

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

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Is there more manipulation of GDP growth in authoritarian regimes?

- Governments of all types have an incentive to exaggerate how well the economy is doing
- Are the checks and balances provided by democracy able to constrain the government's ability to manipulate information?
- Manipulation of official economic statistics:
 - Hinders accountability, reduces efficiency and compromises research
 - Exemplifies the manipulation of information prevalent in autocracies

I use nighttime lights to detect manipulation of GDP figures

- I compare two measures of economic activity that aren't equally prone to manipulation: night lights (hard measure) vs GDP (soft measure)
- Does the same amount of growth in night lights translate into more GDP growth in autocracies than in democracies?
- 179 countries (1992-2008): Henderson et al. ('12) + Freedom House

I find that the night-lights elasticity of GDP is larger in autocracies

- Autocratic regimes exaggerate GDP growth by a factor of 1.15-1.3
- Autocracy gradient in night-lights elasticity of GDP not driven by differences in geography, economic structure, development, etc.
- The autocracy gradient is larger when the manipulation of statistics is easier and when the incentive to exaggerate growth is stronger
- GDP manipulation affects our understanding of comparative economic performance at the turn of the XXI century

Related literature

Do autocrats want to exaggerate GDP growth? Can they do it?

- In the absence of elections, economic indicators may act as coordination devices for mobilization (Hollyer et al., 2015)
 - Plus there is a growing number of hybrid regimes (Levitsky and Way, 2010)
- Autocracies pay substantial attention to the info citizens access (Merridale, 1996; King, 1997; King et al., 2013, 2017)
- Citizens will update positively on incumbent after hearing good news, even when these are potentially false (Gehlbach et al., 2016)

I study the mapping of night lights to GDP in a panel of 179 countries

- I replicate Henderson et al. (2012, AER) allowing for heterogeneity in the mapping from lights to GDP by regime type
- I use the regime classification provided by Freedom House: $FWI \in [0,6]$ with larger values corresponding to more authoritarian regimes

$$\ln(\text{GDP})_{i,t} = \mu_i + \delta_t + \phi_0 \ln(\text{lights})_{i,t} + \phi_1 \text{FWI}_{i,t} + \phi_2 \text{FWI}_{i,t}^2 + \phi_3 (\ln(\text{lights})_{i,t} \times \text{FWI}_{i,t}) + \xi_{i,t}$$

- The ratio ϕ_3/ϕ_0 captures the increase in **proportional** exaggeration of GDP growth for a one-unit increase in FWI Econometric model

Lights grow equally in 'Free' and 'Not free' countries, but GDP doesn't

	Average growth rate	
	GDP	Night lights
Full sample (N=2,724)	0.0397 (0.057)	0.0522 (0.234)
'Free' countries (N=1,182)	0.0357 (0.033)	0.0497 (0.268)
'Partially free' countries (N=761)	0.0406 (0.0632)	0.0572 (0.216)
'Not free' countries (N=781)	0.0446 (0.0764)	0.051 (0.191)
p-value H_0 : Free = Partially Free	0.049	0.498
p-value H_0 : Free = Not Free	0.002	0.897
p-value H_0 : Partially Free = Not Free	0.264	0.554

Notes: Table shows the average yearly growth rate of GDP and the nighttime lights Digital number (DN). The latter is the within-country area-weighted average of grid-level lights digital numbers (0-63). Countries are classified using the adjusted Freedom in the World Index (FWI), which ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Country is 'Free' if $FWI < 2$, 'Partially Free' if $2 \leq FWI < 4$ and 'Not Free' if $FWI \geq 4$. Standard deviation in parentheses.

Evidence of autocracy gradient in the night-lights elasticity of GDP

	Dependent variable: $\ln(\text{GDP})_{i,t}$						
	Yearly fluctuations					Long-run growth	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\ln(\text{lights})_{i,t}$	0.283*** [0.031]	0.279*** [0.031]	0.238*** [0.034]	0.238*** [0.035]	0.264*** [0.032]	0.264*** [0.042]	0.275*** [0.040]
$\text{FWI}_{i,t}$		-0.017* [0.009]	-0.005 [0.010]	-0.004 [0.022]		-0.054 [0.038]	
$\text{FWI}^2_{i,t}$				-0.000 [0.004]		0.010 [0.007]	
$\ln(\text{lights})_{i,t} \times \text{FWI}_{i,t}$			0.012*** [0.004]	0.012*** [0.004]		0.018** [0.007]	
$D(\text{Partially Free})_{i,t}$					-0.006 [0.017]		-0.021 [0.039]
$D(\text{Not Free})_{i,t}$					-0.012 [0.027]		-0.006 [0.053]
$\ln(\text{lights})_{i,t} \times D(\text{Partially Free})_{i,t}$ [a]					0.015 [0.011]		0.037* [0.021]
$\ln(\text{lights})_{i,t} \times D(\text{Not Free})_{i,t}$ [b]					0.028** [0.013]		0.065** [0.026]
Observations	2,914	2,914	2,914	2,914	2,914	334	334
Countries	179	179	179	179	179	167	167
(Within country) R^2	0.772	0.773	0.777	0.777	0.774	0.851	0.852
p-value $H_0: a = b$					0.076		0.160

Notes: Dependent variable is $\ln(\text{GDP})$ in constant local currency units. $\ln(\text{lights})$ is the natural logarithm of the area-weighted average of grid-level lights digital number (0-63). The adjusted Freedom in the World Index (FWI) ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Country is "Free" if $\text{FWI} < 2$, "Partially Free" if $2 \leq \text{FWI} < 4$ and "Not Free" if $\text{FWI} \geq 4$. $D(\text{Free})$ and its interaction with $\ln(\text{lights})$ are the omitted categories in columns 5 and 7. All regressions include country and year fixed effects. In columns 1-5, the sample period is 1992-2008. In columns 6-7, the average of all variables for the years 1992/93 and 2005/06 is used instead. Robust standard errors clustered by country in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Alternative explanations are not supported by the data

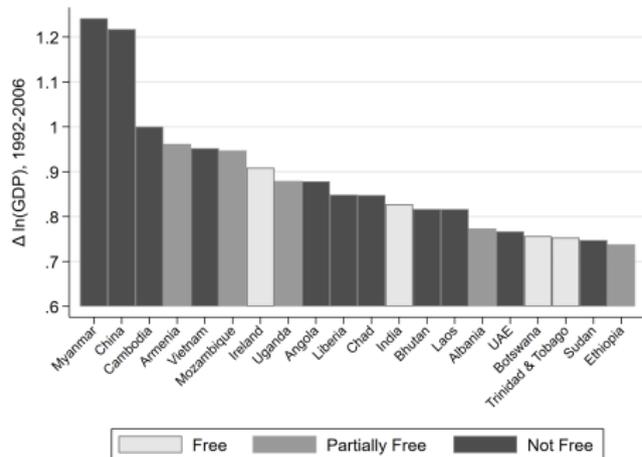
- Results not explained by other potential sources of heterogeneity in the night-lights elasticity of GDP:
 - GDP composition [Table](#)
 - Sectoral composition [Table](#)
 - Level of development, urbanization, electrification [Table](#)
 - Human capital, informality [Table](#)
 - Location, satellite changes, top-coding, spatial concentration [Table](#)
 - Statistical capacity [Table](#)
 - Corruption [Table](#)
 - Specific regions or periods [Graph regions](#) [Graph years](#)
- Results are robust to changes in variables or in specification:
 - Other regime classifications [Table](#)
 - Lagged lights, dynamic panel (GMM), first-differences [Table](#)

