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How Much Should We Trust the Dictator's GDP Growth Estimates?

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Abstract

I study the overstatement of GDP growth in autocratic regimes by comparing the self-reported GDP figures to the night time lights (NTL) recorded by satellites from outer space. I show that the NTL elasticity of GDP is systematically larger in more authoritarian regimes. This autocracy gradient in the elasticity is robust to multiple changes in data sources, econometric specification or sample composition and is not explained by potential differences in a large set of country characteristics. The gradient is larger when the incentive to exaggerate economic growth is stronger or when the constraints on such exaggeration are weaker. The results suggest that autocracies overstate yearly GDP growth by as much as 35%. Adjusting the GDP data for the manipulation taking place in autocracies leads to a more nuanced view on the economic success of non-democracies in recent decades and affects our understanding of the effect of changes to foreign aid inflows on income per capita.

Keywords: GDP, night time lights, economic growth, democracy

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1 Introduction

The importance of economic performance for political survival is well known. The state of the economy is often at the center of political debate and is a major determinant of government turnover in both democracies and autocracies (Leigh, 2009; Burke and Leigh, 2010; Brückner and Ciccone, 2011). However, agents are typically unable to perfectly observe the state of the economy and must often rely on noisy signals, such as Gross Domestic Product (GDP), to assess government performance. Since governments themselves usually produce these estimates, they face a recurring temptation to exaggerate just how well the economy is doing. In this regard, GDP stands out as perhaps the most widely used measure of economic activity and one that is very attractive for governments to manipulate.

Although the incentive to overstate economic growth is shared by governments of all kinds, a democratic regime arguably helps to constrain the manipulation of official statistics. A strong democracy guarantees that opposition parties, the media, the judiciary and the public at large can freely scrutinize government figures. These checks and balances are largely absent in autocracies. The execution of the civil servants in charge of the 1937 population census of the USSR due to its unsatisfactory findings serves as an extreme example (Merridale, 1996). A more recent example involves Chinese premier Li Keqiang's alleged admission of the unreliability of the country's official GDP estimates (Clark et al., 2020).

Until now, the clandestine nature of the manipulation of official economic statistics in non-democracies has hindered economists' ability to detect and measure this phenomenon. In this paper, I use night time lights (NTL) to overcome this limitation. My empirical strategy exploits the fact that both GDP and NTL are positively correlated with real economic activity, but while GDP is self-reported by governments and prone to manipulation, NTL are recorded by satellites from outer space and are much less vulnerable. Using panel data for 184 countries, I examine whether the elasticity of GDP with respect to NTL differs between democracies and autocracies. I derive my baseline econometric specification from a parsimonious model that allows me to recover a structural parameter capturing the proportional exaggeration of GDP growth taking place in autocracies (σ) from the regression estimates.

For the main analysis, I classify countries' political regimes using the Freedom in the World (FiW) index produced by Freedom House. This index has an extensive geographic coverage and is the best available measure to capture the effective enjoyment of civil liberties and political rights. I combine this information with a measure of average night time luminosity at the country-year level using granular data from the Defense Meteorological Satellite Program's Operational Linescan System (DMSP-OLS). This dataset is available from 1992 to 2013, which constitutes my main sample period. The World Bank provides yearly data on

GDP in constant local currency, which it sources directly from countries' statistical agencies.

I find that the NTL elasticity of GDP is systematically larger in more autocratic regimes. This means that the same amount of growth in NTL translates into higher reported GDP growth in autocracies than in democracies. This result is visible in a simple comparison of the average growth rates of GDP and NTL across political regimes, in panel regressions with country and year fixed effects, and in event-study specifications exploiting transitions into and out of autocracy. My main estimates suggest that autocracies overstate yearly GDP growth by approximately 35% (i.e., a true growth rate of 2% is reported as 2.7%).

Underlying the baseline analysis is the assumption that the mapping of changes in NTL to changes in GDP should not be affected by a country's political regime in the absence of manipulation of the official statistics. Naturally, countries with different political regimes may differ in many other dimensions, including their economic structure or level of development. I conduct an exhaustive set of robustness checks to address these concerns, verifying that the autocracy gradient in the elasticity is not confounded by heterogeneity associated with a large set of fixed or time-varying country characteristics. I also verify that the results are robust to the use of other data sources on political regimes or to the inclusion of harmonized NTL data from the more recent VIIRS instrument for the period 2014-2018. I likewise show that the results are robust to changes in the specification, such as the inclusion of a country-specific linear time trend, or to changes in the composition of the sample, such as the exclusion of any subregion of the world. Comparing across approximately 200 regressions, I obtain an average $\hat{\sigma}$ of 0.35, which is equal to my baseline estimate.

Several additional pieces of evidence point to overstatement of GDP growth as the mechanism underlying the autocracy gradient in the NTL elasticity of GDP. First, this gradient is only present for GDP sub-components that are highly reliant on government-provided information, such as investment and government spending. Second, the autocracy gradient in the NTL elasticity of GDP is larger when the domestic economy is underperforming relative to the rest of the world, which arguably provides a stronger incentive to overstate GDP growth. Third, among a subset of 88 developing countries, the autocracy gradient in the NTL elasticity of GDP is only observed after countries exceed a threshold value of Gross National Income (GNI) per capita and become ineligible for concessionary loans and grants from the International Development Association (IDA). The incentive to exaggerate GDP growth is arguably weaker before a country crosses this threshold, as it risks precipitating a large reduction in foreign aid inflows, which I also document.

In the final part of the paper, I study some implications of the bias in the GDP figures for autocracies, as well as efforts at promoting transparency in the production and dissemination of official economic statistics. First, I use the previous estimates to adjust each country's aggregate GDP growth between 1992 and 2013 based on its average FiW index over this period. This adjustment leads to a more nuanced view on the apparent economic success of non-democracies in recent decades. According to the unadjusted GDP data, the average aggregate growth rates for countries deemed as not free, partially free and free by Freedom House were 85%, 76%, and 61% respectively. Once I adjust for manipulation, the respective average growth rates for countries in these categories become 55%, 57% and 56%. Second, I return to the subset of IDA beneficiaries to study the effect of losing IDA eligibility on GDP per capita. I show that naive estimates based on the raw GDP data suggest a positive effect, which disappears once I adjust for the exaggeration of GDP growth taking place in autocracies. Finally, I study the effects of the Special Data Dissemination Standard (SDDS), a set of guidelines for the production of official economic statistics created by the International Monetary Fund (IMF). I show that the NTL elasticity of GDP decreases slightly for all countries that comply with the SDDS, which suggests that the SDDS is somewhat effective at reducing the exaggeration of reported GDP growth. However, the SDDS is unsuccessful at eliminating the autocracy gradient in the elasticity.

Guriev and Treisman (2019) have recently described manipulation of information as the defining feature of modern autocracies. Several theoretical papers study autocrats' incentives to engage in this practice (Egorov et al., 2009; Edmond, 2013; Gehlbach and Sonin, 2014; Lorentzen, 2014). Previous empirical work has systematically questioned the credibility of the official statistics produced by China's autocratic regime, but there is limited evidence on the manipulation of information in other autocracies.[1] I contribute to this literature by documenting a relatively unexplored channel through which the manipulation of information takes place in autocracies around the world, namely the systematic overstatement of GDP growth. In this regard, previous work by Magee and Doces (2015) reports a positive effect of autocracy on GDP growth after controlling for growth in NTL, which the authors interpret as evidence of data manipulation in autocracies.[2] The econometric model I develop suggests that this result could be confounded by differences in the mapping of real growth to NTL across political regimes or by differential rates of electrification across regimes, conditional

[1]Research on China's official statistics includes GDP growth (Mehrotra and Pääkkönen, 2011; Nakamura et al., 2016; Clark et al., 2020; Chen et al., 2019), air pollution (Greenstone et al., 2020) and workplace safety (Fisman and Wang, 2017). King et al. (2013, 2017) document censorship and fabrication of online content.

[2]Wallace (2016) provides a similar result using electricity consumption. Relatedly, Hollyer et al. (2011) show a positive correlation between democracy and the availability of economic data in the World Bank's WDI. Other related research has studied manipulation of government statistics without focusing on political regimes. Sandefur and Glassman (2015) study misinformation by public employees in charge of service provision in the developing world. Kerner et al. (2017) argue that countries that are highly dependent on foreign aid manipulate GNI around the IDA eligibility threshold. Another strand of literature has studied creative accounting in response to EU budget rules (von Hagen and Wolff, 2006; Alt et al., 2014). More generally, Michalski and Stoltz (2013) find that balance of payments data fails to satisfy Benford's law.

on income (Min, 2015). My empirical strategy is robust to these possibilities and enables me to credibly estimate the proportional (i.e., multiplicative) exaggeration of GDP growth taking place in autocracies. Additional results regarding the factors that affect the autocracy gradient in the NTL elasticity of GDP and the extensive battery of robustness tests provide more conclusive evidence on data manipulation as the underlying mechanism.

I also contribute to a strand of literature using innovative data sources to assess and complement the information on living standards contained in the national accounts (Deaton, 2005; Chen and Nordhaus, 2011; Henderson et al., 2012; Young, 2012; Pinkovskiy and Sala-i Martin, 2014, 2016). Existing studies in this literature have largely ignored data manipulation as a potential source of discrepancy between sources.[3] In this regard, I also contribute to the burgeoning literature in forensic economics (Zitzewitz, 2012), where I follow the lead of previous studies that compare data from different sources to uncover hidden behavior (Fisman and Wei, 2004, 2009; Olken, 2007). In closely related work, Cavallo (2013) uses online price data to document the manipulation of inflation statistics in Argentina.

The rest of the paper is structured as follows. Section 2 provides background information on the political incentives and constraints that shape the manipulation of official statistics. Section 3 presents the main data sources and discusses the construction of the main variables used in the analysis. Section 4 presents the econometric model. Section 5 shows the main results and documents the autocracy gradient in the NTL elasticity of GDP. Section 6 provides further evidence on data manipulation in autocracies as the underlying mechanism. Section 7 discusses the implications of the bias in GDP figures. Section 8 concludes.

2 Background

Governments generally have an incentive to overstate GDP growth, irrespective of the political regime under which they operate. In democracies, canonical models of political accountability predict that observable measures of government performance guide the behavior of voters at the polls (Ashworth, 2012). In this regard, GDP growth stands out as a prominent indicator used to assess the state of the economy and the performance of the incumbent. In autocracies, salient economic statistics can facilitate coordination and may trigger mass political action against the ruling regime if the outcome is unsatisfactory (Edmond, 2013; Hollyer et al., 2015). Low economic growth in an autocracy may also cause the incumbent government to lose the support from a key constituency, such as the military (Bueno de

[3]For instance, Henderson et al. (2012) argue that the discrepancy between reported GDP growth and their NTL-based estimate for Myanmar could be driven by "a governing regime that would not be averse to exaggerating GDP growth" (p.1021), but they do not pursue this point further.

Mesquita et al., 2004). Existing evidence shows that economic conditions affect political mobilization and government turnover in both democracies and autocracies (Leigh, 2009; Burke and Leigh, 2010; Brückner and Ciccone, 2011; Manacorda and Tesei, 2020).

The manipulation of GDP growth statistics is facilitated by the fact that these figures are typically produced by countries' national statistical agencies, which are usually under the control of the central government.[4] These agencies estimate GDP growth based on information from multiple sources, such as banks, public utilities, and surveys of households and firms. The government itself is the main source of information on public spending and investment, oftentimes with little third-party verification. Hence, the exaggeration of economic growth can take place at multiple stages in the production of the official figures.

In this paper, I ask whether the institutional constraints provided by democratic forms of government help to prevent the manipulation of official statistics. This question is motivated by the idea that a strong democracy is characterized by a system of checks and balances that effectively limits the power of the executive. These checks and balances are typically manifested in formal political institutions, such as free and regular elections or the separation of powers across branches of government, as well as in the upholding of civil liberties that allow the public and the press to freely scrutinize the actions of the government.

These checks and balances are largely absent in authoritarian regimes. Traditional autocracies lack any form of electoral accountability, though recent decades have seen an increase in the number of hybrid regimes that regularly hold elections while at the same time they impose severe restrictions on civil liberties (Levitsky and Way, 2010). These elections are not, however, effective tools for political accountability and they are easily manipulated through the intimidation of opponents, widespread political propaganda or outright fraud (Enikolopov et al., 2011, 2013). Modern autocracies are characterized by executive control over the other branches of government and by the presence of strict controls over information, including limitations on freedom of speech and media censorship. Modern autocrats are less reliant on repression than their predecessors and they mostly depend on their alleged accomplishments, including economic prosperity, as a way to legitimize their hold on power (Guriev and Treisman, 2019). In sum, modern autocracies have both the willingness and

[4]Systematic measurement of national income only begun in the 1930s and became increasingly sophisticated in response to the need for detailed economic information during World War II (Coyle, 2014). The first estimate of Gross National Product (GNP) for the United States dates back to 1942. The publication of the United Nation's System of National Accounts (SNA) in 1951 was a landmark event in the history of official statistics and aimed to homogenize the estimation of economic activity across countries. During the Cold War, countries under communist rule used the Material Product System (MPS) instead, but they began to transition to the SNA in the 1980s. In the case of China, the transition started in 1985 and ended in 1992 (Xu, 2009). Nowadays, most countries follow the SNA or some variation of it, such as the European System of Accounts. The SNA was updated in 1968, 1993 and most recently in 2008.

the ability to manipulate official statistics in order to overstate economic growth.

Naturally, the Lucas (1976) critique applies in this setting and blatant misreporting of economic indicators should be eventually incorporated in agents' expectations, rendering it ineffective.[5] The manipulation of GDP statistics must be sporadic and subtle in order to be effective.[6] In this regard, proportional (i.e., multiplicative) exaggeration of GDP growth would appear to be more feasible and harder to detect than constant (i.e., additive) exaggeration. Moreover, the extent to which autocracies engage in statistical manipulation may vary across time and space in response to factors such as the actual performance of the domestic economy relative to the rest of the world, or the extent to which the ruling regime benefits from the country's economic disadvantage (i.e., foreign aid inflows).

3 Data

Political Regimes. My preferred measure of democracy is the Freedom in the World (FiW) index produced by Freedom House, which is available at a yearly frequency since 1972. Freedom House constructs the index based on the inputs from a team of analysts and country experts. The FiW index ranges from 0 to 6, with lower values corresponding to a greater enjoyment of political rights and civil liberties.[7] Freedom House classifies countries as 'free' if the FiW index is less than 2, 'partially free' for values between 2 and 4 (both inclusive), and 'not free' if the FiW index is larger than 4. Freedom House also provides a binary indicator for 'electoral democracies' based on the same inputs as the continuous FiW index.

I verify below that the results are robust to measures of democracy from other sources, including Polity V and the World Bank. The FiW index is my preferred measure of democracy for several reasons. To start, the FiW index has an extensive geographic coverage (18% increase in sample size relative to Polity V). The FiW index is also more responsive to the *de facto* enjoyment of political rights and civil liberties than other available measures, which mostly focus on formal rules and institutions. This feature is important insofar as democracy can only constrain the manipulation of information by the executive to the extent that

[5] Cavallo et al. (2016) provide evidence that Argentinian households interpret biased inflation statistics in a sophisticated way. However, Levy and Peart (2011) document the repeated overestimation of the Soviet Union's GDP growth rate in widely-used economics textbooks throughout the twentieth century.

[6] Gehlbach et al. (2016, p.578) provide a sketch of a model of manipulation of information in autocracies, in the spirit of Kamenica and Gentzkow (2011). They show that citizens will update positively on the state of the world upon receiving good news, even if they know that the government is actively manipulating information, as long as the probability of accurate reporting is not zero.

[7] The original index ranges from one to seven and corresponds to a simple average of sub-indices for "civil liberties" and "political rights". I normalize the lowest score in all measures to zero (i.e., subtract one). All references to the FiW index henceforth correspond to this adjusted version.

the ensuing system of checks and balances is actually operative and not a mere formality. The FiW index is arguably the best-suited indicator to capture the nuances of the growing number of hybrid regimes observed during the sample period, which regularly hold elections while simultaneously curtailing basic rights and freedoms (Levitsky and Way, 2010).[8]

Night Time Lights (NTL). Data on night time lights (NTL) is provided by the National Oceanic and Atmospheric Administration (NOAA). The original data source is the Defense Meteorological Satellite Program (DMSP) from the US Air Force, which uses the Operational Linescan System (OLS) sensor to record night time luminosity originating from Earth. The original data is highly granular, corresponding to nightly observations of every point on Earth between the hours of 8:30 and 10:00 pm local time (Henderson et al., 2012). NOAA conducts some preliminary cleaning and processing of the raw data, removing observations affected by factors such as cloud cover, auroral activity, sunlight (i.e., summer months), or moonlight (i.e., bright half of the lunar cycle). NOAA then averages across all remaining observations from the same satellite in the same year. The resulting datasets (one for each satellite-year) correspond to a 30 arc-second grid, with an approximate pixel size of 0.86 square kilometers at the equator. A Digital Number (DN) ranging from 0 to 63 is reported for each pixel, with larger values corresponding to greater night time luminosity. The data is publicly-available for six different satellites, corresponding to 34 satellite-years, and covers the period 1992-2013. Appendix Figure C2 shows data availability for each satellite.

To aggregate the data, I average the NTL DN for each pixel across satellites with information for the same year. I then calculate an area-weighted average of the NTL DN across pixels by country-year, similarly to Henderson et al. (2012) and Pinkovskiy and Sala-i Martin (2016). Appendix B provides additional details on this process and discusses some sample restrictions. As part of the robustness checks, I verify that the results are robust to the inclusion of harmonized data from the Visible Infrared Imaging Radiometer Suite (VIIRS) sensor for the period 2014-2018, provided by Li et al. (2020).

Gross Domestic Product (GDP): I use GDP data in constant local currency from

[8] Appendix Table C1 provides basic correlations of the FIW index with observable political characteristics from the IAEP dataset (Wig et al., 2015). In the cross-section, countries with lower average values of the FiW index (i.e., more democratic) are more likely to have a legislative assembly and to hold legislative elections. They are also less likely to impose restrictions on political parties. These countries have stronger checks and balances, as proxied by the veto power of the different branches of government or by the assembly's ability to remove the executive from office. More democratic countries are less likely to have a new constitution during the sample period and are more likely to have a national constitutional court. In panel regressions with country and year fixed effects, the FiW index is only significantly (and negatively) correlated with having an assembly and with holding elections for the chief executive. The maps in Appendix Figure C1 show the average value of the FiW index for each country, as well as the change that each country experienced during the sample period. Cross-sectionally, the strongest democracies are concentrated in the Americas and western Europe, while most autocracies are in Africa and Asia.

the World Bank's World Development Indicators (WDI), November 2014 release. The data from this version of the WDI allows me to observe GDP up to 2013, which is the last year with data on NTL, while minimizing the impact of data revisions in later versions, which could undo the overstatement of GDP growth in autocracies. As part of the robustness checks, I replicate the analysis using all available versions of the WDI from 2014 to 2021. The World Bank mostly sources the data directly from the national statistical agencies of member countries, as well as from supra-national organizations such as the Organization for Economic Cooperation and Development (OECD). The World Bank's WDI is also my main data source for many other variables, including GDP sub-components, Gross National Income (GNI) per capita, and Official Development Assistance (ODA) inflows.

My main estimating sample results from combining three pieces of data. These are the GDP data from the WDI, the FiW index from Freedom House, and the NTL data from NOAA. It corresponds to a slightly unbalanced panel of 184 countries from 1992 to 2013.

4 Empirical Strategy

In this section I present the econometric model that guides the empirical analysis. The model illustrates how the heterogeneity in the mapping from NTL to GDP across political regimes can be used to detect and measure the overstatement of GDP growth in autocracies.

Let the unobserved variable $\tilde{y}_{i,t}$ represent true economic growth in country i during year t. I allow for the possibility that true growth differs between democracies and autocracies by decomposing it into a baseline growth rate for democracies ($y^d_{i,t}$) and an adjustment factor α for autocracies ($a_{i,t} = 1$):

$$\tilde{y}_{i,t} = y^d_{i,t} + \alpha a_{i,t} \tag{1}$$

The government of each country produces an estimate of economic growth using the concept of Gross Domestic Product (GDP). I assume that the *estimated* GDP growth rate, $\mathrm{g}_{i,t}$, is a linear function of true income growth and an error term $\epsilon_{i,t}$, as shown in equation 2. However, this estimate does not necessarily match the *reported* GDP growth rate, $\widehat{\mathrm{g}}_{i,t}$, which is subject to manipulation in autocracies. In equation 3, I allow for the possibility that autocracies overstate GDP growth by an amount proportional to the true observed growth rate. I focus on proportional (multiplicative) rather than additive exaggeration of GDP growth as it seems more plausible, since it reduces the likelihood of detection when real growth is low, but allows for greater exaggeration in absolute terms when growth is high.[9] Proportional exaggeration is also supported by the observed patterns in the data that

[9]Appendix A shows that the predictions of the model are not affected if I also allow for additive exagger-

I report below. The parameter σ in equation 3 captures the rate at which GDP growth is overstated in autocracies. For instance, σ equal to 0.35 implies that autocracies report a GDP growth rate of 2.7% when the true growth rate is 2%.

$$\mathrm{g}_{i,t} = \beta \tilde{y}_{i,t} + \epsilon_{i,t} \tag{2}$$

$$\hat{g}_{i,t} = (1 + \sigma a_{i,t}) g_{i,t} \tag{3}$$

Several studies have documented a positive and robust correlation between economic activity and night time lights (NTL) recorded by satellites from outer space (Doll et al., 2006; Chen and Nordhaus, 2011; Henderson et al., 2012). In equation 4, I assume that the growth rate of NTL ($l_{i,t}$) is also a linear function of true income growth and a separate error term $u_{i,t}$. Importantly, the data on NTL is independently collected, processed and published, making it immune to manipulation. I allow in equation 4 for the possibility that growth in NTL may not capture true income growth to the same extent across political regimes. This heterogeneity in the mapping from true growth to NTL could be the result of differences in economic structure or public policies across regimes, which NTL may struggle to capture.[10]

$$l_{i,t} = \gamma^d y^d_{i,t} + \gamma^a \alpha a_{i,t} + u_{i,t} \tag{4}$$

This set-up is very similar to those in Henderson et al. (2012) and Pinkovskiy and Sala-i Martin (2016). The main innovation is the introduction of potential manipulation of GDP growth figures in autocracies. Combining equations 1-4 yields:

$$\hat{g}_{i,t} = \frac{\beta}{\gamma^d} l_{i,t} + \frac{\beta\sigma}{\gamma^d} \left(l_{i,t} \times a_{i,t}\right) + (\lambda + \sigma\epsilon_{i,t} - \frac{\sigma\beta}{\gamma^d} u_{i,t}) a_{i,t} + \sigma\lambda a^2_{i,t} + \nu_{i,t} \tag{5}$$

where $\lambda \equiv (1 - \frac{\gamma^a}{\gamma^d})\beta\alpha$ and ν is a combination of the error terms ϵ and u. The coefficient for the interaction of growth in NTL and autocracy in equation 5 is increasing in σ, which is the proportional exaggeration of GDP growth that takes place in autocracies. If there is no exaggeration, the estimate for the interaction term should be zero. Moreover, equation 5

ation of GDP growth in autocracies. I also show in the appendix that a regression of ln(GDP) on ln(NTL) and a measure of autocracy fails to identify the parameter of interest even if exaggeration is only additive.

[10]The parameter α could represent the sum of differences in growth from various sources, as democracies and autocracies plausibly differ in the spatial distribution of output, its sectoral composition, or its allocation between the private and public sectors. Let y^d be the share-weighted sum of growths in a partition of output in democracies (by sector, location, etc.): $y^d = \sum_{k=1}^{n} share_k^{dem} \times growth_k^{dem}$. The parameter α is then equal to the sum of adjustments for autocracies: $\alpha = \sum_{k=1}^{n} share_k^{aut} \times growth_k^{aut} - share_k^{dem} \times growth_k^{dem}$. I assume for simplicity that the mapping from true income growth to GDP growth is independent of regime type. Appendix A provides an extension of the model relaxing this assumption. I also show in the appendix that results are similar if I allow NTL and GDP to capture true growth equally well across regimes, but I assume instead that NTL are affected by differential electrification policies across regimes (Min, 2015).

suggests that it is possible to back out σ by dividing the point estimate for the interaction of NTL and autocracy by the point estimate for NTL.[11]

Following Henderson et al. (2012), I rewrite equation 5 in log-linear form in levels and I disaggregate the error term $\nu_{i,t}$ into a country-specific component (μ_i), a year-specific component (δ_t) and an idiosyncratic error term ($\xi_{i,t}$). Using the FiW index to measure autocracy, I obtain the main equation that I take to the data:

$$\ln(\mathrm{GDP})_{i,t} = \mu_i + \delta_t + \phi_0 \ln(\mathrm{NTL})_{i,t} + \phi_1 \mathrm{FiW}_{i,t} + \phi_2 \mathrm{FiW}^2_{i,t} + \phi_3 \left(\ln(\mathrm{NTL})_{i,t} \times \mathrm{FiW}_{i,t}\right) + \xi_{i,t} \quad (6)$$

In this specification, μ_i is a country fixed effect, δ_t is a year fixed effect and $\epsilon_{i,t}$ is an error term that I cluster by country.[12] $\mathrm{Ln(NTL)}_{i,t}$ is the natural logarithm of NTL (i.e., the area-weighted average of the NTL DN by country-year). The coefficient ϕ_3 captures the autocracy gradient in the NTL elasticity of GDP. A positive value for this coefficient suggests that a same-sized increase in NTL is associated with a larger increase in GDP in more authoritarian regimes. The ratio $\frac{\phi_3}{\phi 0}$ provides a measure of the exaggeration of GDP growth associated with a one-unit increase in the FiW index. To obtain my preferred estimate of σ (i.e., the rate at which GDP growth is overstated in autocracies relative to democracies), I multiply this number by the interquartile range of the FiW index in the estimating sample.

In order to interpret $\phi_3 > 0$ as evidence of overstatement of GDP growth in autocracies, I must assume that the NTL elasticity of GDP does not vary by regime type in the absence of manipulation of the official statistics. This assumption could be violated if countries with different political regimes also vary in other characteristics that generate heterogeneity in the mapping of growth in NTL to growth in GDP. I use two complementary strategies to address these concerns. First, I provide a battery of robustness tests showing that potential heterogeneity in the NTL elasticity of GDP based on differences in a large set of fixed or time-varying country characteristics does not explain away the results. Second, I provide several pieces of additional evidence showing that the autocracy gradient in the NTL elasticity of GDP is larger when the incentive to exaggerate economic growth is stronger or when the constraints on such exaggeration are weaker.

Another source of bias in $\hat{\sigma}$ is the measurement error in equation 4, $u_{i,t}$, which generates a correlation between ln(NTL) and the error term $\xi_{i,t}$ in equation 6. However, it seems unlikely that the results below are an artifact of measurement error for several reasons. First, initial

[11]The autocracy coefficient in equation 5 is not easily interpreted, as it combines multiple parameters and error terms. Equation 5 also includes autocracy squared, which captures the fact that the heterogeneous growth rate in autocracies, itself imperfectly captured by NTL, is compounded by the exaggeration of GDP growth under autocracy. Naturally, this term drops out if the regime classification is binary.

