, we break down economic growth into a leader-specific effect, a country-specific effect, and a (possibly auto-correlated) random error component, and estimate the variance of the different components. As with conventional growth accounting for attribution to factor accumulation or productivity growth, no rigorous claims about causality can be made. Yet as is done with conventional growth accounting, even stylized facts without causality can be used to test consistency with some models or to show inconsistency with other models. For example, Kaldor's (1961) set of stylized facts helped guide early growth models, which Jones and Romer (2010) have updated for new growth theory. Given the importance of political economy as a potential determinant of growth, we feel it is important to quantify the proportion of growth that could plausibly be attributed to national leaders. When we use language like "leader effects" in the rest of the paper, we are following conventional wording on stylized facts that are consistent with causality but do not prove causality.

Following Jones and Olken (2005) and others, we assume that the bulk of the effect of leaders on growth is contemporaneous. While of course leaders may have lagged effects on growth, these are hard to identify, and also may be smaller than the contemporaneous effect (at least in terms of a contribution to annual growth). We also must assume that the leader effect is constant during the leader's tenure in office. While there may be plausible stories for the same leaders to have heterogeneous effects on growth over time, a hypothesis of fully heterogeneous leader effects is not useful because it is non-falsifiable.

Our first result is that for leaders that have short to medium length of tenure, the average growth rate during the leader's tenure will bias upwards the contribution of the leader to growth (positive or negative). The problem is that the idiosyncratic component of growth only dies away slowly, and so the average growth rate reflects both idiosyncratic noise as well as the true leader effect. Even if there were in fact no permanent leader effects, the expected variance of averages of large and temporary idiosyncratic errors is not zero and can be quite large. This problem is particularly bad for autocracies, which tend to have more noisy growth rates. Using Monte Carlo simulations, we show that for a plausible parameterization, the average growth under autocratic leaders attribute 3-4 times more variation in growth to leaders than it should.

Another major problem we identify is due to poor quality growth data. We have four different datasets on growth rates that often show substantially different growth rates for the same years for the same countries. With such measurement error, it is even difficult to say which leaders have the best "growth performance".. Using the criterion of best 5 percent of leaders' growth averages in each dataset, we find disagreement over who are the "best leaders." We find that only around a quarter of the top 5% "best leaders" are ranked in the top 5% across all four growth datasets. The four datasets also disagree on who are the worst leaders. We view measurement error as one of the reasons the idiosyncratic error term has such a large variance, particularly for countries that are both poor and autocratic.

These results corroborate others in the literature. Johnson et al (2013) find that of the studies whose results tended to be revised away across versions of the Penn World Tables were those studies that relied on annual growth rates. In contrast, studies using a cross section of income levels were mostly robust and studies using a panel of 5-year or 10 year average growth rate averages being partially robust. Using night-time lights as a proxy for GDP, Magee and Doce (2014) find that autocracies tend to "overstate" growth rates more than democracies.

So how should we measure variation in leader effects? We use Monte Carlo simulations to show that a measure similar to estimating the variance of individual random effects (including a small sample unbalanced panel adjustment) works pretty well. We estimate the leader effect in a simple model (consisting of only leader and idiosyncratic effects), as well as a full model that also controls for country effects and potential serial correlation in the error term.

In the simple model, we estimate that the standard deviation of the autocratic leader effect to be about 1.5-1.8 percentage points, which explains about 5-10% of the variance of annual growth. In the simple model, the standard deviation of the estimated leader effect is larger under autocracies, but due to the more volatile growth process the share of the total growth variance explained by leaders is higher under democracies.

All of this changes when we control for country effects and serial correlation in the full model (it is the serial correlation that has the largest effect). Here the estimated standard deviation of the autocratic leader share is much smaller. For three of our datasets, the estimated standard deviation of growth for autocratic leaders is between 0.4 and 0.7 and for the other dataset it is even estimated at zero. Using bootstrapped estimates of the empirical distribution of the leader SD, in nearly all cases we can't reject the hypothesis of zero leader effects at standard levels of significance. This suggests the share of variation in growth explained by leader effects is tiny — around 2% on average, and 0-3% for most datasets. Estimated country effects are large (around 1.7 percentage points), and estimates of autocorrelation are modest (0-0.15) — and both are typically significant.

The rest of our paper is as follows. Section 1 describes the model and the sources of bias when the leader effect is calculated using a simple average of growth rates during the leader's tenure. It also presents Monte Carlo results which provide a simple correction. Section 2 describes the data. Section 3 presents an aside on the best and worse leaders and shows how these vary across datasets. Section 4 presents the empirical results using the simple model and Section 5 presents empirical results using the full model. Section 6 presents some additional robustness tests (including to variations in leader tenure) and Section 7 concludes.

Section 1: The bias in standard estimates of leader growth accounting

In the academic literature and in policy discussions, leaders are usually attributed the average growth during their tenure, as discussed above. The problem with this approach is that random *idiosyncratic* component of growth is very large (Easterly et al 1993) and tends to swamp leader effects even over the medium term. This means a good string of good (or bad) growth rates under a leader are attributed to the good (or bad) policies of a leader, when often they are just good (or bad) luck. When measured using a simple average of growth during their tenure, the leader's contribution to growth is biased upwards, as we show more rigorously below. We focus on *autocrats* most of all because of the stylized fact that "leaders matter more" with autocrats. Unfortunately, the idiosyncratic component of growth is particularly volatile for autocratic countries, and so the bias is particularly large for autocratic leader growth accounting.

Section 1.1: A simple decomposition of growth across leaders

To fix ideas, consider a simple decomposition of the annual per capita GDP growth under leader i during year t into a leader component (μ_i) and idiosyncratic (ε_{it}) component for a balanced panel of leaders as in Equation (1) ($\bar{g}$ is the average across all leader-years, which could be seen as the constant world growth rate). We view each of these as *random variables*, from which the country draws $\mu_i \sim (0,\sigma_\mu^2)$ once for each leader and $\varepsilon_{it} \sim (0,\sigma_\varepsilon^2)$ each period, with μ_i and ε_{it} being independent. For the moment, we assume ε_{it} is i.i.d. for all countries and years.

(1) $g_{it} = \bar{g} + \mu_i + \varepsilon_{it}$

Here we want to decompose the $Var(g_{it}) = \sigma_\mu^2 + \sigma_\varepsilon^2$ into a component due to the individual effect σ_μ^2 and the idiosyncratic component σ_ε^2. The key measure of interest is simply σ_μ, the standard deviation of the leader effect. We also report the share of the annual growth variance due to the individual leader effect (Equation 2).

(2) $\mu\text{-}share = \sigma_\mu^2 / (\sigma_\mu^2 + \sigma_\varepsilon^2)$

The simplest approach is to estimate σ_μ^2 by taking the time-series growth average $\bar{g}_i = \frac{1}{T}\sum_{t=1}^{T} g_{it}$ and calculating its variance as in Equation (3). But this will lead to an *upward biased* estimate of σ_μ, which can be seen by taking the expectation in Equation (4).

(3) $$\hat{\sigma}_{\mu 1}^2 = \left[\frac{1}{N}\sum_{i=1}^{N}(\bar{g}_i - \bar{g})^2\right]$$

(4) $$E\hat{\sigma}_1^2 = \sigma_\mu^2 + \frac{\sigma_\varepsilon^2}{T} > \sigma_\mu^2$$

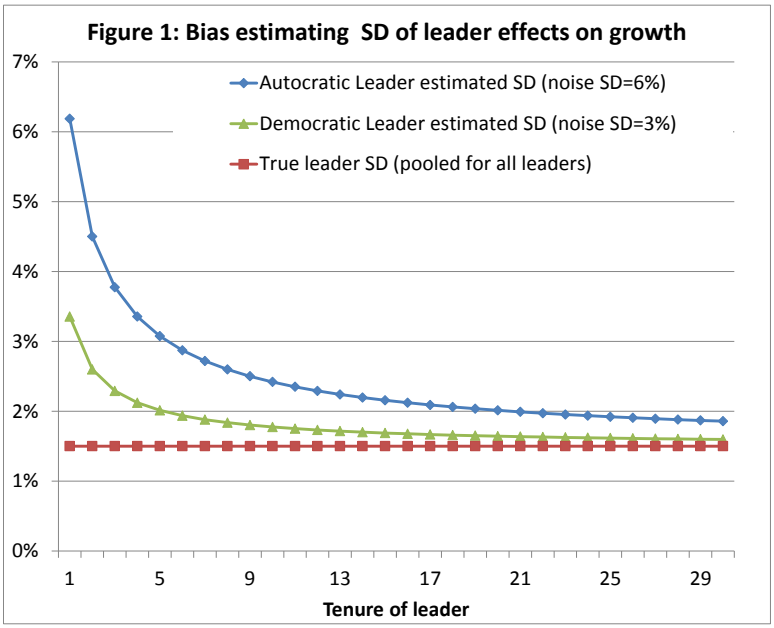
Quantitatively, Equation (4) means that the size of the bias will be large (i) for leaders with a short tenure (small T), and (ii) where σ_ε^2 tend to be large. We will see that (ii) holds much more in autocratic than in democratic countries.

In Figure 1, we plot the results of Monte Carlo simulations for the standard deviation of the leader effect (square root of RHS of Equation 4) when the true standard deviation of the leader effect is 1.5% (the value estimated by Jones and Olken 2005). The blue and green lines are the *estimated* standard deviation of the leader effects, applying Equation (3) to these Monte Carlo simulations for two different sizes of the idiosyncratic noise σ_ε^2

(which will turn out to be close to what we later estimate with the real data for autocratic countries and democratic countries).

The bias is huge in the short term as the idiosyncratic effect of growth swamps the leader effect: for an autocratic leader with tenure of two years, the estimated SD of the leader effect is three times that of the true SD of the leader effect. The bias is also large in the medium term – the estimated leader effect for an autocratic leader with tenure of 5 years is *twice* as large the true effect. Even after 30 years, the biased SD of the leader effect is still 25% larger than the true leader effect for autocratic countries. The bias is much smaller for leaders of democratic countries because (as we will see later) the idiosyncratic SD is much smaller.

These results make a first point that is very simple but quantitatively important. Leader growth accounting based on average growth during the leader's tenure can greatly exaggerate the variance of leader growth effects -- due to the contamination of the "leader variance" by a highly variable idiosyncratic error term that has nothing to do with leaders.



Section 1.2: Monte Carlo evidence and a correction

The difficulty of estimating σ_μ^2 has been long recognized in the random effects panel literature, where estimates of σ_μ^2 and σ_ε^2 are needed to perform Generalized Least Squares. Baltagi (2005 p16) shows that $\hat{\sigma}_\mu^2$ can be backed out from the estimates using Equation (5):

(5) $\hat{\sigma}_\mu^2 = \hat{\sigma}_{\mu 1}^2 - \hat{\sigma}_\varepsilon^2 / T$.

where $\hat{\sigma}_\varepsilon^2$ and $\hat{\sigma}_{\mu 1}^2$ can be estimated using standard variance formulas: $\hat{\sigma}_\varepsilon^2 = \frac{1}{N(T-1)} \sum_{i-1}^{N} \sum_{t=1}^{T} (g_{it} - \bar{g}_i)^2$ and Eq 3, respectively. It is possible for $\hat{\sigma}_{\mu 1}^2$ to be negative if $\hat{\sigma}_{\mu 1}^2$ is small and so the estimator replaces negative estimates with zero (i.e. $\hat{\sigma}_\mu^2 = \max(0, \hat{\sigma}_{\mu 1}^2 - \hat{\sigma}_\varepsilon^2 / T)$), with the Monte Carlo studies finding this not being a serious problem (Baltagi 2005 p18).