Further evidence on increased manipulation of GDP in autocracies

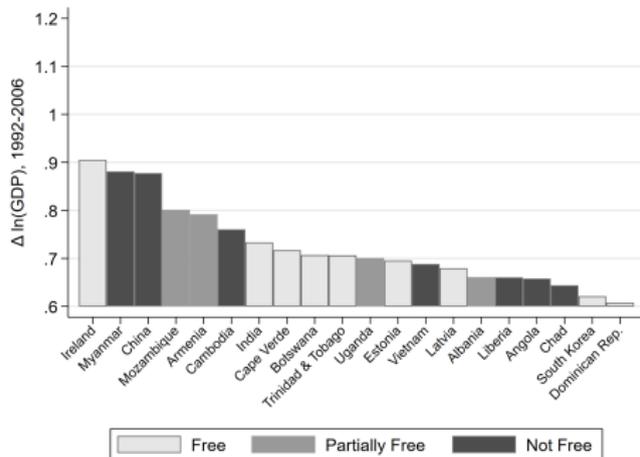
- The autocracy gradient is only present for GDP sub-components reliant on government information [Table](#)
- The autocracy gradient is larger in years in which the incentive to exaggerate growth is stronger
 - Relatively low growth [Table](#)
 - Before national elections [Table](#)
 - After becoming ineligible for IDA aid [Table](#) [Event study](#)
- The autocracy gradient is smaller in the presence of independent economic and political institutions [Table](#) [Regime plot](#)

Economic success stories change after correcting for manipulation

(a) Raw data



(b) Adjusted for manipulation



Note: Panel (a) shows the 20 countries with the largest change in $\ln(\text{GDP})$ between 1992/3 and 2005/6 (two-year average in both cases), as reported in the World Bank's World Development Indicators. Countries are classified according to their average value of the Freedom in the World Index (FWI). Panel (b) shows the same information after the $\ln \text{GDP}$ series has been adjusted for manipulation using the value of σ (0.07) implied by the estimates in column 6 of the main table (long-run).

Concluding remarks

- Autocracy gradient in the night-lights elasticity of GDP indicates that authoritarian regimes inflate GDP growth by a factor of 1.15-1.3
- Autocracy gradient does not disappear with GDP revisions, but is not present among subscribers to IMF's SDDS guidelines GDP revisions SDDS
- Findings provide a rationale for the use of 'hard' measures of economic activity in academic work and policy-making

APPENDIX: EXTRA SLIDES

The paper contributes to several strands of academic literature

- **Manipulation of official statistics**

(Hollyer et al., 2011,15; Cavallo, 2013; Michalski and Stoltz, 2013; Alt et al., 2014; Magge and Doces, 2015; Sandefur and Glassman, 2015; Wallace, 2016; Kerner et al., 2017)

- **Manipulation of media/information in autocracies**

(Egorov et al., 2009; Enikolopov et al., 2011; Edmond, 2013; King et al., 2013, 2017; Gehlbach and Sonin, 2014; Lorentzen, 2014; Gehlbach et al., 2016; Cantoni et al., 2017)

- **Accuracy of Chinese official statistics**

(Rawski, 2001; Young, 2003; Madisson, 2006; Holz, 2006, 2014; Mehrotra, A. and Paakkonen, 2011; Nakamura et al., 2016; Clark et al., 2017)

- **National accounts vs other sources on living standards**

(Deaton, 2005; Chen and Nordhaus, 2011; Henderson et al., 2012; Young, 2012; Pinkovskiy and Sala-i Martin, 2014, 2016a, 2016b)

- **Forensic economics**

(Fisman and Wei, 2004, 2009; Olken, 2007; Zinman and Zitzewitz, 2016)

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Democracies and autocracies may differ in economic structure

- True economic growth in democracies is given by baseline rate $y_{i,t}^d$, which is different from the growth rate of autocracies by shifter α

$$\tilde{y}_{i,t} = y_{i,t}^d + \alpha a_{i,t} \quad (1)$$

- We can think of y^d as the share-weighted sum of growths in a partition of output in democracies (by sector, location, etc.)

$$y^d = \sum_{k=1}^n \text{share}_k^{\text{dem}} \times \text{growth}_k^{\text{dem}}$$

- α is then equal to the sum of adjustments for autocracies

$$\alpha = \sum_{k=1}^n \text{share}_k^{\text{aut}} \times \text{growth}_k^{\text{aut}} - \text{share}_k^{\text{dem}} \times \text{growth}_k^{\text{dem}}$$

GDP and lights correlate with growth, but only GDP can be inflated

- Recorded GDP growth is a noisy measure of true growth ($\beta > 0$)

$$\text{gdp}_{i,t} = \beta \tilde{y}_{i,t} + \epsilon_{i,t} \quad (2)$$

- Reported GDP growth may be inflated in autocracies ($\theta \geq 0$)

$$\widehat{\text{gdp}}_{i,t} = \text{gdp}_{i,t} + \theta a_{i,t} \quad (3)$$

- Night lights growth is also a noisy measure of true growth, that
 - (i) may not capture growth in all regimes equally well ($\gamma^d \neq \gamma^a$)
 - (ii) can't be manipulated

$$\text{lights}_{i,t} = \gamma^d y_{i,t}^d + \gamma^a \alpha a_{i,t} + u_{i,t} \quad (4)$$

Correlation between autocracy and GDP, conditional on lights, is uninformative on manipulation

- Combining (1)-(4) we obtain:

$$\widehat{\text{gdp}}_{i,t} = \frac{\beta}{\gamma^d} \text{lights}_{i,t} + (\lambda + \theta) a_{i,t} + \eta_{i,t}, \quad \lambda \equiv \left(1 - \frac{\gamma^a}{\gamma^d}\right) \beta \alpha \quad (5)$$

- Autocracy coefficient conflates constant bias with differences in the source of economic growth that are not captured equally well by nighttime lights

Proportional exaggeration can be detected through interaction of lights and autocracy

- What if there is proportional exaggeration in autocracies? (i.e. $\sigma \geq 0$)

$$\widehat{\text{gdp}}_{i,t} = (1 + \sigma a_{i,t})\text{gdp}_{i,t} + \theta a_{i,t} \quad (3')$$

$$\Rightarrow \widehat{\text{gdp}}_{i,t} = \frac{\beta}{\gamma^d} \text{lights}_{i,t} + \frac{\beta\sigma}{\gamma^d} (\text{lights}_{i,t} \times a_{i,t}) + (\lambda + \theta + \sigma\epsilon) a_{i,t} + \sigma\lambda a_{i,t}^2 + \nu_{i,t} \quad (6)$$

- Interaction coefficient is increasing in exaggeration
- σ can be backed out from night lights' coefficient and interaction of night lights with autocracy
- Correct specification includes the square of autocracy measure

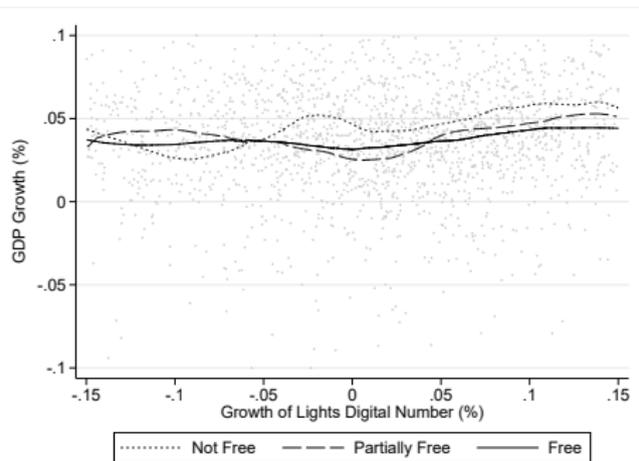
I follow Henderson et al. (2012) in taking the model to the data

- Rewrite (6) in log-linear form in levels
- Disaggregate error term into country, year and idiosyncratic components
- Use FWI (Freedom House) as measure of autocracy:

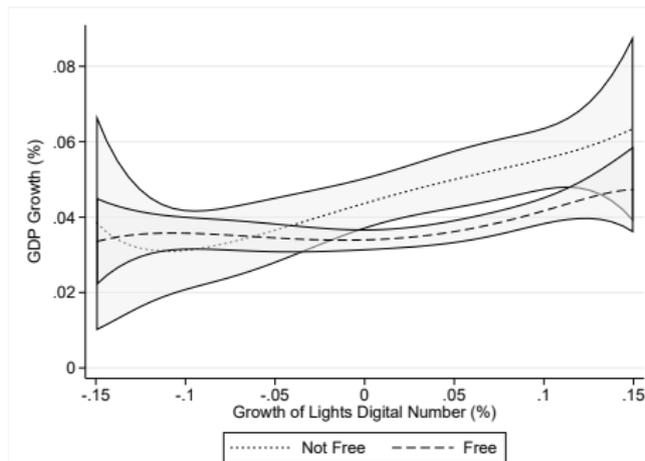
$$\begin{aligned} \ln(\text{GDP})_{i,t} = & \mu_i + \delta_t + \phi_0 \ln(\text{lights})_{i,t} + \phi_1 \text{FWI}_{i,t} + \phi_2 \text{FWI}_{i,t}^2 \\ & + \phi_3 (\ln(\text{lights})_{i,t} \times \text{FWI}_{i,t}) + \xi_{i,t} \end{aligned} \quad (7)$$

Non-parametric analysis shows a similar discrepancy

(a) Lowess smoothing

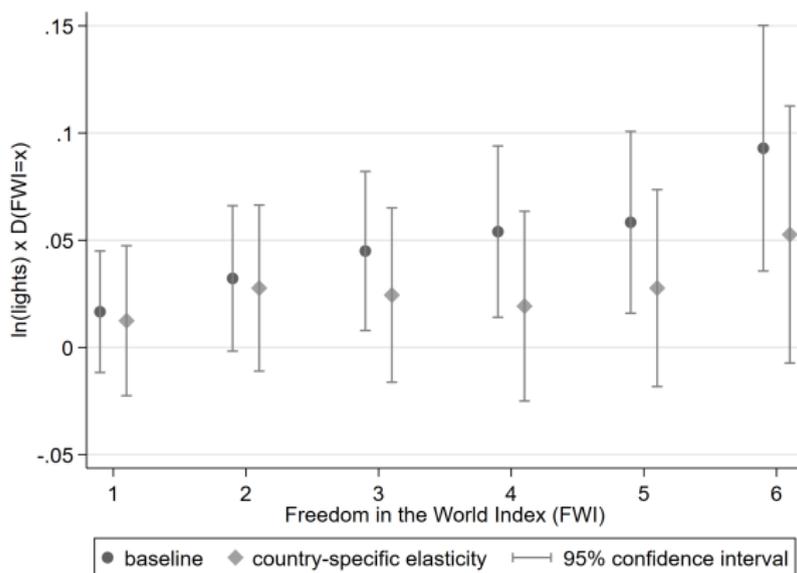


(b) Local polynomial smoothing



Note: Panel (a) shows the scatter of yearly growth in GDP and nighttime lights (DN). Also shown are separate Lowess locally-weighted regression estimates for 'free', 'partially free' and 'not free' countries. Countries are classified using the adjusted Freedom in the World Index (FWI), which ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Country is 'Free' if $FWI < 2$, 'Partially Free' if $2 \leq FWI < 4$ and 'Not Free' if $FWI \geq 4$. Panel (b) shows estimates and 95% confidence intervals of kernel-weighted local polynomial regressions for 'free' and 'not free' countries over the same sample. For this exercise, I use a quartic kernel and a third-order polynomial. The bandwidth for all regressions is 0.3. For these figures, observations with growth of lights DN below -0.15 or above 0.15 are excluded. See online appendix for corresponding figures with the full sample.

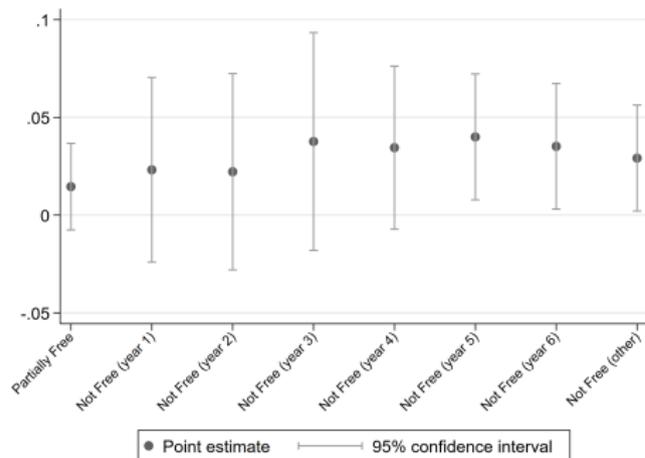
Steady increase in elasticity for larger values of FIW



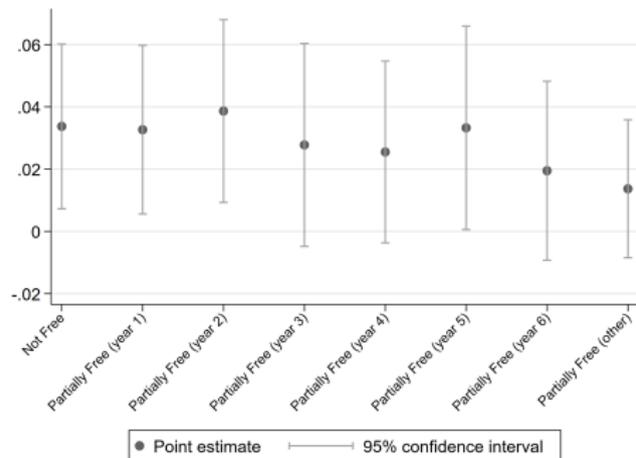
Note: The graph shows point estimates and 95% confidence intervals of a regression of $\ln(\text{GDP})$ on the interaction of $\ln(\text{lights})$ with each value of FWI (rounded to the nearest integer). Other regressors are $\ln(\text{lights})$ [not reported] and separate indicators for each value of FWI [also not reported, omitted category is $\text{FWI}=0$]. The round markers correspond to the baseline specification with country and year fixed effects (i.e. a fully disaggregated version of column 5 of Table 7). The diamond markers show results from an enlarged specification with a full set of interactions of $\ln(\text{lights})$ with country dummies [not reported]. Sample for both regressions includes 2,914 observations from 179 countries. Standard errors clustered by country.

Effect of regime change on elasticity detectable after 5-6 years

Into autocracy



Out of autocracy



Note: Each panel shows point estimates and 95% confidence intervals of a fixed-effects regression (country and year) of $\ln(\text{GDP})$ on $\ln(\text{lights})$ [not reported] and its interaction with dummies for 'partially free,' and 'not free' countries, as defined by the Freedom in the World Index (FWI) (the interaction with 'free' is the omitted category). In panel (a), the interaction with 'not free' countries is disaggregated into individual ones for the first six years after a transition (i.e. becoming 'Not Free') and a separate interaction for all other 'not Free' country-years. Only countries with six consecutive years of 'not Free' status after a transition contribute to the transition estimates. Panel (b) includes equivalent disaggregate interactions for the first six years after a transition out of 'not Free' status. Both regressions also include dummies for the relevant 'partially free' and 'not free' categories [not reported]. Sample for both regressions includes 2,914 observations from 179 countries. Standard errors clustered by country.