[12]The year fixed effects absorb variation in ln(GDP) caused by aggregate shocks. They also account for the fact that the DMSP-OLS data may not be comparable across years due to the lack of onboard calibration.

processing of the NTL data at NOAA removes noise caused by auroral activity, forest fires and cloud cover. Second, the country and year fixed effects included in all regressions absorb all country-specific and time-invariant sources of measurement error and all common shocks. Third, the measurement error arises because the NTL pick up changes in factors other than real economic activity, but I show below that controlling for some of the most plausible sources of measurement error, including top-coding of NTL, economic structure and level of development, has no incidence on the results.[13]

5 Main Results

5.1 Summary Statistics

My first approach to studying the manipulation of GDP figures in autocracies imposes very little structure and relies on basic summary statistics. Figure 1 shows separate binned scatter plots of the yearly growth rates of GDP and NTL by political regime. There is a positive relationship between the growth rates of NTL and GDP for democracies and autocracies, but average reported GDP growth is systematically larger in autocracies, conditional on NTL growth. Moreover, the linear fits suggest that the overstatement of GDP growth increases with NTL growth, in line with proportional or multiplicative exaggeration.

Appendix Table C2 provides the average yearly growth rates of NTL and GDP for the full sample and disaggregated by freedom status. The average growth rates of GDP and NTL in the full sample are 3.7% and 6.6% respectively. These averages are 3.1% and 5.8% in free country-years, and 4.5% and 6.8% in country-years deemed not free. Even though both GDP and NTL grow at higher average rates in the not free group, the difference in means is only statistically significant for GDP (p-values of 0.00 and 0.28 respectively). Based on the ratio of growth in GDP and NTL across these groups, I obtain a back-of-the-envelope estimate of the exaggeration of GDP growth in autocracies ($\hat{\sigma}$) equal to 0.25.

5.2 Baseline Estimates

Table 1 shows the main results of the paper. The dependent variable in all columns is ln(GDP) and all regressions include country and year fixed effects. I report an average NTL elasticity of GDP equal to 0.3 in column 1, which is very similar to the estimate of 0.28

[13] Appendix A provides a more formal discussion of the identification of σ, under the assumption of classical measurement error in $\epsilon_{i,t}$ and $u_{i,t}$. Further assuming that true growth ($\tilde{y}_{i,t}$) and autocracy are independent (also that the latter is time-invariant) is a sufficient condition for $\hat{\sigma}$ to provide an unbiased estimate of σ, despite the fact that the coefficients used to estimate $\hat{\sigma}$ are both affected by attenuation bias. I also provide necessary conditions for $\hat{\sigma} \leq \sigma$ in the more general case in which $\tilde{y}$ and a_i are correlated.

reported by Henderson et al. (2012) using data until 2008. Anticipating the main finding, Figure 2 shows that there is a strong positive correlation between disaggregate estimates of this elasticity by country and countries' average FiW index over the sample period.[14]

In column 2, I add the FiW index as an additional regressor. Conditional on NTL growth, reported GDP growth appears to be smaller in more authoritarian regimes, but this specification fails to account for the proportional overstatement of GDP growth in autocracies. To address this limitation, I include the interaction of the FiW index with ln(NTL) in column 3. This causes the point estimate for the FiW index to become small and insignificant. In contrast, the coefficient for the interaction term is positive and very precisely estimated, suggesting that a one-unit increase in the FiW index is associated with an increase of 0.02 units in the NTL elasticity of GDP. Given an estimated elasticity of 0.22 for FiW equal to zero (i.e., the strongest democracies), a one-unit increase in the FiW index is associated with a 9.5% overstatement of the GDP growth rate. Using the interquartile range of the FIW index to distinguish democracies from autocracies, I estimate $\hat{\sigma}$ equal to 0.34, with a standard error of 0.14 (p=0.01). The results are almost identical after I introduce the square of the FiW index in column 4 ($\hat{\sigma}$=0.35). This regression corresponds to equation 6 and is my preferred specification for most subsequent analyses.[15]

I allow for greater flexibility in the autocracy gradient of the NTL elasticity of GDP by replacing the FiW index with dummies for partially free and not free country-years in column 5 (free is the omitted category). Not-free status is associated with a 0.07 unit increase in the elasticity, relative to a baseline value of 0.25. The $\hat{\sigma}$ implied by these estimates suggests that not free countries exaggerate reported GDP growth by approximately 27%. The NTL elasticity of GDP is also 0.04 units larger for observations falling in the partially-free category ($\hat{\sigma} = 0.16$, p=0.03), which suggests a roughly monotonic relationship between the degree of authoritarianism and the overstatement of GDP growth.[16] Column 6 shows that the results are robust to using Freedom House's binary autocracy indicator, though the coarser regime classification causes $\hat{\sigma}$ to fall to 0.18 (p=0.00).[17]

[14]Appendix Figure C3 plots all the country-specific estimates of the NTL elasticity of GDP, ranging from smallest to largest. Not-free countries are predominantly concentrated in the upper tail of the distribution.

[15]Appendix Figure C4 provides year-specific estimates of $\hat{\sigma}$ based on an expanded version of equation 6. Overstatement of GDP growth in autocracies falls in the mid-1990s and steadily increases after 2002.

[16]Appendix Figure C5 plots disaggregate estimates of the NTL elasticity of GDP for each (rounded) value of the FiW index. The elasticity increases monotonically with the FiW index.

[17]Appendix Figure C6 provides disaggregate estimates of the NTL elasticity of GDP for two subcategories of democracy (parliamentary and presidential) and two subcategories of autocracy (civilian and military/royal). The elasticity is lowest for parliamentary democracies, which have the lowest average FiW index, while it is highest for civilian dictatorships. These results suggest that established parliamentary democracies (concentrated in western Europe) are more successful at preventing the manipulation of GDP growth figures than the weaker presidential regimes of Africa or Latin America. They also suggest that royal/military autocracies may lack strong incentives to exaggerate economic growth, plausibly as a result

All the previous results are based on yearly fluctuations in ln(GDP). In Column 7, I examine whether the autocracy gradient in the NTL elasticity of GDP is observed over a longer time horizon. For this purpose, I estimate equation 6 using a restricted sample that only includes the average value of each variable for the years 1992/1993 and 2012/2013 (i.e., only two observations per country, twenty years apart). The results indicate the presence of an autocracy gradient in the long-run elasticity, with $\hat{\sigma}$ equal to 0.39 (p=0.03).[18] In section 7, I use this estimate to adjust the long-run GDP growth figures for 1992-2013.

5.3 Robustness Checks

The previous results strongly suggest that autocracies exaggerate yearly GDP growth by as much as 35% relative to democracies. Naturally, countries with different political institutions may differ in many other characteristics, such as their economic structure or level of development, and it could be these characteristics that drive the autocracy gradient in the NTL elasticity of GDP. To address these concerns, I subject the previous results to a large battery of robustness tests, checking their sensitivity to the inclusion of additional controls, as well as to changes in data sources, the composition of the sample, or the regression specification. In this section, I provide a brief overview of these tests. I reserve a more thorough discussion, as well as all tables and figures, for Appendix D.

Appendix Tables D1-D9 examine the robustness of the results as I allow the NTL elasticity of GDP to vary based on various country characteristics. In Table D1, I allow the elasticity to vary based on the importance of different GDP sub-components (using the expenditure decomposition), while in Table D2 I allow for heterogeneity in the elasticity based on the sectoral composition of the economy. Table D3 probes the robustness of the results to changes in the elasticity associated with characteristics of NTL, such as the number of top-coded or unlit cells, or the spatial concentration of NTL (i.e., Gini coefficient). In this table, I also allow the elasticity to vary by year, latitude/longitude or subregion of the world. Moreover, Figure D1 verifies that the results are robust to the exclusion of any one of the 22 subregions of the world, as defined by the UN geoscheme. Table D4 considers the impact of population size, urbanization or access to electricity on the elasticity, while Table D5 allows the elasticity to vary based on the country's level of development. In Table D6, I further

of their increased reliance on patronage or repression as means of securing regime stability.

[18]The long-run $\hat{\sigma}$ is only 10% larger than the one obtained with the full yearly panel in column 4. This suggests that autocracies do not overstate GDP growth at the same constant rate every year, which arguably helps the exaggeration go undetected. This result is consistent with Gehlbach et al. (2016), who show that constant manipulation of information by an autocrat fully undermines its credibility. However, the comparison of $\hat{\sigma}$ over different time horizons could also be affected by potential differences in the ability of NTL to capture long-run economic growth relative to short-term economic fluctuations, which plausibly varies across countries based on factors such as economic structure or level of development.

examine the sensitivity of the results to heterogeneity in the elasticity related to measures of human capital or to the importance of the informal economy.

One prominent alternative explanation for the main results revolves around limitations in statistical capacity that may prevent some countries, which happen to disproportionately be dictatorships, from accurately measuring economic activity. In Table D7 and Figure D2 I test this hypothesis by allowing the NTL elasticity of GDP to vary based on a large battery of indicators of statistical capacity produced by the World Bank. Table D8 looks at a complementary measure of state capacity using data from Chong et al. (2014) on the number of days it takes for a wrongly-addressed letter to be returned. Another plausible alternative explanation is that the autocracy gradient in the NTL elasticity of GDP is a reflection of more inefficient government spending or greater corruption. I examine this hypothesis in Table D9 using data from Transparency International and the World Bank.

Table D10 replicates the analysis using democracy measures from other sources, such as Polity V, while Table D11 replicates the analysis using NTL data from previous studies (e.g., Henderson et al., 2012). In this table, I also use harmonized NTL data from the DMSP-OLS and VIIRS instruments provided by Li et al. (2020) to extend the sample period to 2018. Relatedly, Figure D3 verifies that the results are unaffected if I use GDP data from any release of the World Bank's WDI from 2014 to 2021.

In Table D12, I replicate the analysis using the average value of the FiW index for each country rather than allowing it to vary over time, while in Table D13 I conduct the analysis replacing the natural logarithm of NTL and GDP with the corresponding growth rates. Finally, Table D14 considers alternative specifications that replace the year fixed effects with more stringent subregion by year fixed effects, add country-specific linear time trends, or include the lagged value of ln(NTL) as an additional regressor.

Figure 3 summarizes the results of the robustness tests by showing all the estimated $\hat{\sigma}$ and their 95% confidence interval. The estimates are quite stable, with an average value of 0.35 and a median of 0.32. These figures are remarkably similar to the baseline estimate of 0.35 reported in Table 1. Only 7 out of 198 estimates are not statistically significant at the 10% level, with the largest p-value equal to 0.17 (Figure C7 shows the full distribution of p-values). Taken together, the evidence from these tests suggests that the documented autocracy gradient in the NTL elasticity of GDP is unlikely to have arisen by chance and is also unlikely to reflect variation in the elasticity related to other country characteristics.

5.4 Regime Transitions

I exploit episodes of regime change to provide further evidence that dictatorships have a higher NTL elasticity of GDP, in line with their greater propensity to overstate GDP growth. I focus here on the binary measure of autocracy from column 6 of Table 1 and I separately study transitions into and out of autocracy. I restrict the analysis to regime transitions observed over an eight-year window (four years before and four years after the change) during the sample period. Between 1992 and 2013, there are 23 such transitions into autocracy and 20 transitions into democracy, which are listed in Appendix Table C3. To capture the fluctuation in the NTL elasticity of GDP following regime change, I regress ln(GDP) on ln(NTL), dummies for each event year and their interaction with ln(NTL). The regression also includes a dummy for country-years classified as autocracies that are not in these spells and their interaction with ln(NTL), as well as country and year fixed effects.

Figure 4 plots the point estimates and 95% confidence intervals for the interaction of the event year dummies with ln(NTL). These coefficients indicate the difference in the NTL elasticity of GDP in each event year relative to the baseline elasticity for country-years corresponding to democracies. Panel (a) shows results for transitions into autocracy. The coefficients are stable and close to zero in all periods before the transition, but steadily increase following regime change. Six years after the transition, the NTL elasticity of GDP is 0.1 units higher than the baseline elasticity of 0.26, with an estimated $\hat{\sigma}$ of 0.40 (p=0.05). Panel (b) shows results for transitions into democracy. In this case, the years before the transition are characterized by a stable excess elasticity of around 0.08 units (relative also to a baseline elasticity of 0.26), which corresponds to a $\hat{\sigma}$ of 0.31. However, these estimates are not statistically significant at conventional levels. Following democratization, the excess elasticity steadily falls until it reaches zero after approximately six years.

These regressions suggest that transitions into and out of democracy have opposite but roughly symmetric effects on the overstatement of GDP growth. Importantly, those autocracies not involved in these transitions also have a higher NTL elasticity of GDP, with $\hat{\sigma}$ equal to 0.21 in panel (a) and 0.19 in panel (b). This indicates that the exaggeration of GDP growth in autocracies is not exclusively associated to episodes of regime change.

6 Mechanism

In this section, I present three additional sets of results that shed light on the mechanisms underlying the overstatement of GDP growth in autocracies. First, I use the expenditure decomposition to establish which GDP sub-components drive the autocracy gradient in the

NTL elasticity of GDP. Second, I examine whether this autocracy gradient is larger when the domestic economy is underperforming relative to the rest of the world. Lastly, I study the impact of changes in eligibility for concessional loans and grants from the International Development Association (IDA) on the autocracy gradient. Overall, the results show that the autocracy gradient in the NTL elasticity of GDP is larger when governments are more able or willing to overstate economic growth.

6.1 GDP Sub-components

The disaggregate analysis of GDP sub-components allows me to identify the drivers of the autocracy gradient in the NTL elasticity. Based on the expenditure decomposition, I break down GDP into private consumption, investment, government spending, exports and imports. I then estimate equation 6 using the natural log of each of these variables as dependent variable, which allows me to separately test for the presence of an autocracy gradient in the mapping from NTL to each GDP sub-component. *Ex ante*, it is not clear whether autocracies would want to overstate growth in some components of GDP more than in others. However, the ability of autocracies to overstate growth may vary across sub-components, especially since the government is a major source of information for some of them, such as investment or public spending.

Table 2 shows the results. Column headers indicate the GDP sub-component used as dependent variable. The results in the top row show that growth in NTL is strongly and positively correlated with growth in each of the GDP sub-components, validating the use of nighttime luminosity as a proxy for economic activity. The coefficients for the interaction between NTL and the FiW index in the bottom row indicate the presence of substantial heterogeneity in the NTL elasticities of investment and government spending (columns 2 and 3), with an estimated $\hat{\sigma}$ of 0.40 (p=0.01) and 0.51 (p=0.02) respectively. Though the interaction term for imports in column 5 is also marginally significant (p=0.099), the point estimate is much smaller and the implied $\hat{\sigma}$ of 0.17 is not statistically significant (p=0.16).

These results suggest that the exaggeration of GDP growth in autocracies is predominantly concentrated in the sub-components corresponding to investment and government spending.[19] This is not surprising, as these components rely on information directly provided by the government, with limited third-party verification. Naturally, the government is the primary source of information on public spending in column 3, but the estimate for investment in column 2 also relies on information on public investment provided by the government (Lequiller and Blades, 2014). In contrast, export values are hard to inflate since they must

[19] Chen et al. (2019) show that subnational governments in China overstate GDP growth via investment.

roughly align with those reported by trade partners (but see Fisman and Wei, 2004, 2009). Similarly, the figures on private consumption can be cross-checked using household surveys and retail sales data, which are more difficult to manipulate.[20]

6.2 Economic Underperformance

I next examine whether the autocracy gradient in the NTL elasticity of GDP is larger in years when the domestic economy is underperforming relative to the rest of the world. If what constitutes satisfactory economic growth is partly determined by economic growth in other countries, then the incentive to exaggerate GDP growth should arguably be higher when the domestic economy is relatively underperforming. To test this hypothesis, I rely on the unbiased measure of economic activity provided by night time luminosity. I characterize country-years as having low growth by demeaning ln(NTL) by country and year and creating a dummy equal to one if the residual is negative. In these cases, NTL growth is below the world average for that year, after adjusting for average differences in luminosity across countries. I then estimate an expanded version of equation 6 that allows both the NTL elasticity of GDP and the autocracy gradient to vary in years of low growth.

Table 3 shows the results for the main variables of interest (Appendix Table C6 provides full results). The dependent variable in all columns is ln(GDP). In column 1, I simply allow the NTL elasticity of GDP to vary in years of low growth. I find no evidence of heterogeneity, as the interaction term between ln(NTL) and the dummy for low growth is very small and insignificant. I introduce the interaction between ln(NTL) and the FiW index in column 2. As in the main analysis, this interaction is positive and very precise ($\hat{\sigma}$=0.37, p=0.03), while the interaction of ln(NTL) with the dummy for low-growth years remains small and insignificant. This suggests that the autocracy gradient in the NTL elasticity of GDP is not confounded by heterogeneity in the elasticity associated to episodes of relatively low growth.

In column 3, I allow the autocracy gradient in the elasticity to vary in years of low growth by including the triple interaction between ln(NTL), the FiW index, and the low growth dummy. I find that a one-unit increase in the FiW index is associated with a 0.016 unit increase in the NTL elasticity of GDP in years of high growth and with a 0.023 unit increase in years of low growth. These estimates correspond to a $\hat{\sigma}$ of 0.27 in high-growth

[20]Consumption is often estimated as a residual in the national accounts, following the commodity flow method (Deaton, 2005). This method involves establishing the value of each product available for domestic use and allocating it to the various expenditure sub-components of GDP. Overstatement of government consumption will not lead to understatement of household final consumption as long as there is little overlap in the product categories consumed by households and the government, which seems plausible. Furthermore, unreliable information from state-owned enterprises could also lead to overstatement of domestic output in the initial stage of the process.

years and 0.42 in low-growth years, both of which are significant at the 5% level. Columns 4-5 replicate the analysis using the dummies for freedom status instead of the FiW index. Column 4 shows that the baseline results hardly change if I allow the NTL elasticity of GDP to vary in years of low growth. In column 5, I find that the triple interactions for country-years classified as partially free or not free are both positive, but only the latter is statistically significant. Focusing on the not free category, I obtain an estimate of $\hat{\sigma}$ equal to 0.19 in high-growth years and 0.35 in low-growth years, with respective p-values of 0.07 and 0.02. These results suggest that the incentive to exaggerate economic growth is indeed greater when the economy is relatively underperforming.

6.3 Eligibility for Foreign Aid

In this section, I study the impact of changes in eligibility for concessionary loans and grants from the International Development Association (IDA) on the autocracy gradient in the NTL elasticity of GDP. The IDA is an international financial organization that is part of the World Bank and serves the poorest countries in the world. In order to remain eligible for IDA funding, a country's Gross National Income (GNI) per capita must remain below a threshold value that is adjusted every year. As I show below, crossing the threshold leads to a substantial reduction in the amount of foreign aid that a country receives. Assuming that a country with higher GDP growth will be expected to cross the GNI threshold relatively sooner, governments should be less willing to overstate growth before crossing the threshold, as the benefit from doing so could be offset by a potential loss in foreign aid.

I test this hypothesis in Table 4 using data for the 88 countries that were IDA beneficiaries during the sample period.[21] Column 1 reports an average NTL elasticity of GDP of 0.27 in this sample, very similar to the one of 0.29 that I find for the full sample. Column 2 verifies the existence of an autocracy gradient in the elasticity for this sample, with a $\hat{\sigma}$ of 0.23 (p=0.12), which is somewhat smaller and less precisely estimated than in the full sample. In column 3, I introduce a dummy for years in which a country's GNI per capita is above the threshold for continued IDA eligibility (estimate not reported), and its interaction with ln(NTL). Thirty-five countries cross the threshold during the sample period. The interaction term is positive and significant, suggesting that countries increasingly overstate GDP growth after crossing the threshold. Naturally, countries that cross the threshold have higher levels of GNI per capita, which could be driving the previous result. Column 4 shows that the excess elasticity associated with crossing the threshold becomes slightly larger and more

[21] Appendix B provides additional information on the process that I follow to determine which countries cross the IDA eligibility threshold. Appendix Table C4 lists the countries that cross the threshold during the sample period, while Appendix Table C7 provides full regression results.

precise once I allow the elasticity to also vary based on the level of GNI per capita.

In column 5, I introduce the triple interaction between ln(NTL), the FiW index and the dummy for years after a country crosses the GNI threshold. The coefficient for this variable is positive and significant, while the interaction between ln(NTL) and the FiW index becomes small and insignificant. This indicates that the autocracy gradient in the NTL elasticity of GDP only arises after countries cross the GNI threshold and become ineligible for IDA funding. The estimated $\hat{\sigma}$ is 0.10 before crossing the threshold and 0.38 after crossing, with respective p-values of 0.36 and 0.12. As complementary evidence, Figure 5 shows results from an event-study specification that separately estimates the autocracy gradient in the NTL elasticity of GDP in every year around a crossing episode. The graph confirms that a one-unit increase in the FiW index is associated with a higher elasticity only after a country's GNI per capita exceeds the IDA eligibility threshold. These results suggest that autocracies do not exaggerate GDP growth when they are in peril of losing access to IDA loans and grants, but begin to do so once they become ineligible for these benefits.

7 Implications

In this section, I explore some of the consequences of the overstatement of GDP growth in autocracies. I first study the long-run economic performance of countries with different political regimes between 1992 and 2013. I document a substantial change in the conclusions once the GDP data has been adjusted for manipulation. I also show that the unadjusted data can lead to erroneous conclusions on the effects of foreign aid on GDP per capita, exploiting the variation in IDA eligibility discussed in the previous section. Finally, I examine the effectiveness of the International Monetary Fund's Special Data Dissemination Standard (SDDS) at tempering the manipulation of official economic statistics.

7.1 Aggregate Growth: 1992-2013

I measure aggregate long-run economic growth by calculating the change in the two-year average of ln(GDP) between 1992/93 and 2012/13, similarly to column 7 of Table 1. According to this metric, countries with a higher average FiW index (i.e., less democratic) appear to have grown at higher rates. The average aggregate growth rates for countries deemed not free, partially free and free are 85%, 76%, and 61%, respectively. Relatedly, the average not free country ranks 65th out of the 168 countries with full data on long-run growth, while the average countries in the partially free or free categories rank 76th and 99th, respectively.[22] Panel (a) in Figure 6 plots the change in ln(GDP) between 1992 and 2013 for the 20 fastest-growing economies according to the raw data. Even though only 21% of countries in the sample are classified as not free, 45% of countries in the top-20 fall in this category, with a further six countries classified as partially free and only five deemed free.

I adjust the GDP data for manipulation by first calculating a country-specific GDP exaggeration rate based on its average FiW index and the estimates in column 7 of Table 1. I then use this number to deflate the aggregate change in ln(GDP).[23] These adjusted figures must be interpreted with caution, as they correspond to a back-of-the envelope calculation based on each country's average value of the FiW index and an estimated average rate of GDP growth exaggeration. Still, this adjustment has a sizable impact on countries' relative aggregate economic performance during the sample period. The adjusted long-run growth rates for not free, partially free and free countries become 55%, 57% and 56% respectively. These figures no longer suggest that the economies of less democratic countries outperformed those of more democratic ones. Panel (b) in Figure 6 shows that the 20 fastest-growing economies post-adjustment have a more balanced composition of political regimes, with 10 countries classified as free, four countries as partially free and six that are deemed as not free. Appendix Figure C9 shows the adjustment to relative long-run growth for all countries, which is largest for those in the middle of the distribution. The average positions of not free, partially free and free countries in the adjusted ranking are 87th, 81st and 86th, respectively.

7.2 Application: Foreign Aid and Income

I return to the subsample of IDA beneficiaries discussed in section 6.2 to illustrate the implications of the bias in the GDP growth figures of autocracies for academic work. I first show that crossing the IDA eligibility threshold leads to a sizable reduction in foreign aid inflows. I then examine the consequences of crossing the threshold on GDP per capita, as reduced-form evidence on the effect of foreign aid on income. This is an ideal setting to examine the impact of overstated GDP growth in autocracies, insofar as these regimes only appear to exaggerate GDP growth after crossing the IDA eligibility threshold, as documented above. Estimates of the effect of crossing the threshold on GDP per capita that fail to take this into account will likely be upward-biased.

[22] Appendix Figure C8 shows a positive correlation of the country rankings for long-run growth in unadjusted GDP and NTL.

[23] The results in column 7 of Table 1 suggest that a one-unit increase in the FiW index is associated with a long-run GDP growth rate that is overstated by a factor of 0.11 (=0.032/0.288). I multiply this exaggeration rate by each country's average value of the FIW index and add one to construct the country-specific deflator. I divide the long-run change in ln(GDP) by this number to obtain the unbiased estimate.

Using the subsample of IDA beneficiaries, I estimate panel regressions with country and year fixed effects, in which I also control for the level of GNI per capita (i.e., the running variable determining IDA eligibility). Table 5 shows the results. Column 1 shows that crossing the GNI threshold leads to a 24% decrease in Official Development Assistance (ODA) as a share of GNI. The dependent variable in column 2 is the natural log of unadjusted GDP per capita. To account for the fact that countries crossing the threshold are likely growing at higher rates, I include a country-specific time trend as an additional control. The results suggest that crossing the threshold is associated with a roughly 5.4% increase in GDP per capita, which is statistically significant at the 5% level. Column 3 replicates the analysis using the adjusted GDP data to construct the dependent variable.[24] The point estimate drops by almost half and is no longer significantly different from zero. In columns 4-5, I consider an alternative specification using the first difference of ln(GDP p.c.) as dependent variable and dropping the country-specific time trend. As before, the point estimate using the raw GDP data is positive and significant (column 4), but it becomes negligible and insignificant using the adjusted data (column 5). I conclude that the reduction in foreign aid triggered by crossing the IDA eligibility threshold does not affect GDP per capita, but that this null result crucially depends on adjusting the GDP data for manipulation in autocracies.

7.3 Preventive Policies: The IMF's SDDS

The Special Data Dissemination Standard (SDDS) is a set of guidelines created by the International Monetary Fund (IMF) in 1996 for the production and dissemination of official economic data. Subscription to the SDDS is voluntary. Seventy countries subscribed to the SDDS during the sample period. These are listed in Appendix Table C5. The average FiW index among SDDS subscribers is 1.32 (i.e., free status), while it is 2.35 in the full sample (i.e., partially free). These averages suggest that more authoritarian regimes are less willing to commit to policies favoring transparency in the production and release of official statistics.

In Table 6, I study the impact of the SDDS on the NTL elasticity of GDP (Appendix Table C8 provides full results). In column 1, I first examine whether the average elasticity differs in countries that subscribe to the SDDS. The interaction of ln(NTL) with a time-invariant dummy for SDDS subscribers is negative, but imprecise. In column 2, I include an additional dummy for years after a country is deemed compliant with the SDDS (estimate not reported), and its interaction with ln(NTL). This interaction term is negative and significant, indicating

[24]The results in column 5 of Table 4 suggest an exaggeration rate of 0.13 (=(0.008+0.023)/(0.230+0.013)) for a one-unit increase in the FiW index. I deflate yearly GDP growth for all years after crossing the threshold by this estimate multiplied by the country's FiW index, plus one. Based on this adjusted growth rate, I impute GDP for all years post-crossing and divide by population to obtain adjusted GDP per capita.

that the NTL elasticity of GDP decreases following SDDS compliance. This suggests that compliance with the SDDS limits the ability of all countries to overstate GDP growth, irrespective of their political regime. Column 3 verifies that the autocracy gradient in the elasticity is not confounded by heterogeneity related to the SDDS ($\hat{\sigma}$=0.33, p=0.02).