We use two variations of Equation (5) to generate feasible estimates the true leader effects $\hat{\sigma}_{\mu}^{2}$: the first is Stata's default for random effects (which we label RE), and the second is similar but includes a small sample correction for unbalanced panels (which we label SA) from Baltagi and Chang (1994).[9] Our panel of leaders is very unbalanced, and so the SA method is usually preferred. The methods are identical for balanced panels.

Before beginning the actual estimation, we check the performance of these estimators under our conditions. To show the performance of the different methods we perform a Monte Carlo simulation of annual growth rates as following Equation (1) (Table 1).[10] As in Figure 1, we draw a leader effect from the same distribution across democracies and autocracies, but we will use the actual leadership structure from the data on leaders. In panel A, we constrain the variance of the idiosyncratic noise to be the same across democratic and autocratic countries, and allow only the structure of the leadership tenure to differ (the tenure of autocratic leaders is longer and more variable than that of democrats). In Panel B we allow the variance of idiosyncratic noise to vary across autocracies and democracies as it does in the data. The structure of leader tenure to which the Monte Carlo is applied is from Jones and Olken (2005), as described more below. Results are almost identical using the Archigos structure of leader tenure (not reported) – see the next section for a discussion of data.

Table 1: Monte Carlo Std Dev of leader effect (mean of 1000 reps)

True data generating process: SD(leader effect) =1% (JO leaders)

	Panel A: Same iid SD			**Panel B: Different iid SD**		
Method (see text)	Pooled	Democracy	Autocracy	Pooled	Democracy	Autocracy
SD (Ave Leader Growth; Eq 3)	3.33%	3.42%	3.29%	3.42%	2.20%	3.89%
	[0.10%]	[0.17%]	[0.12%]	[0.12%[	[0.11%]	[0.15%]
RE	0.95%	0.93%	0.90%	0.31%	0.97%	0.88%
	[0.40%]	[0.62%]	[0.47%]	[0.43%]	[0.28%]	[0.60%]
SA	1.00%	0.98%	0.99%	0.74%	1.00%	0.97%
	[0.14%]	[0.35%]	[0.16%]	[0.24%]	[0.14%]	[0.23%]
Gen Std Dev (iid)		5%			3%	6%

Notes: standard errors in brackets

[9] Both of these methods use Swamy-Arora's approach to calculate residuals, which involves calculating $\hat{\sigma}_{\varepsilon}^{2}$ and $\hat{\sigma}_{\mu 1}^{2}$ using the residuals from two regressions: $\hat{\sigma}_{\varepsilon}^{2}$ is calculated from the residuals of a within regression (only time variation) and $\hat{\sigma}_{\mu 1}^{2}$ is calculated using a between regression (only cross-sectional variation). Baltagi and Chang (1994) show their unbalanced panel small sample adjustment show performs well in Monte Carlo simulations. The methods are implemented in Stata using `xtreg, re` (default) and `xtreg, sa` (with unbalanced panel correction). See the Stata manual, Baltagi (2005) and Baltagi and Chang (1994 for further details).

[10] In all Monte Carlo simulations we assume that idiosyncratic and leader effects (and hence log growth) are normally distributed. This a convenient assumption given the ease of drawing from a normal, and that a normal distribution is defined by only two parameters (mean and SD). Unfortunately, as Figure A2 (in the Appendix for the Jones-Olken dataset) shows, the data have excess kurtosis relative to a normal (the normal has the same mean and SD as PWT6.1 growth). Tests reject normality for all the dataset based on both skewness and kurtosis. An interesting extension for future work would be to draw data from a mixture of normals in the Monte Carlo to match these higher-order moments.

Monte Carlo results verify the large upward bias in the standard deviation of the leader effects when using the average growth rate during a leader's tenure (first row)[11]. Note that the bias is much larger than predicted in Figure 1 (using the average tenure of 5.8 years) because the bias function is concave in tenure and so a more unbalanced panel (greater variability of tenure) will increase the bias. Autocracies only have a much a larger bias in Panel B where they also have a higher SD of noise. This suggests that the differences in leader tenure across democracies (4.6 years on average) and autocrats (6.5 years on average) are not all that important.

So how should we estimate the leader effects? In general, RE and SA are pretty close to being unbiased (pooled RE panel B being an exception). SA is preferred to RE because of its much smaller standard errors, and also because of its better performance in pooled panel B.[12] All methods estimate σ_ε very accurately (not reported).

Section 2: Data and data quality (or lack thereof)

Section 2.1: Data Sources

In order to estimate the size of leader effects we need data on leaders, growth and a measure of whether each country is a Democracy or Autocracy. To make sure that our results are robust across methods, we use multiple measures of leaders and growth.

Data on leaders is taken from the Jones and Olken (2005) and Archigos 2.9 datasets (Goemans et al 2009). In the body of the paper we report findings using the Jones and Olken dataset (henceforth JO) dataset, but replicate all calculations using the Archigos dataset in the Appendix.[13] For most leaders and countries the datasets overlap, though the Archigos generally has a wider coverage of countries and periods. Following Jones and Olken (2005), we use the log growth rate: $\ln(Y_t)$- $\ln(Y_{t-1})$, where Y_t is real per capita GDP. This measure has the convenient property that the antilog of the average log growth over a given period is equal to the compound growth rate over that period.

We use data on growth from four sources: the Penn World Tables (PWT) versions 7.1 (the latest at time of the first draft of this paper; Heston et al 2012), version 6.1 (used by Jones and Olken 2005; Heston et al 2002), Angus Maddison's (MAD) growth series and real per capita GDP growth from the World Bank's World Development Indicators (WDI). See the Appendix for further details.

Democracies are defined as countries with an average Polity IV score >8. This is somewhat stricter than the Polity>0 score used by Jones and Olken (2005) and others in the political science literature, but is only slightly stricter than the 6-10 range recommended in the Polity IV documentation. We choose the higher cutoff to minimize transitions in and out of democracy that occur with a lower cutoff.

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[11] This is calculated using the xtreg, fe command in Stata, which reports the variance of average growth under each leader.

[12] This small downward bias is due to rounding when the leader variance becomes very small. In other simulations with a leader SD of 2% and the SA method, the small downward bias disappears (not reported).

[13] JO and Archigos leader-country-year structures are almost identical for Monte Carlo simulations, so we only report JO.

Section 2.2: Descriptive Statistics

After some dropping outliers (see next subsection) are 112 countries for which we have growth, leader and polity data (129 for Archigos), of these about 20% are democracies (see Appendix Table 1B for the full listing). The sample is 1950-2000 to be consistent with Jones and Olken (2005), except for WDI which starts in 1961.

Table 2 shows the basic descriptive statistics the JO dataset (Appendix Table 2 shows the corresponding statistics for Archigos). We have around 4000-5000 observations and 600-800 leaders. Average growth is about 1.8% per annum, and is higher on average in democracies than autocracies. As pointed out in the previous section, the unconditional variance of growth is much higher for autocratic countries than democratic ones.

Table 2: Growth Descriptive Statistics (JO leaders)

	A. All				
	Mean	SD	Obs	Leaders	Tenure
PWT 7.1	1.85%	5.7%	4794	825	5.8
PWT 6.1	1.80%	5.7%	4762	820	5.8
Maddison	1.80%	4.9%	4759	804	5.9
WDI	1.71%	5.0%	3860	662	5.8
	B. Democracies				
	Mean	SD	Obs	Leaders	Tenure
PWT 7.1	2.5%	3.7%	1220	275	4.4
PWT 6.1	2.6%	3.6%	1218	274	4.4
Maddison	2.7%	3.1%	1139	253	4.5
WDI	2.4%	3.0%	906	204	4.4
	C. Autocracies				
	Mean	SD	Obs	Leaders	Tenure
PWT 7.1	1.6%	6.2%	3574	550	6.5
PWT 6.1	1.5%	6.3%	3544	546	6.5
Maddison	1.5%	5.3%	3620	551	6.6
WDI	1.5%	5.4%	2954	458	6.4

Section 2.2 Outliers

Per capita growth rates are often very volatile and a small number of observations can have a large effect on estimated results. Intuitively, this is because the importance of the observation increases with the square of its size. Other things equal, a growth observation 5 percentage points above the mean has 100 times the weight of one 0.5 percentage points above the mean. Things get worse for very extreme observations: a growth rate 50 percentage points above the mean has 10000 times the weight of one 0.5% above the mean. These extreme observations do exist, for example, for countries entering or exiting civil wars. By this logic, a couple of coincidental leader transitions around times of civil wars or other extraordinary events can completely change our results, and overturn the evidence of thousands of other observations.

Another reason to exclude extreme outliers is that the log-growth approximation is only valid for small rates of growth. For a 2% growth rate, the approximation is very accurate, ln(1+0.02)= 0.0198. But for a 50% growth rate it is both inaccurate and asymmetric: ln(1+0.5)= 0.41 and ln(1-0.5)=-0.69.[14]

We take a very conservative definition of outliers – log growth of more than 40% (in absolute value) in particular year – and drop these from our main results. There are only around 6 outliers per dataset for the 3000-4000 observations (10 for Archigos). The individual observations dropped are listed in Appendix Table 1A.

Two aspects of the outliers are striking. First, the number of extreme observations that coincide with wars. Some of the largest outliers include in Iraq during the gulf war of 1991, the Rwandan genocide of 1994 (and rebound in 1995), the Lebanese civil war in the late 1970s and early 1980s and the first Liberian civil war around the early 1990s (and rebound in 1997 with peace). The second striking fact is the level of disagreement about growth rates during these periods: the average difference between the maximum and minimum growth rates in each year across the four datasets is 42%! This reflects the difficulty of measuring the change in per capita output during extreme times like civil war or genocide, and further justifies dropping them from the dataset.

Section 3: Best and worst leaders (an aside)

One reason that leader growth accounting is popular that it identifies who, exactly, are the "good" (high growth) or "bad" (low growth) leaders. However, it turns out that leader growth accounting is a disappointment at even this basic task due to the poor quality of growth data.

Consider a policymaker who asked four researchers to bring them a list of the best 5% of leaders (leaders with the highest average growth rate during their tenure). Each researcher choses a different dataset from one of the four used in this paper. How much would their lists overlap? The answer: not that much.

Table 3A the list of the best of leaders by each of the measures.[15] The cutoff to be a benevolent leader varies slightly across datasets, but is around 6% - which seems unofficially to be regarded as "miracle" growth rate in policy circles. Of the 36 "best" leaders, it turns out that only around a quarter are common to all four datasets. Moreover, the average number of datasets in which each "benevolent leader" appears is only 2.3. Even some of the most famous benevolent leaders are not universally recognized as such – the average growth rate under Deng Xiaoping is a whisker under 6% according to PWT6.1 and Lee Kwan Yew records an average growth rate of around 5.6% for PWT7.1 – both marginally under the cutoffs. The fact that even these celebrity leaders sometimes miss out on the top 5% reflects the error rate of growth measurement under different leaders.