Results not explained by changes in GDP composition

	Dependent variable: $\ln(\text{GDP})_{i,t}$					
	Baseline (1)	Consumption (2)	Investment (3)	Government (4)	Exports (5)	Imports (6)
$\ln(\text{lights})_{i,t}$	0.215*** [0.030]	0.199*** [0.038]	0.194*** [0.028]	0.241*** [0.033]	0.216*** [0.031]	0.208*** [0.033]
$\text{FWI}_{i,t}$	0.003 [0.023]	0.001 [0.023]	0.003 [0.023]	-0.000 [0.022]	0.005 [0.022]	0.003 [0.022]
$\text{FWI}_{i,t}^2$	-0.001 [0.004]	-0.001 [0.004]	-0.001 [0.004]	-0.000 [0.004]	-0.001 [0.004]	-0.001 [0.004]
$x_{i,t}$		-0.004*** [0.001]	0.004*** [0.001]	-0.004** [0.002]	0.002 [0.001]	-0.001 [0.001]
$\ln(\text{lights})_{i,t} \times \text{FWI}_{i,t}$	0.008* [0.004]	0.008** [0.004]	0.008* [0.004]	0.008* [0.004]	0.007* [0.004]	0.009** [0.004]
$\ln(\text{lights})_{i,t} \times x_{i,t}$		-0.000 [0.000]	0.001* [0.000]	-0.002 [0.001]	-0.000 [0.000]	0.000 [0.000]
Observations	2,624	2,624	2,624	2,624	2,624	2,624
Countries	167	167	167	167	167	167
(Within country) R ²	0.785	0.812	0.794	0.788	0.789	0.789

Notes: Dependent variable is $\ln(\text{GDP})$ in constant local currency units. $\ln(\text{lights})$ is the natural logarithm of the area-weighted average of grid-level lights digital number (0-63). The adjusted Freedom in the World Index (FWI) ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Column 1 replicates the baseline specification for the reduced sample for which GDP composition data is available. Regressions in columns 2-6 include the percentage of GDP corresponding to the category in the header and its interaction with $\ln(\text{lights})$ as additional controls: 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. All regressions include country and year fixed effects. Robust standard errors clustered by country are shown in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Results not driven by changes in economic structure

	Dependent variable: $\ln(\text{GDP})_{i,t}$						
	Agriculture		Nat. resources	Oil	Industry	Manufacturing	Services
	(% land)	(% GDP)	(% GDP)	(% GDP)	(% GDP)	(% GDP)	(% GDP)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\ln(\text{lights})_{i,t}$	0.240*** [0.043]	0.265*** [0.044]	0.230*** [0.037]	0.220*** [0.052]	0.223*** [0.043]	0.199*** [0.045]	0.254*** [0.039]
$\text{FWI}_{i,t}$	-0.005 [0.023]	0.004 [0.022]	-0.003 [0.022]	0.016 [0.026]	0.001 [0.023]	0.003 [0.025]	0.001 [0.023]
$\text{FWI}^2_{i,t}$	0.000 [0.004]	-0.001 [0.004]	-0.001 [0.004]	-0.005 [0.005]	-0.001 [0.004]	-0.001 [0.005]	-0.000 [0.004]
$x_{i,t}$	0.000 [0.002]	-0.009*** [0.002]	0.003 [0.002]	0.002 [0.003]	0.003 [0.002]	0.002 [0.002]	-0.000 [0.001]
$\ln(\text{lights})_{i,t} \times \text{FWI}_{i,t}$	0.012*** [0.004]	0.013*** [0.004]	0.009** [0.004]	0.015** [0.006]	0.012*** [0.004]	0.011** [0.005]	0.012*** [0.004]
$\ln(\text{lights})_{i,t} \times x_{i,t}$	-0.000 [0.001]	-0.002** [0.001]	0.001** [0.001]	-0.000 [0.001]	0.000 [0.001]	0.002** [0.001]	-0.000 [0.001]
Observations	2,898	2,650	2,877	2,101	2,562	2,456	2,562
Countries	179	170	178	133	167	164	167
(Within country) R^2	0.776	0.802	0.785	0.794	0.787	0.786	0.783

Notes: Dependent variable is $\ln(\text{GDP})$ in constant local currency units. $\ln(\text{lights})$ is the natural logarithm of the area-weighted average of grid-level lights digital number (0-63). The adjusted Freedom in the World Index (FWI) ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Each column includes the variable in the header (x) and its interaction with $\ln(\text{lights})$ as additional controls. All these variables correspond to sectoral shares of GDP (expressed as a percentage) except for column 1, which is the percentage of land devoted to agriculture. All regressions include country and year fixed effects. Robust standard errors, clustered by country, are shown in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Results not explained by differences in economic development

	Dependent variable: $\ln(\text{GDP})_{i,t}$						
	Initial values		Population		Access to electricity		
	$\ln(\text{GDP})$ (1)	$\ln(\text{lights})$ (2)	$\ln(\text{Total})$ (3)	Urban share (4)	Total (5)	Urban (6)	Rural (7)
$\ln(\text{lights})_{i,t}$	0.325*** [0.095]	0.232*** [0.036]	-0.144 [0.146]	0.287*** [0.043]	0.217*** [0.045]	0.241*** [0.047]	0.223*** [0.042]
$\text{FWI}_{i,t}$	-0.004 [0.023]	-0.004 [0.023]	-0.004 [0.024]	-0.011 [0.023]	-0.002 [0.023]	-0.014 [0.025]	0.002 [0.023]
$\text{FWI}^2_{i,t}$	-0.000 [0.004]	-0.000 [0.004]	-0.000 [0.004]	0.001 [0.004]	-0.001 [0.004]	0.000 [0.005]	-0.001 [0.004]
$x_{i,t}$			0.079 [0.114]	0.004 [0.004]	-0.001 [0.001]	0.001 [0.001]	-0.000 [0.001]
$\ln(\text{lights})_{i,t} \times \text{FWI}_{i,t}$	0.012*** [0.004]	0.011** [0.004]	0.011*** [0.004]	0.010** [0.004]	0.012*** [0.004]	0.011** [0.005]	0.008* [0.005]
$\ln(\text{lights})_{i,t} \times x_{i,t}$	-0.009 [0.008]	-0.005 [0.010]	0.026** [0.010]	-0.001* [0.001]	0.000 [0.000]	-0.000 [0.000]	0.000 [0.000]
Observations	2,914	2,914	2,914	2,914	2,847	2,220	2,776
Countries	179	179	179	179	178	170	175
(Within country) R^2	0.778	0.777	0.780	0.779	0.782	0.808	0.775

Notes: Dependent variable is $\ln(\text{GDP})$ in constant local currency units. $\ln(\text{lights})$ is the natural logarithm of the area-weighted average of grid-level lights digital number (0-63). The adjusted Freedom in the World Index (FWI) ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Each column includes the variable in the header (x) [if time-varying] and its interaction with $\ln(\text{lights})$ as additional controls. In column 1, the natural log of GDP in 1992, or the first available year; In column 2, the 1992-1994 average of $\ln(\text{lights})$; The specification in column 3 includes log population while the one in column 4 uses the percentage of population living in urban areas; The percentage with access to electricity in column 5; the percentages of urban and rural population with access to electricity, respectively, in columns 6 and 7. All regressions include country and year fixed effects. Robust standard errors, clustered by country, are shown in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Results not explained by differences in human capital or informality