Column 4 examines whether the autocracy gradient in the elasticity varies among SDDS subscribers. For this purpose, I introduce the triple interaction between ln(NTL), the FiW index, and the dummy for SDDS subscribers. The coefficient for this triple interaction is positive, but insignificant. I find a larger $\hat{\sigma}$ for SDDS subscribers (0.49) than for non-subscribers (0.30), but this is mostly driven by the smaller baseline elasticity in the SDDS subsample and I fail to reject that both estimates of $\hat{\sigma}$ are equal (p=0.46). In column 5, I further allow the autocracy gradient to vary after a country complies with the SDDS by introducing the triple interaction between ln(NTL), the FiW index, and the dummy for SDDS compliance. The coefficient for this triple interaction is positive and insignificant, while the estimate for the triple interaction with the time-invariant dummy for SDDS subscribers becomes negative and very small. As a result, the estimated $\hat{\sigma}$ is now comparable for SDDS subscribers and non-subscribers (0.33 and 0.30 respectively), but it is much larger for countries that comply with the SDDS (0.49). The latter, however, is somewhat imprecise (p=0.11) and I again fail to reject that all $\hat{\sigma}$ are equal.

Importantly, the estimated change in the NTL elasticity of GDP after a country complies with the SDDS remains negative and statistically significant throughout. As complementary evidence, Appendix Figure C11 plots estimates from an event-study specification that allows the NTL elasticity of GDP to vary in each year around an episode of SDDS compliance. The results show that the elasticity is fairly stable in the years before a country complies with the SDDS, but decreases sharply following compliance. This further suggests that the SDDS is effective at reducing the exaggeration of reported GDP growth for all countries, even those deemed democratic. However, the magnitude of this effect is small and corresponds to a one-unit decrease in the FiW index in column 5. Moreover, the SDDS does not appear to be effective at reducing the differential exaggeration of GDP growth taking place in autocracies.

8 Concluding Remarks

Governments of all kinds have an incentive to overstate their accomplishments, but those that are less democratic are arguably better able to do so. In this paper, I use night time lights (NTL) to detect and measure the exaggeration of reported GDP growth in autocracies. In particular, I study the heterogeneity in the mapping from NTL to GDP across political regimes, exploiting the fact that GDP growth statistics are self-reported by governments and prone to manipulation, while the NTL recorded by satellites from outer space are not. I document a positive and robust autocracy gradient in the NTL elasticity of GDP, which does not appear to be confounded by cross-country differences in a large set of fixed or time-varying characteristics. Moreover, the autocracy gradient in the elasticity is larger when the incentive to exaggerate economic growth is stronger or when the constraints on such exaggeration are weaker. The evidence strongly suggests that the overstatement of GDP growth in autocracies is what underlies this gradient.

The magnitude of the estimated exaggeration of economic growth in autocracies is substantial. On average, authoritarian regimes overstate yearly GDP growth by as much as 35%. Adjusting the GDP data for manipulation changes our understanding of countries' relative economic performance at the turn of the twenty-first century and downplays the apparent economic success of countries with non-democratic forms of government during this period. From a political economy perspective, these results constitute new evidence on the disciplining role of democratic institutions for the functioning of government. These findings also provide a warning for academics, policy-makers and other consumers of official economic statistics, as well as an incentive for the development and systematic use of alternative measures of economic activity.

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Table 1: The Autocracy Gradient in the NTL Elasticity of GDP

	Dependent variable: $\ln(\text{GDP})_{i,t}$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\ln(\text{NTL})_{i,t}$	0.296***	0.292***	0.215***	0.214***	0.251***	0.265***	0.288***
	[0.044]	[0.042]	[0.043]	[0.043]	[0.044]	[0.042]	[0.067]
$\text{FiW}_{i,t}$		-0.023**	-0.006	-0.015			-0.086*
		[0.010]	[0.010]	[0.025]			[0.048]
$\text{FiW}_{i,t}{}^2$				0.002			0.012
				[0.005]			[0.008]
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t}$			0.021***	0.022***			0.032***
			[0.005]	[0.005]			[0.008]
$\text{D(Partially Free)}_{i,t}$					0.001		
					[0.020]		
$\text{D(Not Free)}_{i,t}$					0.014		
					[0.039]		
$\ln(\text{NTL})_{i,t} \times \text{D(Partially Free)}_{i,t}$					0.041***		
					[0.015]		
$\ln(\text{NTL})_{i,t} \times \text{D(Not Free)}_{i,t}$					0.067***		
					[0.021]		
$\text{D(Autocracy)}_{i,t}$						0.043**	
						[0.018]	
$\ln(\text{NTL})_{i,t} \times \text{D(Autocracy)}_{i,t}$						0.047***	
						[0.011]	
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,895	3,895	3,895	3,895	3,895	3,895	332
Countries	184	184	184	184	184	184	166
(Within country) R^2	0.219	0.226	0.259	0.260	0.238	0.240	0.466
$\hat{\sigma}$			0.342	0.354	0.269	0.177	0.388
$\hat{\sigma}$ SE			[0.135]	[0.142]	[0.111]	[0.057]	[0.183]

Notes: Dependent variable is ln(GDP) in constant local currency units. ln(NTL) is the natural logarithm of the area-weighted average of a country's cell-level nighttime lights (NTL) digital number. The adjusted Freedom in the World (FiW) index produced by Freedom House ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Dummies for "Partially Free" and "Not Free"' countries in column 5 ("Free" is the omitted category) and for "Autocracy" in column 6 also from Freedom House. The sample in columns 1-6 includes country-years between 1992 and 2013. In column 7, two-year averages for 1992/93 and 2012/13 are used instead. All regressions include country and year fixed effects. Robust standard errors clustered by country in brackets. The estimated value of σ, the structural parameter capturing the proportional exaggeration of GDP growth in autocracies, and its standard error are reported at the bottom of columns 3-7. In columns 3-4, this estimate is based on the interquartile range of the FiW index, while in column 5 it is based on the "Not Free" dummy. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 2: The Autocracy Gradient in the NTL Elasticity of GDP Sub-Components

	Consumption	Investment	Government	Exports	Imports
	(1)	(2)	(3)	(4)	(5)
$\ln(\text{NTL})_{i,t}$	0.184***	0.353***	0.210***	0.354***	0.253***
	[0.041]	[0.083]	[0.060]	[0.077]	[0.054]
$\text{FiW}_{i,t}$	-0.003	0.023	-0.002	-0.007	-0.006
	[0.035]	[0.062]	[0.041]	[0.058]	[0.042]
${\text{FiW}_{i,t}}^2$	-0.002	-0.010	-0.001	-0.004	-0.005
	[0.006]	[0.012]	[0.007]	[0.011]	[0.008]
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t}$	0.004	0.040***	0.030***	0.011	0.013*
	[0.006]	[0.010]	[0.007]	[0.012]	[0.008]
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	3,416	3,414	3,416	3,416	3,416
Countries	173	173	173	173	173
(Within country) R^2	0.081	0.141	0.128	0.095	0.099
$\hat{\sigma}$	0.078	0.400	0.505	0.105	0.174
$\hat{\sigma}$ SE	[0.114]	[0.163]	[0.222]	[0.135]	[0.124]

Notes: Dependent variable in the header (natural logarithm of amount in constant local currency units): household final consumption expenditure in column 1; gross capital formation in column 2; general government final consumption in column 3; exports of goods and services in column 4; imports of goods and services in column 5. ln(NTL) is the natural logarithm of the area-weighted average of a country's cell-level nighttime lights (NTL) digital number. The adjusted Freedom in the World (FiW) index produced by Freedom House ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. All regressions include country and year fixed effects. Robust standard errors clustered by country in brackets. The corresponding estimate of σ, the structural parameter capturing the proportional exaggeration of GDP growth in autocracies, and its standard error are reported at the bottom of each column. Sample period: 1992-2013. *** p<0.01, ** p<0.05, * p<0.1

Table 3: Heterogeneous Effects: Economic Underperformance

	Dependent variable: $\ln(\text{GDP})_{i,t}$				
	(1)	(2)	(3)	(4)	(5)
$\ln(\text{NTL})_{i,t}$	0.280***	0.203***	0.214***	0.239***	0.241***
	[0.063]	[0.055]	[0.053]	[0.060]	[0.057]
$\ln(\text{NTL})_{i,t} \times \text{D(Low Growth)}_{i,t}$	0.003	-0.001	-0.018***	0.000	-0.011*
	[0.005]	[0.005]	[0.007]	[0.005]	[0.006]
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t}$		0.022***	0.016***		
		[0.005]	[0.005]		
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t} \times \text{D(Low Growth)}_{i,t}$			0.007**		
			[0.003]		
$\ln(\text{NTL})_{i,t} \times \text{D(Partially Free)}_{i,t}$				0.041***	0.035**
				[0.015]	[0.014]
$\ln(\text{NTL})_{i,t} \times \text{D(Not Free)}_{i,t}$				0.067***	0.046**
				[0.021]	[0.020]
$\ln(\text{NTL})_{i,t} \times \text{D(Partially Free)}_{i,t} \times \text{D(Low Growth)}_{i,t}$					0.012
					[0.009]
$\ln(\text{NTL})_{i,t} \times \text{D(Not Free)}_{i,t} \times \text{D(Low Growth)}_{i,t}$					0.034**
					[0.016]
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	3,895	3,895	3,895	3,895	3,895
Countries	184	184	184	184	184
(Within country) R^2	0.219	0.260	0.267	0.238	0.247
$\hat{\sigma}$		0.374		0.281	
$\hat{\sigma}$ SE		[0.168]		[0.129]	
$\hat{\sigma}$ high growth			0.268		0.190
$\hat{\sigma}$ high growth SE			[0.132]		[0.105]
$\hat{\sigma}$ low growth			0.424		0.346
$\hat{\sigma}$ low growth SE			[0.185]		[0.153]

Notes: Dependent variable is ln(GDP) in constant local currency units. ln(NTL) is the natural logarithm of the area-weighted average of a country's cell-level nighttime lights (NTL) digital number. The adjusted Freedom in the World (FiW) index produced by Freedom House ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Dummies for "Partially Free" and "Not Free"' countries (columns 4-5, "Free" is the omitted category) also from Freedom House. $\text{D(Low Growth)}_{i,t}$ is a dummy equal to one if the value of ln(NTL) demeaned by country and year is negative. Estimates for single terms and lower order interactions not reported. Appendix Table C6 provides full results. Robust standard errors clustered by country in brackets. The corresponding estimate of σ, the parameter capturing the proportional exaggeration of GDP growth in autocracies, and its standard error are reported at the bottom of columns 2 and 4. Columns 3 and 5 provide separate estimates of σ for D(Low Growth) equal to zero or one. Sample period: 1992-2013. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 4: Heterogeneous Effects: IDA Eligibility

	Dependent variable: $\ln(\text{GDP})_{i,t}$				
	(1)	(2)	(3)	(4)	(5)
$\ln(\text{NTL})_{i,t}$	0.272***	0.208***	0.260***	0.262***	0.230***
	[0.043]	[0.052]	[0.042]	[0.040]	[0.050]
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t}$		0.016**			0.008
		[0.007]			[0.007]
$\ln(\text{NTL})_{i,t} \times \text{D(GNI> IDA threshold)}_{i,t}$			0.060*	0.085***	0.013
			[0.031]	[0.024]	[0.034]
$\ln(\text{NTL})_{i,t} \times \text{GNI}_{i,t}$				-0.035***	-0.032***
				[0.007]	[0.007]
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t} \times \text{D(GNI> IDA threshold)}_{i,t}$					0.023*
					[0.013]
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	1,832	1,832	1,832	1,832	1,832
Countries	88	88	88	88	88
(Within country) R^2	0.211	0.242	0.273	0.346	0.380
$\hat{\sigma}$		0.234			
$\hat{\sigma}$ SE		[0.152]			
$\hat{\sigma}$ below threshold					0.100
$\hat{\sigma}$ below threshold SE					[0.109]
$\hat{\sigma}$ above threshold					0.383
$\hat{\sigma}$ above threshold SE					[0.246]

Notes: Dependent variable is ln(GDP) in constant local currency units. ln(NTL) is the natural logarithm of the area-weighted average of a country's cell-level nighttime lights (NTL) digital number. The adjusted Freedom in the World (FiW) index produced by Freedom House ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. GNI is Gross National Income per capita in thousands of current US dollars (Atlas method). $\text{D(GNI> IDA threshold)}_{i,t}$ equals one if GNI per capita is above the yearly value determining eligibility for IDA loans and grants. Estimates for single terms and lower order interactions not reported. See Appendix Table C7 for full results. Robust standard errors clustered by country in brackets. Baseline sample includes the 88 countries that were IDA beneficiaries at some point in the sample period. The corresponding estimate of σ, the parameter capturing the proportional exaggeration of GDP growth in autocracies, and its standard error are reported at the bottom of column 2. Column 5 provides separate estimates of σ for country-years below and above the IDA eligibility threshold. Sample period: 1992-2013. *** p<0.01, ** p<0.05, * p<0.1

Table 5: Application: Foreign Aid and Income

Dependent variable:	$\ln(\text{ODA/GNI})_{i,t}$	$\ln(\text{GDP p.c.})_{i,t}$		$\Delta \ln(\text{GDP p.c.})_{i,t}$	
	(1)	(2)	(3)	(4)	(5)
D(GNI> IDA threshold)$_{i,t}$	-0.244***	0.054**	0.029	0.018**	-0.001
	[0.075]	[0.021]	[0.017]	[0.009]	[0.008]
GNI per capita	-0.116**	0.071***	0.036**	-0.007**	-0.007**
	[0.048]	[0.013]	[0.015]	[0.003]	[0.003]
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Country-year trend	No	Yes	Yes	No	No
GDP data correction	No	No	Yes	No	Yes
Observations	1,799	1,799	1,799	1,799	1,799
Countries	86	86	86	86	86
(Within country) R^2	0.245	0.904	0.882	0.0788	0.0699

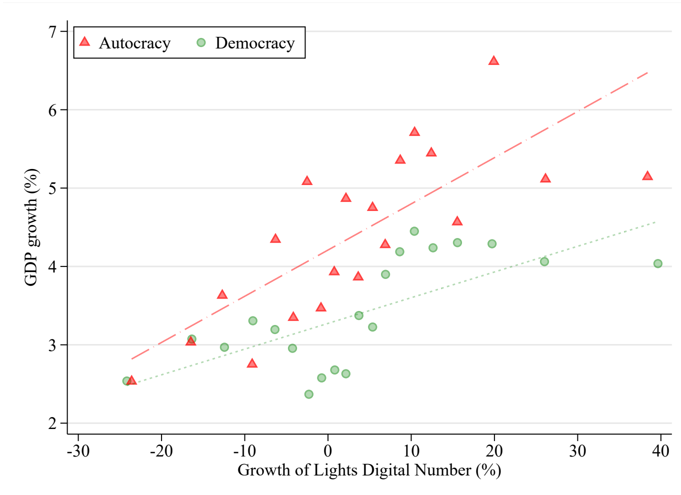
Notes: Dependent variable in column 1 is the natural logarithm of official development assistance (ODA) over Gross National Income (GNI) in US dollars. In columns 2 and 3 it is the natural logarithm of GDP per capita in constant local currency units, while in columns 4 and 5 it is the first difference of log GDP per capita. D(GNI> IDA threshold)$_{i,t}$ equals one if GNI per capita is above the yearly value determining eligibility for IDA loans and grants. Sample includes all countries that were IDA beneficiaries at some point in the sample period, except Serbia, Montenegro and Kosovo due to data availability. All regressions include country and year fixed effects. Columns 2 and 3 also include country-specific time (year) trends. Sample period: 1992-2013. Robust standard errors clustered by country in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 6: The Special Data Dissemination Standard

	Dependent variable: $\ln(\text{GDP})_{i,t}$				
	(1)	(2)	(3)	(4)	(5)
$\ln(\text{NTL})_{i,t}$	0.302***	0.299***	0.219***	0.223***	0.222***
	[0.046]	[0.048]	[0.048]	[0.049]	[0.049]
$\ln(\text{NTL})_{i,t} \times \text{D(SDDS country)}_i$	-0.049	-0.046	-0.022	-0.037	-0.038
	[0.041]	[0.039]	[0.036]	[0.043]	[0.043]
$\ln(\text{NTL})_{i,t} \times \text{D(SDDS compliant)}_{i,t}$		-0.036***	-0.028**	-0.027**	-0.020*
		[0.012]	[0.012]	[0.011]	[0.011]
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t}$			0.021***	0.019***	0.019***
			[0.006]	[0.007]	[0.007]
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t} \times \text{D(SDDS country)}_i$				0.007	-0.002
				[0.010]	[0.012]
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t} \times \text{D(SDDS compliant)}_{i,t}$					0.006
					[0.011]
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	3,895	3,895	3,895	3,895	3,895
Countries	184	184	184	184	184
(Within country) R^2	0.221	0.229	0.265	0.265	0.269
$\hat{\sigma}$			0.328		
$\hat{\sigma}$ SE			[0.143]		
$\hat{\sigma}$ non-SDDS				0.300	0.301
$\hat{\sigma}$ non-SDDS SE				[0.154]	[0.154]
$\hat{\sigma}$ SDDS country				0.486	0.327
$\hat{\sigma}$ SDDS country SE				[0.244]	[0.239]
$\hat{\sigma}$ SDDS compliant					0.489
$\hat{\sigma}$ SDDS compliant SE					[0.310]

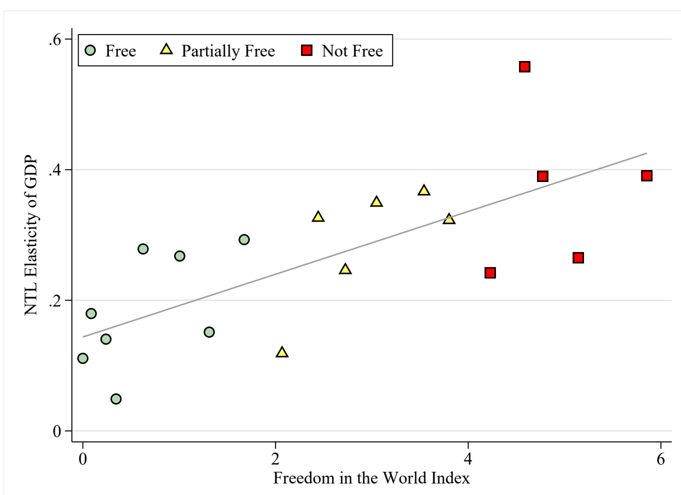
Notes: Dependent variable is ln(GDP) in constant local currency units. ln(NTL) is the natural logarithm of the area-weighted average of a country's cell-level nighttime lights (NTL) digital number. The adjusted Freedom in the World (FiW) index produced by Freedom House ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. D(SDDS country)_i is a dummy equal to one for countries that joined the SDDS during the sample period. $\text{D(SDDS compliant)}_{i,t}$ is a dummy equal to one in the years after the country is deemed compliant with the SDDS. Estimates for single terms and lower order interactions not reported. See Appendix Table C8 for full results. The corresponding estimate of σ, the parameter capturing the proportional exaggeration of GDP growth in autocracies, and its standard error are reported at the bottom of column 3. Column 4 provides separate estimates of σ for SDDS and non-SDDS countries, while column 5 further disaggregates based on SDDS compliance. Sample period: 1992-2013. Robust standard errors clustered by country in brackets. *** p<0.01, ** p<0.05, * p<0.1

Figure 1: Average Growth Rates: NTL and GDP



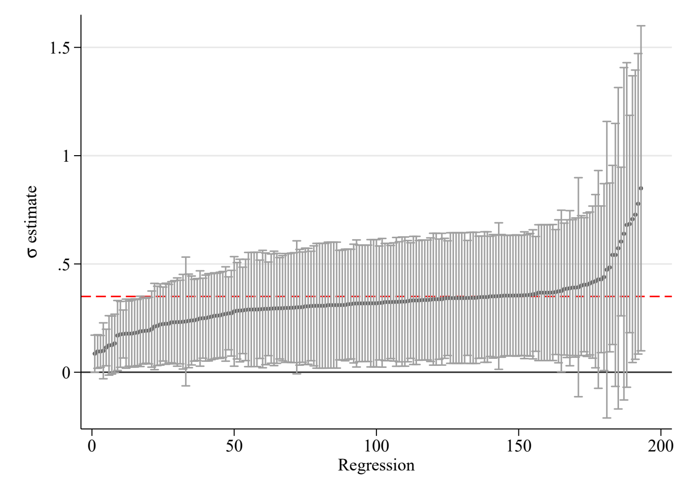
Notes: Figure shows separate binned scatter plots of yearly growth in real GDP (constant local currency) and NTL for country-years classified as democracies and autocracies. Classification based on the binary measure of Electoral Democracy produced by Freedom House. Figure also shows separate lines of best fit, which are estimated using the disaggregate data without binning. Sample size: 3,432. Sample period: 1993-2013.

Figure 2: The NTL Elasticity of GDP and the FIW Index: Country-Level Correlation



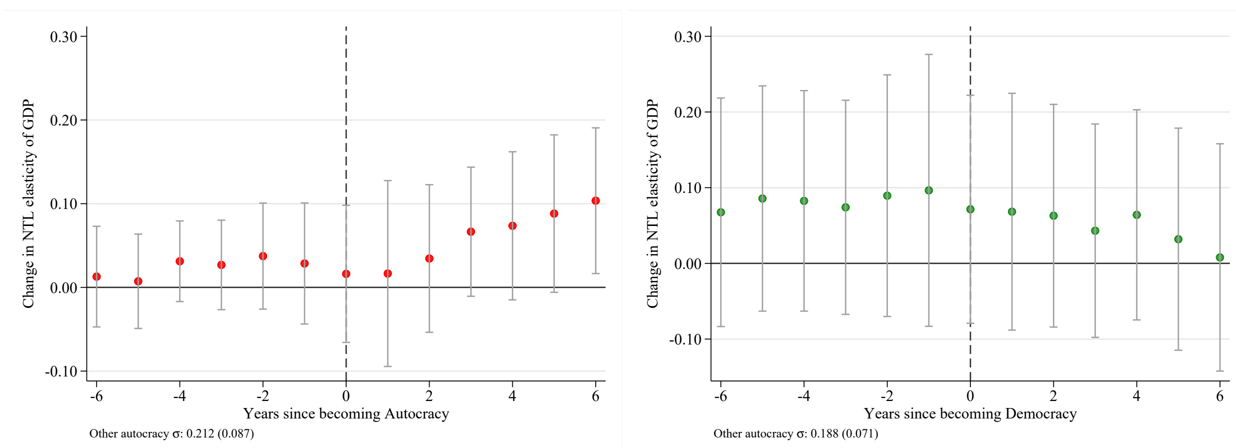
Notes: Figure shows a binned scatter plot of disaggregate estimates of the NTL elasticity of GDP by country against countries' average FiW index between 1992-2013. The regression used to estimate the country-specific NTL elasticity of GDP includes country and year fixed effects. Sample size: 3,895. Sample period: 1992-2013.

Figure 3: Summary of Robustness Checks



Notes: Figure plots the estimated value of σ and its 95% confidence interval from the regressions in Tables 1, 3, 4, 6, Appendix Tables D1-D14 and Appendix Figures D1-D3. The average value of $\hat{\sigma}$ (denoted by the dashed line) is 0.350, while the median is 0.318. The total number of estimates is 198. To facilitate visualization, five estimates larger than 1 have been excluded from the plot.

Figure 4: Political Transitions

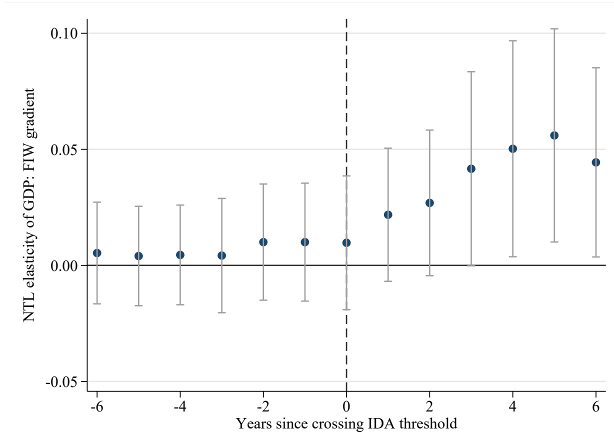


(a) Democracy to Autocracy

(b) Autocracy to Democracy

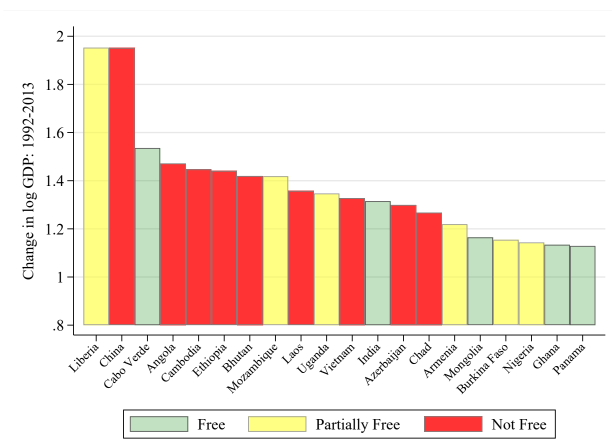
Notes: Each panel shows point estimates and 95% confidence intervals from a regression of ln(GDP) on interactions of dummies for the six years before and after a political transition with ln(NTL). Additional interactions with dummies for years 7 and beyond on both ends not reported. Regression also includes ln(NTL) and the respective transition year dummies, as well as a dummy for other autocracies (i.e., non-transitions) and its interaction with ln(NTL) (estimates not reported). The estimate of $\hat{\sigma}$ for these stable autocracies is reported at the bottom of each figure. Country and year fixed effects also included. Standard errors clustered by country. Sample size: 3,895. Sample period: 1992-2013. Transitions are defined according to the binary measure of Electoral Democracy produced by Freedom House. Transition events are listed in Appendix Table C3. To be included, a transition event must last at least four years. Also, the four years prior to the event and the four years after the event must take place during the sample period.

Figure 5: IDA Eligibility

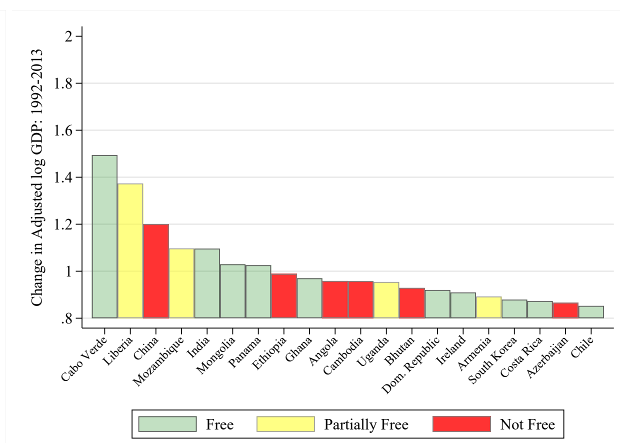


Notes: Panel shows point estimates and 95% confidence intervals from a regression of ln(GDP) on interactions of ln(NTL) with dummies for the six years before and after a country crosses the threshold value of GNI per capita for IDA eligibility. Additional interactions with dummies for years 7 and beyond on both ends not reported. Regression also includes ln(NTL) and the respective crossing year dummies, GNI per capita and its interaction with ln(NTL), as well as the FiW index for countries not crossing the threshold and its interaction with ln(NTL) (estimates not reported). Country and year fixed effects also included. Standard errors clustered by country. Sample includes 88 countries that were IDA beneficiaries at the start of the sample period. Sample size: 1,832. Sample period: 1992-2013.