Unfortunately we can't be much more confident about the worst leaders either (listed in Table 3B). Only around 20% of the worst leaders are listed in all four datasets, and the worst leaders are only in 2.2 datasets. Results using the Archigos dataset are similar and are presented in the Appendix (Appendix Table 3A-3B).

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[14] Moreover, in the Monte Carlo simulations, we model log growth rates as a being normally distributed, which is a bad assumption if the tails are too fat. If growth is log-normally distributed with mean 1.5% with a standard deviation of 5.7% (as estimate for PWT7.1 data), a 50% growth rate is 8.5σ event, which is to say it will never happen (prob=$1x10^{-17}$).

[15] We drop leaders with tenure of 3 years of less to more accurately measure average growth under each leader.

Table 3A: Best leaders (1 if average growth in top 5% of outcomes) (JO leaders)						
Leader name and country	**ISO code**	**PWT 6.1**	**PWT 7.1**	**Maddison**	**WDI**	**Count**
Raab Julius	AUT	1	1	1	0	3
Kubitschek Juscelino	BRA	0	1	0	1	2
Medici Emilio	BRA	1	1	1	1	4
Khama Sir Seretse	BWA	1	1	1	1	4
Aylwin (Azocar) Patricio	CHL	1	1	1	1	4
Xiaoping Deng	CHN	0	1	1	1	3
Fernandez Reyna Leonel Antonio	DOM	1	0	1	0	2
Rodriguez (Lara) Guillermo	ECU	1	1	0	1	3
Mba Leon	GAB	1	0	0	0	1
Obiang Nguema Mbasongo Teodoro	GNQ	0	0	1	1	2
Pavlos I	GRC	0	0	0	1	1
Papadopoulos Georgios Christou	GRC	1	1	1	1	4
Preval Rene Garcia	HTI	1	0	0	0	1
Bustamante William Alexander	JAM	0	0	1	0	1
Shearer Hugh Lawson	JAM	1	0	0	1	2
Ikeda Hayato	JPN	1	1	1	1	4
Sato Eisaku	JPN	1	1	1	1	4
Chun Doo Hwan	KOR	1	1	1	1	4
Park Chung Hee	KOR	1	1	1	0	3
Roh Tae Woo	KOR	0	1	1	1	3
Muluzi Bakili	MWI	1	0	0	0	1
Razak Tun Abdul	MYS	0	1	0	0	1
Debayle Luis Anastasio Somoza	NIC	0	0	0	1	1
Mendez Marco Aurelio Robles	PAN	0	1	0	0	1
Caetano Marcello das Neves Alves	PRT	0	1	1	1	3
Salazar Antonio de Oliveira	PRT	0	0	0	1	1
Ceausescu Nicolae	ROM	1	0	0	0	1
Kagame Paul	RWA	1	0	0	1	2
Lee Kuan Yew	SGP	1	0	1	1	3
Margai Sir Milton	SLE	0	1	0	0	1
Grunitzky Nicolas	TGO	1	1	1	1	4
Thanarat Sarit	THA	0	0	1	0	1
Ching-Kuo Chiang	TWN	1	1	1	1	4
Kai-Shek Chiang	TWN	0	0	1	1	2
Teng-Hui Lee	TWN	0	0	0	1	1
Lacalle Luis	URY	0	1	0	0	1
Growth Cutoff (best leader)		6.06%	5.87%	5.48%	6.04%	
Number of leaders						**36**
Average number of datasets leader for which leader is in best 5%						**2.3**
Proportion of all “best” leaders (by at least one measure) for which all datasets agree						**25.0%**

Table 3B: Worst leaders (1 if average growth in worst 5% of outcomes) (JO Leaders)						
Leader name and country	**ISO code**	**PWT 6.1**	**PWT 7.1**	**Maddison**	**WDI**	**Count**
Yameogo Maurice	BFA	1	0	0	0	1
Rahman Sheikh Mujibur	BGD	0	1	1	1	3
Siles (Zuazo) Hernan	BOL	0	0	0	1	1
Kolingba Andre	CAF	1	1	1	0	3
Patasse Ange-Felix	CAF	1	0	0	0	1
Lissouba Pascal	COG	1	0	1	1	3
Odio Rodrigo Jose Ramon Carazo	CRI	1	1	1	1	4
Trujillo y Molina Rafael Leonidas	DOM	0	0	0	1	1
Acheampong Ignatius Kuti	GHA	1	0	0	0	1
Cordova Roberto Suazo	HND	0	1	0	0	1
Khomeini Ayatollah Sayyed Ruhollah Mousavi	IRN	1	1	1	1	4
Manley Michael Norman	JAM	0	0	0	1	1
Hurtado Miguel de la Madrid	MEX	0	1	0	0	1
Keita Modibo	MLI	1	1	0	0	2
Machel Samora	MOZ	1	1	1	1	4
Haidalla Mohamed Khouna Ould	MRT	1	0	1	0	2
Kountche Seyni	NER	0	1	0	0	1
Obasanjo Olusegun	NGA	0	1	0	0	1
Shagari Alhaji Shehu	NGA	1	1	1	1	4
Chamorro Violeta Barrios de	NIC	1	0	0	0	1
Saavedra Jose Daniel Ortega	NIC	1	0	1	1	3
Morena Manuel Antonio Noriega	PAN	0	0	1	1	2
Garcia (Perez) Alan	PER	1	1	1	1	4
Constantinescu Emil	ROM	1	0	1	0	2
Iliescu Ion	ROM	0	0	1	0	1
Momoh Joseph Saidu	SLE	0	1	1	1	3
Strasser Valentine	SLE	0	1	1	0	2
Fuentes Jose Napoleon Duarte	SLV	0	0	0	1	1
Malloum Felix	TCD	0	1	1	1	3
Chambers George Michael	TTO	0	1	1	1	3
Manning Patrick Augustus Mervyn	TTO	1	0	0	0	1
Robinson Arthur Napoleon Raymond	TTO	0	1	0	0	1
Obote Apollo Milton	UGA	0	0	0	1	1
Alvarez (Armelino) Gregorio	URY	1	1	1	1	4
Herrera (Campins) Luis	VEN	1	1	1	1	4
al-Hashidi Ali 'Abd Allah Saleh	YEM	1	0	0	0	1
Seko Mobutu Sese (Joseph)	ZAR	1	1	1	1	4
Growth Cutoff (worst leader)		-2.85%	-2.19%	-2.35%	-2.55%	
Number leaders						**37**
Average number of datasets leader for which leader is in worst 5%						**2.2**
Proportion of all “worst” leaders (by at least one measure) for which all datasets agree						**21.6%**

Section 4: Simple model decomposition results

We now turn to estimating the size of leader effects, using the simplest model of leader effects (Equation 1). Monte Carlo simulations in Table 1 showed that if the true model for the growth process is Equation (1), we can use the random-effects estimator SA (with adjustment for unbalanced panels) to estimate the leader effect fairly accurately. This is close to being unbiased, unlike taking a simple average of growth during the leader's tenure, which will substantially bias upwards the estimated variance of the leader effect. We now implement these methods on the actual growth data.

Table 4A: Std Dev. of Leader contribution and iid noise: by dataset (JO leaders)

Growth	All		Democracies		Autocracies		Autocracies (incl. outliers)	
Dataset	SD(leader)	sd(iid)	SD(leader)	sd(iid)	SD(leader)	sd(iid)	SD(leader)	sd(iid)
PWT7.1	1.36%	5.53%	1.39%	3.42%	1.50%	6.04%	1.35%	6.62%
	[0.29%]	[0.24%]	[0.28%]	[0.28%]	[0.34%]	[0.27%]	[0.43%]	[0.46%]
PWT 6.1	1.55%	5.53%	1.24%	3.33%	1.74%	6.06%	1.51%	6.71%
	[0.25%]	[0.27%]	[0.29%]	[0.30%]	[0.29%]	[0.31%]	[0.44%]	[0.43%]
Maddison	1.71%	4.58%	1.40%	2.72%	1.83%	4.99%	1.86%	5.23%
	[0.17%]	[0.21%]	[0.22%]	[0.20%]	[0.21%]	[0.24%]	[0.21%]	[0.30%]
WDI	1.66%	4.70%	1.34%	2.69%	1.82%	5.13%	1.79%	5.35%
	[0.18%]	[0.22%]	[0.22%]	[0.19%]	[0.22%]	[0.24%]	[0.24%]	[0.31%]

Notes: bootstrap std errors in brackets (country-level non-parametric iid bootstrap 1000 reps). Dep. variable is per capita GDP growth. Method: SA. Sample 1950-2000 (1961-2000 for WDI). Outliers dropped.

Table 4A shows the estimated standard deviation of leader effects is fairly small at 1.25%-1.8%, even for autocrats (Jones and Olken 2005 estimate 1.5%). While the estimated leader SD is generally larger for autocracies -as hypothesized in the literature's quotes above – the difference is not particularly large, especially for the PWT 7.1 dataset. Including outliers (RHS of table 4A), *lowers* the autocrat SD for PWT6.1 and PWT7.1, but barely affect it for Maddison and WDI datasets.

One very important finding in this table, which will remain robust in future tables, is that the standard deviation of the iid error process is much higher under autocracies (SD around 5-7 percentage points) than under democracies (around 3 percentage points). As noted in Section 1, this suggests conventional leader growth accounting will exaggerate leader effects more under autocracy than under democracy.

Rodrik's (2000) finding of a higher within-country variance of growth under autocracy than under democracy left open the possibility that it was leader shifts within countries that explains this finding. Our finding does not support this possibility -- a great deal of the high within-country variance of growth in autocratic countries is due to idiosyncratic noise rather than shifts in leader quality within autocratic systems.

To put these numbers in another context, consider μ-share, which is the share of total growth variance due to leader effects (equation 2, Table 4B). Focusing on autocracies, leaders never contribute much more than 10% of the total variance of growth, and depending on the dataset, can contribute as low as 6%. Interestingly, leaders are *relatively* more important for growth in democracies than autocracies. Although variance of leader effects is lower in democracies, the general growth variance is even lower - resulting in a higher leader share. These

results suggest that attribution of periods of high growth to the leaders in power at the time is not supported by the stylized facts – especially when the periods are not very long and the leaders are autocrats.

Table 4B: Leader share of total growth variance (JO)				
	All	Democracies	Autocracies	Autocracies (incl. outliers)
PWT 7.1	5.72%	14.22%	5.80%	3.97%
PWT 6.1	7.28%	12.15%	7.64%	4.80%
Maddison	12.28%	20.99%	11.81%	11.20%
WDI	11.07%	19.99%	11.21%	10.11%
Notes: Calculated from Table 4A using Equation 2				

Section 5: Full model decomposition (with country effects and serial correlation)

In this section, we expand the simple model growth (Equation 1) to include country effects (μ_c) and first order serial correlation (ρ) as in Equation 6. μ_c is designed to capture persistent features of a country that contribute to a country's growth, such as its economic and political institutions, geography and culture which a vast literature has shown are important for growth.

The autocorrelation parameter ρ is designed to capture the fact that shocks to growth often have some persistence, such as terms of trade shocks, business cycles, wars or growth of trading partners. As the only persistent component to growth in Equation (1) is the leader effect, these other persistent features of the data may be masquerading as leader effects. Note that the error term ε_{ct} with the autocorrelation parameter ρ is modeled the same way for all countries and years. Although the idiosyncratic random shocks may have some persistence, they are still idiosyncratic and, as modeled, they have nothing to do with either permanent country effects or leader effects.