	Dependent variable: $\ln(\text{GDP})_{i,t}$							
	Education		Health		Informality			
	Mean years of schooling (1)	Net primary enrolment rate (2)	Life expectancy (3)	Infant mortality rate (4)	Firms starting formal (5)	Years before formalizing (6)	Competition from informals (7)	Constrained by informals (8)
$\ln(\text{lights})_{i,t}$	0.236*** [0.045]	0.195*** [0.054]	0.165* [0.086]	0.256*** [0.040]	0.309** [0.130]	0.263*** [0.046]	0.279*** [0.071]	0.300*** [0.062]
$\text{FWI}_{i,t}$	-0.014 [0.024]	0.020 [0.026]	-0.016 [0.023]	-0.024 [0.022]	0.002 [0.026]	0.001 [0.026]	-0.001 [0.025]	-0.001 [0.024]
$\text{FWI}^2_{i,t}$	0.003 [0.004]	-0.002 [0.005]	0.002 [0.004]	0.004 [0.004]	-0.001 [0.005]	-0.001 [0.005]	-0.001 [0.004]	-0.001 [0.004]
$x_{i,t}$	-0.000 [0.019]	-0.001 [0.001]	0.013*** [0.003]	-0.006*** [0.001]				
$\ln(\text{lights})_{i,t} \times \text{FWI}_{i,t}$	0.013*** [0.004]	0.011** [0.005]	0.013*** [0.004]	0.012*** [0.004]	0.010** [0.004]	0.010** [0.004]	0.010** [0.004]	0.010** [0.004]
$\ln(\text{lights})_{i,t} \times x_{i,t}$	-0.000 [0.005]	-0.001 [0.001]	0.001 [0.001]	-0.001* [0.000]	-0.001 [0.001]	-0.019 [0.022]	-0.000 [0.001]	-0.002 [0.002]
Observations	2,553	1,595	2,855	2,914	2,161	2,161	2,209	2,195
Countries	173	164	178	179	130	130	133	132
(Within country) R^2	0.791	0.824	0.788	0.788	0.790	0.790	0.787	0.787

Notes: Dependent variable is $\ln(\text{GDP})$ in constant local currency units. $\ln(\text{lights})$ is the natural logarithm of the area-weighted average of grid-level lights digital number (0-63). The adjusted Freedom in the World Index (FWI) ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Each column includes the variable in the header (x) [if time-varying] and its interaction with $\ln(\text{lights})$ as additional controls. In column 1, the mean number of years of schooling; In column 2, the net primary enrolment rate; The specification in column 3 includes life expectancy while the one in column 4 uses the infant mortality rate; Columns 5-8 include various time-invariant measures of informality, which were recorded for some countries after the end of the sample period: 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. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Results not driven by changes in characteristics of night lights

	Dependent variable: $\ln(\text{GDP})_{i,t}$							
	Lights quartic (1)	Year FE x lights (2)	Latitude, longitude (3)	Region FE x lights (4)	Area (5)	Top-coding (6)	Unlit cells (7)	Lights Gini (8)
$\ln(\text{lights})_{it}$	0.233*** [0.043]	0.231*** [0.034]	0.232*** [0.047]	0.349*** [0.103]	0.054 [0.100]	0.225*** [0.036]	0.050 [0.097]	0.438*** [0.114]
$\text{FWI}_{i,t}$	-0.003 [0.023]	-0.003 [0.022]	-0.003 [0.023]	-0.008 [0.023]	-0.001 [0.023]	-0.001 [0.022]	-0.001 [0.023]	-0.005 [0.023]
$\text{FWI}^2_{i,t}$	-0.000 [0.004]	-0.000 [0.004]	-0.000 [0.004]	0.000 [0.004]	-0.001 [0.004]	-0.001 [0.004]	-0.001 [0.004]	0.000 [0.004]
$x_{i,t}$						0.013** [0.006]	-0.067** [0.028]	0.506* [0.278]
$\ln(\text{lights})_{it} \times \text{FWI}_{i,t}$	0.011*** [0.004]	0.013*** [0.004]	0.011*** [0.004]	0.009** [0.004]	0.010** [0.004]	0.012*** [0.004]	0.011*** [0.004]	0.012*** [0.004]
$\ln(\text{lights})_{it} \times x_{i,t}$					0.017* [0.009]	0.001 [0.002]	0.017* [0.009]	-0.195* [0.108]
Observations	2,914	2,914	2,914	2,914	2,914	2,914	2,914	2,914
Countries	179	179	179	179	179	179	179	179
(Within country) R^2	0.780	0.778	0.780	0.790	0.779	0.779	0.779	0.778

Notes: Dependent variable is $\ln(\text{GDP})$ in constant local currency units. $\ln(\text{lights})$ is the natural logarithm of the area-weighted average of grid-level lights digital number (0-63). The adjusted Freedom in the World Index (FWI) ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Each column includes the variable x in the header (if time-varying) and its interaction with $\ln(\text{lights})$. The model in column 1 includes a quartic polynomial in $\ln(\text{lights})$ [coefficients on the higher powers not reported]. In column 2, $\ln(\text{lights})$ is interacted with 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, $\ln(\text{lights})$ is interacted with 17 subregional fixed effects (estimates not shown); In column 5, the natural log of permanent ice-free land area in square km; 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 night lights. All regressions include country and year fixed effects. Robust standard errors, clustered by country, are shown in brackets.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Results not explained by changes in statistical capacity

	Dependent variable: $\ln(\text{GDP})_{i,t}$											
	Time-invariant binary measure of statistical capacity											Data quality score (12)
	Baseline (reduced sample) (1)	Nat. acc. base year ≥ 1991 (2)	CPI base year ≥ 1991 (3)	Pop. census ≥ 1991 (4)	Agr. census ≥ 1991 (5)	BOP manual v5 (6)	SDDS (7)	Vital registr. system (8)	External debt is actual (9)	Industrial production index (10)	Imp/Exp price index (11)	
$\ln(\text{lights})_{i,t}$	0.273*** [0.045]	0.248*** [0.046]	0.274*** [0.059]	0.276*** [0.045]	0.279*** [0.052]	0.242*** [0.072]	0.280*** [0.048]	0.253*** [0.047]	0.265*** [0.071]	0.283*** [0.048]	0.279*** [0.047]	0.267*** [0.069]
$\text{FWI}_{i,t}$	0.010 [0.028]	0.012 [0.028]	0.010 [0.028]	0.010 [0.028]	0.011 [0.028]	0.011 [0.028]	0.008 [0.027]	0.011 [0.028]	0.010 [0.028]	0.007 [0.028]	0.009 [0.028]	0.010 [0.028]
$\text{FWI}^2_{i,t}$	-0.002 [0.005]	-0.002 [0.005]	-0.002 [0.005]	-0.002 [0.005]	-0.002 [0.005]	-0.002 [0.005]	-0.002 [0.005]	-0.002 [0.005]	-0.002 [0.005]	-0.002 [0.005]	-0.002 [0.005]	-0.002 [0.005]
$\ln(\text{lights})_{i,t} \times \text{FWI}_{i,t}$	0.008* [0.005]	0.009** [0.004]	0.008* [0.005]	0.008* [0.004]	0.008* [0.005]	0.009* [0.005]	0.007 [0.005]	0.009** [0.004]	0.008* [0.005]	0.008 [0.005]	0.008* [0.005]	0.008* [0.005]
$\ln(\text{lights})_{i,t} \times x_i$		0.056 [0.060]	-0.003 [0.054]	-0.004 [0.055]	-0.020 [0.051]	0.038 [0.070]	-0.051 [0.048]	0.044 [0.066]	0.010 [0.069]	-0.051 [0.071]	-0.044 [0.060]	0.001 [0.012]
Observations	1,938	1,938	1,938	1,938	1,938	1,938	1,938	1,938	1,938	1,938	1,938	1,938
Countries	117	117	117	117	117	117	117	117	117	117	117	117
(Within country) R^2	0.785	0.786	0.785	0.785	0.785	0.785	0.785	0.785	0.785	0.785	0.785	0.785