Figure 6: Top 20 Fastest-Growing Economies: 1992/3 - 2012/13



(a) Raw GDP



(b) Adjusted GDP

Note: Panel (a) shows the 20 countries with the largest change in ln(GDP) between 1992/3 and 2012/13 (two-year average in both cases), as reported in the World Bank's World Development Indicators (Nov 2014 release). Countries are classified according to the average value of the Freedom in the World (FiW) index during this period. Panel (b) shows the the 20 countries with the largest change in ln(GDP) over the same period, once the GDP data has been adjusted for manipulation. See text for details on adjustment procedure.

How Much Should We Trust the Dictator's GDP Growth Estimates?

APPENDIX (FOR ONLINE PUBLICATION)

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A Extensions of the Econometric Model

This appendix presents several extensions of the econometric model introduced in section 4 of the body of the paper. I first show in section A.1 that the predictions of the model are largely unchanged if I also allow for additive exaggeration of GDP growth in autocracies. I further show in section A.2 that even if exaggeration is only additive, a regression of ln(GDP) on ln(NTL) and the autocracy measure fails to identify the structural parameter of interest. In section A.3, I present another extension of the model that relaxes the assumption that GDP growth captures true growth equally well in autocracies and democracies. I present an alternative extension that allows for differential electrification policies across political regimes in section A.4. Finally, in section A.5 I study the impact of measurement error on the estimation of $\hat{\sigma}$ and provide sufficient conditions for identification.

A.1 Additive and Multiplicative Exaggeration of GDP Growth

In this extension of the model, I assume that autocracies overstate GDP growth in both a proportional and additive manner. In this case, equation 3 becomes:

$$\hat{g}_{i,t} = (1 + \sigma a_{i,t}) g_{i,t} + \theta a_{i,t} \tag{3.1}$$

where $\theta > 0$ captures the fixed exaggeration of GDP growth that takes place in autocracies, irrespective of true growth. Everything else in the model remains unchanged. If I combine the new equation 3.1 with equations 1, 2 and 4, I obtain:

$$\hat{\mathrm{g}}_{i,t} = \frac{\beta}{\gamma^d} l_{i,t} + \frac{\beta\sigma}{\gamma^d} (l_{i,t} \times a_{i,t}) + (\lambda + \sigma\epsilon_{i,t} - \frac{\sigma\beta}{\gamma^d} u_{i,t} + \theta) a_{i,t} + \sigma\lambda a_{i,t}^2 + \nu_{i,t} \tag{5.1}$$

Relative to the baseline model, the only difference is that the coefficient for autocracy now also includes the parameter θ. Importantly, I can still back out $\hat{\sigma}$ using the coefficient for NTL and the one for its interaction with the autocracy measure.

A.2 Additive Exaggeration of GDP Growth Exclusively

I now consider the possibility that overstatement of GDP growth in autocracies only takes place in an additive fashion. In this case, equation 3 becomes:

$$\hat{g}_{i,t} = g_{i,t} + \theta a_{i,t} \tag{3.2}$$

where $\theta > 0$ captures once again the fixed exaggeration of GDP growth that takes place in autocracies, irrespective of true growth. Everything else in the model remains unchanged.

If I combine the new equation 3.2 with equations 1, 2 and 4, I obtain:

$$\hat{\mathrm{g}}_{i,t} = \frac{\beta}{\gamma^d} l_{i,t} + (\lambda + \theta) a_{i,t} + + \nu_{i,t} \tag{5.2}$$

Equation 5.2 shows that the coefficient for autocracy in a regression of GDP growth on NTL growth and the autocracy measure is equal to the sum of the fixed reporting bias (θ) with λ, which is a function of the parameters that govern the link between regime type and true income growth in equation 1 and those that map true income growth into growth in NTL and GDP in equations 2 and 4. As a result, even if autocracies only overstate GDP growth by the constant amount θ, the regression above fails to identify this parameter, as long as $\alpha \neq 0$ (autocracies and democracies have different true growth rates) and $\gamma^d \neq \gamma^a$ (NTL do not capture growth equally well across political regimes).

A.3 Heterogeneity in the Mapping of True Growth to GDP

I next modify equation 2 to allow GDP growth to differentially reflect real economic growth in democracies and autocracies (i.e., $\beta^d \neq \beta^a$):

$$g_{i,t} = \beta^d y^d_{i,t} + \beta^a \alpha a_{i,t} + \epsilon_{i,t} \tag{2.1}$$

If I combine the new equation 2.1 with equations 1, 3 and 4, I obtain:

$$\hat{\mathrm{g}}_{i,t} = \frac{\beta^d}{\gamma^d} l_{i,t} + \frac{\beta^d \sigma}{\gamma^d} (l_{i,t} \times a_{i,t}) + (\bar{\lambda} + \sigma \epsilon_{i,t} - \frac{\sigma \beta^d}{\gamma^d} u_{i,t}) a_{i,t} + \sigma \bar{\lambda} a^2_{i,t} + \bar{\nu}_{i,t} \tag{5.3}$$

where $\bar{\lambda} \equiv \frac{\alpha}{\gamma^d} \left[\beta^a \gamma^d - \beta^d \gamma^a\right]$. As before, the coefficient for the interaction term between growth in NTL and autocracy will only be positive if autocracies overstate GDP growth proportionally at a rate σ. It is also still true that I can back out $\hat{\sigma}$ by dividing the coefficient for the interaction term by the estimate for NTL growth.

A.4 Differential Electrification Policy Across Regimes

I now extend the model to allow for the possibility that political regimes differ in their electrification policies, which could generate a link between autocracy and growth in NTL, even after conditioning on true economic growth. There is ample evidence supporting this alternative formulation of the model. For instance, Lenin famously said in one of his speeches that "Communism is Soviet Power plus the electrification of the whole country."[1] More recently, Min (2015) provides quantitative evidence showing that democracies provide more

[1]See https://www.marxists.org/archive/lenin/works/1920/nov/21.htm (last accessed 06/28/2021).

electricity than autocracies, conditional on income. To simplify the analysis, I assume that NTL capture true growth in autocracies and democracies equally well, but that growth in NTL varies by political regime after controlling for true income growth. In this case, equation 4 becomes:

$$l_{i,t} = \gamma \tilde{y}_{i,t} + \psi a_{i,t} + u_{i,t} \tag{4.1}$$

where ψ captures the differential growth rate of NTL in autocracies. Combining the new equation 4.1 with equations 1-3 yields:

$$\hat{g}_{i,t} = \frac{\beta}{\gamma} l_{i,t} + \frac{\beta\sigma}{\gamma}(l_{i,t} \times a_{i,t}) + (\sigma\epsilon_{i,t} - \frac{\sigma\beta}{\gamma} u_{i,t} - \frac{\psi\beta}{\gamma}) a_{i,t} - \frac{\sigma\psi\beta}{\gamma} a_{i,t}^2 + \nu_{i,t} \tag{5.4}$$

Similarly to the baseline model, the coefficient for the interaction of growth in NTL and autocracy is increasing in σ, which is the proportional exaggeration of GDP growth that takes place in autocracies. It is also still possible to back out $\hat{\sigma}$ from the regression coefficients.

A.5 Measurement Error and Identification

In this section, I explore the impact of measurement error in NTL and GDP on the estimate of $\hat{\sigma}$ that I obtain from the regression coefficients in equation 6. For tractability, I simplify the model and assume that NTL capture true economic growth ($\tilde{y}$) equally well in autocracies and democracies. I also leave the relationship between true growth and political regimes unspecified, but consider both the case in which true growth and autocracy are independent and the case in which they are not. Hence, equations 4 and 5 become:

$$l_{i,t} = \gamma \tilde{y}_{i,t} + + u_{i,t} \tag{4.2}$$

$$\hat{g}_{i,t} = \frac{\beta}{\gamma} l_{i,t} + \frac{\beta\sigma}{\gamma}(l_{i,t} \times a_{i,t}) + (\sigma\epsilon_{i,t} - \frac{\sigma\beta}{\gamma} u_{i,t}) a_{i,t} + \nu_{i,t} \tag{5.5}$$

Similarly to the main analysis, I disaggregate the error term $\nu_{i,t}$ into a country-specific component (μ_i), a year-specific component (δ_t) and an idiosyncratic error term ($\xi_{i,t}$). To further facilitate the analysis, I take autocracy to be a time-invariant characteristic captured by a_i. In consequence, the individual terms for autocracy and its square in equation 5.5 are absorbed by the country fixed effects. The estimating equation becomes:

$$\hat{g}_{i,t} = \mu_i + \delta_t + \pi_0 l_{i,t} + \pi_1 l_{i,t} a_i + \xi_{i,t} \tag{6.1}$$

Table D12 provides results from an analogous specification (in log-linear form in levels) using the average value of the FiW index. In what follows, I assume that the error terms $\epsilon_{i,t}$ and $u_{i,t}$ in equations 2 and 4.2 are independent from each other, as well as from $\tilde{y}_{i,t}$ and a_i. I also assume that all variables are measured such that they have zero mean. I first consider the case in which true economic growth ($\tilde{y}$) and a_i are independent random variables. The previous assumptions imply that $l_{i,t}$ and its interaction with a_i are uncorrelated:

$$\begin{aligned}\mathrm{cov}(l_{i,t}, a_i l_{i,t}) =& \mathrm{cov}(\gamma\tilde{y}_{i,t} + u_{i,t}, \gamma a_i\tilde{y}_{i,t} + a_i u_{i,t})\\ =&\gamma^2\mathrm{cov}(\tilde{y}_{i,t}, a_i\tilde{y}_{i,t}) + \gamma\left[\mathrm{cov}(u_{i,t}, a_i\tilde{y}_{i,t}) + \mathrm{cov}(\tilde{y}_{i,t}, a_i u_{i,t})\right] + \mathrm{cov}(u_{i,t}, a_i u_{i,t})\\ =&0 \qquad \text{(since all single variables are independent and have zero mean)}\end{aligned}$$

As a result, the coefficients π_0 and π_1 from the multivariate regression 6.1 (partialling out the fixed effects) are equal to the corresponding estimates from separate bivariate regressions of $\hat{g}_{i,t}$ on $l_{i,t}$ and $l_{i,t} \times a_i$. In particular:

$$\begin{aligned}\hat{\pi}_1 =& \frac{\mathrm{cov}(\hat{g}_{i,t}, l_{i,t}a_i)}{\mathrm{var}(l_{i,t}a_i)}\\ =&\frac{\mathrm{cov}(\beta\tilde{y}_{i,t} + \epsilon_{i,t} + \sigma\beta a_i\tilde{y}_{i,t} + \sigma a_i\epsilon_{i,t}, \gamma a_i\tilde{y}_{i,t} + a_i u_{i,t})}{\mathrm{var}(a_i)\mathrm{var}(l_{i,t})}\\ =&\frac{\gamma\beta\sigma\ \mathrm{var}(\tilde{y}_{i,t})}{\gamma^2\mathrm{var}(\tilde{y}_{i,t}) + \mathrm{var}(u_{i,t})}\end{aligned}$$

$$\text{Similarly,} \qquad \hat{\pi}_0 = \frac{\mathrm{cov}(\hat{g}_{i,t}, l_{i,t})}{\mathrm{var}(l_{i,t})} = \frac{\gamma\beta\mathrm{var}(\tilde{y}_{i,t})}{\gamma^2\mathrm{var}(\tilde{y}_{i,t}) + \mathrm{var}(u_{i,t})}$$

In the previous derivations, I exploit the fact that the variance of the product of two independent random variables with mean zero is equal to the product of the variances. The expressions for $\hat{\pi}_0$ and $\hat{\pi}_1$ indicate the presence of attenuation bias in both coefficients, due to the presence of the measurement error $u_{i,t}$ in $l_{i,t}$, which also affects the interaction of the latter variable with a_i. Despite this, however, the ratio of the two coefficients provides an unbiased estimate of σ, the main structural parameter of interest:

$$\hat{\sigma} = \frac{\hat{\pi}_1}{\hat{\pi}_0} = \frac{\gamma\beta\sigma\ \mathrm{var}(\tilde{y}_{i,t})}{\gamma^2\mathrm{var}(\tilde{y}_{i,t}) + \mathrm{var}(u_{i,t})} \times \frac{\gamma^2\mathrm{var}(\tilde{y}_{i,t}) + \mathrm{var}(u_{i,t})}{\gamma\beta\mathrm{var}(\tilde{y}_{i,t})} = \sigma$$

Hence, independence of $\tilde{y}_{i,t}$ and a_i is a sufficient condition for the identification of σ. If these variables are not independent, it becomes necessary to use the more general formula for two-variable regressions:

$$\hat{\pi}_0 = \frac{\text{var}(l_{i,t}a_i)\text{cov}(\hat{g}_{i,t}, l_{i,t}) - \text{cov}(l_{i,t}a_i, l_{i,t})\text{cov}(\hat{g}_{i,t}, l_{i,t}a_i)}{\text{var}(l_{i,t})\text{var}(l_{i,t}a_i) - \text{cov}(l_{i,t}, l_{i,t}a_i)^2}$$

$$\text{and} \qquad \hat{\pi}_1 = \frac{\text{var}(l_{i,t})\text{cov}(\hat{g}_{i,t}, l_{i,t}a_i) - \text{cov}(l_{i,t}a_i, l_{i,t})\text{cov}(\hat{g}_{i,t}, l_{i,t})}{\text{var}(l_{i,t})\text{var}(l_{i,t}a_i) - \text{cov}(l_{i,t}, l_{i,t}a_i)^2}$$

Combining these estimates, I obtain:

$$\hat{\sigma} = \frac{\hat{\pi}_1}{\hat{\pi}_0} = \frac{\beta\gamma\sigma\left[\text{var}(l_{i,t})\text{var}(\tilde{y}_{i,t}a_i) - \gamma^2\text{cov}(\tilde{y}_{i,t}, \tilde{y}_{i,t}a_i)^2\right] + \beta\gamma\text{cov}(\tilde{y}_{i,t}, \tilde{y}_{i,t}a_i)\text{var}(u_{i,t})}{\beta\gamma\left[\text{var}(l_{i,t}a_i)\text{var}(\tilde{y}_{i,t}) - \gamma^2\text{cov}(\tilde{y}_{i,t}, \tilde{y}_{i,t}a_i)^2\right] + \beta\gamma\sigma\text{cov}(\tilde{y}_{i,t}, \tilde{y}_{i,t}a_i)\text{var}(a_i)\text{var}(u_{i,t})}$$

The case in which $\tilde{y}_{i,t}$ and a_i are independent is nested within this more general formulation. If $\tilde{y}_{i,t}$ and a_i are independent, the covariance terms in the above expression all become zero, the variances of products become equal to the products of the respective variances and I obtain again $\hat{\sigma} = \sigma$. If these variables are not independent, I can use the above expression to identify necessary conditions such that $\hat{\sigma} \leq \sigma$:

$$\begin{aligned}
\hat{\sigma} &\leq \sigma \\
\iff \sigma\text{var}(\tilde{y}_{i,t}a_i) + \text{cov}(\tilde{y}_{i,t}, \tilde{y}_{i,t}a_i) &\leq \sigma\text{var}(a_i)\text{var}(\tilde{y}_{i,t}) + \sigma^2\text{cov}(\tilde{y}_{i,t}, \tilde{y}_{i,t}a_i) \\
\iff \frac{\sigma}{1-\sigma^2} &\leq \frac{\text{var}(a_i)\text{var}(\tilde{y}_{i,t}) - \text{var}(\tilde{y}_{i,t}a_i)}{\text{cov}(\tilde{y}_{i,t}, \tilde{y}_{i,t}a_i)} \\
\iff \frac{\sigma}{1-\sigma^2} &\leq \frac{\text{cov}(a_i^2, \tilde{y}_{i,t}^2) - \text{cov}(\tilde{y}_{i,t}, a_i)^2}{\text{cov}(\tilde{y}_{i,t}, \tilde{y}_{i,t}a_i)} \qquad (7)
\end{aligned}$$

For $\sigma \in [0, 1]$, the expression on the left of the inequality is positive and increasing. Hence, $\hat{\sigma}$ will not be biased upward as long as σ remains below a threshold value ($\bar{\sigma}$) determined implicitly by equation 7. In order for $\bar{\sigma} > 0$, it is also necessary that the fraction on the right-hand side of equation 7 is positive. The condition $\text{cov}(a_i^2, \tilde{y}_{i,t}^2) > \text{cov}(\tilde{y}_{i,t}, a_i)^2$ is satisfied, for instance, if $\tilde{y}_{i,t}$ and a_i are jointly normally distributed, in which case $\text{cov}(a_i^2, \tilde{y}_{i,t}^2) = 2\ \text{cov}(\tilde{y}_{i,t}, a_i)^2$ (assuming still that both variables have zero mean). The sign of the fraction on the right will also depend on $\text{cov}(\tilde{y}_{i,t}, \tilde{y}_{i,t}a_i)$, which can also be expressed as $E[a_i\tilde{y}_{i,t}^2]$.

B Further Information on Data Sources and Variables

Night Time Lights (NTL). As mentioned in the main text, the starting point for the data on night time lights (NTL) is version 4 of the composite images provided by the National Oceanic and Atmospheric Administration (NOAA).[2] These images are based on raw data from the US Air Force's Defense Meteorological Satellite Program (DMSP), which is recorded using the Operational Linescan System (OLS) sensor. This instrument records information in the form of a 6-bit integer, which is transformed into a NTL Digital Number (DN) ranging from 0 to 63 (i.e., $2^6 = 64$), with larger values corresponding to greater night time luminosity. NOAA conducts some preliminary cleaning and processing of the raw DMSP data, removing observations affected by factors such as cloud cover, auroral activity, sunlight (i.e., summer months), or moonlight (i.e., bright half of the lunar cycle). NOAA then averages across all remaining observations from the same satellite in the same year and provides a composite dataset for each satellite-year. Each dataset corresponds to a 30 arc-second grid, with an approximate pixel size of 0.86 square kilometers at the equator. The data is publicly-available for six different satellites (34 satellite-years) and covers the period 1992-2013, with some overlap across satellites. Figure C2 shows the years with available data from each satellite.

The original datasets from NOAA cover the entire world between the latitudes of 65 degrees south and 75 degrees north. This restriction has a very limited impact on NTL as a measure of economic activity, given that a negligible share of the world popualtion lives in the excluded areas (Henderson et al., 2012). Following Henderson et al. (2012), I restrict the sample to observations below the Arctic circle (i.e., 66 degrees, 32 arc-minutes latitude), given the disproportionate share of pixels above this latitude that end up with missing data after the initial processing by NOAA (most likely as a result of auroral activity). For years with information from multiple satellites, I then calculate a simple average across satellites for each pixel. Importantly, the OLS instrument lacks onboard calibration, which makes it impossible to adjust for instrument degradation over time and also hinders data comparability across satellites. The pixel-level average helps to reduce the impact of measurement variability across satellites. The inclusion of year fixed effects in all estimations further helps to control for the impact of fluctuations in measured NTL resulting from satellite changes. Moreover, I verify in Table D3 that the autocracy gradient in the NTL elasticity of GDP is robust to allowing the elasticity to vary across years.

Once I have a single measurement of the NTL DN for each pixel-year, I combine this information with a shapefile containing the boundaries of all the countries in the world. To

[2] Data is publicaly available at `https://ngdc.noaa.gov/eog/dmsp/downloadV4composites.html` (last accessed 06/29/2021).

aggregate the data to the country-year level, I calculate an area-weighted average of the NTL DN across all the pixels that fall within a country's boundaries. Weighting by area (i.e., the share of the country's land area that falls inside the pixel) accounts for the fact that pixel size varies based on location and becomes smaller at more extreme latitudes.

I also follow Henderson et al. (2012) in imposing two additional restrictions on the resulting dataset at the country-year level. First, I exclude observations in which at least 5% of the land area south of the Arctic circle is missing data as a result of the initial cleaning and processing done by NOAA. This results in 32 country-years with missing data. Second, I exclude three countries from the sample due to anomalies in the NTL data. The first two, Singapore and Bahrain, have a disproportionate share of their pixels top-coded (i.e., DN=63). Averaging across years, I observe that 78% of pixels in Singapore and 41% of pixels in Bahrain are top-coded, relative to a sample average of 1.1%. The third country excluded is Equatorial Guinea because more than 90% of its recorded NTL correspond to gas flares.

As part of the robustness checks I verify that the results are not driven by ad-hoc choices in the processing and aggregation of the NTL data. For this purpose, I use publicaly-available replication data from previous studies using NTL, such as Henderson et al. (2012), Hodler and Raschky (2014) and Pinkovskiy and Sala-i Martin (2016). I also verify that the results are robust to the inclusion of harmonized data from the newer VIIRS instrument for the period 2014-2018. For this purpose, I use the pixel-year-level dataset produced by Li et al. (2020) for 1992-2018 and I aggregate to the country-year level following the same process as for the baseline DMSP-only dataset, which I just outlined.

IDA eligibility. Countries' eligibility for concessionary loans and grants from the International Development Association (IDA) is based on their Gross National Income (GNI) per capita as reported by the World Bank using the Atlas method. Specifically, a country's GNI per capita must remain below a threshold value (adjusted every year for inflation) in order for it to remain eligible for IDA assistance.[3]

Information on the countries that cross the IDA eligibility threshold and the year in which they do so is not readily available. I manually code these crossings using the following procedure. First, I determine the threshold value of GNI per capita for every year between 1992 and 2013. Unfortunately, information on the yearly threshold is not easily accessible. However, the replication files from Galiani et al. (2017) contain this information for years up to 2010. I extend this information to 2013 (the last year in my sample) based on various documents, mostly from the International Monetary Fund.[4] I list in my replication files the

[3]See `https://ida.worldbank.org/about/how-does-ida-work` and `https://documents1.worldbank.org/curated/en/287661468782159368/pdf/264980IDA0eligibility035.pdf` for more information (last accessed 06/29/2021).

[4]For instance, page 5 of `https://www.imf.org/external/np/pp/eng/2013/031813a.pdf` provides the

source for the threshold value that I assign for each year after 2010.

Second, I compile the list of all countries that were beneficiaries of the IDA at some point during the sample period using information from the IDA website.[5] I then compare the yearly value of GNI per capita reported in the World Bank's World Development Indicators (WDI) for each of these countries to the corresponding IDA eligibility threshold. However, data on GNI per capita varies across different releases of the WDI, which complicates this process. I overcome this challenge by using data from multiple releases of the WDI (20 in total, covering the period 1998 to 2020) to determine whether a country crosses the threshold. Given potential inconsistencies across sources (arguably due to data revisions), I code a country i as crossing the threshold in year t if it meets two conditions. First, I must observe GNI per capita for that country for at least three years before the crossing and these years must take place within the sample period (1992-2013). Second, at least 75% of WDI releases must agree in that the country's GNI per capita exceeds the IDA eligibility threshold for the first time in year t. These sources must also be more than five. Table C4 provides the resulting list of countries that cross the IDA threshold and the year in which they do so.

IDA cutoff for FY 2013 (last accessed 06/29/2021).

[5]The IDA website contains a list of current IDA beneficiaries. It also shows the list of countries that have graduated from the IDA and the year in which they did so. Graduation, however, is the final step in a multi-year process that starts when a country crosses the eligibility threshold and finishes when a country is deemed eligible for funding from the International Bank for Reconstruction and Development (IBRD). Together, the IDA and the IBRD make up what is commonly referred to as the World Bank.

C Additional Tables and Figures

Table C1: Observable Political Characteristics and the FiW index

	Coefficient	SE	N	R^2	Mean
	(1)	(2)	(3)	(4)	(5)
Panel A: Cross-sectional Regressions					
Country has a formal legislative body	-5.056***	[1.306]	160	0.051	0.98
Country has a unicameral legislature	0.684**	[0.320]	160	0.028	0.56
Country holds national elections for the legislature	-4.663***	[0.730]	160	0.152	0.95
Country holds national elections for an executive	0.125	[0.333]	160	0.001	0.59
Registration is required to participate in elections	-2.296***	[0.315]	158	0.213	0.61
Some parties are banned	1.834***	[0.358]	159	0.144	0.30
All parties are banned	2.673***	[0.401]	160	0.081	0.05
There is an official state party	3.330***	[0.294]	160	0.126	0.05
Executive has constitutional veto power	-0.629**	[0.317]	160	0.024	0.56
Legislative has constitutional veto power	-0.869**	[0.409]	159	0.032	0.77
Executive can dissolve the legislature	-0.223	[0.344]	160	0.003	0.63
Legislature can remove the executive	-1.133**	[0.454]	159	0.043	0.76
Executive can use military power without legislative approval	0.429	[0.457]	160	0.006	0.77
Executive can change taxes without legislative approval	1.944***	[0.678]	159	0.034	0.06
Executive must secure legislative approval for the budget	-1.672*	[0.853]	160	0.026	0.95
Country has new constitution[a]	1.308***	[0.279]	158	0.125	0.56
Country has national constitutional court	-1.301**	[0.551]	160	0.054	0.83
Country has a federal system	-0.961***	[0.338]	160	0.048	0.27
Regional governments are autonomously selected	-0.816**	[0.343]	159	0.034	0.50
Panel B: Panel Regressions					
Country has a formal legislative body	-0.699***	[0.163]	3.144	0.012	0.99
Country has a unicameral legislature	-0.132	[0.164]	3,079	0.003	0.56
Country holds national elections for the legislature	-0.245*	[0.142]	3,087	0.004	0.95
Country holds national elections for an executive	-0.687***	[0.214]	3,124	0.043	0.60
Registration is required to participate in elections	-0.0621	[0.0776]	3,013	0.001	0.64
Some parties are banned	0.131	[0.104]	3,067	0.003	0.30
All parties are banned	0.436	[0.352]	3,103	0.005	0.05
There is an official state party	0.186	[0.293]	3,023	0.001	0.05
Executive has constitutional veto power	0.124	[0.111]	2,966	0.002	0.56
Legislative has constitutional veto power	0.189	[0.146]	2,916	0.004	0.78
Executive can dissolve the legislature	0.0424	[0.139]	2,977	0.0002	0.64
Legislature can remove the executive	-0.0326	[0.109]	2,972	0.0002	0.76
Executive can use military power without legislative approval	0.0809	[0.0943]	2,905	0.001	0.78
Executive can change taxes without legislative approval	0.0987	[0.168]	2,911	0.001	0.05
Executive must secure legislative approval for the budget	-0.251	[0.192]	3,003	0.003	0.95
Country has new constitution	0.133	[0.145]	3,000	0.002	0.45
Country has national constitutional court	-0.0465	[0.180]	3,057	0.0002	0.85
Country has a federal system	0.144	[0.115]	3,098	0.001	0.27
Regional governments are autonomously selected	-0.0819	[0.0949]	3,009	0.002	0.51

Notes: The adjusted Freedom in the World (FiW) index produced by Freedom House ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Panel A shows results of bivariate cross-sectional regressions of the average value of the FiW index between 1992 and 2012 on the average of the variable listed in the leftmost column of each row over the same period (Source: Wig et al. (2015)). Panel B shows estimates from bivariate panel regressions of the FiW index on each listed variable, with country and year fixed effects. Robust standard errors in brackets in column 2 (clustered by country in panel B). Sample period in panel B: 1992-2012. *** p<0.01, ** p<0.05, * p<0.1

Table C2: Average Growth in GDP and NTL Across Political Regimes

	Average growth rate	
	GDP	Lights
	(1)	(2)
Full sample (N=3,700)	0.037	0.066
	[0.001]	[0.004]
Free (N=1,657)	0.031	0.058
	[0.001]	[0.005]
Partially free (N=1,157)	0.041	0.076
	[0.001]	[0.007]
Not free (N=886)	0.045	0.068
	[0.002]	[0.007]
p-value H_0: Free = Partially Free	0.000	0.035
p-value H_0: Free = Not Free	0.000	0.275
p-value H_0: Partially Free = Not Free	0.098	0.417

Notes: Top row shows the average yearly growth rates of GDP and nighttime lights between 1993 and 2013. The latter is the area-weighted average of a country's cell-level nighttime lights (NTL) digital number (DN). Rows 2-4 show disaggregate averages for observations (country-years) classified as "Free" (row 2), "Partially Free" (row 3) and "Not Free" (row 4) by Freedom House. Sample period: 1993-2013. Standard errors in brackets.