Estimating Equation (6) is challenging, and we will check our preferred method before applying it to the real data. Our method is to estimate (6) using the same SA method (which involves a small sample adjustment) but a two-step process: we estimate Equation (7) first using the SA method (with country dummies) and collect the estimate of error component $\hat{\varepsilon}_{ict}$, we then estimate the second stage SA regression (Equation 8) with $\hat{\varepsilon}_{ict-1}$ and country dummies as explanatory variables.

(6) $g_{ict} = \bar{g} + \mu_i + \mu_c + \varepsilon_{ct}$ where $\varepsilon_{ct}=\rho\varepsilon_{ct-1}+\eta_{ct}$

(7) First step: $g_{ict} = \bar{g} + \mu_i + \mu_c + \varepsilon_{ct} \rightarrow \hat{\varepsilon}_{ct}$

(8) Second step: $g_{ict} = \bar{g} + \mu_i + \mu_c + \rho\hat{\varepsilon}_{ct-1}$

We will use Monte Carlo simulations again to see how well this method does under different scenarios of real or nonexistent country effects, and real or nonexistent autocorrelation. Table 5A shows the Monte Carlo performance of Equation (1) and Equation (6) in each of four scenarios with combinations of a 1% country effect and autocorrelation of 0.2 (these simulated parameters are similar to what we will find in the actual data in Table 5B below). The Monte Carlo results show that Equation 1 only performs well in the scenario with no serial correlation or country effects –the SD (leader) is otherwise strongly upward biased. Both country effects and autocorrelation have their own separate effect on upward bias: if either exists, when Equation (1) fails to take them into account, the resulting SD of leader effects will be higher than the true value. If they both exist,

when Equation (1) fails to take them into account, the Monte Carlo simulation shows the upward bias to the SD of leader effects to be even higher.

Column 2 of Table 5A shows the estimated SD of the leader effect for our estimation methods for the unrestricted model from Equation 6: the upward bias is mostly gone if there are only country effects, and is much smaller in Scenarios 3 and 4 which have serial correlation (and the standard error of the estimates is still small). However, the Monte Carlo results show our method is not completely successful in eliminating the bias, especially when there is autocorrelation of the error term. As the bias in the estimated leader share is *upwards* when estimating Equation (6), if anything, we are overstating the variance of leader effects.

Table 5A: Monte Carlo SD(leader effect) with country effects (CE) and autocorrelation (AR)

True data generating process: SD(leader effect) =1% (JO leaders)

	True DGP	Equation 1	Equation 6 (unrestricted model)		
		(1) SD(u)	(2) SD(u)	(3) SD(CE)	(4) AR
Scenario 1	CE=0, AR=0	0.99% [0.14%]	1.08% [0.27%]	0.94% (0.85)	-0.05 (0.50)
Scenario 2	SD(CE)=1%, AR=0	1.41% [0.13%]	1.08% [0.26%]	1.38% (0.00)	-0.05 (0.50)
Scenario 3	SD(CE)=0, AR=0.2	1.54% [0.10%]	1.38% [0%]	1.12% (0.73)	0.12 (0.00)
Scenario 4	SD(CE)=1%, AR=0.2	1.83% [0.12%]	1.37% [0.21%]	1.50% (0.01)	0.12 (0.00)

Notes: SD(e)=5% constant for all replications. Mean of 1000 replications (std dev in brackets[]). Column 3-4 p-value in parentheses: Column 3 from first stage test of all country effects=0, Column 4 for Wooldridge test for serial correlation

Column 3 shows the estimated SD of the country effects in the Monte Carlo simulations: they are insignificant in those scenarios without true country effects, and are significant but slightly upward biased otherwise. Column 4 shows the estimated autoregressive coefficients, which are insignificant in the case where $\rho=0$, and positive and significant (if downward biased) when $\rho>0$. In sum, estimating Equation (6) makes progress on reducing the upward bias of SD(u) of Equation (1) in scenarios when there really do exist country effects and/or serial correlation, although it still leaves some upward bias (especially in the case of serial correlation).

We now apply our estimation method of Equations (6) through (8) to the actual growth data. When controlling for country effects and serial correlation, the estimated autocratic leader SD is considerably smaller than previously estimated in the simple model of Equation (1). The estimated autocratic leader SD is now zero in the PWT 7.1 dataset, and between 0.4-0.7% in the other datasets. In reality, the leader SD would not be exactly zero in PWT 7.1. Recall from the discussion of equation (5) above for random effects that the procedure could produce negative values for leader SD in finite samples when the true leader SD is very small. The estimation procedure replaces the negative values with zeroes in these cases, which has been shown not to be a serious problem in Monte Carlo simulations.

The bootstrapped standard errors range from 0.26-0.55, so (as always) there some margin for error around these estimates – including around zero. We don't know the distribution of the t-statistic, so we calculate this below using the empirical bootstrap distribution of the leader share. The results are even stronger when they include

outliers, as in the last two columns of Table 5B. Estimated Autocratic leader SD for the Archigos dataset are shown in Appendix Table 5B, and are very similar for PWT7.1 and WDI datasets, but somewhat larger for PWT6.1 and Maddison datasets (though these are less precisely estimated). Recall from the previous paragraph that our estimates of SD(leader) could be seen as an upward bound because our method still has some upward bias for these estimates when there are country effects and/or serial correlation of the error term.

Table 5B: Std Dev. of Leader contribution and iid noise: by dataset (JO leaders)

	All		Democracies		Autocracies		Autocracies (incl. outliers)	
	SD(leader)	sd(iid)	SD(leader)	sd(iid)	SD(leader)	sd(iid)	SD(leader)	sd(iid)
PWT7.1	0.00%	5.45%	0.98%	3.32%	0.00%	5.96%	0.00%	6.53%
	[0.16%]	[0.24%]	[0.44%]	[0.25%]	[0.26%]	[0.27%]	[0.27%]	[0.47%]
PWT 6.1	0.00%	5.38%	0.85%	3.26%	0.39%	5.89%	0.00%	6.55%
	[0.38%]	[0.26%]	[0.41%]	[0.30%]	[0.57%]	[0.30%]	[0.65%]	[0.43%]
Maddison	0.00%	4.55%	1.03%	2.61%	0.61%	4.97%	0.64%	5.17%
	[0.42%]	[0.22%]	[0.32%]	[0.18%]	[0.50%]	[0.24%]	[0.50%]	[0.29%]
WDI	0.48%	4.60%	1.29%	2.64%	0.73%	5.02%	0.59%	5.29%
	[0.48%]	[0.21%]	[0.32%]	[0.18%]	[0.55%]	[0.23%]	[0.55%]	[0.31%]

Notes: bootstrap standard errors in brackets (country-level non-parametric iid bootstrap 1000 reps). Dependent variable is per capita GDP growth. Method: SA. Sample 1950-2000 (1961-2000 for WDI)

For all leaders, we find that the leader SD almost always estimated to be zero (except for WDI), though of course this just means that leader SD is extremely close to zero. The lower overall leader SD also reflects a lower leader SD for democrats, though the fall is much less pronounced than for autocrats. On average the democratic leader standard deviation is about *double* that of autocrats.

In sum, the results of Table 5B contradict the main result of the previous literature, and much conventional wisdom, that autocratic systems have higher variance of leader effects. As in our previous results, the SDs of idiosyncratic errors are much higher for autocracy than democracy: around 5-6% for autocracies and 2-3% for democracies. Our results suggest that it is only the larger idiosyncratic error under autocracy compared to democracy that produced the higher variance of growth under autocracy compared to democracy, NOT the conventional stylized fact of a higher variance of unconstrained "good" and "bad" leaders.

Section 5.1 Country SD and AR(1) estimates

Table 5C reports the estimated SD(country effects) and serial correlation that goes with the estimates in Table 5B. In most cases, both serial correlation and country effects are significant at the 5% level. While the serial correlation coefficient is fairly small, usually around 0.1-0.2, the SD(CE) is quite large – usually above 1.5%. This is consistent with a persistent national component of economic growth

The country effect could conceivably reflect the quality of an autocratic system (such as China's) even if we find little evidence of variation of leader quality within such a system (see Besley and Kudamatsu 2009 for a discussion of varying performance of autocratic systems). The only problem with this autocratic system story is that there are a large number of alternative national factors: to institutions, historical legacies, culture, geography

or other factors emphasized by the literature (and also SD(CE) is biased upwards). Hence, we continue to think of our exercise of growth during the leader's tenure as the most specific way to test the stylized facts about good and bad autocrats.

Table 5C: Estimated SD (country effects) and AR(1) coefficient: by dataset (JO Leaders)

	All		Democracies		Autocracies		Autocracies (incl outliers)	
	SD(CE)	rho	SD(CE)	rho	SD(CE)	rho	SD(CE)	rho
PWT7.1	1.65%	0.08	0.92%	0.14	1.76%	0.06	1.83%	0.08
	(0.00)	(0.17)	(0.06)	(0.00)	(0.00)	(0.35)	(0.00)	(0.02)
PWT 6.1	1.52%	0.02	0.74%	0.09	1.60%	-0.01	1.57%	-0.01
	(0.00)	(0.16)	(0.02)	(0.00)	(0.00)	(0.31)	(0.00)	(0.26)
Maddison	1.68%	0.14	0.86%	0.10	1.74%	0.12	1.85%	0.11
	(0.00)	(0.04)	(0.00)	(0.00)	(0.00)	(0.09)	(0.00)	(0.02)
WDI	1.71%	0.16	0.94%	0.18	1.84%	0.15	1.95%	0.13
	(0.00)	(0.00)	(0.07)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Notes: p-values in parentheses (AR(1) from Wooldridge SC test). Dependent variable is per capita GDP growth. Method: SA. Sample 1950-2000 (1961-2000 for WDI)

Table 5D: Boostrap 5% cutoff from empirical distribution: by dataset (JO leaders; 1000 reps)

	All		Democracies		Autocracies		Autocracies (incl outliers)	
Dataset	SD(leader)	sd(iid)	SD(leader)	sd(iid)	SD(leader)	sd(iid)	SD(leader)	sd(iid)
PWT71	0.00%	5.05%	0.00%	2.93%	0.00%	5.50%	0.00%	5.76%
PWT61	0.00%	4.96%	0.00%	2.80%	0.00%	5.41%	0.00%	5.87%
MAD	0.00%	4.19%	0.44%	2.32%	0.00%	4.58%	0.00%	4.68%
WDI	0.00%	4.27%	0.70%	2.35%	0.00%	4.65%	0.00%	4.79%

What is driving the dramatic fall in the leader share moving from the simple model to the full model? Table 5E reports leader(SD) when we estimate equation (6) including *either* country effects or an AR(1) term. For autocracies, it seems that it is the AR(1) term is doing most of the work. This suggests that it is persistent shocks – such as terms of trade shocks -- that are responsible for most of the bias. This makes sense as the frequency of these events – lasting a few years on average - is much closer to the average leader's tenure of 5 years than differences in country effects lasting 40 years. Results are similar using the Archigos dataset (Appendix Table 5E).