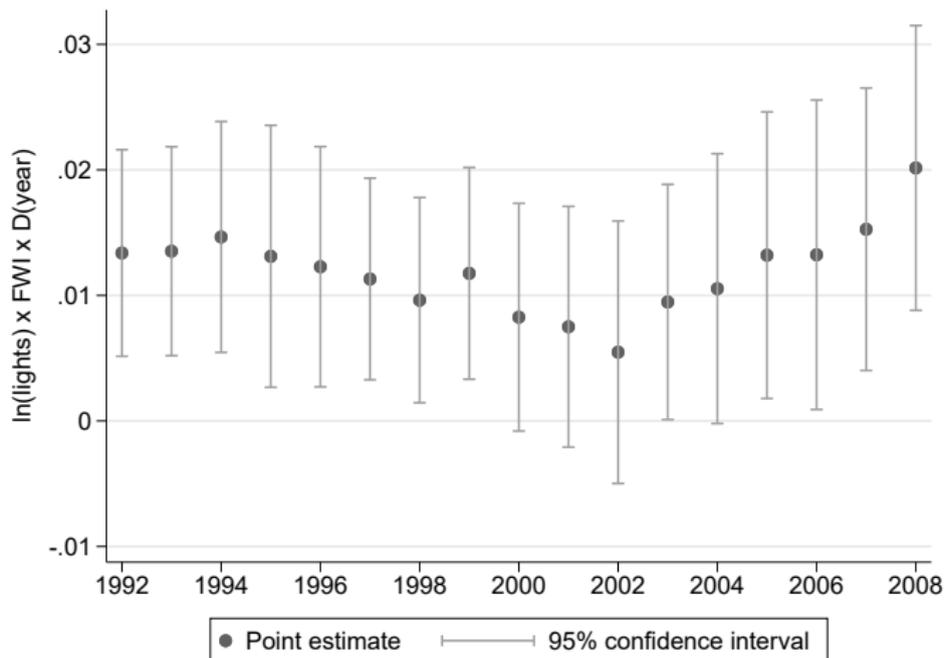
Notes: Dependent variable is $\ln(\text{GDP})$ in constant local currency units. $\ln(\text{lights})$ is the natural logarithm of the area-weighted average of grid-level lights digital number (0-63). The adjusted Freedom in the World Index (FWI) ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Column 1 shows the baseline specification for the reduced sample for which cross-sectional data on statistical capacity is available from the World Bank (2002). Starting in column 2, each column includes the interaction of the variable in the header (x_i) with $\ln(\text{lights})$: in columns 2 and 3, respective dummies if the base year of the national accounts or the consumer price index is more recent than 1991. In columns 4 and 5, respective dummies if there was a population or agricultural census after 1991. In columns 6 and 7, dummies for the adoption of the Balance of Payments manual v. 5 or the Special Data Dissemination Standard. In column 8, a dummy for the existence of a vital registration system. In column 9, a dummy if information on external debt is actual or preliminary (rather than estimated). In columns 10 and 11, dummies for the availability of a industrial production index or an import/export price index. In column 12, the data quality score, which ranges from 0 to 10 with higher values corresponding to better data quality. All regressions include country and year fixed effects. Robust standard errors, clustered by country, are shown in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Results not explained by changes in observable measures of corruption

	Dependent variable: $\ln(\text{GDP})_{i,t}$								
	Corruption Perception Index (CPI)			Control of Corruption Index (CCI)			Transparency index (HRV)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\ln(\text{lights})_{i,t}$	0.130*** [0.041]	0.219*** [0.056]	0.167*** [0.048]	0.172*** [0.035]	0.201*** [0.033]	0.172*** [0.034]	0.270*** [0.037]	0.296*** [0.033]	0.269*** [0.035]
$\text{FWI}_{i,t}$	-0.005 [0.022]		-0.005 [0.021]	0.002 [0.024]		0.009 [0.024]	0.016 [0.027]		0.018 [0.027]
$\text{FWI}_{i,t}^2$	0.000 [0.005]		0.001 [0.005]	-0.001 [0.004]		-0.002 [0.004]	-0.003 [0.005]		-0.004 [0.005]
$\ln(\text{lights})_{i,t} \times \text{FWI}_{i,t}$	0.020*** [0.007]		0.020*** [0.007]	0.009* [0.005]		0.008* [0.004]	0.009** [0.004]		0.007* [0.004]
$x_{i,t}$		0.023* [0.013]	0.024* [0.013]		0.047* [0.026]	0.044* [0.025]		0.012 [0.008]	0.012 [0.007]
$\ln(\text{lights})_{i,t} \times x_{i,t}$		-0.009* [0.005]	-0.008 [0.005]		-0.010 [0.011]	-0.004 [0.010]		-0.009** [0.004]	-0.007** [0.003]
Observations	1,310	1,310	1,310	1,705	1,705	1,705	2,015	2,015	2,015
Countries	169	169	169	178	178	178	122	122	122
(Within country) R ²	0.796	0.795	0.800	0.762	0.761	0.764	0.824	0.823	0.827

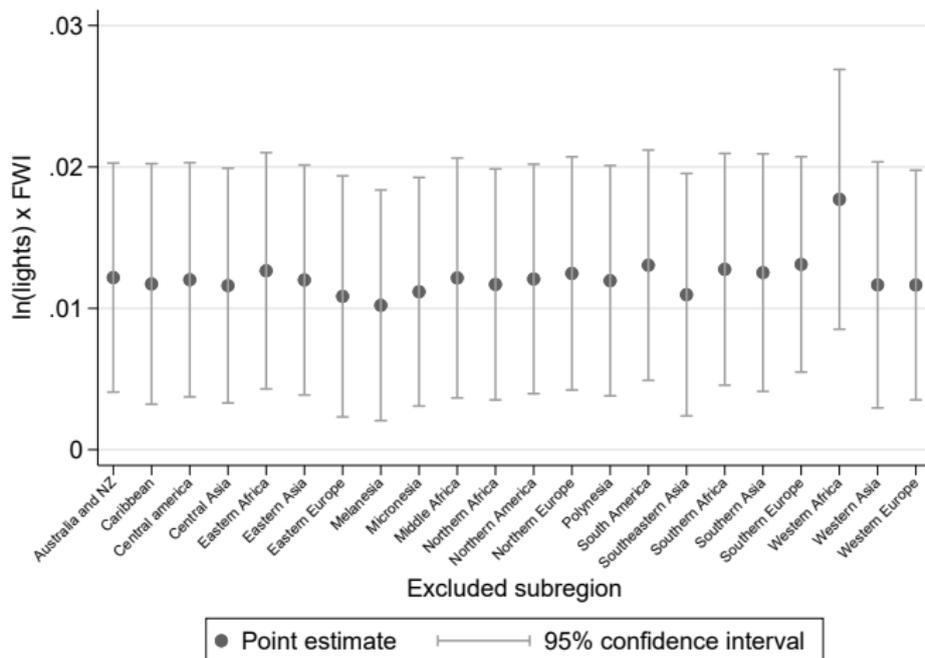
Notes: Dependent variable is $\ln(\text{GDP})$ in constant local currency units. $\ln(\text{lights})$ is the natural logarithm of the area-weighted average of grid-level lights digital number (0-63). The adjusted Freedom in the World Index (FWI) ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. The Corruption Perceptions Index (CPI) used in columns 1-3 is produced by Transparency International and has been re-scaled from 0 to 10, with larger values corresponding to decreased perception of corruption. The Control of Corruption Index (CCI) used in columns 4-6 is produced by the World Bank and ranges from -2.5 to 2.5, with larger values corresponding to decreased perception of corruption. The source of the HRV transparency index used in columns 7-9 is Hollyer et al. (2014). The HRV transparency index is based on data availability in the World Bank's WDI, with larger values corresponding to increased availability of information and transparency. Observed values of the HRV index range from -3.04 to 9.98. All regressions include country and year fixed effects. Robust standard errors, clustered by country, are shown in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Results are not driven by any particular year or period



Note: Panel shows point estimates and 95% confidence intervals for a regression of $\ln(\text{GDP})$ on a full set of triple interactions of year indicators, $\ln(\text{lights})$ and FWI. Other regressors are $\ln(\text{lights})$, FWI, FWI squared, and separate year interactions with $\ln(\text{lights})$ and FWI. Regression includes country and year fixed effects. Standard errors clustered by country. Sample includes 2,914 observations from 179 countries.