Table C3: Countries Experiencing Regime Change

Into Autocracy		Into Democracy	
Country	Year	Country	Year
(1)	(2)	(3)	(4)
Armenia	2003	Armenia	1999
Burundi	2010	Antigua and Barbuda	2004
Congo, Rep	1997	Burundi	2005
Georgia	2008	Bosnia and Herzegovina	2008
Guinea-Bissau	2010	Comoros	2004
Honduras	2009	Ghana	1996
Haiti	2000	Haiti	2006
Haiti	2010	Indonesia	1999
Kenya	2007	Kenya	2002
Kyrgyz Republic	2000	Liberia	1997
Liberia	2001	Liberia	2005
Sri Lanka	2010	Lesotho	2002
Lesotho	1998	Mexico	2000
Madagascar	2009	Nigeria	1999
Mozambique	2009	Peru	2001
Nigeria	2006	Senegal	2000
Nepal	2002	Serbia	2000
Pakistan	1999	Tonga	2010
Russian Federation	2004	Tanzania	2010
Solomon Islands	2006	Zambia	2006
Thailand	2006		
Venezuela, RB	2008		
Zambia	1996		

Notes: The table lists the countries included in the event-study analysis in Figure 4. These are countries that experience regime change during the sample period, as measured by the binary indicator for electoral democracy produced by Freedom House. In order for a regime change episode to be included in the analysis, the transition must last at least four years. Also, the four years before and after the event must take place within the sample period. Countries experiencing a transition into autocracy are listed in column 1, with the year of the event in column 2. Countries experiencing a transition into democracy are listed in column 3, with the year of the event in column 4.

Table C4: Countries Crossing the IDA Eligibility Threshold

Country	Year	Country	Year
(1)	(2)	(3)	(4)
Indonesia	1994	Nigeria	2008
Bolivia	1997	Nicaragua	2009
Maldives	1997	Papua New Guinea	2009
Albania	1999	Yemen, Rep	2010
China	2000	Cote d'Ivoire	2010
Honduras	2001	India	2010
Guyana	2002	Sudan	2010
Bhutan	2003	Uzbekistan	2010
Sri Lanka	2003	Cameroon	2011
Armenia	2003	Sao Tome and Principe	2011
Georgia	2004	Lesotho	2011
Angola	2005	Vietnam	2011
Azerbaijan	2005	Lao PDR	2012
Congo, Rep	2006	Solomon Islands	2012
Moldova	2007	Zambia	2012
Mongolia	2007	Pakistan	2013
Timor-Leste	2007	Mauritania	2013
Ghana	2008		

Notes: The table lists the countries that become ineligible for concessionary loans and grants from the IDA because their level of Gross National Income (GNI) per capita exceeds the threshold value determining eligibility. For each country, the table also reports the first year in which GNI per capita exceeds the eligibility threshold. See Appendix B for further details on the process followed to determine crossing years.

Table C5: Countries Complying with SDDS

Country	Year	Country	Year
(1)	(2)	(3)	(4)
Argentina	1999	Australia	2001
Canada	1999	Austria	2001
Czech Republic	1999	Belgium	2001
El Salvador	1999	Brazil	2001
Korea, Rep	1999	Costa Rica	2001
Latvia	1999	Croatia	2001
Lithuania	1999	France	2001
Peru	1999	India	2001
Slovak Republic	1999	Ireland	2001
United Kingdom	1999	Philippines	2001
United States	1999	Switzerland	2001
Chile	2000	Tunisia	2001
Colombia	2000	Turkey	2001
Denmark	2000	Greece	2002
Ecuador	2000	Armenia	2003
Estonia	2000	Bulgaria	2003
Finland	2000	Kazakhstan	2003
Germany	2000	Ukraine	2003
Hong Kong	2000	Belarus	2004
Hungary	2000	Iceland	2004
Indonesia	2000	Kyrgyz Republic	2004
Israel	2000	Uruguay	2004
Italy	2000	Egypt	2005
Japan	2000	Morocco	2005
Malaysia	2000	Romania	2005
Mexico	2000	Russian Federation	2005
Netherlands	2000	Luxembourg	2006
Norway	2000	Moldova	2006
Poland	2000	Cyprus	2009
Portugal	2000	Malta	2009
Slovenia	2000	Georgia	2010
South Africa	2000	Jordan	2010
Spain	2000	North Macedonia	2011
Sweden	2000	Mauritius	2012
Thailand	2000	West Bank and Gaza	2012

Notes: The table lists the countries that have been deemed compliant with the Special Data Dissemination Standard issued by the International Monetary Fund, and the year in which they first were compliant.

Table C6: Heterogeneous Effects: Economic Underperformance (full table)

	Dependent variable: $\ln(\text{GDP})_{i,t}$				
	(1)	(2)	(3)	(4)	(5)
$\ln(\text{NTL})_{i,t}$	0.280***	0.203***	0.214***	0.239***	0.241***
	[0.063]	[0.055]	[0.053]	[0.060]	[0.057]
$\text{D(Low Growth)}_{i,t}$	-0.009	-0.007	0.010	-0.007	-0.000
	[0.017]	[0.013]	[0.019]	[0.015]	[0.017]
$\ln(\text{NTL})_{i,t} \times \text{D(Low Growth)}_{i,t}$	0.003	-0.001	-0.018***	0.000	-0.011*
	[0.005]	[0.005]	[0.007]	[0.005]	[0.006]
$\text{FiW}_{i,t}$		-0.015	-0.017		
		[0.025]	[0.025]		
$\text{FiW}_{i,t}{}^2$		0.002	0.002		
		[0.005]	[0.005]		
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t}$		0.022***	0.016***		
		[0.005]	[0.005]		
$\text{D(Low Growth)}_{i,t} \times \text{FiW}_{i,t}$			-0.003		
			[0.007]		
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t} \times \text{D(Low Growth)}_{i,t}$			0.007**		
			[0.003]		
$\text{D(Partially Free)}_{i,t}$				0.001	-0.006
				[0.020]	[0.021]
$\text{D(Not Free)}_{i,t}$				0.015	0.016
				[0.039]	[0.039]
$\ln(\text{NTL})_{i,t} \times \text{D(Partially Free)}_{i,t}$				0.041***	0.035**
				[0.015]	[0.014]
$\ln(\text{NTL})_{i,t} \times \text{D(Not Free)}_{i,t}$				0.067***	0.046**
				[0.021]	[0.020]
$\text{D(Low Growth)}_{i,t} \times \text{D(Partially Free)}_{i,t}$					0.011
					[0.021]
$\text{D(Low Growth)}_{i,t} \times \text{D(Not Free)}_{i,t}$					-0.012
					[0.036]
$\ln(\text{NTL})_{i,t} \times \text{D(Partially Free)}_{i,t} \times \text{D(Low Growth)}_{i,t}$					0.012
					[0.009]
$\ln(\text{NTL})_{i,t} \times \text{D(Not Free)}_{i,t} \times \text{D(Low Growth)}_{i,t}$					0.034**
					[0.016]
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	3,895	3,895	3,895	3,895	3,895
Countries	184	184	184	184	184
(Within country) R^2	0.219	0.260	0.267	0.238	0.247
$\hat{\sigma}$		0.374		0.281	
$\hat{\sigma}$ SE		[0.168]		[0.129]	
$\hat{\sigma}$ high growth			0.268		0.190
$\hat{\sigma}$ high growth SE			[0.132]		[0.105]
$\hat{\sigma}$ low growth			0.424		0.346
$\hat{\sigma}$ low growth SE			[0.185]		[0.153]

Notes: Dependent variable is ln(GDP) in constant local currency units. ln(NTL) is the natural logarithm of the area-weighted average of a country's cell-level nighttime lights (NTL) digital number. The adjusted Freedom in the World (FiW) index produced by Freedom House ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Dummies for "Partially Free" and "Not Free"' countries (columns 4-5, "Free" is the omitted category) also from Freedom House. $\text{D(Low Growth)}_{i,t}$ is a dummy equal to one if the value of ln(NTL) demeaned by country and year is negative. Robust standard errors clustered by country in brackets. The corresponding estimate of σ, the parameter capturing the proportional exaggeration of GDP growth in autocracies, and its standard error are reported at the bottom of columns 2 and 4. Columns 3 and 5 provide separate estimates of σ for D(Low Growth) equal to zero or one. Sample period: 1992-2013. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table C7: Heterogeneous Effects: IDA Eligibility (full table)

	Dependent variable: $\ln(\text{GDP})_{i,t}$				
	(1)	(2)	(3)	(4)	(5)
$\ln(\text{NTL})_{i,t}$	0.272***	0.208***	0.260***	0.262***	0.230***
	[0.043]	[0.052]	[0.042]	[0.040]	[0.050]
$\text{FiW}_{i,t}$		-0.003			-0.013
		[0.043]			[0.040]
$\text{FiW}_{i,t}{}^2$		-0.000			-0.001
		[0.007]			[0.006]
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t}$		0.016**			0.008
		[0.007]			[0.007]
$\text{D(GNI> IDA threshold)}_{i,t}$			0.169***	0.107**	-0.026
			[0.057]	[0.044]	[0.071]
$\ln(\text{NTL})_{i,t} \times \text{D(GNI> IDA threshold)}_{i,t}$			0.060*	0.085***	0.013
			[0.031]	[0.024]	[0.034]
$\text{GNI}_{i,t}$				0.095***	0.087***
				[0.027]	[0.024]
$\ln(\text{NTL})_{i,t} \times \text{GNI}_{i,t}$				-0.035***	-0.032***
				[0.007]	[0.007]
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t} \times \text{D(GNI> IDA threshold)}_{i,t}$					0.023*
					[0.013]
$\text{D(GNI> IDA threshold)}_{i,t} \times \text{FiW}_{i,t}$					0.042*
					[0.022]
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	1,832	1,832	1,832	1,832	1,832
Countries	88	88	88	88	88
(Within country) R^2	0.211	0.242	0.273	0.346	0.380
$\hat{\sigma}$		0.234			
$\hat{\sigma}$ SE		[0.152]			
$\hat{\sigma}$ below threshold					0.100
$\hat{\sigma}$ below threshold SE					[0.109]
$\hat{\sigma}$ above threshold					0.383
$\hat{\sigma}$ above threshold SE					[0.246]

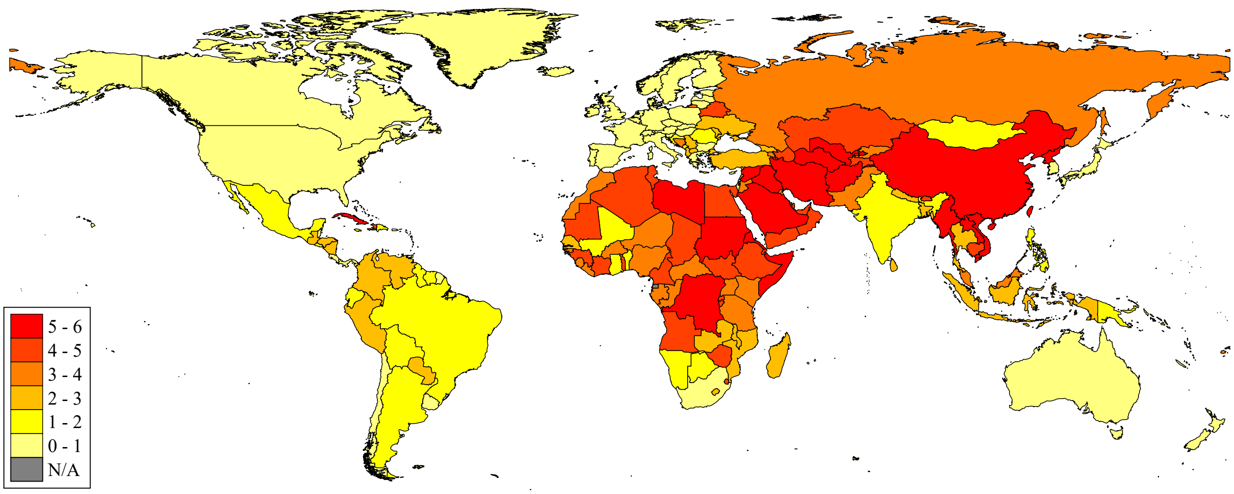
Notes: Dependent variable is ln(GDP) in constant local currency units. ln(NTL) is the natural logarithm of the area-weighted average of a country's cell-level nighttime lights (NTL) digital number. The adjusted Freedom in the World (FiW) index produced by Freedom House ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. GNI is Gross National Income per capita in thousands of current US dollars (Atlas method). $\text{D(GNI> IDA threshold)}_{i,t}$ equals one if GNI per capita is above the yearly value determining eligibility for IDA loans and grants. Robust standard errors clustered by country in brackets. Baseline sample includes the 88 countries that were IDA beneficiaries at some point in the sample period. The corresponding estimate of σ, the parameter capturing the proportional exaggeration of GDP growth in autocracies, and its standard error are reported at the bottom of column 2. Column 5 provides separate estimates of σ for country-years below and above the IDA eligibility threshold. Sample period: 1992-2013. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table C8: The Special Data Dissemination Standard (full table)

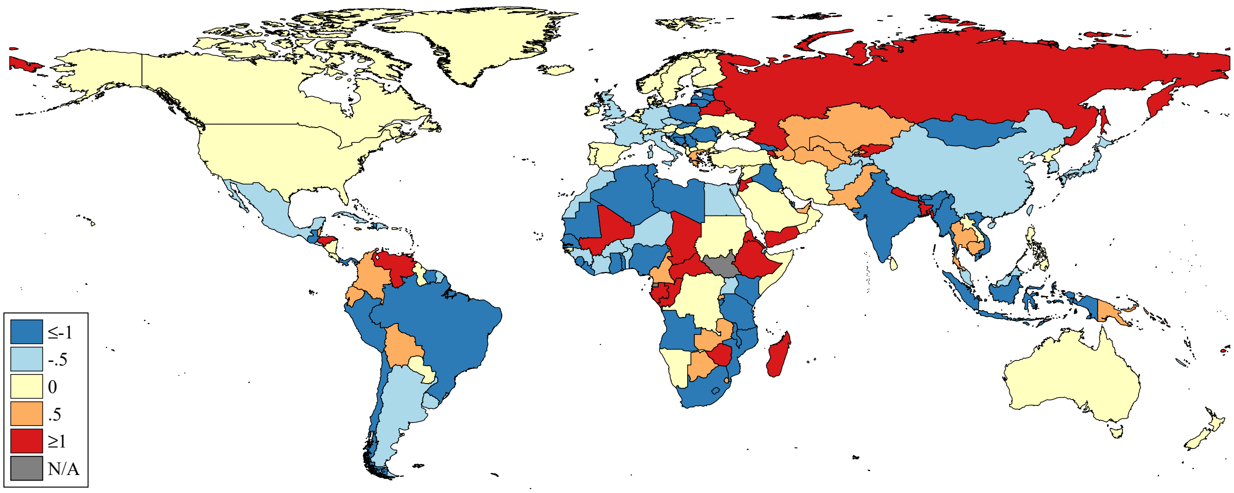
	Dependent variable: $\ln(\text{GDP})_{i,t}$				
	(1)	(2)	(3)	(4)	(5)
$\ln(\text{NTL})_{i,t}$	0.302***	0.299***	0.219***	0.223***	0.222***
	[0.046]	[0.048]	[0.048]	[0.049]	[0.049]
$\ln(\text{NTL})_{i,t} \times$ D(SDDS country)$_i$	-0.049	-0.046	-0.022	-0.037	-0.038
	[0.041]	[0.039]	[0.036]	[0.043]	[0.043]
D(SDDS compliant)$_{i,t}$		0.048*	0.041*	0.042*	0.002
		[0.024]	[0.024]	[0.025]	[0.028]
$\ln(\text{NTL})_{i,t} \times$ D(SDDS compliant)$_{i,t}$		-0.036***	-0.028**	-0.027**	-0.020*
		[0.012]	[0.012]	[0.011]	[0.011]
$\text{FiW}_{i,t}$			-0.015	-0.025	-0.025
			[0.025]	[0.027]	[0.026]
${\text{FiW}_{i,t}}^2$			0.001	0.002	0.002
			[0.005]	[0.004]	[0.004]
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t}$			0.021***	0.019***	0.019***
			[0.006]	[0.007]	[0.007]
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t} \times$ D(SDDS country)$_i$				0.007	-0.002
				[0.010]	[0.012]
D(SDDS country)$_i \times \text{FiW}_{i,t}$				0.011	0.002
				[0.018]	[0.018]
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t} \times$ D(SDDS compliant)$_{i,t}$					0.006
					[0.011]
D(SDDS compliant)$_i \times \text{FiW}_{i,t}$					0.020*
					[0.011]
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	3,895	3,895	3,895	3,895	3,895
Countries	184	184	184	184	184
(Within country) R^2	0.221	0.229	0.265	0.265	0.269
$\hat{\sigma}$			0.328		
$\hat{\sigma}$ SE			[0.143]		
$\hat{\sigma}$ non-SDDS				0.300	0.301
$\hat{\sigma}$ non-SDDS SE				[0.154]	[0.154]
$\hat{\sigma}$ SDDS country				0.486	0.327
$\hat{\sigma}$ SDDS country SE				[0.244]	[0.239]
$\hat{\sigma}$ SDDS compliant					0.489
$\hat{\sigma}$ SDDS compliant SE					[0.310]

Notes: Dependent variable is ln(GDP) in constant local currency units. ln(NTL) is the natural logarithm of the area-weighted average of a country's cell-level nighttime lights (NTL) digital number. The adjusted Freedom in the World (FiW) index produced by Freedom House ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. D(SDDS country)$_i$ is a dummy equal to one for countries that joined the SDDS during the sample period. D(SDDS compliant)$_{i,t}$ is a dummy equal to one in the years after the country is deemed compliant with the SDDS. The corresponding estimate of σ, the parameter capturing the proportional exaggeration of GDP growth in autocracies, and its standard error are reported at the bottom of column 3. Column 4 provides separate estimates of σ for SDDS and non-SDDS countries, while column 5 further disaggregates based on SDDS compliance. Sample period: 1992-2013. Robust standard errors clustered by country in brackets. *** p<0.01, ** p<0.05, * p<0.1

Figure C1: The Freedom in the World (FiW) Index



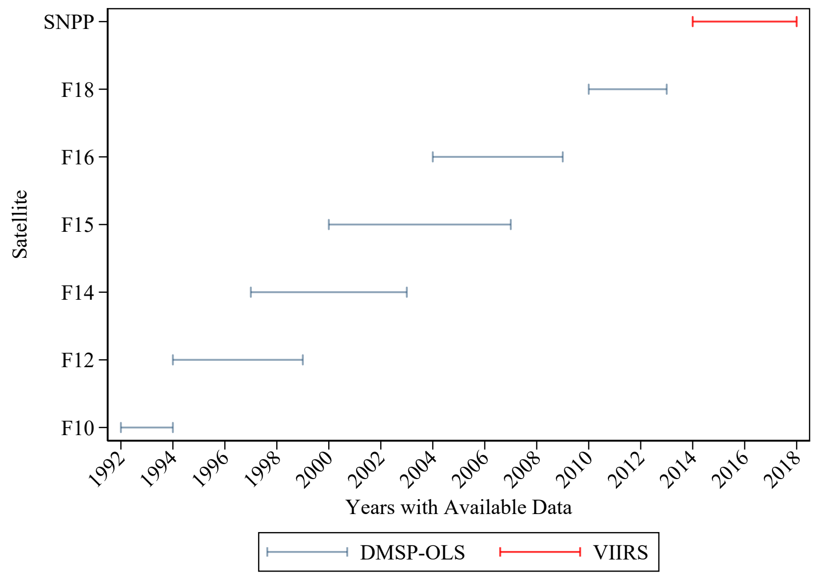
(a) Average 1992-2013



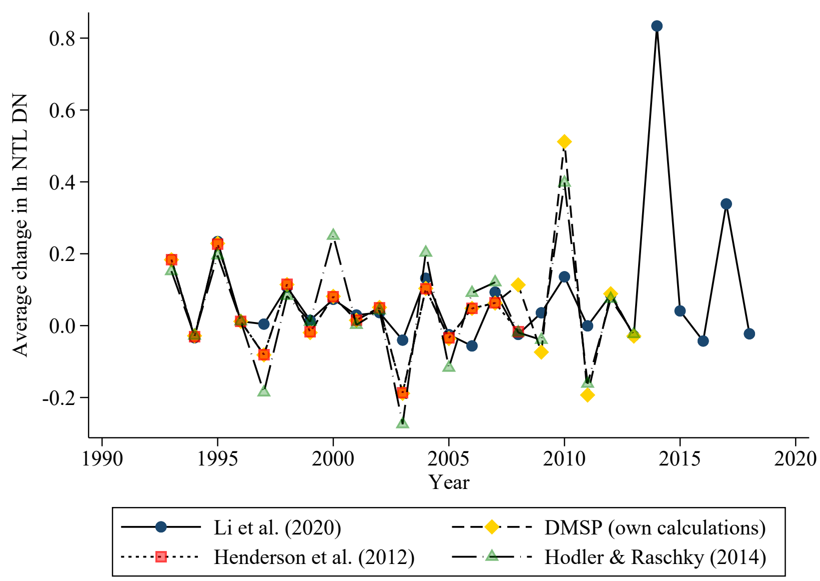
(b) Change between 1992/3 and 2012/13

Notes: Panel (a) shows each country's average value of the adjusted Freedom in the World (FiW) index for the period 1992-2013. FiW ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Panel (b) shows the difference between the average FiW index for 2012/13 and the average for 1992/3.

Figure C2: NTL Data Sources



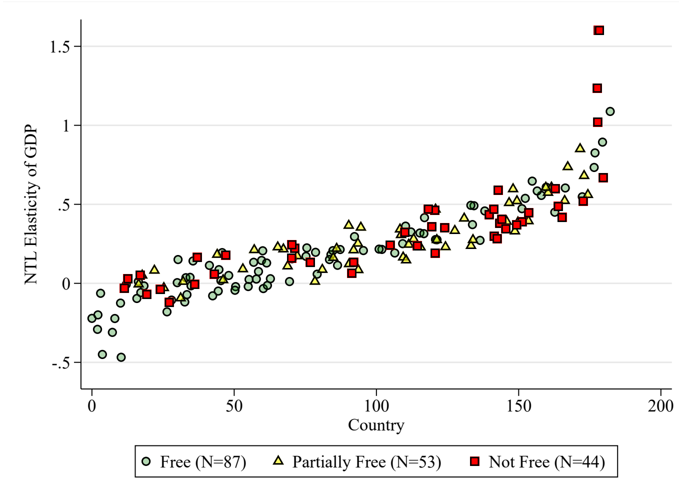
(a) NTL Data Availability by Satellite



(b) Average Growth in NTL Across Sources

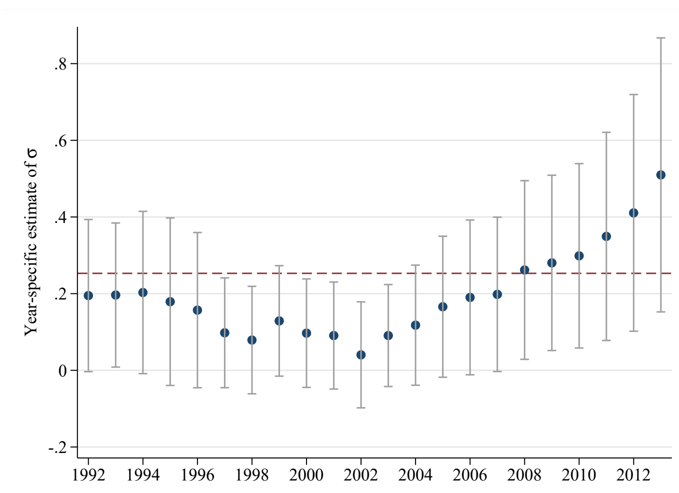
Notes: Panel (a) shows the years for which data on night time lights (NTL) is available from each satellite. Data from satellites F10-F18 corresponds to the Defense Metereological Satellite Program's Operational Linescan System (DMSP-OLS). Data from the Suomi National Polar Partnership (SNPP) satellite corresponds to the Visible Infrared Imaging Radiometer Suite (VIIRS). Panel (b) shows the average yearly change in ln(NTL) based on harmonized DMSP-VIIRS data by Li et al. (2020), own calculations using DMSP data and the replication files from Henderson et al. (2012) and Hodler and Raschky (2014), also with DMSP data.

Figure C3: Country-specific NTL Elasticities of GDP



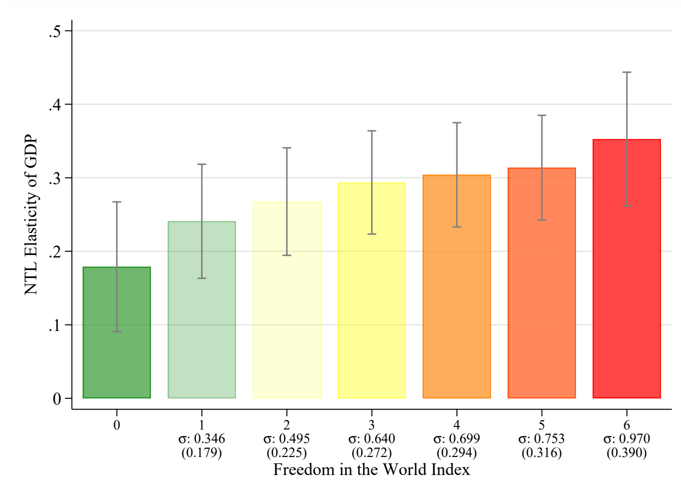
Notes: Figure plots each country's estimated NTL elasticity of GDP, ranked by magnitude, from a regression with country and year fixed effects. Spherical noise has been added to markers to facilitate visuzaliation (10% jittering factor). Countries are classified as "Free", "Partially Free" or "Not Free" based on their average FiW index over the sample period. Sample size: 3,895. Sample period: 1992-2013.