Table 5E: Std Dev. of Leader Effects: whether country effects (CE) or autocorrelation (AR(1)) is more important in changing estimates (JO leaders)

	All		Democracies		Autocracies	
Model:	CE Only	AR(1) Only	CE Only	AR(1) Only	CE Only	AR(1) Only
PWT7.1	1.03%	0.00%	1.43%	0.82%	1.21%	0.00%
PWT 6.1	1.41%	0.00%	1.22%	0.77%	1.76%	0.00%
Maddison	1.41%	0.86%	1.38%	0.97%	1.59%	1.04%
WDI	1.52%	0.85%	1.39%	1.10%	1.74%	1.04%

Note: SD(leader) adding either country effects (CE) OR allowing for autocorrelation (AR(1))

Section 5.3 Testing the significance of leader effects

Although many of the leader effects are small, are they statistically different from zero? In most cases, we unable to reject the hypothesis that the leader share is zero using its empirical bootstrap distribution. To do the test, we perform a country-level non-parametric iid bootstrap with 1000 replications (draw a sample of countries 1000 times with replacement, and estimate the leader SD by the same method as in Table 5B). We then order the 1000 estimates of the leader share from lowest to highest and report the 5th percentiles of the distribution. These cutoffs are reported in Table 5D and are an assumption-free way of testing whether the leader coefficient is greater than zero at the 5% level. We find that in all cases the 5% cutoff of the empirical distribution is not greater than zero. For the Archigos dataset (reported in Appendix Table 5D) the 5% cutoff is zero for ¾ of the datasets for autocracies (½ of the datasets if outliers are included). For all datasets, the 1% lower cutoff is at zero for the autocratic leader share (not reported). This suggests that even when the point estimate of the autocratic leader share is positive, the estimates are sufficiently noisy that we cannot be confident that the true autocratic leader share is positive.

Section 5.4: Interpretation: what proportion of total growth variance is explained by leaders?

Taking into account all of the different datasets, what is the share of variance accounted for by contemporaneous variation in leader quality? We calculate this as the variance of the leader effect from Table 5B as share of total variation in growth (from Table 2), with the results reported in Table 5F. We find that the average autocratic leader accounts for only about 2% of annual variation in growth, with the range 0-3% in all but one of the datasets (Maddison Archigos, which is 10%). Interestingly, the share of growth credited to democratic leaders is substantially higher, due in part to a less volatile growth process.

The much higher SD of the error term under autocracy in part drives the results on the very low share of leaders in growth variation under autocracy. However, recall from the previous section that it is also true that the SD of the leader effects was already smaller under autocracy than under democracy, so our main result contradicting the conventional wisdom on the importance of "good" and "bad" leaders under autocracy does NOT depend on the noisy error term under autocracy.

Table 5F: full model estimates of leader share of growth variations

	All leaders		Democrats		Autocrats	
	JO	Archigos	JO	Archigos	JO	Archigos
PWT7.1	0.00%	0.00%	7.03%	0.00%	0.00%	0.00%
PWT 6.1	0.00%	0.28%	5.78%	0.00%	0.38%	2.90%
Maddison	0.00%	6.82%	11.42%	10.45%	1.32%	9.41%
WDI	0.92%	1.16%	18.32%	20.97%	1.83%	2.15%
Average	1.15%		9.25%		2.25%	

Notes: calculated as SD(leader)^2/SD(total growth)^2 from Tables 5B and 2 respectively.

Section 6: Tenure length and other robustness lengths

In this section, we perform a number of further robustness tests which show our core result – a small autocratic leader SD and variance share - is robust to variations in tenure or the number of leaders per country, transition effects or the addition of year dummies. Results using the Archigos dataset are broadly similar (not reported).

Leader tenure is plausibly endogenous to economic growth, with strong growth helping leaders retain power, and (perhaps) leaders anticipating a long tenure perusing policies that promote long-run growth.[16] To see if the length of a leader's tenure has an important effect on the estimated leader SD for autocrats, we split the sample into leaders whose tenure is less than 10 years, and those leaders with tenure greater than 10 years (approximately a 50-50 split in terms of years). As shown in the first two columns of Table 6, regardless of tenure the autocratic leader SD is zero for both PWT datasets, and is small for Maddison and WDI datasets. Except for Maddison's dataset, the estimated leader SD is similar for leaders of different tenures. All four datasets suggest, if anything, that the estimated leader SD is larger for leaders with a *short* tenure. In contrast, those leaders most celebrated (or despised) for their growth performance in the literature typically have long tenures.

Table 6: Robustness to tenure and other specifications - Autocracies (JO leaders)

		Tenure		Excl. First and Last Years	Year Dummies*	Leaders/country
		≤10yrs	>10yrs	of Leader Tenure		Excl . 10% tails (<5 or >22)
PWT7.1	SD (leader)	0.0%	0.0%	0.0%	0.0%	0.0%
	Var share (leader)	0.0%	0.0%	0.0%	0.0%	0.0%
	Leaders	408	113	329	540	528
	Obs	1459	1887	2237	3484	3423
PWT 6.1	SD (leader)	0.0%	0.0%	0.0%	0.7%	0.0%
	Var share (leader)	0.0%	0.0%	0.0%	1.3%	0.0%
	Leaders	402	113	326	535	523
	Obs	1434	1877	2219	3448	3389
Maddison	SD (leader)	1.0%	0.0%	0.0%	0.8%	0.5%
	Var share (leader)	4.8%	0.0%	0.0%	2.3%	0.9%
	Leaders	414	110	325	542	530
	Obs	1481	1918	2242	3536	3469
WDI	SD (leader)	1.0%	0.7%	0.8%	0.8%	0.7%
	Var share (leader)	4.7%	1.6%	1.9%	2.3%	1.6%
	Leaders	331	100	284	449	442
	Obs	1187	1565	1854	2867	2824

Notes: Dependent variable is per capita GDP growth. Method: SA. Sample 1950-2000 (1961-2000 for WDI) *excludes some years due to collinearlity

Other questions arise on whether leader effects are really instantaneous and contemporaneous. The first year of a leader's term may reflect the effect of the previous leader. The first and last year of a leader's term may also reflect the effects of a leadership transition rather than leaders per se. These concerns motivate us to calculate results in which we omit the first and last year of a leader's term (third column of Table 6), though the results

[16] For example, short expected tenures encourage leaders to strip assets from the state, rather than build wealth in the longer term, which can then be taxed. Using the leader's age as an instrument for length of tenure, Popa (2013) finds that leaders with a longer tenure tend to lead to have a higher average growth during their tenure.

are robust to these omissions. Results are also robust to adding year dummy variables (fourth column of Table 6), which control for world economic growth in that particular year.

Another set of concerns arise when we have too many or too few leaders for one country. Too many leaders may just indicate political instability in which leaders are less likely to leave their mark on growth rates. At the other extreme, too few leaders for a country make it difficult to separate out country effects from leader effects. In the final column of Table 6, we drop countries with few leaders per country or countries with many leaders per country. The results are robust to these omissions.

Section 7: Conclusions

What proportion of the economic growth can be attributed to the good policies and vision of national leaders? In this paper we show that one common way to measure the contribution of leaders – the average economic growth rate during their tenure – will bias upward the attribution of growth to variation in leader quality. We propose a range of alternatives which perform better in Monte Carlo simulations. Our preferred measure, which controls for country effects and autocorrelated errors, suggests little of the variation in growth can be attributed to national leaders — changes in leadership and changes in growth simply do not line up well enough.

What are the implications of these results? First, policymakers should be much more careful about attributing economic growth to leadership. This is especially true when the tenures of leaders are short and in autocracies, where annual growth is more volatile. However, it is also a problem over longer periods – with our calibration of leader effects and idiosyncratic growth variation, we find a bias of 50% even after 20 years. And then, as the bias due to the error term dies away, there then arises a new difficulty in distinguishing between a long-serving leader effect and a country effect.

Second, much of the conventional wisdom on the existence of "benevolent autocrats" – as well as the existence of other "malevolent autocrats" – is not consistent with the stylized facts as we have refined them here. The stylized facts here suggest little support for the view that strong positive growth outcomes under autocracy can be attributed mainly to unconstrained "good" leaders. Since almost any autocratic leader will try to claim that they are a "benevolent autocrat," this removes what may often be a popular justification for autocratic rule, which seems to be influential even among aid policymakers and humanitarian advocates of development.

Third, our results are consistent with plausible views of how even seemingly unconstrained autocratic leaders might find it difficult to exert control over the growth rate of the economy. Even if there were a "benevolent" autocrat determined to raise growth, he or she has to solve difficult principal-agent problems to get his growth-promoting orders carried out all the way down the government bureaucracy. The autocrat also has to solve a serious knowledge problem getting accurate information from the lower levels on what are the most serious obstacles to growth and/or what are the biggest opportunities for government actions to raise growth. Autocratic leaders also may face many constraints even though they don't face democratic ones, as there are other power centers in autocratic systems that may be able to veto actions contrary to their interests. The theory of benevolent autocrats producing growth miracles requires strong assumptions about the autocrats' ability to motivate the government bureaucracy, solve knowledge problems, and overcome other elite interests running contrary to growth. But the biggest assumption of all was that an autocrat selected through a ruthless process of amassing power could even turn out to be benevolent.

Development policy could be one of the last refuges of the "Great Man" theory of history, which has been discarded in history itself and in most other social science analysis. But growth could be and often is modeled in economics as the outcome of a general equilibrium process (which could include political economy general equilibrium), where the outcome does not correspond to the intentions of any one individual, not even the national leader. We find in this paper little reason to believe in "great men" –either benevolent or malevolent – driving the growth process.

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Appendix 1: Additional Figures and Tables