Results are not driven by any particular country or region



Note: Graph shows point estimates and 95% confidence intervals from regressions of $\ln(\text{GDP})$ on the interaction of $\ln(\text{lights})$ and the Freedom in the World Index (FWI) in which the subregion indicated at the bottom has been excluded from the sample. Other regressors [estimates not shown] are $\ln(\text{lights})$, FWI and FWI squared, as well as country and year fixed effects. Standard errors clustered by country. Subregional classification is based on the United Nations geoscheme.

GDP exaggerated by a factor of 1.15-1.2 in authoritarian regimes

	Dependent variable: $\ln(\text{GDP})_{i,t}$						
	Polity IV indices			Binary measures of autocracy			
	Polity2 (1)	Democracy (2)	Autocracy (3)	FH (4)	ANRR (5)	PS (6)	DD (7)
$\ln(\text{lights})_{i,t}$	0.293*** [0.029]	0.267*** [0.032]	0.247*** [0.030]	0.261*** [0.031]	0.277*** [0.029]	0.272*** [0.045]	0.274*** [0.032]
$\text{score}_{i,t}$	-0.004* [0.002]	-0.005 [0.010]	-0.015 [0.012]	0.050** [0.021]	0.023 [0.020]	0.053* [0.031]	0.017 [0.023]
$\text{score}^2_{i,t}$	0.000 [0.000]	0.000 [0.001]	0.003* [0.002]				
$\ln(\text{lights})_{i,t} \times \text{score}_{i,t}$	-0.002** [0.001]	-0.002 [0.002]	0.005** [0.002]	0.031*** [0.010]	0.020*** [0.007]	0.040*** [0.015]	0.016 [0.011]
Observations	2,531	2,458	2,458	2,881	2,531	1,936	2,911
Countries	156	155	155	177	156	167	179
(Within country) R^2	0.783	0.793	0.795	0.773	0.783	0.683	0.773

Notes: Dependent variable is $\ln(\text{GDP})$ in constant local currency units. $\ln(\text{lights})$ is the natural logarithm of the area-weighted average of grid-level lights digital number (0-63). The Polity2 score from the Polity IV project (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. The autocracy measure in column 4 is defined as one minus the 'electoral democracy' dummy produced by Freedom House. In column 5, the autocracy dummy equals one if the country is classified by Freedom House as 'not free' or the Polity score is less than or equal to zero, following Acemoglu et al. (2016). Column 6 uses the democracy indicator produced by Papaioannou and Siourounis (2008). Column 8 uses the dummy for autocracy from the DD dataset by Cheibub et al. (2010), which is an updated version of the Przeworski et al. (2000) dataset. All regressions include country and year fixed effects. Robust standard errors, clustered by country, are shown in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Results robust to modified specification

	Dependent variable: $\ln(\text{GDP})_{i,t}$				Dependent variable: $\Delta \ln(\text{GDP})_{i,t}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\ln(\text{lights})_{i,t}$	0.156*** [0.036]	0.167*** [0.029]	-0.013 [0.014]	0.002 [0.027]				
$\Delta \ln(\text{lights})_{i,t}$					0.060** [0.024]	0.001 [0.013]	0.006 [0.013]	0.002 [0.014]
$\text{FWI}_{i,t}$	0.016 [0.018]	-0.001 [0.024]	0.008 [0.009]	-0.001 [0.018]		0.018** [0.008]	0.017** [0.008]	0.026 [0.019]
$\text{FWI}_{i,t}^2$	-0.002 [0.003]	-0.001 [0.004]	-0.001 [0.002]	-0.001 [0.003]		-0.004*** [0.001]	-0.004*** [0.002]	-0.008*** [0.003]
$\ln(\text{lights})_{i,t} \times \text{FWI}_{i,t}$	0.009** [0.004]	0.011** [0.004]	0.009*** [0.003]	0.013*** [0.005]				
$\Delta \ln(\text{lights})_{i,t} \times \text{FWI}_{i,t}$						0.027*** [0.009]	0.024*** [0.009]	0.029*** [0.009]
$\ln(\text{lights})_{i,t-1}$		0.098*** [0.025]						
$\ln(\text{GDP})_{i,t-1}$			0.870*** [0.030]	1.000*** [0.078]			-0.104*** [0.020]	0.048 [0.049]
Observations	2,914	2,736	2,724	2,724	2,811	2,724	2,724	2,724
Countries	179	179	179	179	188	179	179	179
(Within country) R ²	0.906	0.782	0.952		0.097	0.150	0.204	
Country-specific time trend	Yes	No	No	No	No	No	No	No
Estimation	OLS	OLS	OLS	GMM	OLS	OLS	OLS	GMM

Notes: The dependent variable in columns 1-4 is $\ln(\text{GDP})$ in constant local currency units. The dependent variable in columns 5-8 is the yearly change in $\ln(\text{GDP})$. $\ln(\text{lights})$ is the natural logarithm of the area-weighted average of grid-level lights digital number (0-63). The adjusted Freedom in the World Index (FWI) 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. Column 1 includes a country-specific time trend. The method of estimation in columns 4 and 8 is system-GMM (Blundell-Bond). Robust standard errors, clustered by country, are shown in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Only investment and government spending display autocracy gradient

Dependent variable:	ln(Consumption) (1)	ln(Investment) (2)	ln(Government) (3)	ln(Exports) (4)	ln(Imports) (5)
$\ln(\text{lights})_{i,t}$	0.161*** [0.033]	0.355*** [0.121]	0.202*** [0.051]	0.340*** [0.082]	0.262*** [0.059]
$\text{FWI}_{i,t}$	-0.016 [0.031]	-0.007 [0.057]	-0.048 [0.039]	-0.042 [0.058]	-0.056 [0.038]
$\text{FWI}^2_{i,t}$	0.001 [0.005]	-0.004 [0.011]	0.008 [0.007]	0.001 [0.010]	0.002 [0.006]
$\ln(\text{lights})_{i,t} \times \text{FWI}_{i,t}$	0.006 [0.006]	0.022** [0.011]	0.027*** [0.008]	0.005 [0.012]	0.008 [0.009]
Observations	2,624	2,622	2,624	2,624	2,624
Countries	167	167	167	167	167
(Within country) R^2	0.650	0.395	0.479	0.544	0.624

Notes: Dependent variable in the header (natural logarithm of value 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. $\ln(\text{lights})$ is the natural logarithm of the area-weighted average of grid-level lights digital number (0-63). The adjusted Freedom in the World Index (FWI) ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Regressions include country and year fixed effects. Robust standard errors clustered by country are shown in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Autocracy gradient larger in low-growth years and before elections