Figure C4: Year-specific estimates of σ



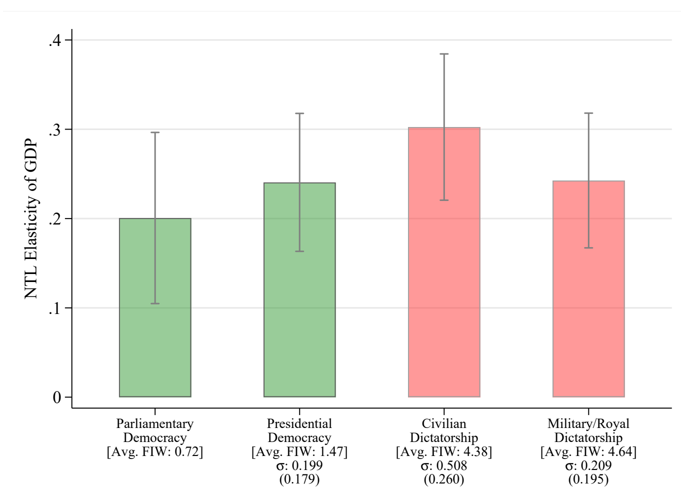
Notes: Figure shows year-specific estimates of σ and their 95% confidence interval. These estimates are obtained from a regression of log GDP on the triple interaction of log NTL (DN), the FiW index and a full set of year dummies (no omitted category). Regression also includes the lower-order interactions of the year dummies with log NTL and with the FiW index and its square (estimates not reported), as well as country and year fixed effects. Standard errors clustered by country. Countries with any missing data are excluded from the sample. Sample size: 3,278. Sample period: 1992-2013.

Figure C5: Disaggregate Estimates of the Autocracy Gradient in the NTL elasticity of GDP



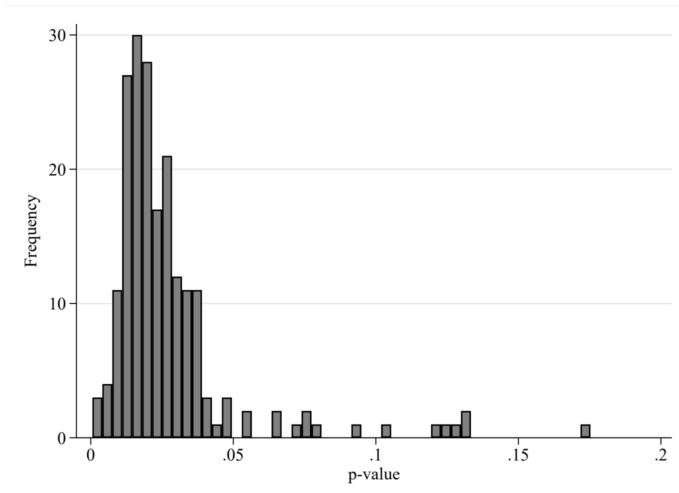
Notes: The graph shows point estimates and 95% confidence intervals of a regression of log GDP on the interaction of log NTL (DN) with dummies for each value of the adjusted Freedom in the World (FiW) index (rounded to the nearest integer, no omitted category). Lower values of the FiW index correspond to greater enjoyment of civil liberties and political rights. Regression also includes the respective dummies for each value of the FiW index, as well as country and year fixed effects. Standard errors clustered by country. Sample size: 3,895. Sample period: 1992-2013.

Figure C6: The NTL elasticity of GDP Across Political Regimes



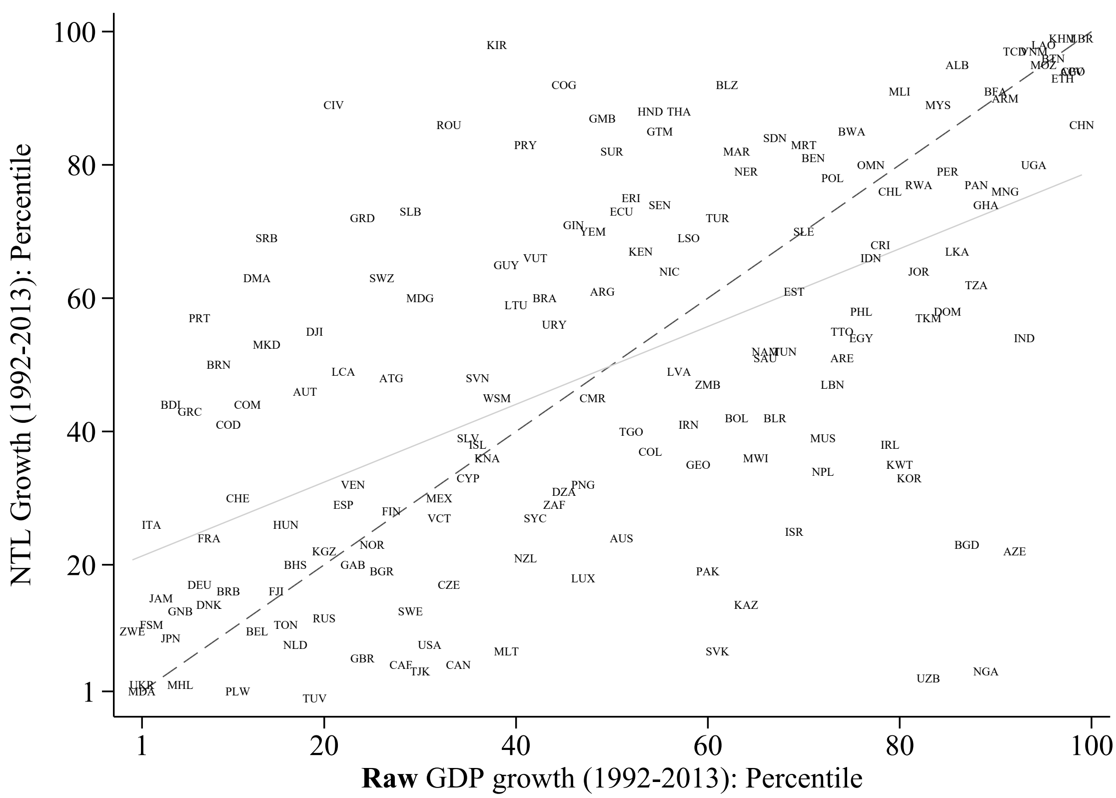
Notes: The graph shows point estimates and 95% confidence intervals of a regression of log GDP on the interaction of log NTL (DN) and four dummies for different political regimes. Regression also includes three of the regime dummies [estimates not reported], but there is no omitted category in the interactions with log NTL. Political regimes are defined based on information from Freedom House and Cheibub et al. (2010). See Appendix text for details. The average value of the FiW index for each regime type is reported below each bar, as well as the implied value of σ relative to parliamentary democracies. The regression also includes country and year fixed effects. Standard errors clustered by country. Sample size: 2,994. Sample period: 1992-2008.

Figure C7: P-values of Estimates of σ



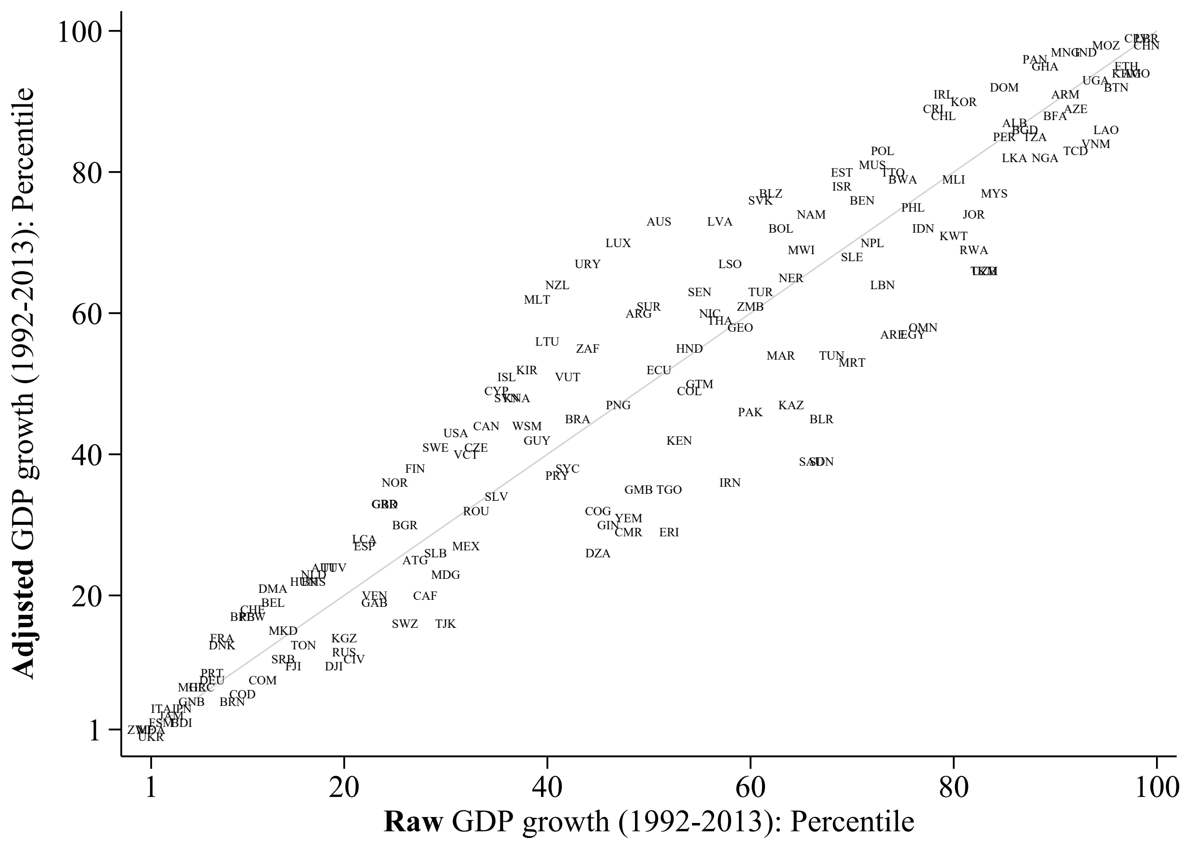
Notes: Figure plots the distribution of p-values across all the estimates of σ from the regressions in Tables 2, 4, 5, 7, A3-A16 and Figures A5, A7, and A8. The null hypothesis in all cases is that σ equals zero. The total number of estimates is 198. The average p-value is 0.028, while the median is 0.021.

Figure C8: Long-run Growth of GDP and Nighttime Lights: Country Rankings



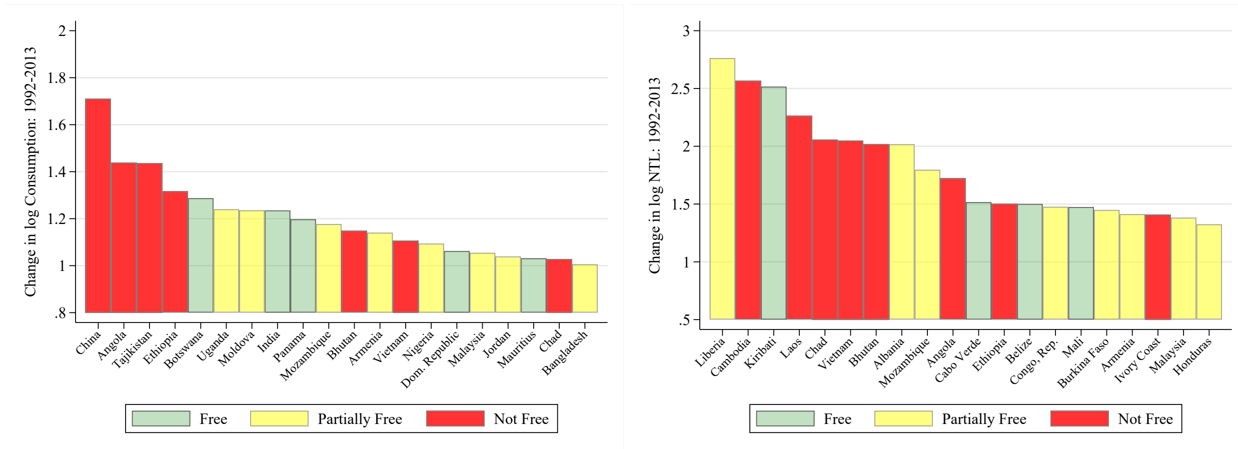
Notes: Graph shows a scatter plot of each country's ranking (percentile) in the distribution of long-run GDP growth (difference in log GDP between 2012/13 average and 1992/3 average) against its ranking (percentile) in the distribution of long-run growth in nighttime lights (difference in log NTL (DN) between 2012/13 average and 1992/3 average). Dashed line corresponds to the 45-degree line. Lighter solid line shows the line of best fit.

Figure C9: Long-run GDP growth: Raw Data vs Adjustment for Manipulation



Notes: Graph shows a scatter plot of each country's ranking (percentile) in the distribution of long-run GDP growth (difference in log GDP between 2012/13 average and 1992/3 average) based on the raw data (x-axis) against its ranking (percentile) in the distribution of long-run GDP growth once the GDP data has been adjusted for manipulation. The adjustment is based on the estimate of the bias parameter σ implied by the results in column 7 of Table 1. Dashed line corresponds to the 45-degree line.

Figure C10: Long-run Growth in Private Household Consumption and Nighttime Lights: Top 20

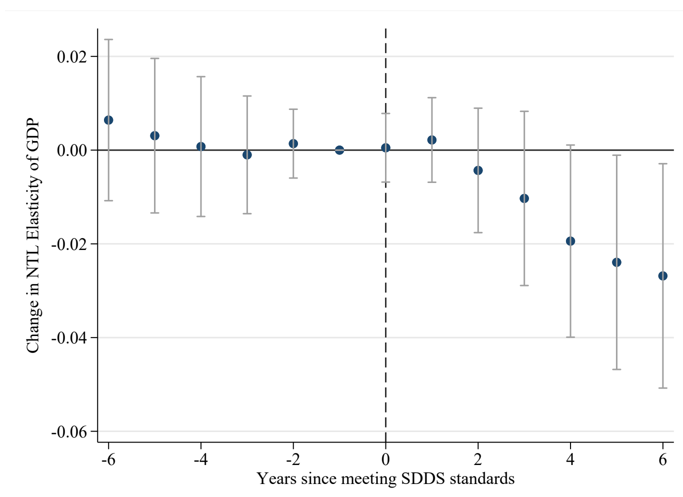


(a) Private Consumption

(b) Nighttime Lights (DN)

Note: Panel (a) shows the 20 countries with the largest change in log Private Consumption between 1992/3 and 2012/13 (two-year average in both cases), as reported in the World Bank's World Development Indicators (Nov 2014 release). Panel (b) shows the the 20 countries with the largest change in log NTL (DN) over the same period. Countries are classified according to the average value of the Freedom in the World (FiW) index during this period.

Figure C11: SDDS Compliance and the NTL Elasticity of GDP



Notes: Panel shows point estimates and 95% confidence intervals from a regression of log GDP on interactions of log NTL (DN) with dummies for the six years before and after a country meets the requirements of the IMF's Special Data Dissemination Standard (SDDS). Additional interactions with dummies for years 7 and beyond on both ends not reported. Regression also includes log NTL and the respective year dummies, as well as the interaction of log NTL with a dummy for countries that adhere to the SDDS requirements over the sample period (estimates not reported). Country and year fixed effects also included. Standard errors clustered by country. Sample includes 88 countries that were IDA beneficiaries at the start of the sample period. Sample size: 3,895. Sample period: 1992-2013.

D Robustness Checks

This appendix presents detailed results from a large battery of auxiliary tests aimed at establishing the sensitivity of the main findings to the inclusion of additional controls, as well as to changes to the composition of the sample, the main data sources, or the regression equation.

In Tables D1-D9 I first verify that the autocracy gradient in the NTL elasticity of GDP is not confounded by heterogeneity in the elasticity arising from other country characteristics. For this purpose, I estimate an expanded version of equation 6 that includes an additional control $x_{i,t}$ (if time-varying) and its interaction with ln(NTL) as additional regressors:

$$\begin{aligned}\ln(\text{GDP})_{i,t} =& \mu_i + \delta_t + \phi_0 \ln(\text{NTL})_{i,t} + \phi_1 \text{FiW}_{i,t} + \phi_2 \text{FiW}^2_{i,t} + \phi_3 \left(\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t}\right) \\ &+ \phi_4 x_{i,t} + \phi_5 \left(\ln(\text{NTL})_{i,t} \times x_{i,t}\right) + \xi_{i,t} \qquad (6.2)\end{aligned}$$

For each additional regression, I re-estimate $\hat{\sigma}$ as $\frac{\hat{\phi}_3}{\hat{\phi}_0}$ multiplied by the interquartile range of the FiW index in the estimating sample. This yields an estimate of the overstatement of GDP growth associated with a discrete jump from democracy to autocracy, rather than with a one-unit increase in the FiW index. When suitable, I adjust the denominator in this calculation to reflect the baseline elasticity at the average value of the control $x_{i,t}$ (i.e., divide by $\phi_0 + (\phi_5 \times \bar{x}_{i,t})$.

In Table D1, I first examine the impact on the results of potential differences in the composition of GDP across political regimes (e.g., higher share of government spending in autocracies). I disaggregate GDP based on the familiar expenditure decomposition and use data from the World Bank's WDI. Column 1 replicates the main analysis for the smaller sample with complete data on all GDP sub-components. Columns 2-6 allow in turn for the NTL elasticity of GDP to vary based on the share of GDP represented by the sub-component in the header. Finally, column 7 allows the elasticity to vary based on all sub-components simultaneously (except imports to avoid perfect multicollinearity). The estimate for $\hat{\sigma}$ remains positive and significant throughout. Its magnitude only decreases slightly as I introduce the additional controls, suggesting that differences in the composition of GDP do not underlie the autocracy gradient in the NTL elasticity of GDP.

In Table D2, I next examine whether potential differences in the sectoral composition of the economy are confounding the results. For instance, it could be the case that less democratic countries rely predominantly on agriculture and that NTL are less effective at picking up economic activity in remote, rural areas. All the additional controls in this table are constructed using information from the World Bank's WDI. In column 1, I allow the NTL elasticity of GDP to vary based on the share of land devoted to agriculture, while in columns 2-7 the source of heterogeneity in the elasticity is the share of GDP corresponding to the variable in the header. I allow for heterogeneity based on the share of GDP corresponding to agriculture (column 2), industry (column 5) and services (column 7). I further examine potential heterogeneity associated with the share of GDP represented by natural resource rents in column 3 or by oil rents in column 4. Column 6 considers manufacturing separately from the rest of industry. Again, $\hat{\sigma}$ remains positive and significant throughout. The estimate in column 4 is somewhat larger ($\hat{\sigma} = 0.48$), but it is also less precise, since the sample with information on oil rents is smaller than the main estimating sample (only 135 countries).

Table D3 examines the robustness of the results to potential non-linearities in the mapping of NTL to GDP, as well as to fluctuations in the elasticity across years or based on a country's location. In column 1, I allow the mapping from NTL to GDP to be non-linear by including a 4th-order (i.e., quartic) polynomial in ln(NTL) as additional regressors. In column 2, I allow the elasticity to vary year-on-year by including a full set of year dummies interacted with ln(NTL). Column 3 similarly allows the elasticity to vary based on the latitude and longitude of each country's capital. In column 4, I also allow for this mapping to be heterogeneous across the 22 subregions of the world defined in the UN geoscheme. The estimate for ϕ_3 (i.e., the interaction of ln(NTL) with the FiW index) remains positive and significant throughout, suggesting the presence of an autocracy gradient in the elasticity. Similarly, $\hat{\sigma}$ is also positive and significant in columns 1 and 3. The latter corresponds to latitude and longitude zero (i.e., Null Island). Regarding the spatial heterogeneity in the elasticity, Figure D1 further shows that the results are robust to excluding any of the 22 subregions of the world from the sample.

I also use Table D3 to study the impact of several important features of the DMSP-OLS NTL data on the results, including the way it is measured and aggregated (own calculations). Columns 5-7 respectively verify that the autocracy gradient in the elasticity is not confounded by differences in country area (i.e., more pixels) or in the log number of pixels that are top-coded (DN=63) or unlit (DN=0). I additionally check in column 8 that the results are not driven by variation in the spatial concentration of NTL, as measured by the Gini coefficient.

In Table D4, I further consider the impact of changes in population growth and urbanization rates, which plausibly correlate with regime type and could naturally affect the mapping of changes in NTL to changes in GDP (Wallace, 2014). I also allow the NTL elasticity of GDP to vary based on the share of population with access to electricity (total, urban, and rural), which could also correlate with autocracy (Min, 2015), or based on the natural logarithm of total electricity consumption. All the additional controls in this table come from the World Bank's WDI. The estimates for $\hat{\sigma}$ remain positive and significant throughout, with the one in column 6 being particularly large and imprecise ($\hat{\sigma} = 0.68$, p=0.08), which is plausibly driven by the smaller sample with information on electricity consumption (only 131 countries).

Table D5 takes a detailed look at the possibility that differences in the level of development across countries are confounding the autocracy gradient in the NTL elasticity of GDP. I proceed in two complementary ways. In columns 1-6, I allow the elasticity to vary based on each country's GDP per capita (in constant USD, columns 1-3) or NTL (columns 4-6) at the start of the sample period. I measure these initial values in levels (columns 1 and 4) or logs (columns 2 and 5). I also consider a more flexible and non-linear mapping based on quintiles of these variables (in levels) in columns 3 and 6. Alternatively, in columns 7 and 8 I use pre-specified measures of each country's level of development provided by the United Nations and the World Bank respectively. Once again, the estimates of $\hat{\sigma}$ are largely stable and remain positive and significant throughout. Columns 1-4 in Table D6 further allow for heterogeneity in the NTL elasticity of GDP based on measures of education and health from the World Bank's WDI, which have no incidence on the main results.

In the remainder of Table D6, I use additional information on informality from the World Bank's Enterprise Surveys. This information allows me to explore the robustness of the results to heterogeneity in the NTL elasticity of GDP associated with differences in the size of the informal sector across countries. This is important insofar as greater informality arguably hinders accurate measurement of economic growth. The World Bank provides four (time-invariant) measures on the economic impact of the informal economy for 144 countries, which I use as sources of heterogeneity in the NTL elasticity of GDP in columns 5-8. The results show that the autocracy gradient in the elasticity is robust to the inclusion of the additional regressors, though $\hat{\sigma}$ is somewhat smaller (around 0.2) in this subsample.

Another plausible alternative explanation for the main results revolves around variation in the state's capacity to produce credible statistical information. For instance, Jerven (2013) provides a detailed account of the limited data, funding and technical capacity that underlies the production of official statistics in sub-Saharan Africa. In Table D7, I allow the NTL elasticity of GDP to vary based on three subindices and one aggregate index of statistical capacity produced by the World Bank. The three sub-indices are meant to capture the quality of the underlying source data, the employment of up-to-date statistical methodologies, and the periodicity and timeliness of the resulting statistics. This information is available for 137 countries since 2004. In Table D7, I use country-level averages of these indices, but I also report in Figure D2 additional results for each specific measure of statistical capacity that goes into their construction. Column 1 replicates the main analysis for the reduced sample with information on statistical capacity, which yields $\hat{\sigma} = 0.3$ (p=0.03). Columns 2-4 allow the elasticity to vary based on each sub-index, while column 5 considers the aggregate index. The estimate for $\hat{\sigma}$ is not affected by the inclusion of these regressors and remains close to its baseline value for this sample. This indicates that the autocracy gradient in the elasticity is not simply capturing differences in statistical capacity across countries.

Table D8 provides complementary evidence on the impact of differences in an alternative measure of state capacity. For this purpose, I use cross-sectional data on the number of days that it takes for a wrongly-addressed letter to be returned to the sender, from Chong et al. (2014). This data is also not available for the full sample (only 153 countries), so I begin in column 1 by replicating the baseline analysis for this subsample ($\hat{\sigma} = 0.18$, p=0.02). In the remaining columns, I first examine the impact of each alternative measure of state capacity provided by Chong et al. and I then check the robustness of the autocracy gradient to this alternative source of heterogeneity in the elasticity. I find that the NTL elasticity of GDP is, in fact, larger in countries that are deemed as having lower state capacity based on these measures. Moreover, the autocracy gradient in the elasticity and the associated $\hat{\sigma}$ do become smaller once I account for these differences in state capacity, though they remain positive and significant. One possible interpretation of these findings is that the bureaucratic inefficiency captured by the Chong et al. measures facilitates the manipulation of official statistics in authoritarian regimes.

I conclude the analysis of potential confounders by studying the robustness of the results to allowing the NTL elasticity of GDP to vary based on measures of corruption in Table D9. These robustness checks are also important, insofar as the autocracy gradient in the elasticity could plausibly be reflecting greater inefficiency in government spending (i.e., public spending is occurring, but corruption is preventing it from translating into observable outputs that produce NTL, such as infrastructure). I assess this possibility using data on corruption from two different sources: Transparency International (columns 1-3) and the World Bank (columns 4-6). Similarly to the previous table, I first estimate the baseline regression using the sample with available corruption data, and then allow the elasticity to vary based on the respective measure. Finally, I provide estimates of equation 6.2 for each measure (i.e., including the interaction of ln(NTL) with the FiW index). The baseline estimates in columns 1 and 4 are very robust to possible heterogeneity in the elasticity associated with differences in the prevalence of corruption across countries (columns 3 and 6).

Tables D10 and D11 examine the robustness of the results to alternative data sources on democracy and NTL. For this purpose, I return to the baseline specification shown in equation 6. Table D10 looks at different measures of autocracy (which I have rescaled as needed to ensure that larger values correspond to more autocratic regimes). In column 1, I use the polity2 score produced by Polity V, while in columns 2 and 3 I use instead the subindices for democracy and autocracy that go into its construction. In column 4 I use the Voice and Accountability (VA) index that is produced by the World Bank as part of its Worldwide Governance Indicators. Columns 5-7 consider binary measures of autocracy based on the respective classifications produced by Cheibub et al. (2010), Papaioannou and Siourounis (2008) and Acemoglu et al. (2019). The estimated $\hat{\sigma}$ is positive in all columns, and is also statistically significant in all columns with the exception of column 5 (p=0.13). The magnitude of $\hat{\sigma}$ is smaller than the baseline estimate when using the Polity V measures (close to 0.1), but is much larger when using the VA index (0.6). It is also relatively smaller when using the binary measures. These results are consistent with the idea that the FiW index is better able to capture variation in the effective enjoyment of civil liberties and political rights than the alternative measures (i.e., measurement error in the autocracy measure leads to attenuation bias in the autocracy gradient of the elasticity).

Columns 1-3 in Table D11 verify that the results are not driven by ad-hoc choices in my cleaning and processing of the data on NTL. For this purpose, I replicate the analysis using NTL data from the replication files for Henderson et al. (2012), Pinkovskiy and Sala-i Martin (2016) and Hodler and Raschky (2014). Despite differences in the sample period and in the number of countries in the sample, the results are largely unaffected, though $\hat{\sigma}$ is particularly large in column 3. This is arguably due to the fact that the original data from Hodler and Raschky is available for level-2 subnational administrative units and I am calculating an unweighted average to aggregate to the country-year level.