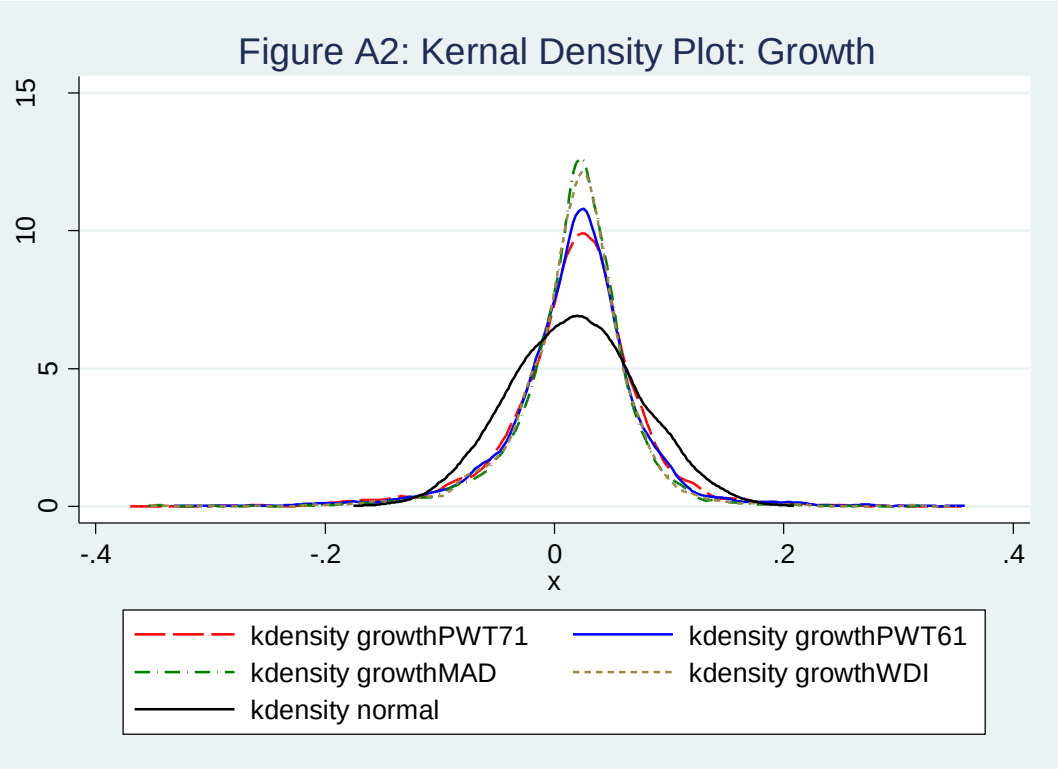
Appendix Table 1A: Outliers

			JO Outliers					Archigos outliers					Max-Min
Country Name	**Isocode**	**Year**	**PWT7.1**	**PWT 6.1**	**WDI**	**MAD**	**Total**	**PWT7.1**	**PWT 6.1**	**WDI**	**MAD**	**Total**	**Growth**
Afghanistan	AFG	1993						-0.41				1	0.26
Algeria	DZA	1962	-0.45				1	-0.45				1	0.28
Angola	AGO	1975		-0.44		-0.47	2						0.43
Angola	AGO	1993		-0.49			1						0.29
Chad	TCD	1979		0.50			1		0.50			1	0.76
Congo	COG	1962		0.50			1		0.50			1	0.56
Equatorial Guinea	GNQ	1996	0.65				1	0.65				1	0.46
Equatorial Guinea	GNQ	1997	0.77	0.57	0.51	0.51	4	0.77	0.57	0.51	0.51	4	0.26
Equatorial Guinea	GNQ	1999		-0.44			1		-0.44			1	0.76
Equatorial Guinea	GNQ	2000		0.55			1		0.55			1	0.46
Iraq	IRQ	1991						-1.04			-0.95	2	0.08
Lebanon	LBN	1976						-0.81				1	0.83
Lebanon	LBN	1977						0.56				1	0.53
Lebanon	LBN	1982						-0.58				1	0.51
Lebanon	LBN	1984						0.40				1	0.38
Lebanon	LBN	1989						-0.58		-0.56		2	0.57
Liberia	LBR	1990						-0.59		-0.70		2	0.84
Liberia	LBR	1992						-0.50		-0.41		2	0.46
Liberia	LBR	1993						-0.43				1	0.41
Liberia	LBR	1997						0.64		0.65		2	0.73
Mauritania	MRT	1964	0.43	0.42			2	0.43	0.42			2	0.21
Nicaragua	NIC	1979	-0.49				1	-0.49				1	0.22
Oman	OMN	1967								0.48	0.48	2	0.00
Oman	OMN	1968								0.57	0.57	2	0.00
Romania	ROM	1980		-0.54			1		-0.54			1	0.59
Rwanda	RWA	1994	-0.71	-0.54	-0.64	-0.51	4	-0.71	-0.54	-0.64	-0.51	4	0.20
Rwanda	RWA	1995	0.61			0.44	2	0.61			0.44	2	0.34
Swaziland	SWZ	1974						0.40				1	0.38
Tanzania	TZA	1988		-0.43			1		-0.43			1	0.51
Total			7	11	2	4	24	19	9	8	6	42	
Average Max-Min Diff													0.42

Notes: log growth rates, which explain how it is possible to get a number less than -1.

Appendix Table 1B: Country List

Country Name	Isocode	Democracy		Country Name	Isocode	Democracy	
		Archigos	JO			Archigos	JO
Afghanistan	AFG	0		South Korea	KOR	0	0
Angola	AGO		0	Kuwait	KWT	0	
Albania	ALB	0		Laos	LAO	0	
United Arab Emirates	ARE	0		Lebanon	LBN	0	
Argentina	ARG	0	0	Liberia	LBR	0	
Australia	AUS	1	1	Libya	LBY	0	
Austria	AUT	1	1	Sri Lanka	LKA	0	0
Burundi	BDI	0	0	Lesotho	LSO	0	0
Belgium	BEL	1	1	Luxembourg	LUX		1
Benin	BEN	0	0	Morocco	MAR	0	0
Burkina Faso	BFA	0	0	Madagascar	MDG	0	0
Bangladesh	BGD	0	0	Mexico	MEX	0	0
Bulgaria	BGR	0		Mali	MLI	0	0
Bahrain	BHR	0		Myanmar	MMR	0	
Bolivia	BOL	0	0	Mongolia	MNG	0	
Brazil	BRA	0	0	Mozambique	MOZ		0
Bhutan	BTN	0		Mauritania	MRT	0	0
Botswana	BWA	0	0	Mauritius	MUS	1	1
Central African Republic	CAF	0	0	Malawi	MWI	0	0
Canada	CAN	1	1	Malaysia	MYS	0	0
Switzerland	CHE	1	1	Namibia	NAM		0
Chile	CHL	0	0	Niger	NER	0	0
China	CHN	0	0	Nigeria	NGA	0	0
Cote d'Ivoire	CIV	0	0	Nicaragua	NIC	0	0
Cameroon	CMR	0	0	Netherlands	NLD	1	1
Congo	COG	0	0	Norway	NOR	1	1
Colombia	COL	0	0	Nepal	NPL	0	0
Comoros	COM		0	New Zealand	NZL	1	1
Costa Rica	CRI	1	1	Oman	OMN	0	
Cuba	CUB	0		Pakistan	PAK	0	0
Cyprus	CYP	1		Panama	PAN	0	0
Czech Republic	CZE	0		Peru	PER	0	0
Germany	DEU	1	1	Philippines	PHL	0	0
Denmark	DNK	1	1	Papua New Guinea	PNG		1
Dominican Republic	DOM	0	0	Poland	POL	0	0
Algeria	DZA	0	0	Portugal	PRT	0	0
Ecuador	ECU	0	0	Paraguay	PRY	0	0
Egypt	EGY	0	0	Qatar	QAT	0	
Spain	ESP	0	0	Romania	ROM	0	0
Ethiopia	ETH	0	0	Rwanda	RWA	0	0
Finland	FIN	1	1	Saudi Arabia	SAU	0	
Fiji	FJI	0	0	Sudan	SDN	0	
France	FRA	0	0	Senegal	SEN	0	0
Gabon	GAB	0	0	Singapore	SGP	0	0
United Kingdom	GBR	1	1	Sierra Leone	SLE	0	0
Ghana	GHA	0	0	El Salvador	SLV	0	0
Guinea	GIN	0	0	Somalia	SOM	0	
Gambia	GMB	0	0	Sweden	SWE	1	1
Guinea-Bissau	GNB		0	Swaziland	SWZ	0	
Equatorial Guinea	GNQ	0	0	Syria	SYR	0	0
Greece	GRC	0	0	Chad	TCD	0	0
Guatemala	GTM	0	0	Togo	TGO	0	0
Guyana	GUY	0	0	Thailand	THA	0	0
Honduras	HND	0	0	Trinidad and Tobago	TTO	1	1
Haiti	HTI	0	0	Tunisia	TUN	0	0
Hungary	HUN	0	0	Turkey	TUR	0	0
Indonesia	IDN	0	0	Taiwan	TWN	0	0
India	IND	1	1	Tanzania	TZA	0	0
Ireland	IRL	1	1	Uganda	UGA	0	0
Iran	IRN	0	0	Uruguay	URY	0	0
Iraq	IRQ	0		United States	USA	1	1
Iceland	ISL		1	Venezuela	VEN	0	0
Israel	ISR	1	1	Vietnam	VNM	0	
Italy	ITA	1	1	Yemen	YEM		0
Jamaica	JAM	1	1	Yugoslavia	YUG	0	
Jordan	JOR	0	0	South Africa	ZAF	0	0
Japan	JPN	1	1	Dem. Rep. of Congo	ZAR	0	0
Kenya	KEN	0	0	Zambia	ZMB	0	0
Cambodia	KHM	0		Zimbabwe	ZWE	0	0
Countries		**129**	**112**				
Democracies		**24**	**26**				
Autocracies		**105**	**86**				
Common Countries		**103**					



Appendix Table 2: Descriptive Statistics (Archigos leaders)					
	A. All				
	Mean	SD	Obs	Leaders	Tenure
PWT7.1	1.86%	6.2%	5161	894	5.8
PWT 6.1	1.86%	5.6%	4622	829	5.6
Maddison	1.69%	5.4%	5750	961	6.0
WDI	1.68%	5.4%	4150	722	5.7
	B. Democracies				
	Mean	SD	Obs	Leaders	Tenure
PWT7.1	2.6%	3.8%	1132	256	4.4
PWT 6.1	2.6%	3.6%	1127	256	4.4
Maddison	2.7%	3.0%	1130	255	4.4
WDI	2.5%	2.9%	830	189	4.4
	C. Autocracies				
	Mean	SD	Obs	Leaders	Tenure
PWT7.1	1.6%	6.7%	4029	638	6.3
PWT 6.1	1.6%	6.1%	3495	573	6.1
Maddison	1.5%	5.8%	4620	706	6.5
WDI	1.5%	5.8%	3320	533	6.2

Appendix Table 3A: Best leaders (1 if average growth in top 5% of outcomes) (Archigos)						
Leader name and country	**ISO code**	**PWT 6.1**	**PWT 7.1**	**Maddison**	**WDI**	**Count**
Berisha	ALB	0	0	0	1	1
Raab	AUT	0	1	1	0	2
Mwambutsa	BDI	1	0	0	0	1
Kubitschek	BRA	0	0	0	1	1
Medici	BRA	1	1	1	1	4
Khama	BWA	1	1	1	1	4
Aylwin	CHL	0	1	1	0	2
Deng Xiaoping	CHN	1	1	1	1	4
Hua Guofeng	CHN	0	1	0	1	2
Fernandez Reyna	DOM	1	0	1	0	2
Rodriguez Lara	ECU	1	1	0	1	3
Mba	GAB	1	0	0	0	1
Papadopoulos	GRC	1	1	1	1	4
Preval	HTI	1	0	0	0	1
Shearer	JAM	1	0	0	1	2
Ikeda	JPN	1	1	1	1	4
Sato	JPN	1	1	1	1	4
Chun Doo Hwan	KOR	1	1	1	1	4
Hee Park	KOR	1	1	1	0	3
Roh Tae Woo	KOR	0	1	1	1	3
Elias Hrawi	LBN	0	1	1	1	3
Razak	MYS	0	1	1	0	2
Robles	PAN	0	1	0	0	1
Caetano	PRT	0	1	1	1	3
Salazar	PRT	0	0	0	1	1
Ceausescu	ROM	1	0	0	0	1
Paul Kagame	RWA	1	0	0	1	2
Lee Kuan Yew	SGP	1	0	1	1	3
Margai,M	SLE	0	1	0	0	1
Grunitzky	TGO	1	1	1	1	4
Sarit	THA	0	0	1	0	1
Chiang Ching-Kuo	TWN	1	0	1	1	3
Chiang Kai-shek	TWN	0	0	0	1	1
Lee Teng-Hui	TWN	0	0	0	1	1
Do Muoi	VNM	1	1	1	1	4
Growth Cutoff (best leader)		6.26%	6.04%	5.53%	6.20%	
Number of leaders						35
Average number of datasets leader for which leader is in best 5%						**2.4**
Proportion of all “best” leaders (by at least one measure) for which all datasets agree						**25.7%**

Appendix Table 3B: Worst leaders (1 if average growth in worst 5% of outcomes) (Archigos)						
Leader name and country	**ISO code**	**PWT 6.1**	**PWT 7.1**	**Maddison**	**WDI**	**Count**
Alia	ALB	0	1	1	1	3
Yameogo	BFA	1	0	0	0	1
Siles Zuazo	BOL	0	0	0	1	1
Kolingba	CAF	1	1	1	0	3
Patasse	CAF	1	0	0	0	1
Lissouba	COG	1	0	1	1	3
Carazo Odio	CRI	1	1	1	1	4
Rafel Trujillo	DOM	0	0	0	1	1
Acheampong	GHA	1	1	0	0	2
Suazo Cordova	HND	0	1	0	0	1
Ayatollah Khomeini	IRN	1	1	1	1	4
Manley	JAM	0	0	0	1	1
de La Madrid	MEX	0	1	0	0	1
Keita	MLI	1	1	0	0	2
Ould Haidalla	MRT	1	0	1	1	3
Kountche	NER	0	1	0	0	1
Seibou	NER	0	0	1	1	2
Obasanjo	NGA	0	1	0	0	1
Shagari	NGA	1	1	1	1	4
Anastasio Somoza Debayle	NIC	0	0	1	0	1
Daniel Ortega	NIC	1	0	1	1	3
Violeta Chamorro	NIC	1	0	0	0	1
Noriega	PAN	0	0	1	0	1
Garcia Perez	PER	1	1	1	1	4
Momoh	SLE	0	1	1	1	3
Strasser	SLE	1	1	1	0	3
Duarte	SLV	1	0	0	1	2
Malloum	TCD	0	1	1	1	3
Chambers	TTO	0	1	1	1	3
Manning	TTO	1	0	0	0	1
Robinson	TTO	0	1	0	0	1
Obote	UGA	0	0	0	1	1
Alvarez Armalino	URY	1	1	1	1	4
Betancourt	VEN	0	0	1	0	1
Caldera Rodriguez	VEN	1	0	0	0	1
Campins	VEN	1	1	1	1	4
Mobutu	ZAR	1	1	1	1	4
		-2.62%	-2.16%	-2.26%	-2.49%	
Number leaders						**37**
Average number of datasets leader for which leader is in worst 5%						**2.2**
Proportion of all “worst” leaders (by at least one measure) for which all datasets agree						**18.9%**

Appendix Table 4A: Std Dev. of Leader contribution and iid noise: by dataset (Archigos leaders)								
Growth	All		Democracies		Autocracies		Autocracies (incl. outliers)	
Dataset	SD(leader)	sd(iid)	SD(leader)	sd(iid)	SD(leader)	sd(iid)	SD(leader)	sd(iid)
PWT7.1	1.22%	6.07%	1.13%	3.60%	1.40%	6.56%	2.12%	7.59%
	[0.36%]	[0.28%]	[0.50%]	[0.46%]	[0.38%]	[0.31%]	[0.64%]	[0.61%]
PWT 6.1	1.65%	5.40%	0.90%	3.51%	1.89%	5.85%	1.62%	6.44%
	[0.23%]	[0.25%]	[0.45%]	[0.42%]	[0.26%]	[0.28%]	[0.39%]	[0.42%]
Maddison	1.95%	5.06%	1.39%	2.70%	2.10%	5.45%	2.11%	5.85%
	[0.19%]	[0.25%]	[0.23%]	[0.19%]	[0.22%]	[0.27%]	[0.22%]	[0.37%]
WDI	2.05%	4.96%	1.50%	2.49%	2.21%	5.37%	2.92%	5.75%
	[0.25%]	[0.22%]	[0.28%]	[0.17%]	[0.28%]	[0.24%]	[0.55%]	[0.32%]

Notes: bootstrap std errors in brackets (country-level non-parametric iid bootstrap 1000 reps). Dep. variable is per capita GDP growth. Method: SA. Sample 1950-2000 (1961-2000 for WDI). Outliers dropped.

Appendix Table 4B: Leader share of total growth variance (Archigos)				
	All	Democracies	Autocracies	Autocracies (incl. outliers)
PWT7.1	3.87%	9.00%	4.38%	7.27%
PWT 6.1	8.56%	6.22%	9.45%	5.97%
Maddison	12.91%	21.01%	12.95%	11.45%
WDI	14.53%	26.50%	14.50%	20.45%

Notes: Calculated from Appendix Table 4A using Equation 2

[**Appendix Table 5A**: Monte Carlo results using Archigos leader structure are almost identical and so omitted]

Appendix Table 5B: Std Dev. of Leader contribution and iid noise: by dataset (Archigos leaders)								
	All		Democracies		Autocracies		Autocracies (incl outliers)	
	SD(leader)	sd(iid)	SD(leader)	sd(iid)	SD(leader)	sd(iid)	SD(leader)	sd(iid)
PWT7.1	0.00%	5.92%	0.00%	3.50%	0.00%	6.41%	1.59%	7.57%
	[0.17%]	[0.27%]	[0.49%]	[0.43%]	[0.37%]	[0.30%]	[1.11%]	[0.60%]
PWT 6.1	0.30%	5.26%	0.00%	3.41%	1.05%	5.70%	0.86%	6.33%
	[0.45%]	[0.24%]	[0.42%]	[0.40%]	[0.53%]	[0.27%]	[0.70%]	[0.43%]
Maddison	1.41%	5.02%	0.98%	2.58%	1.79%	5.41%	1.70%	5.86%
	[0.55%]	[0.25%]	[0.32%]	[0.17%]	[0.54%]	[0.27%]	[0.56%]	[0.36%]
WDI	0.58%	4.85%	1.33%	2.46%	0.85%	5.25%	2.96%	5.67%
	[0.51%]	[0.21%]	[0.32%]	[0.17%]	[0.58%]	[0.23%]	[1.11%]	[0.31%]

Notes: bootstrap standard errors in brackets (country-level non-parametric iid bootstrap 1000 reps). Dependent variable is per capita GDP growth. Method: SA. Sample 1950-2000 (1961-2000 for WDI)

Appendix Table 5C: Estimated SD(country effects) and AR(1) coefficient: by dataset (Archigos)

	All		Democracies		Autocracies		Autocracies (incl outliers)	
	SD(CE)	rho	SD(CE)	rho	SD(CE)	rho	SD(CE)	rho
PWT7.1	1.77%	0.08	0.92%	0.19	1.86%	0.06	1.97%	0.04
	(0.00)	(0.09)	(0.01)	(0.00)	(0.00)	(0.20)	(0.63)	(0.00)
PWT 6.1	1.51%	0.01	0.84%	0.10	1.60%	-0.01	1.57%	-0.02
	(0.00)	(0.30)	(0.00)	(0.00)	(0.00)	(0.59)	(0.00)	(0.60)
Maddison	1.71%	0.12	0.93%	0.10	1.77%	0.11	1.81%	0.10
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.12)
WDI	2.25%	0.20	1.07%	0.13	2.41%	0.19	2.82%	0.14
	(0.00)	(0.00)	(0.04)	(0.01)	(0.00)	(0.00)	(0.40)	(0.00)

Notes: p-values in parentheses (AR(1) from Wooldridge SC test). Dependent variable is per capita GDP growth. Method: SA. Sample 1950-2000 (1961-2000 for WDI)

Appendix Table 5D: Boostrap 5% cutoff from empirical distribution: by dataset (Archigos Leaders; 1000 reps)

	All		Democracies		Autocracies		Autocracies (incl outliers)	
Dataset	SD(leader)	sd(iid)	SD(leader)	sd(iid)	SD(leader)	sd(iid)	SD(leader)	sd(iid)
PWT71	0.00%	5.47%	0.00%	2.84%	0.00%	5.93%	0.00%	6.60%
PWT61	0.00%	4.88%	0.00%	2.77%	0.00%	5.26%	0.00%	5.68%
MAD	0.00%	4.60%	0.33%	2.30%	0.69%	4.96%	0.56%	5.27%
WDI	0.00%	4.49%	0.76%	2.19%	0.00%	4.88%	0.43%	5.17%

Appendix Table 5E: Std Dev. of Leader contrib: by dataset (Archigos leaders)

	All		Democracies		Autocracies	
Model:	CE Only	AR(1) Only	CE Only	AR(1) Only	CE Only	AR(1) Only
PWT7.1	0.94%	0.00%	1.07%	0.00%	1.29%	0.00%
PWT 6.1	1.65%	0.31%	0.75%	0.00%	2.06%	0.79%
Maddison	2.08%	1.16%	1.31%	0.96%	2.38%	1.38%
WDI	1.91%	1.04%	1.58%	1.15%	2.15%	1.20%

Note: SD(leader) adding either country effects (CE) or allowing for autocorrelation (AR(1))

Appendix 2: Close assassinations and economic growth

While leader deaths through illness or accident are one type of exogenous leader transition (Jones and Olken 2005; Besley et al 2011), they are not the only one. Jones and Olken (2009) examine the effect of successful assassinations on democracy and war (but not on growth). They argue that within the set of "serious" assassination attempts (attempts where the assassination weapon was discharged), whether a leader is killed (a "hit") or not (a "miss") is essentially random. For example, President Kennedy was killed in a moving car by a bullet fired from a range of 265 feet in 1963, whereas Ugandan leader Idi Amin survived an assassination attempt in 1976 when a thrown grenade bounced off his chest (Jones and Olken 2009 p 65). They show the sample of "hits" is not statistically different from the sample of "misses" for a range of economic and political variables in the years before the assassination attempt.

In this Appendix, we extend the analysis in Jones and Olken (2009) to see if successful assassination attempts, and hence leader changes, have an effect on economic growth. Using a similar approach as in Jones and Olken (2005), we calculate the average growth rate in the 5 years before the assassination attempt ($PRE_{t-1,t-5}$) and the 5 years after the assassination attempt ($POST_{t+1,t+5}$) and test if the difference or squared difference is statistically different in successful vs unsuccessful assassination attempts (i.e. if $\beta \neq 0$ in the equations below). As the assassinations database dates back to 1875, we use growth data from Maddison (the other data sources start in the 1950s or 1960s). After merging the assassinations data with Maddison's growth data and other controls, we have 171 serious assassination attempts, of which 42 were successful. Units are percentage points, or squared percentage points.

$$(POST_{t+1,t+5} - PRE_{t-1,t-5})^2 \quad = \beta_{sq} success_i + \boldsymbol{\delta X_i} + \varepsilon_i \qquad (6)$$

$$POST_{t+1,t+5} - PRE_{t-1,t-5} \ = \beta_d success_i + \boldsymbol{\delta X_i} + \varepsilon_i \qquad (7)$$

Appendix Table 2.1: Assassinated leaders and economic growth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dep: Variable			[POST-PRE]^2	(ppt^2)				POST-PRE (ppts)		
Sample	All	All	Ex-outlier	Autocracies	Strict Control	All	All	Ex-outlier	Autocracies	Strict Control
Successful Assassination	-0.67	1.85	4.40	9.74	2.84	0.10	-0.35	0.27	0.47	-0.27
	(-10.48)	(12.91)	(12.34)	(14.79)	(14.16)	(1.01)	(1.11)	(1.09)	(1.29)	(1.21)
Weapon dummies	NO	YES	YES	YES	YES	NO	YES	YES	YES	YES
Number of attacks dummies	NO	YES	YES	YES	YES	NO	YES	YES	YES	YES
Observations	171	171	166	139	145	171	171	166	139	145
Implied leader SD	0^	0.96	1.48	2.21	1.19					

Note: Robust standard errors in parentheses, clustered at the country level. *** p<0.01, ** p<0.05, * p<0.1 (all results insignificant) The sample consists of all serious assassination attempts from Jones and Olken (2009). POST (PRE) is the difference between the average growth rate in the 5 years after (before) the assassination attempt. Growth data from Maddison.Units: Columns 1-6 ppt^2 (X10000), Columns 7-12 ppts (X100) ^ Normalized to be

The results are presented in Appendix Table 2.1, and suggest that a change in leader due to a successful assassination *never* leads to a statistically significant change in economic growth (relative to the growth difference around unsuccessful assassination attempts). In the first 5 columns of Appendix Table 2.1, the dependent variable is square of the change in average growth POST-PRE, and in the last 5 columns it is the *directional* shift. Column (1) and (6) report simple regressions on the successful assassination dummy with no other controls and Columns (2) and (7) adds weapon and number of attacks dummies (following Jones and Olken 2009). In Columns (1) it seems that a successful assassination actually leads to a slightly *smaller* change in average growth than an unsuccessful assassination, which indicates insignificance is not just driven by wide standard errors. In Columns (6) and (7) there is no clear directional effect of successful assassination attempts.