Columns 4-6 use additional NTL data for the years 2014-2018, which is recorded by the VIIRS sensor aboard the Suomi National Polar Partnership (SNPP) satellite. This data has been harmonized with the DMSP data for 1992-2013 by Li et al. (2020). These authors provide data on NTL DN at the grid-cell level for 1992-2018. I aggregate this dataset to the country-year level using the same process as for the baseline DMSP data. The estimate of $\hat{\sigma}$ using this measure of NTL in column 4 is 0.64 (p=0.103), which is almost twice as large as the baseline elasticity reported above. The discrepancy between my baseline estimates and those from the extended sample to 2018 plausibly relate to difficulties in the harmonization of NTL data from DMSP and VIIRS. In this regard, panel (b) of Figure C2 shows that the harmonized DMSP-VIIRS data exhibits a substantial jump in 2014 (the first year corresponding to VIIRS) when aggregated to the country-year level, with an average yearly change in ln(NTL) across countries of 0.8. In column 5, I examine the impact of this sharp jump in NTL in 2014 on the results. For this purpose, I impute the data for 2014 based on the average change in ln(NTL) in the previous two years (2012-13) and the following two years (2015-16) for each country. This average combines within-DMSP growth in lights before 2014 with within-VIIRS growth in lights after 2014. Using the smoothed data series, I obtain a $\hat{\sigma}$ of 0.54 (p=0.08), which is somewhat closer to my baseline estimate and is also more precise. Going back to Figure C2, I also observe a somewhat abrupt jump in the average growth of VIIRS-based NTL in 2017. If I also impute the data for this year based on the average growth in NTL in 2016 and 2018 for each country (i.e., only using years with VIIRS data for the imputation), I obtain a $\hat{\sigma}$ of 0.35 (p=0.04), which is identical to my baseline estimate. Figure C2 also shows a large average change in ln(NTL) in 2010, which arguably corresponds to the fact that DMSP data for that year comes exclusively from the F18 satellite, as shown in panel (a) of that same figure. However, column 7 shows that the results hardly change relative to the baseline estimates if I impute ln(NTL) in 2010 using the average change in lights per country between 2008 and 2012 (excluding 2010). In this case, $\hat{\sigma}$ is 0.33 (p=0.02). I conclude that the main findings of the paper are robust to the inclusion of harmonized NTL data from VIIRS. However, the magnitude and the precision of the estimates using the extended sample are somewhat sensitive to features of the data that appear to be directly related to difficulties in combining information from sources as heterogeneous as DMSP and VIIRS.

Figure D3 provides further evidence on the robustness of the results to changes in data sources. To produce this figure I replicate the main analysis using GDP data (in constant local currency) from every available release of the World Bank's WDI since 2014 until the time of writing. Not only are all the estimates of $\hat{\sigma}$ positive and statistically significant, but there is also no evidence of a trend in these estimates as I use data from more recent versions of the WDI. This suggests that the revision of GDP figures over time fails to adjust for the overstatement of GDP growth by autocracies.

Tables D12-D14 provide additional robustness tests concerning changes to the specification in equation 6. In Table D12, I replace the time-varying FiW index with a time-invariant measure. In this case, the terms corresponding to the FiW index and its square in the regression equation are absorbed by the country fixed effects:

$$\ln(\text{GDP})_{i,t} = \mu_i + \delta_t + \phi_0 \ln(\text{NTL})_{i,t} + \phi_3 \left(\ln(\text{NTL})_{i,t} \times a_i\right) + \xi_{i,t} \tag{6.3}$$

Identification of the interaction coefficient ϕ_3 relies entirely on cross-sectional variation in regime type across countries. This alternative specification helps to address concerns related to the endogenous co-determination of economic growth and a country's political regime. In columns 1-2, I use the average of the FiW index over the sample period (1992-2013) as the measure of autocracy. The results in column 1 indicate the presence of a robust autocracy gradient in the NTL elasticity of GDP based on this measure, with $\hat{\sigma}$ equal to 1.32 (p=0.06). Panel (a) in Figure C1 shows that there is strong spatial correlation in the average value of the FiW index, with more authoritarian countries predominantly located in Africa and Asia. To minimize the impact of geographical features that may correlate with a country's average FiW index, I replace the year fixed effects with subregion by year fixed effects in column 2. These subregions correspond to the UN's geoscheme. The introduction of this more stringent set of controls reduces the magnitude of $\hat{\sigma}$ to 0.57 (p=0.13). I fail to reject that this estimate is equal to my baseline estimate of 0.35. Columns 3-4 replicate the analysis using countries' freedom status based on the same average value of the FiW index. The results are highly comparable to the ones I obtain with the continuous index. In columns 5-6, I further replicate the analysis using the average of the FiW index over the ten years prior to the start of the sample period (1982-1991) as the measure of autocracy. This predetermined measure further alleviates concerns about the joint determination of economic growth and regime type. The estimated $\hat{\sigma}$ in column 6, which includes year by subregion fixed effects, is 1.3 (p=0.07), which is much larger than my baseline estimate of 0.35 but also substantially less precise, which prevents me from rejecting the null hypothesis that both estimates are equal.

In Table D13, I examine the robustness of the results to using the growth rates of GDP and NTL instead of the natural logarithm of the level. To minimize the impact of outliers, these growth rates have been winsorized at the 1 and 99% levels. Column 1 shows an overall NTL elasticity of GDP of 0.04 when using the growth rates. Columns 2-4 then replicate the steps in the main analysis from Table 1 using this specification. The estimate of $\hat{\sigma}$ in column 4, which corresponds to the full specification in equation 6, is 0.71 (p=0.04), which is twice as large as my baseline estimate of 0.35, though the two are statistically indistinguishable. In columns 5-6, I further explore the impact of outliers on the results from this specification by further winsorizing the growth rates of GDP and NTL. In column 5, I winsorize both variables at the 2.5 and 97.5% levels, while in column 6 I winsorize at the 5 and 95% levels. The results show that a slightly stricter winsorization has a large impact on $\hat{\sigma}$, which falls to 0.43 (p=0.095) and 0.39 (p=0.13) in columns 5 and 6, respectively. These estimates are highly comparable to the baseline estimate.

Finally, Table D14 provides additional tests confirming that the main findings of the paper are robust to alternative specifications. In column 1, I replace the year fixed effects in equation 6 with year by subregion fixed effects (i.e., similarly to Table D12, but using the time-varying FiW index). In column 2, I include a country-specific linear time trend as an additional control, while in column 3 I include the first lag of ln(NTL). The estimates of $\hat{\sigma}$ are slightly smaller than the baseline estimate, but remain positive and significant at conventional levels. In Columns 4-7, I replace the natural logs of GDP and NTL in equation 6 with their first-differences, which I winsorize at the 1 and 99% level. I obtain a baseline elasticity of 0.05 with this specification (column 4), which is expectedly very similar to the one reported in Table D13 using growth rates. Column 5 then replicates the main analysis using this specification, which yields $\hat{\sigma} = 0.85$ (p=0.03). Once again, this estimate is larger than the one from my baseline analysis, but I cannot statistically reject that the two are equal. In column 6, I include the lagged level of ln(GDP) as an additional control, and in column 7 I replicate the analysis using system-GMM for estimation. Both estimates of $\hat{\sigma}$ are positive, significant and statistically identical to my baseline estimate of 0.35 (though substantially larger in magnitude).

Table D1: Robustness checks I: GDP composition

	Dependent variable: $\ln(\text{GDP})_{i,t}$						
Heterogeneous elasticity ($x_{i,t}$):	Baseline	Private consumption	Investment	Government spending	Exports	Imports	All
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\ln(\text{NTL})_{i,t}$	0.228***	0.215***	0.187***	0.264***	0.238***	0.235***	0.246***
	[0.036]	[0.042]	[0.035]	[0.037]	[0.036]	[0.036]	[0.059]
$\text{FiW}_{i,t}$	0.008	0.007	0.007	0.007	0.008	0.008	0.007
	[0.026]	[0.026]	[0.025]	[0.026]	[0.026]	[0.026]	[0.025]
${\text{FiW}_{i,t}}^2$	-0.001	-0.002	-0.001	-0.001	-0.002	-0.002	-0.002
	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]
$x_{i,t}$		-0.467***	0.549***	-0.576***	0.051	-0.157*	
		[0.126]	[0.107]	[0.203]	[0.094]	[0.082]	
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t}$	0.015***	0.013***	0.014***	0.016***	0.015***	0.015***	0.013***
	[0.005]	[0.004]	[0.005]	[0.005]	[0.005]	[0.005]	[0.004]
$\ln(\text{NTL})_{i,t} \times x_{i,t}$		-0.013	0.127***	-0.261***	-0.044	-0.018	
		[0.042]	[0.039]	[0.097]	[0.027]	[0.029]	
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,416	3,416	3,416	3,416	3,416	3,416	3,416
Countries	173	173	173	173	173	173	173
(Within country) R^2	0.223	0.289	0.271	0.245	0.227	0.234	0.342
$\hat{\sigma}$	0.231	0.214	0.224	0.250	0.231	0.224	0.178
$\hat{\sigma}$ SE	[0.096]	[0.093]	[0.095]	[0.101]	[0.098]	[0.093]	[0.081]

Notes: Dependent variable is ln(GDP) in constant local currency units. ln(NTL) is the natural logarithm of the area-weighted average of a country's cell-level nighttime lights (NTL) digital number. The adjusted Freedom in the World (FiW) index produced by Freedom House ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. The regression in column 1 replicates the baseline results for the reduced sample with complete data on all GDP subcomponents (expenditure approach). Columns 2-7 include the variable $x_{i,t}$ in the header and its interaction with ln(NTL) as additional regressors. All variables correspond to shares of GDP: household final consumption expenditure in column 2; gross capital formation in column 3; general government final consumption in column 4; exports in column 5; imports in column 6. Column 7 includes all subcomponents and their interaction with ln(lights), bar imports. All regressions include country and year fixed effects. Robust standard errors, clustered by country, are shown in brackets. Sample period: 1992-2013. The estimated σ, the parameter capturing the proportional exaggeration of GDP growth in autocracies, and its standard error are reported at the bottom of all columns. These estimates are based on the interquartile range of the FiW index in the estimating sample. In columns 2-6, the baseline NTL elasticity of GDP used to estimate σ has been adjusted based on the average of the variable $x_{i,t}$ and the estimated heterogeneity in the elasticity, captured by $\ln(\text{NTL})_{i,t} \times x_{i,t}$. *** p<0.01, ** p<0.05, * p<0.1

Table D2: Robustness checks II: Sectoral composition of the economy

Heterogeneous elasticity ($x_{i,t}$):	Dependent variable: $\ln(\text{GDP})_{i,t}$						
	Agriculture		Natural Resources	Oil revenue	Industry	Manufacturing	Services
	(% land)	(% GDP)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\ln(\text{NTL})_{i,t}$	0.232***	0.269***	0.207***	0.201***	0.201***	0.200***	0.302***
	[0.046]	[0.048]	[0.044]	[0.048]	[0.050]	[0.048]	[0.040]
$\text{FiW}_{i,t}$	-0.016	0.005	-0.014	-0.006	-0.008	0.000	-0.004
	[0.025]	[0.026]	[0.025]	[0.030]	[0.026]	[0.026]	[0.026]
$\text{FiW}_{i,t}{}^2$	0.001	-0.001	0.001	-0.002	-0.001	-0.002	-0.001
	[0.005]	[0.005]	[0.005]	[0.006]	[0.005]	[0.005]	[0.005]
$x_{i,t}$	0.001	-0.008***	0.000	-0.000	0.004*	0.001	0.000
	[0.002]	[0.003]	[0.001]	[0.003]	[0.002]	[0.002]	[0.001]
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t}$	0.019***	0.021***	0.018***	0.024***	0.017***	0.016***	0.016***
	[0.006]	[0.006]	[0.005]	[0.006]	[0.006]	[0.006]	[0.005]
$\ln(\text{NTL})_{i,t} \times x_{i,t}$	-0.001	-0.001	0.001	-0.000	0.002**	0.003**	-0.001*
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,675	3,446	3,692	2,686	3,474	3,308	3,440
Countries	183	175	183	135	175	175	175
(Within country) R^2	0.245	0.316	0.254	0.212	0.305	0.266	0.292
$\hat{\sigma}$	0.317	0.293	0.295	0.484	0.239	0.233	0.232
$\hat{\sigma}$ SE	[0.140]	[0.110]	[0.130]	[0.199]	[0.105]	[0.112]	[0.104]

Notes: Dependent variable is ln(GDP) in constant local currency units. ln(NTL) is the natural logarithm of the area-weighted average of a country's cell-level nighttime lights (NTL) digital number. The adjusted Freedom in the World (FiW) index produced by Freedom House ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Each column includes the variable $x_{i,t}$ in the header and its interaction with ln(NTL) as additional regressors. All variables correspond to shares of GDP, except for the percentage of land devoted to agriculture in column 1. All regressions include country and year fixed effects. Robust standard errors, clustered by country, are shown in brackets. Sample period: 1992-2013. Sample size varies based on data availability. The estimated σ, the parameter capturing the proportional exaggeration of GDP growth in autocracies, and its standard error are reported at the bottom of all columns. These estimates are based on the interquartile range of the FiW index in the estimating sample. In all columns, the baseline NTL elasticity of GDP used to estimate σ has been adjusted based on the average of the variable $x_{i,t}$ and the estimated heterogeneity in the elasticity, captured by $\ln(\text{NTL})_{i,t} \times x_{i,t}$. *** p<0.01, ** p<0.05, * p<0.1

Table D3: Robustness Checks III: Characteristics of NTL

	Dependent variable: $\ln(\text{GDP})_{i,t}$							
Heterogeneous elasticity ($x_{i,t}$):	NTL polynomial	Year	Latitude, Longitude	Subregion	Area	Top-coded cells	Unlit cells	NTL Gini
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\ln(\text{NTL})_{i,t}$	0.208***		0.286***		0.205***	0.196***	-0.077	0.199***
	[0.047]		[0.054]		[0.042]	[0.044]	[0.070]	[0.052]
$\text{FiW}_{i,t}$	-0.012	-0.017	-0.010	-0.013	-0.014	-0.011	-0.007	-0.008
	[0.025]	[0.025]	[0.025]	[0.025]	[0.025]	[0.025]	[0.025]	[0.025]
${\text{FiW}_{i,t}}^2$	0.001	0.001	-0.000	-0.000	0.001	0.001	-0.001	0.000
	[0.004]	[0.005]	[0.005]	[0.005]	[0.005]	[0.004]	[0.004]	[0.004]
$x_{i,t}$						0.018***	-0.097***	0.593**
						[0.007]	[0.023]	[0.236]
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t}$	0.021***	0.022***	0.015***	0.008*	0.020***	0.022***	0.015***	0.019***
	[0.005]	[0.005]	[0.005]	[0.004]	[0.005]	[0.005]	[0.005]	[0.005]
$\ln(\text{NTL})_{i,t} \times x_{i,t}$					0.005**	-0.000	0.028***	0.086
					[0.002]	[0.002]	[0.006]	[0.091]
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,895	3,895	3,895	3,895	3,879	3,895	3,895	3,888
Countries	184	184	184	184	184	184	184	184
(Within country) R^2	0.270	0.0528	0.285	0.0156	0.280	0.269	0.291	0.278
$\hat{\sigma}$	0.350		0.189		0.291	0.384	0.223	0.286
$\hat{\sigma}$ SE	[0.146]		[0.083]		[0.116]	[0.155]	[0.087]	[0.102]

Notes: Dependent variable is ln(GDP) in constant local currency units. ln(NTL) is the natural logarithm of the area-weighted average of a country's cell-level nighttime lights (NTL) digital number. The adjusted Freedom in the World (FiW) index produced by Freedom House ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. The regression in column 1 includes a quartic polynomial in ln(NTL) [estimates not shown]. Other columns include the variable x in the header (if time-varying) and its interaction with ln(NTL) as additional regressors: In column 2, a full set of year fixed effects [estimates not shown]; in column 3, quadratics for both the longitude and latitude of the country's capital [estimates not shown]; in column 4, 22 subregional fixed effects based on the UN geoscheme [estimates not shown]; in column 5, the country's land area in square km (/100,000); in columns 6 and 7, the natural log of the number of top-coded (DN=63) and unlit (DN=0) cells, respectively; in column 8, the natural log of the Gini coefficient of NTL. All regressions include country and year fixed effects. Robust standard errors, clustered by country, are shown in brackets. The estimated σ, the parameter capturing the proportional exaggeration of GDP growth in autocracies, and its standard error are reported at the bottom of all columns, except 2 and 4. These estimates are based on the interquartile range of the FiW index in the estimating sample. In columns 5-8, the baseline NTL elasticity of GDP used to estimate σ has been adjusted based on the average of the variable $x_{i,t}$ and the estimated heterogeneity in the elasticity, captured by $\ln(\text{NTL})_{i,t} \times x_{i,t}$. *** p<0.01, ** p<0.05, * p<0.1

Table D4: Robustness checks IV: Urbanization, access to electricity and consumption

Heterogeneous elasticity ($x_{i,t}$):	Dependent variable: $\ln(\text{GDP})_{i,t}$					
	Population		Access to Electricity			Electricity consumption
	Total	Urban	Total	Urban	Rural	
	(1)	(2)	(3)	(4)	(5)	(6)
$\ln(\text{NTL})_{i,t}$	-0.321**	0.226***	0.208***	0.262***	0.176***	-0.217
	[0.130]	[0.047]	[0.047]	[0.052]	[0.043]	[0.195]
$\text{FiW}_{i,t}$	-0.025	-0.020	-0.025	-0.029	-0.037	-0.026
	[0.026]	[0.025]	[0.028]	[0.028]	[0.028]	[0.029]
${\text{FiW}_{i,t}}^2$	0.002	0.002	0.003	0.003	0.004	0.002
	[0.005]	[0.004]	[0.005]	[0.005]	[0.006]	[0.005]
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t}$	0.013***	0.021***	0.017***	0.018***	0.020***	0.019***
	[0.005]	[0.006]	[0.005]	[0.005]	[0.006]	[0.006]
$x_{i,t}$	0.277***	0.003	0.002	-0.000	0.001*	0.221***
	[0.104]	[0.004]	[0.001]	[0.002]	[0.001]	[0.043]
$\ln(\text{NTL})_{i,t} \times x_{i,t}$	0.038***	-0.000	-0.000	-0.001*	-0.000	0.014
	[0.009]	[0.001]	[0.000]	[0.001]	[0.000]	[0.009]
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,892	3,895	3,313	3,265	3,126	2,514
Countries	184	184	184	182	183	131
(Within country) R^2	0.320	0.262	0.196	0.200	0.179	0.288
$\hat{\sigma}$	0.178	0.356	0.324	0.343	0.404	0.680
$\hat{\sigma}$ SE	[0.077]	[0.149]	[0.133]	[0.135]	[0.158]	[0.382]

Notes: Dependent variable is ln(GDP) in constant local currency units. ln(NTL) is the natural logarithm of the area-weighted average of a country's cell-level nighttime lights (NTL) digital number. The adjusted Freedom in the World (FiW) index produced by Freedom House ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Each column includes the variable $x_{i,t}$ in the header and its interaction with ln(NTL) as additional regressors: in column 1, log total population; in column 2, the share of population living in urban areas; the total percentage of population with access to electricity in column 3; the respective percentages of urban and rural population with access to electricity in columns 4 and 5; in column 6, total electricity consumption (KwH). All regressions include country and year fixed effects. Robust standard errors, clustered by country, are shown in brackets. Sample period: 1992-2013. Sample size varies based on data availability. The estimated σ, the parameter capturing the proportional exaggeration of GDP growth in autocracies, and its standard error are reported at the bottom of all columns. These estimates are based on the interquartile range of the FiW index in the estimating sample. In all columns, the baseline NTL elasticity of GDP used to estimate σ has been adjusted based on the average of the variable $x_{i,t}$ and the estimated heterogeneity in the elasticity, captured by $\ln(\text{NTL})_{i,t} \times x_{i,t}$. *** p<0.01, ** p<0.05, * p<0.1

Table D5: Robustness checks V: Initial level of development

Heterogeneous elasticity (x_i):	Dependent variable: $\ln(\text{GDP})_{i,t}$							
	Initial GDP p.c.			Initial NTL			UN categories	WB categories
	Level	Log	Quintiles	Level	Log	Quintiles		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\ln(\text{NTL})_{i,t}$	0.221***	0.596***	0.251***	0.214***	0.216***	0.215***	0.165***	0.162***
	[0.044]	[0.111]	[0.061]	[0.044]	[0.048]	[0.055]	[0.061]	[0.056]
$\text{FiW}_{i,t}$	-0.015	-0.017	-0.021	-0.015	-0.015	-0.013	-0.018	-0.017
	[0.025]	[0.024]	[0.025]	[0.025]	[0.025]	[0.025]	[0.025]	[0.025]
$\text{FiW}_{i,t}{}^2$	0.001	0.001	0.002	0.002	0.002	0.001	0.002	0.001
	[0.005]	[0.004]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t}$	0.021***	0.015***	0.018***	0.022***	0.021***	0.022***	0.021***	0.019***
	[0.006]	[0.005]	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]	[0.005]
$\ln(\text{NTL})_{i,t} \times x_i$	-0.000	-0.055***		-0.000	-0.005			
	[0.000]	[0.015]		[0.007]	[0.032]			
$\ln(\text{NTL})_{i,t} \times \text{D(Quintile=2)}_i$			-0.022			-0.031		
			[0.063]			[0.055]		
$\ln(\text{NTL})_{i,t} \times \text{D(Quintile=3)}_i$			-0.081			0.034		
			[0.055]			[0.066]		
$\ln(\text{NTL})_{i,t} \times \text{D(Quintile=4)}_i$			-0.125**			0.012		
			[0.057]			[0.063]		
$\ln(\text{NTL})_{i,t} \times \text{D(Quintile=5)}_i$			-0.138			-0.001		
			[0.088]			[0.084]		
$\ln(\text{NTL})_{i,t} \times \text{D(Developing)}_i$							0.082	
							[0.058]	
$\ln(\text{NTL})_{i,t} \times \text{D(Least Developed)}_i$							0.046	
							[0.065]	
$\ln(\text{NTL})_{i,t} \times \text{D(Upper middle income)}_i$								0.052
								[0.060]
$\ln(\text{NTL})_{i,t} \times \text{D(Lower middle income)}_i$								0.042
								[0.057]
$\ln(\text{NTL})_{i,t} \times \text{D(Low income)}_i$								0.097
								[0.064]
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,882	3,882	3,882	3,895	3,895	3,895	3,895	3,895
Countries	183	183	183	184	184	184	184	184
(Within country) R^2	0.265	0.288	0.274	0.260	0.260	0.262	0.264	0.264
$\hat{\sigma}$	0.360	0.300	0.375	0.355	0.356	0.306	0.439	0.420
$\hat{\sigma}$ SE	[0.152]	[0.157]	[0.190]	[0.142]	[0.143]	[0.129]	[0.220]	[0.204]

Notes: Dependent variable is ln(GDP) in constant local currency units. ln(NTL) is the natural logarithm of the area-weighted average of a country's cell-level nighttime lights (NTL) digital number. The adjusted Freedom in the World (FiW) index produced by Freedom House ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Columns 1, 2, 4, and 5 include the interaction of the variable x_i in the header with ln(NTL) as an additional regressor: in column 1, GDP per capita in constant USD at the start of the sample period; in column 2, the natural logarithm of initial GDP per capita; in column 3, dummies for quintiles 2-5 of initial GDP per capita (top quintile is the omitted category); in column 4, NTL DN at the start of the sample period; in column 5, the natural log of initial NTL DN; in column 6, dummies for quintiles 2-5 of initial NTL DN (top quintile is the omitted category); in column 7, dummies for developing and least developed countries, as defined by the United Nations (developed is the omitted category); in column 8, dummies for middle income (upper and lower) and low income countries, as defined by the World Bank (High income is the omitted category). All regressions include country and year fixed effects. Robust standard errors, clustered by country, are shown in brackets. Sample period: 1992-2013. The estimated σ, the parameter capturing the proportional exaggeration of GDP growth in autocracies, and its standard error are reported at the bottom of all columns. These estimates are based on the interquartile range of the FiW index in the estimating sample. In columns 1, 2, 4, and 5, the baseline NTL elasticity of GDP used to estimate σ has been adjusted based on the average of the variable x_i and the estimated heterogeneity in the elasticity, captured by $\ln(\text{NTL})_{i,t} \times x_i$. In columns 3 and 6, the baseline elasticity has been adjusted based on the estimated heterogeneity in the elasticity for countries in the third quintile. *** p<0.01, ** p<0.05, * p<0.1

Table D6: Robustness Checks VI: Human capital and informality

Heterogeneous elasticity ($x_{i,t}$):	Dependent variable: ln(GDP)$_{i,t}$							
	Education		Health		Informality			
	Years of schooling	Primary enrollment	Life expectancy	Infant mortality	Start formal	Years informal	Informal competition	informal constraints
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln(NTL)$_{i,t}$	0.259***	0.207***	0.233***	0.229***	0.558***	0.254***	0.277***	0.283***
	[0.040]	[0.047]	[0.088]	[0.045]	[0.178]	[0.047]	[0.056]	[0.059]
FiW$_{i,t}$	-0.030	0.001	-0.020	-0.041*	-0.006	-0.004	-0.004	-0.004
	[0.027]	[0.028]	[0.025]	[0.024]	[0.026]	[0.027]	[0.026]	[0.026]
FiW$_{i,t}{}^2$	0.005	0.000	0.002	0.006	-0.001	-0.001	-0.001	-0.001
	[0.005]	[0.005]	[0.005]	[0.004]	[0.005]	[0.005]	[0.005]	[0.005]
ln(NTL)$_{i,t}$ × FiW$_{i,t}$	0.019***	0.015***	0.016***	0.018***	0.015***	0.017***	0.017***	0.017***
	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]
$x_{i,t}$	-0.014	0.001	0.015***	-0.008***				
	[0.018]	[0.001]	[0.004]	[0.002]				
ln(NTL)$_{i,t}$ × $x_{i,t}$	-0.003	-0.000	-0.000	-0.001*	-0.003*	0.008	-0.001	-0.000
	[0.004]	[0.000]	[0.001]	[0.000]	[0.002]	[0.034]	[0.002]	[0.001]
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,519	2,088	3,598	3,877	3,064	3,064	3,086	3,105
Countries	181	164	181	183	142	142	143	144
(Within country) R^2	0.270	0.197	0.286	0.336	0.294	0.287	0.290	0.291
$\hat{\sigma}$	0.272	0.292	0.248	0.311	0.175	0.193	0.190	0.192
$\hat{\sigma}$ SE	[0.086]	[0.138]	[0.112]	[0.131]	[0.078]	[0.079]	[0.078]	[0.077]

Notes: Dependent variable is ln(GDP) in constant local currency units. ln(NTL) is the natural logarithm of the area-weighted average of a country's cell-level nighttime lights (NTL) digital number. The adjusted Freedom in the World (FiW) index produced by Freedom House ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Each column includes the variable $x_{i,t}$ in the header (if time-varying) and its interaction with ln(NTL) as additional regressors: in column 1, average years of schooling; in column 2, the net primary enrolment rate; in column 3, life expectancy at birth; in column 4, the infant mortality rate. Columns 5-8 include various time-invariant measures of informality from the World Bank's enterprise surveys: The percentage of firms formally registered when they started operations in column 5; the number of years that firms operated without formal registration in column 6; the percentage of firms that report facing competition from informal firms in column 7 and the percentage of firms that report being constrained by the activities of informal firms in column 8. All regressions include country and year fixed effects. Robust standard errors, clustered by country, are shown in brackets. Sample period: 1992-2013. Sample size varies based on data availability. The estimated σ, the parameter capturing the proportional exaggeration of GDP growth in autocracies, and its standard error are reported at the bottom of all columns. These estimates are based on the interquartile range of the FiW index in the estimating sample. In all columns, the baseline NTL elasticity of GDP used to estimate σ has been adjusted based on the average of the variable $x_{i,t}$ and the estimated heterogeneity in the elasticity, captured by ln(NTL)$_{i,t}$ × $x_{i,t}$. *** p<0.01, ** p<0.05, * p<0.1

Table D7: Robustness Checks VII: Data quality and statistical capacity

Heterogeneous elasticity (x_i):	Baseline	Source data score	Periodicity score	Methodology score	Overall score
	Dependent variable: $\ln(\text{GDP})_{i,t}$				
	(1)	(2)	(3)	(4)	(5)
$\ln(\text{NTL})_{i,t}$	0.207***	0.056	-0.113	0.103	-0.010
	[0.048]	[0.084]	[0.178]	[0.082]	[0.115]
$\text{FiW}_{i,t}$	0.005	0.013	0.013	0.013	0.015
	[0.028]	[0.027]	[0.027]	[0.028]	[0.027]
${\text{FiW}_{i,t}}^2$	-0.001	-0.002	-0.003	-0.002	-0.003
	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t}$	0.021***	0.021***	0.019***	0.022***	0.021***
	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]
$\ln(\text{NTL})_{i,t} \times x_i$		0.280**	0.433**	0.226*	0.375**
		[0.116]	[0.213]	[0.123]	[0.165]
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	2,917	2,917	2,917	2,917	2,917
Countries	137	137	137	137	137
(Within country) R^2	0.257	0.278	0.270	0.268	0.276
$\hat{\sigma}$	0.304	0.273	0.240	0.284	0.261
$\hat{\sigma}$ SE	[0.137]	[0.101]	[0.096]	[0.114]	[0.100]

Notes: Dependent variable is ln(GDP) in constant local currency units. ln(NTL) is the natural logarithm of the area-weighted average of a country's cell-level nighttime lights (NTL) digital number. The adjusted Freedom in the World (FiW) index produced by Freedom House ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. The regression in column 1 replicates the baseline results for the reduced sample with complete data on statistical capacity from the World Bank. Columns 2-5 include the interaction of the variable x_i in the header with ln(NTL) as an additional regressor: in column 2, the score for quality of source data; in column 3, the score for periodicity and timeliness; in column 4, the score for statistical methodology; in column 5, the overall score (average of previous three). These scores are averages for the period 2004-2020. All regressions include country and year fixed effects. Robust standard errors, clustered by country, are shown in brackets. Sample period: 1992-2013. The estimated σ, the parameter capturing the proportional exaggeration of GDP growth in autocracies, and its standard error are reported at the bottom of all columns. These estimates are based on the interquartile range of the FiW index in the estimating sample. In columns 2-5, the baseline NTL elasticity of GDP used to estimate σ has been adjusted based on the average of the variable $x_{i,t}$ and the estimated heterogeneity in the elasticity, captured by $\ln(\text{NTL})_{i,t} \times x_{i,t}$. The scores in columns 2-4 are derived from 25 observable measures of data quality and statistical capacity. Appendix Figure D2 provides estimates of σ controlling for each individual indicator at a time. *** p<0.01, ** p<0.05, * p<0.1

Table D8: Robustness Checks VIII: State capacity

	Dependent variable: $\ln(\text{GDP})_{i,t}$						
Heterogeneous elasticity (x_i):	Baseline	Average Days		Share returned		Share returned (<90 days)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\ln(\text{NTL})_{i,t}$	0.282***	0.202***	0.196***	0.407***	0.346***	0.384***	0.336***
	[0.042]	[0.062]	[0.062]	[0.050]	[0.055]	[0.041]	[0.045]
$\text{FiW}_{i,t}$	-0.004	0.012	-0.002	0.015	-0.001	0.010	-0.004
	[0.029]	[0.028]	[0.028]	[0.028]	[0.028]	[0.028]	[0.028]
${\text{FiW}_{i,t}}^2$	-0.001	-0.005	-0.002	-0.005	-0.002	-0.005	-0.001
	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t}$	0.015***		0.010**		0.011**		0.010**
	[0.005]		[0.005]		[0.005]		[0.005]
$\ln(\text{NTL})_{i,t} \times x_i$		0.048**	0.036*	-0.155**	-0.114*	-0.210***	-0.167***
		[0.019]	[0.018]	[0.067]	[0.065]	[0.063]	[0.061]
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,250	3,250	3,250	3,250	3,250	3,250	3,250
Countries	153	153	153	153	153	153	153
(Within country) R^2	0.277	0.279	0.284	0.277	0.283	0.282	0.286
$\hat{\sigma}$	0.183		0.126		0.133		0.124
$\hat{\sigma}$ SE	[0.078]		[0.068]		[0.069]		[0.070]

Notes: Dependent variable is ln(GDP) in constant local currency units. ln(NTL) is the natural logarithm of the area-weighted average of a country's cell-level nighttime lights (NTL) digital number. The adjusted Freedom in the World (FiW) index produced by Freedom House ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. The regression in column 1 replicates the baseline results for the reduced sample of countries with data on state capacity from Chong et al. (2014). Columns 2-7 include the interaction of the variable x_i in the header with ln(NTL) as an additional regressor: in columns 2-3, the average number of days to have a letter returned (/100); in columns 4-5, the share of letters returned; in columns 6-7, the share of letters returned in less than 90 days. All regressions include country and year fixed effects. Robust standard errors, clustered by country, are shown in brackets. Sample period: 1992-2013. The estimated σ, the parameter capturing the proportional exaggeration of GDP growth in autocracies, and its standard error are reported at the bottom of all columns. These estimates are based on the interquartile range of the FiW index in the estimating sample. In columns 2-7, the baseline NTL elasticity of GDP used to estimate σ has been adjusted based on the average of the variable x_i and the estimated heterogeneity in the elasticity, captured by $\ln(\text{NTL})_{i,t} \times x_i$. *** p<0.01, ** p<0.05, * p<0.1

Table D9: Robustness Checks IX: Corruption

	Dependent variable: $\ln(\text{GDP})_{i,t}$					
Heterogeneous elasticity (x_i):	Corruption Perceptions Index (CPI)			Control of Corruption Index (CCI)		
	(1)	(2)	(3)	(4)	(5)	(6)
$\ln(\text{NTL})_{i,t}$	0.259***	0.378***	0.279***	0.189***	0.241***	0.185***
	[0.041]	[0.059]	[0.061]	[0.038]	[0.036]	[0.037]
$\text{FiW}_{i,t}$	-0.010	0.008	-0.010	-0.022	-0.008	-0.024
	[0.026]	[0.028]	[0.026]	[0.027]	[0.026]	[0.026]
${\text{FiW}_{i,t}}^2$	0.000	-0.005	0.000	0.004	-0.001	0.004
	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t}$	0.017***		0.016***	0.019***		0.016***
	[0.005]		[0.005]	[0.005]		[0.005]
$\ln(\text{NTL})_{i,t} \times x_i$		-0.001	-0.001		-0.034**	-0.023
		[0.001]	[0.001]		[0.014]	[0.015]
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,614	3,614	3,614	2,656	2,656	2,656
Countries	170	170	170	182	182	182
(Within country) R^2	0.271	0.255	0.271	0.194	0.185	0.201
$\hat{\sigma}$	0.263		0.257	0.362		0.310
$\hat{\sigma}$ SE	[0.102]		[0.101]	[0.135]		[0.129]

Notes: Dependent variable is ln(GDP) in constant local currency units. ln(NTL) is the natural logarithm of the area-weighted average of a country's cell-level nighttime lights (NTL) digital number. The adjusted Freedom in the World (FiW) index produced by Freedom House ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. The regressions in columns 1 and 4 replicate the baseline results for the reduced samples of countries with data on corruption from Transparency International and the World Bank, respectively. Remaining columns include the interaction of the variable x_i in the header with ln(NTL) as an additional regressor: in columns 2-3, the Corruption Perceptions Index produced by Transparency International; in columns 5-6, the Control of Corruption Index (CCI) produced by the World Bank. All regressions include country and year fixed effects. Robust standard errors, clustered by country, are shown in brackets. Sample period: 1992-2013. The estimated σ, the parameter capturing the proportional exaggeration of GDP growth in autocracies, and its standard error are reported at the bottom of all columns, except columns 2 and 5. These estimates are based on the interquartile range of the FiW index in the estimating sample. In columns 3 and 6, the baseline NTL elasticity of GDP used to estimate σ has been adjusted based on the average of the variable x_i and the estimated heterogeneity in the elasticity, captured by $\ln(\text{NTL})_{i,t} \times x_i$. *** p<0.01, ** p<0.05, * p<0.1

Table D10: Robustness checks X: Democracy Data from Other Sources

	Dependent variable: $\ln(\text{GDP})_{i,t}$						
Democracy measure:	Polity IV			-VA index (WGI)	CGV (2010)	PS (2008)	ANRR (2019)
	-Polity2	-Democracy	Autocracy				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\ln(\text{NTL})_{i,t}$	0.338***	0.326***	0.290***	0.199***	0.242***	0.253***	0.266***
	[0.041]	[0.036]	[0.036]	[0.036]	[0.047]	[0.053]	[0.041]
Autocracy measure$_{i,t}$	0.004	0.018	0.002	-0.062**	0.023	0.057*	0.019
	[0.003]	[0.014]	[0.012]	[0.024]	[0.027]	[0.032]	[0.025]
Autocracy measure$_{i,t}{}^2$	0.000	0.001	0.000	0.077***			
	[0.000]	[0.001]	[0.002]	[0.023]			
$\ln(\text{NTL})_{i,t}$ × Autocracy measure$_{i,t}$	0.003**	0.005**	0.007***	0.070***	0.024	0.043**	0.023**
	[0.001]	[0.002]	[0.003]	[0.013]	[0.015]	[0.018]	[0.011]
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,320	3,231	3,231	2,740	2,994	1,937	3,225
Countries	156	156	156	188	183	168	175
(Within country) R^2	0.256	0.227	0.231	0.221	0.191	0.248	0.209
$\hat{\sigma}$	0.096	0.114	0.096	0.604	0.099	0.170	0.086
$\hat{\sigma}$ SE	[0.038]	[0.043]	[0.040]	[0.175]	[0.066]	[0.082]	[0.043]

Notes: Dependent variable is ln(GDP) in constant local currency units. ln(NTL) is the natural logarithm of the area-weighted average of a country's cell-level nighttime lights (NTL) digital number. If needed, democracy measures have been rescaled such that smaller values correspond to stronger democracies (denoted by a minus sign in the column header). Columns 1-3 use democracy measures from the Polity V project. The Polity2 score (column 1) is the difference between the democracy and autocracy scores and ranges from -10 to 10 (most democratic). The democracy (column 2) and autocracy (column 3) scores range from 0 to 10, with larger values corresponding to more democratic and autocratic regimes, respectively. Column 4 uses the Voice and Accountability Index provided by the World Bank as part of its Worldwide Governance Indicators. Columns 5-7 use binary autocracy measures. Column 5 uses the dummy for dictatorship from the Cheibub et al. (2010) DD dataset, which is an updated version of the Przeworski et al. (2000) dataset. Column 6 uses the democracy indicator produced by Papaioannou and Siourounis (2008). In column 7, the autocracy dummy is constructed following Acemoglu et al. (2019) and equals one if the observation is classified by Freedom House as 'not free' or the Polity score is less than or equal to zero, with missing observations from both sources classified according to the DD dataset. Robust standard errors, clustered by country, are shown in brackets. The estimated σ, the parameter capturing the proportional exaggeration of GDP growth in autocracies, and its standard error are reported at the bottom of all columns. In columns 1-4, this estimate is based on the interquartile range of the respective index. Sample period: 1992-2013, except column 5 (1992-2008) and column 6 (1992-2003). *** p<0.01, ** p<0.05, * p<0.1

Table D11: Robustness Checks XI: NTL Data from Other Sources

	Dependent variable: $\ln(\text{GDP})_{i,t}$						
NTL source:	HSW (2008)	PS (2016)	HR (2014)	LZZZ (2020) [smoothing]			DMSP w/ 2010 adj.
				[None]	[2014]	[2014/17]	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\ln(\text{NTL})_{i,t}$	0.238***	0.215***	0.166***	0.068***	0.102***	0.162***	0.220***
	[0.035]	[0.040]	[0.042]	[0.020]	[0.033]	[0.032]	[0.044]
$\text{FiW}_{i,t}$	-0.005	-0.354***	-0.043*	0.037	0.025	0.017	-0.012
	[0.022]	[0.128]	[0.026]	[0.035]	[0.032]	[0.030]	[0.025]
${\text{FiW}_{i,t}}^2$	-0.000	-0.004	0.001	-0.010	-0.006	-0.004	0.001
	[0.004]	[0.004]	[0.005]	[0.006]	[0.006]	[0.005]	[0.005]
$\ln(\text{NTL})_{i,t} \times \text{FiW}_{i,t}$	0.012***	0.011***	0.028***	0.013**	0.016***	0.016***	0.021***
	[0.004]	[0.004]	[0.006]	[0.005]	[0.006]	[0.006]	[0.006]
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,915	3,291	3,622	4,790	4,785	4,785	3,895
Countries	179	178	169	185	184	184	184
Sample period	92-08	92-10	92-13	92-18	92-18	92-18	92-13
(Within country) R^2	0.236	0.217	0.211	0.171	0.132	0.180	0.255
$\hat{\sigma}$	0.178	0.181	0.684	0.647	0.542	0.352	0.331
$\hat{\sigma}$ SE	[0.079]	[0.080]	[0.256]	[0.395]	[0.310]	[0.173]	[0.136]

Notes: Dependent variable is ln(GDP) in constant local currency units. ln(NTL) is the natural logarithm of the country's average nighttime lights (NTL) digital number (DN). Columns 1-3 use NTL data from DMSP-OLS. Column 1 uses the area-weighted average of the country's cell-level DN provided by Henderson et al. (2012). Column 2 uses the unweighted average of DN across pixels provided by Pinkovskiy and Sala-i Martin (2016). Column 3 uses the unweighted average of DN across each country's level-2 administrative areas from Hodler and Raschky (2014). Columns 4-6 use harmonized NTL data from DMSP-OLS and VIIRS, extending to 2018, from Li et al. (2020). Column 4 uses the area-weighted average of the country's cell-level DN. Column 5 imputes the country's DN for 2014 (transition year from DMSP-OLS to VIIRS) using the average DN growth between 2012 and 2016 (excluding 2014). Column 6 further imputes the country's DN for 2017 using the average DN growth in 2016 and 2018. The adjusted Freedom in the World (FiW) index ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. All regressions include country and year fixed effects. Sample period (indicated at the bottom of each column) varies based on data availability. Robust standard errors clustered by country in brackets. The estimated σ, the parameter capturing the proportional exaggeration of GDP growth in autocracies, and its standard error are reported at the bottom of all columns. These estimates are based on the interquartile range of the FiW index in the estimating sample. *** p<0.01, ** p<0.05, * p<0.1

Table D12: Robustness checks XII: Constant Political Regime

	Dependent variable: $\ln(\text{GDP})_{i,t}$					
Period for FIW average:	1992-2013				1982-1991	
	(1)	(2)	(3)	(4)	(5)	(6)
$\ln(\text{NTL})_{i,t}$	0.136***	0.191***	0.171***	0.221***	0.085*	0.117**
	[0.049]	[0.053]	[0.048]	[0.049]	[0.045]	[0.046]
$\ln(\text{NTL})_{i,t} \times$ Avg. $\text{FiW}_{i,t}$	0.053***	0.032**			0.055***	0.043***
	[0.012]	[0.014]			[0.010]	[0.010]
$\ln(\text{NTL})_{i,t} \times$ D(Avg. Partially $\text{Free})_{i,t}$			0.155***	0.085		
			[0.056]	[0.063]		
$\ln(\text{NTL})_{i,t} \times$ D(Avg. Not $\text{Free})_{i,t}$			0.197***	0.104*		
			[0.053]	[0.062]		
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	No	Yes	No	Yes	No
Subregion x Year FE	No	Yes	No	Yes	No	Yes
Observations	3,895	3,892	3,895	3,892	3,736	3,733
Countries	184	184	184	184	175	175
(Within country) R^2	0.270	0.226	0.259	0.220	0.281	0.241
$\hat{\sigma}$	1.316	0.572	1.151	0.473	2.255	1.293
$\hat{\sigma}$ SE	[0.709]	[0.379]	[0.577]	[0.349]	[1.468]	[0.718]

Notes: Dependent variable is ln(GDP) in constant local currency units. ln(NTL) is the natural logarithm of the area-weighted average of a country's cell-level nighttime lights (NTL) digital number. The adjusted Freedom in the World (FiW) index produced by Freedom House ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Dummies for "Partially Free" and "Not Free"' countries (columns 3-4, "Free" is the omitted category) also from Freedom House. In columns 1-2, Avg. FiW is the average of the FiW index between 1992 and 2013. In columns 3-4, this average is used to determine country status: "Partially Free" if 2 $\leq$FiW Avg.$\leq$ 4 and "Not Free" if FiW Avg.$>$ 4. In columns 5-6, the FiW index is averaged using data from the decade before the start of the sample period (1982-1991). All regressions include country fixed effects. Odd-numbered columns include year fixed effects, while even-numbered columns include subregion-year fixed effects based on the UN geoscheme (22 units). Robust standard errors, clustered by country, are shown in brackets. The estimated σ, the parameter capturing the proportional exaggeration of GDP growth in autocracies, and its standard error are reported at the bottom of all columns. In columns 1-2 and 5-6, this estimate is based on the interquartile range of the FiW average, while in columns 3-4 it is based on the "Not Free" dummy. *** p<0.01, ** p<0.05, * p<0.1

Table D13: Robustness Checks XIII: Growth rates

	Dependent variable: GDP Growth Rate $_{i,t}$					
	(1)	(2)	(3)	(4)	(5)	(6)
NTL Growth Rate$_{i,t}$	0.039***	0.039***	0.027***	0.027***	0.030***	0.030***
	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]	[0.007]
FiW$_{i,t}$		-0.004*	-0.005*	0.016***	0.013**	0.011***
		[0.003]	[0.003]	[0.006]	[0.005]	[0.004]
FiW$_{i,t}{}^2$				-0.003***	-0.003***	-0.002***
				[0.001]	[0.001]	[0.001]
NTL Growth Rate$_{i,t}$ $\times$ FiW$_{i,t}$			0.006***	0.005***	0.004**	0.003*
			[0.002]	[0.002]	[0.002]	[0.002]
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,700	3,700	3,700	3,700	3,700	3,700
Countries	184	184	184	184	184	184
Winsorization	1-99	1-99	1-99	1-99	2.5-97.5	5-95
(Within country) R^2	0.0222	0.0253	0.0288	0.0395	0.0359	0.0342
$\hat{\sigma}$			0.727	0.707	0.429	0.393
$\hat{\sigma}$ SE			[0.341]	[0.338]	[0.257]	[0.258]

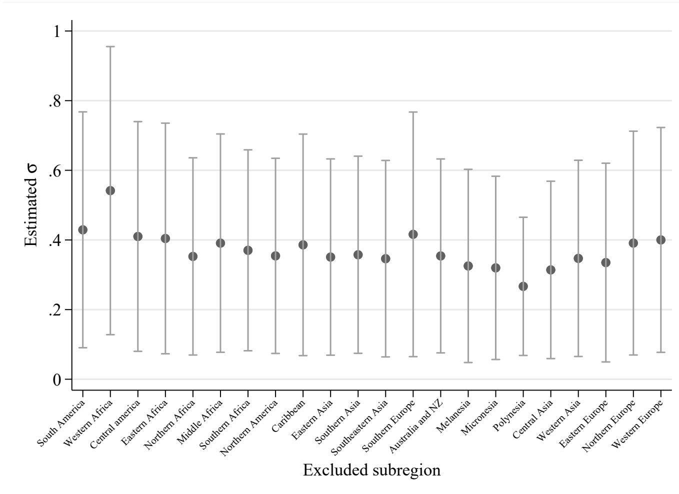
Notes: Dependent variable is the yearly growth rate of GDP in constant local currency units. NTL Growth Rate is the yearly growth rate of the area-weighted average of a country's cell-level nighttime lights (NTL) digital number. In columns 1-4, growth rates of GDP and NTL are winsorized at the 1 and 99% levels. In column 5, growth rates are winsorized at the 2.5 and 97.5% level, while in column 6 winsorization occurs at the 5 and 95% levels. The adjusted Freedom in the World (FiW) index ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. All regressions include country and year fixed effects. Sample period: 1993-2013. Robust standard errors clustered by country in brackets. The estimated σ, the parameter capturing the proportional exaggeration of GDP growth in autocracies, and its standard error are reported at the bottom of all columns. These estimates are based on the interquartile range of the FiW index in the estimating sample. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table D14: Robustness Checks XIV: Specification checks

	Dependent variable: ln(GDP)$_{i,t}$			Dependent variable: Δln(GDP)$_{i,t}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln(NTL)$_{i,t}$	0.233***	0.131***	0.169***				
	[0.044]	[0.029]	[0.030]				
FiW$_{i,t}$	-0.029	-0.014	-0.013		0.015***	0.015**	0.012
	[0.027]	[0.019]	[0.026]		[0.006]	[0.006]	[0.015]
FiW$_{i,t}{}^2$	0.002	0.003	0.001		-0.003***	-0.003***	-0.004*
	[0.005]	[0.003]	[0.005]		[0.001]	[0.001]	[0.002]
ln(NTL)$_{i,t}$ × FiW$_{i,t}$	0.014**	0.009***	0.019***				
	[0.005]	[0.003]	[0.005]				
ln(NTL)$_{i,t-1}$			0.093***				
			[0.026]				
ln(GDP)$_{i,t-1}$						-0.044***	0.052**
						[0.010]	[0.023]
Δln(NTL)$_{i,t}$				0.047***	0.029***	0.030***	0.028***
				[0.007]	[0.006]	[0.006]	[0.007]
Δln(NTL)$_{i,t}$ × FiW$_{i,t}$					0.007***	0.007***	0.009***
					[0.002]	[0.002]	[0.002]
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Subregion x Year FE	Yes	No	No	No	No	No	No
Country-specific time trend	No	Yes	No	No	No	No	No
Estimation method	OLS	OLS	OLS	OLS	OLS	OLS	GMM
Observations	3,892	3,895	3,710	3,698	3,698	3,698	3,698
Countries	184	184	184	184	184	184	184
(Within country) R^2	0.235	0.102	0.275	0.025	0.044	0.068	-
$\hat{\sigma}$	0.211	0.237	0.249		0.849	0.778	1.107
$\hat{\sigma}$ SE	[0.102]	[0.110]	[0.094]		[0.383]	[0.354]	[0.465]

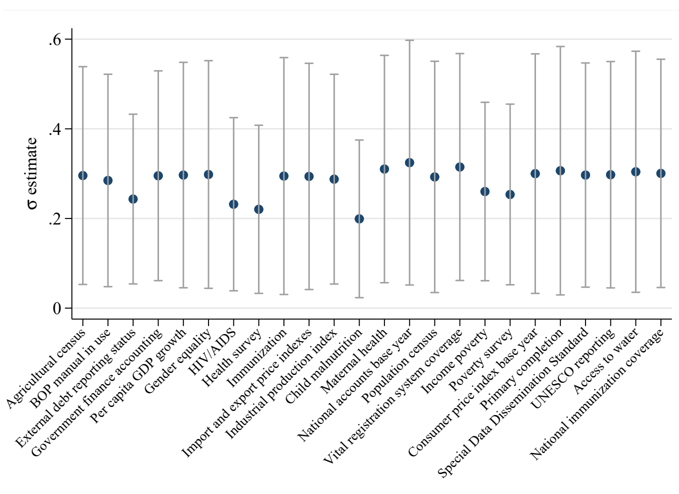
Notes: The dependent variable in columns 1-3 is ln(GDP) in constant local currency units. The dependent variable in columns 4-7 is the yearly change (first difference) of ln(GDP). ln(NTL) is the natural logarithm of the area-weighted average of a country's cell-level nighttime lights (NTL) digital number. Δln(NTL)$_{i,t}$ is the yearly change (first difference) of ln(NTL). The adjusted Freedom in the World (FiW) index ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. All columns include country fixed effects. Column 1 includes subregion-year fixed effects, based on the UN Geoscheme (22 units), while columns 2-7 include year fixed effects. Column 2 includes a country-specific linear time trend. Column 3 includes the first lag of ln(NTL) as an additional regressor, while columns 6-7 include the first lag of ln(GDP) as an additional regressor. The method of estimation in columns 1-6 is OLS, while column 7 uses system-GMM (Blundell-Bond). Δln(GDP)$_{i,t}$ and Δln(NTL)$_{i,t}$ in columns 4-7 have been winsorized at the 1 and 99% levels. Sample period: 1992-2013 in columns 1-2, 1993-2013 in columns 3-7. Robust standard errors clustered by country in brackets. The estimated σ, the parameter capturing the proportional exaggeration of GDP growth in autocracies, and its standard error are reported at the bottom of all columns. These estimates are based on the interquartile range of the FiW index in the estimating sample. *** p<0.01, ** p<0.05, * p<0.1

Figure D1: Robustness Checks XV: Excluding Sub-regions of the World



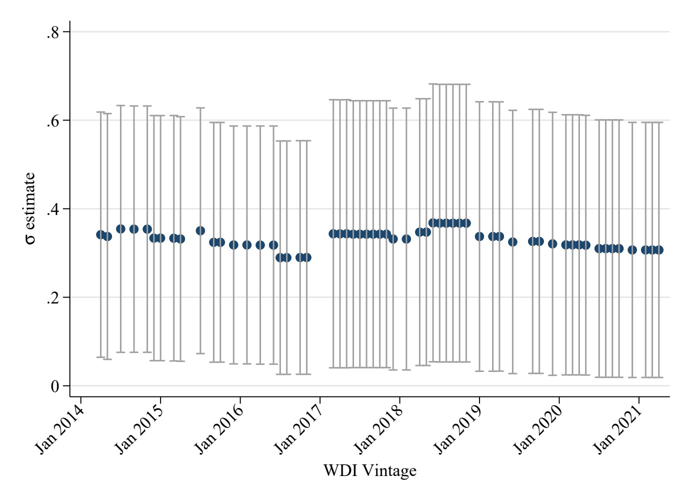
Notes: The figure shows the estimated value of σ and its 95% confidence interval from separate regressions replicating the analysis in column 4 of Table 1 (i.e., equation 6) excluding countries from the sub-region indicated in the x-axis. Subregional classification is based on the United Nations geoscheme. The dependent variable is log GDP and the explanatory variables are log NTL (DN), the FiW index and its square, and the interaction of the FiW index with log NTL. Regressions also include country and year fixed effects. Standard errors clustered by country. Sample size varies based on number of countries excluded. Sample period: 1992-2013.

Figure D2: Robustness Checks XVI: Individual Measures of Statistical Capacity



Notes: Figure shows estimates of σ and their 95% confidence interval. These estimates are obtained from a regression of log GDP on log NTL (DN), the FiW index and its square, and the interaction of the FiW index with log NTL. The regression also includes the interaction of log NTL with the time-invariant binary measure of statistical capacity indicated in the x-axis, as well as country and year fixed effects. Standard errors clustered by country. Sample size: 2,917. Sample period: 1992-2013.

Figure D3: Robustness Checks XVII: GDP Data from different WDI Releases



Notes: The figure shows the estimated value of σ and its 95% confidence interval from separate regressions replicating the analysis in column 4 of Table 1 (i.e., equation 6) using GDP data (in constant local currency units) from all available releases of the World Bank's World Development Indicators (WDI) between 2014 and 2021. The dependent variable is log GDP and the explanatory variables are log NTL (DN), the FiW index and its square, and the interaction of the FiW index with log NTL. Regressions also include country and year fixed effects. Standard errors clustered by country. Sample size varies slightly based on data availability. Sample period: 1992-2013.

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