The other columns in Appendix Table 2.1 run the same regression (with weapon and number of attack controls) on different samples to check for robustness. In Column (3) and (8) we drop outliers, defined here as periods where average growth over the pre- or post-assassination period exceeds 10% in absolute value. This has little effect on the results. In Columns (4) and (9) we focus on the assassination of autocrats (polity<8 in the year before the attempt). While the squared difference in growth around a success is larger around successful attempts, it is still statistically insignificant by a wide margin. Finally in Columns (5) and (10) we restrict the sample to cases where there was no leader change in the control group (unsuccessful assassinations) in the assassination attempt year. Results are similar, as they are when we look at looking at 2 year windows rather than 5 year windows (not reported).

Columns 1-5 represent an estimate of the *difference* in the variance of POST-PRE with successful vs unsuccessful assassination attempts. If we apply Equation 1 (simple model), an estimate the leader SD is $\sqrt{0.5\beta_{sq}}$. In our case, this runs from 0 (normalized to be non-negative) to around 2ppts, though all estimates are not significantly different from zero.

These results suggest that the causal effect of leaders transitions on growth found in Jones and Olken (2005) and Besley et al (2011) for a small sample of leader transitions in a specific context might not apply in all other settings.[17] For this reason, in this paper we take a leader growth accounting approach which allows us to look at all leader transitions.

Appendix 3: Data quality and Jones and Olken (2005)

In an influential study, Jones and Olken (2005) used random leader deaths due to illness or accident to estimate the effect of leader transitions on economic growth. They found that variation in leader quality explains about 1.5 percentage points of variation in economic growth, and is statistically different from zero. Moreover, they found that the results are driven by "autocrats" (leaders in countries with a negative Polity IV score), rather than democrats, which is rationalized by autocratic leaders being more "unconstrained" than democrats.

Since the publication of JO in 2005, new versions of Penn World Table growth data have been released which question some of the findings of Jones and Olken (2005). Johnson et al (2013) re-estimate the key results of Jones and Olken (2005) using PWT 6.2 or PWT 7 (JO used PWT6.1). In all versions they find a significant leader effect, but using PWT 6.2 this was driven by *democrats* rather than autocrats, but using PWT 7.0 both autocratic and democratic leaders transitions have a significant effect on growth.

Appendix Table 3.1 - Replication of JO (2005) with New Growth Data

	Original (JO 2005 QJE, Table 3/5)			With new PWT 7.1 Data		
	J-stat	p-val	Num Leaders	J-stat	p-val	Num Leaders
All leaders	1.312	0.057	57	1.464	0.013	57
Tenure >= 2 Years	1.392	0.039	47	1.627	0.004	47
Autocrats Only (Polity)	1.621	0.019	29	1.084	0.346	29
Democrats Only (Polity)	1	0.46	22	2.182	0.001	22

[17] If the effect of leaders on economic growth depends on local political institutions or other country-specific factors (the equivalent of a heterogeneous treatment effect in the randomized control literature), then we would expect to see the estimated leader effect vary from context to context. The use of a small sample makes this more likely.

In this Appendix, we make two contributions: first we revisit JO 2005 with newer PWT 7.1 data,[18] and second we examine the set of the most influential leader transitions. The first set of results are shown in Appendix Table 3.1. On the left hand side of Appendix Table 3.1 are the original results from JO 2005 (Table 3 & 5) using PWT 6.1 showing a significant leader effect for all leaders and leaders with >=2 years tenure, driven by *autocrats*. With an error SD $\sigma_\varepsilon \approx 0.06$, J=1.312 implies a leader SD of 1.5%, as reported in JO(2005) (Equation A3.1).[19] With JO's original estimates, the autocratic leader SD is even larger, at 2.1 %.

$$\text{(A3.1)} \quad \sigma_\mu = [(J-1)\sigma_\varepsilon^2/T]^{0.5}$$

On the RHS of the Table A3.1 are the new results using PWT 7.1 data. The overall effect of leaders is even larger, but it is driven by democrats (as Johnson et al 2003 found using PWT 6.2). The estimated leader SD for autocrats (again using $\sigma_\varepsilon \approx 0.06$), is around 0.8% and insignificantly different from zero.

Table A3.2: Influential leader transitions (p-value<0.1) with original and revised data

Country	Year	Code	Leader Name	JO Classif	Change Growth	P-value	Change Growth	P-value
					PWT 6.1 (JO 2005 Original)		PWT 7.1 (Revised Data)	
Nigeria	1998	NGA	Abacha	Autocrat	-0.197	**0.002**	*Not influential (p-val<0.1) with PWT7.1*	
Angola	1979	AGO	Neto	Autocrat	0.124	**0.009**		
Spain	1975	ESP	Franco	Autocrat	-0.035	0.064		
New Zealand	1974	NZL	Kirk	Democrat	-0.048	**0.036**		
Iran	1989	IRN	Khomeini	Autocrat	0.086	**0.022**	0.128	**0.006**
Mozambique	1986	MOZ	Machel	Autocrat	0.119	**0.012**	0.091	0.068
Rwanda	1994	RWA	Habyarimana	Autocrat	0.092	0.054	0.095	0.058
Iceland	1970	ISL	Benediktsson	Democrat	0.047	**0.012**	0.051	**0.013**
Trinidad &Tob	1981	TTO	Williams	Democrat	-0.057	0.094	-0.142	**0.000**
Nicaragua	1966	NIC	Schick	Autocrat	*Not influential (p-val<0.1) with PWT 6.1*		-0.066	**0.039**
Guyana	1997	GUY	Jagan	Democrat			-0.089	**0.015**
Sierra Leone	1964	SLE	Margai	Democrat			-0.147	**0.024**

Notes: Table contains leaders for whom the change in growth following their death is statistically significant (p-value<0.1). P-values in bold indicate significant at the 5% level.

Poor quality growth data makes it difficult to identify which random leader transitions lead to a large change in economic growth- a point made in Section 3. Table A3.2 presents those leaders where the change in growth (in either direction) following their death is statistically significant from zero at the 10% level. Of the 9 leaders which are individually influential using PWT 6.1, around half are not influential using PWT 7.1. We also get three more influential leaders using PWT7.1 data.

The list of influential leader transitions reveals some further important factors that question the generalizability of the results: many of the influential leader transitions are in small countries (Iceland, Trinidad and Tobago) or countries involved in war (Iran, Mozambique, Rwanda). In some countries, one wonders whether the leader death lead to peace: in Iran for example, the Iran-Iraq war finished in 1988 before the death of Khomeni in 1989.

[18] We keep using PWT data as the sample of countries/leaders would change with Maddison or WDI growth data.

[19] Eq A3.1 comes from Equation 4 in JO (2005) with no autocorrelation of leader quality and the SD of [unobservable] leader quality normalized to 1%. T=5 years is the length of the period that one averages on either side of a leader death.

Data Sources

Leader Data

The main data series on leaders come from Jones and Olken (2005) – we thank Ben Jones and Ben Olken for sharing their data with us. In the case where there are multiple leaders in a single year, we keep the leader who ended his/her tenure in that year and started their tenure earliest.

The secondary data source on leaders is Archigos 2.9 dataset (Goemans et al 2009), downloaded from http://www.rochester.edu/college/faculty/hgoemans/Archigos_v.2.9_tv-Public.dta (accessed 3 Sept 2013). As with JO, in the case there are multiple leaders in a year, we keep the leader who ended his/her tenure in that year and started their tenure earliest.[20]

Polity IV Data (Democracy vs Autocracy)

Polity IV data comes from: http://www.systemicpeace.org/inscr/p4v2012.xls (accessed 3 Sept 2013). We calculated the average Polity score over our sample, with a democracies having an average polity score >8, and autocracies <=8. Countries with no Polity data for the whole sample were dropped. [21]

PWT Growth Data

We use two versions of PWT data 6.1 and 7.1, over the sample 1950-2000. These can be downloaded from: https://pwt.sas.upenn.edu/php_site/pwt_index.php (Accessed 3 Sept 2013) . Our GDP per capita variable is *rgdpl:* Real GDP per capita (Constant Prices: Laspeyres). We generate $growth_t = \ln(rgdpl_t) - \ln(rgdpl_{t-1})$

World Bank World Development Indicator Growth Data

We use GDP per capita growth (annual %) (NY.GDP.PCAP.KD.ZG) Data can be downloaded from: http://databank.worldbank.org/data/views/variableSelection/selectvariables.aspx?source=world-development-indicators (Accessed 3 Sept 2013) We convert actual growth rates into log growth rates for comparison growth=log(1+G/100)

Madison Growth Data

We downloaded Angus Maddison original (pre-2010) Statistics on World Population, GDP and Per Capita GDP, 1-2008 AD from http://www.ggdc.net/maddison/oriindex.htm (Accessed 3 Sept 2013). We calculate growth from Maddison's series on Per Capita GDP (1990 Int. Geary-Khamis dollars): $growth = \ln(GDPpc_t) - \ln(GDPpc_{t-1})$

Data Sample and Cleaning

Following Jones-Olken, we used annual data over 1950-2000. WDI growth data was only available starting in 1961 (and so the sample runs 1961-2000). We drop observations where |growth|>0.4 as described in the text. (listed in Table A1). For Archigos, we drop countries with less than 30 years of growth data (combined across all our data sources). We follow JO and drop observations for which there is no PWT6.1 data, or less the 5 years of observations (there are no countries with 5-30 observations of data in JO after dropping these observations).

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[20] To merge 3-letter country isocodes and Correlates of War country codes we used Andreas Beger's crosswalk (http://myweb.fsu.edu/ab05h/research.html#dofiles). We thank Andreas Beger for making this publicly available.

[21] Jones and Olken's dataset uses an older version of Polity IV, which categorizes almost all countries into autocracies/democracies the same as the latest version of Polity IV - except for Botswana. In the most modern version of Polity IV, Botswana is (just) an autocracy by our definition, and so we code it as such in both databases.