	Dependent variable: $\ln(\text{GDP})_{i,t}$			
	Low growth		Before election	
	(1)	(2)	(3)	(4)
$\ln(\text{lights})_{i,t}$	0.241*** [0.042]	0.258*** [0.040]	0.261*** [0.040]	0.287*** [0.035]
$\ln(\text{lights})_{i,t} \times x_{i,t}$	-0.008 [0.007]	-0.001 [0.005]	-0.002 [0.003]	-0.001 [0.002]
$\ln(\text{lights})_{i,t} \times \text{FWI}_{i,t}$	0.006 [0.004]		0.010** [0.004]	
$\ln(\text{lights})_{i,t} \times \text{FWI}_{i,t} \times x_{i,t}$	0.005* [0.003]		0.002 [0.001]	
$\ln(\text{lights})_{i,t} \times \text{D(Partially Free)}_{i,t}$		0.010 [0.012]		0.014 [0.012]
$\ln(\text{lights})_{i,t} \times \text{D(Not Free)}_{i,t}$		0.010 [0.014]		0.023* [0.013]
$\ln(\text{lights})_{i,t} \times \text{D(Partially Free)}_{i,t} \times x_{i,t}$		0.002 [0.009]		-0.001 [0.005]
$\ln(\text{lights})_{i,t} \times \text{D(Not Free)}_{i,t} \times x_{i,t}$		0.022* [0.012]		0.013** [0.005]
Observations	2,914	2,914	2,500	2,500
Countries	179	179	154	154
(Within country) R^2	0.781	0.778	0.781	0.779

Notes: Dependent variable is $\ln(\text{GDP})$ in constant local currency units. $\ln(\text{lights})$ is the natural logarithm of the area-weighted average of grid-level lights digital number (0-63). Adjusted Freedom in the World Index (FWI) ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Country is "Free" if $\text{FWI} < 2$, "Partially Free" if $2 \leq \text{FWI} < 4$ and "Not Free" if $\text{FWI} \geq 4$. D(Free) and its interactions are the omitted categories in columns 2 and 4. In columns 1-2, $x_{i,t}$ is a dummy equal to one if the value of $\ln(\text{lights})$ demeaned by country and year is negative. In columns 3-4, $x_{i,t}$ is a dummy equal to one if there is a national election in the following year. Only the estimates for $\ln(\text{lights})$ and its interactions are shown in the table. See the online appendix for full results. All regressions include country and year fixed effects. Robust standard errors, clustered by country, are shown in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

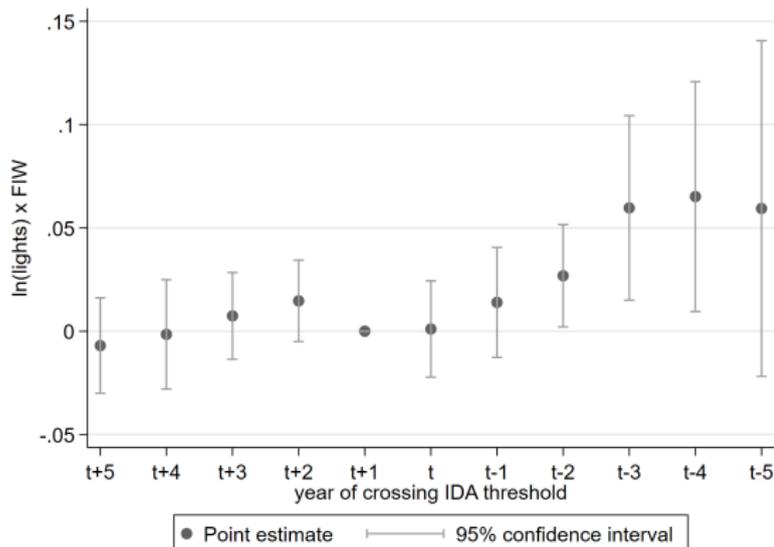
Back

Autocracy gradient only arises after losing eligibility for foreign aid

	Dependent variable: $\ln(\text{GDP})_{i,t}$							
	Baseline results (reduced sample)		Changing elasticity above GNI threshold			Galiani et al. (2017) crossings	Ineligible countries	Crossings ≤ 1
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\ln(\text{lights})_{i,t}$	0.252*** [0.037]	0.210*** [0.042]	0.233*** [0.037]	0.244*** [0.035]	0.226*** [0.041]	0.225*** [0.041]	0.239*** [0.041]	0.236*** [0.041]
$\ln(\text{lights})_{i,t} \times \text{FWI}_{i,t}$		0.012* [0.007]			0.004 [0.006]	0.004 [0.006]	0.004 [0.006]	0.001 [0.006]
$\ln(\text{lights})_{i,t} \times \text{D}(\text{GNI} > \text{threshold})_{i,t}$			0.061* [0.032]	0.081*** [0.025]	0.001 [0.035]	0.001 [0.037]	-0.000 [0.036]	-0.017 [0.029]
$\ln(\text{lights})_{i,t} \times \text{GNI}_{i,t}$				-0.048*** [0.010]	-0.043*** [0.010]	-0.040*** [0.010]	-0.046*** [0.011]	-0.049*** [0.009]
$\ln(\text{lights})_{i,t} \times \text{FWI}_{i,t} \times \text{D}(\text{GNI} > \text{threshold})_{i,t}$					0.023* [0.013]	0.023* [0.014]	0.024* [0.013]	0.028** [0.012]
Observations	1,308	1,308	1,308	1,308	1,308	1,308	1,357	1,274
Countries	82	82	82	82	82	82	85	80
(Within country) R ²	0.760	0.766	0.774	0.794	0.806	0.807	0.799	0.811

Notes: Dependent variable is $\ln(\text{GDP})$ in constant local currency units. $\ln(\text{lights})$ is the natural logarithm of the area-weighted average of grid-level lights digital number (0-63). The adjusted Freedom in the World Index (FWI) 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 using Atlas method. $\text{D}(\text{GNI} > \text{threshold})_{i,t}$ equals one if GNI per capita is above the yearly value set by IDA for eligibility for loans and grants. All regressions include the relevant individual variables and second-order interaction terms (estimates not reported). All regressions include country and year fixed effects. Robust standard errors clustered by country in brackets. Baseline sample includes all countries that were eligible for IDA aid at some point in the sample period (current + graduates). In column 6, I use the crossing dates reported by Galiani et al. (2017). In column 7, I include Syria, Turkmenistan and Ukraine, which were not excluded from IDA aid. In column 8, I exclude Guyana and Indonesia, which cross the threshold more than once. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Autocracy gradient only arises after becoming ineligible for foreign aid



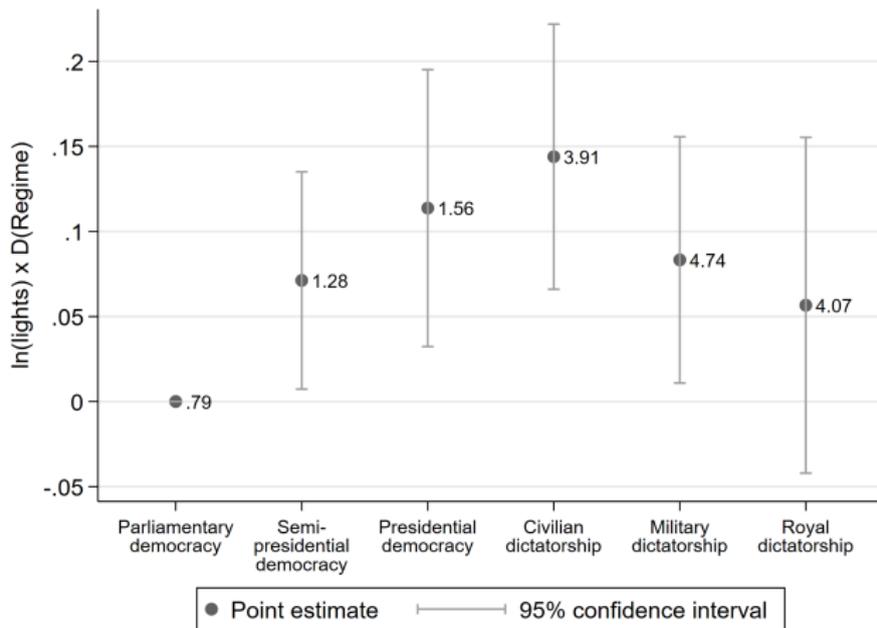
Note: The graph shows point estimates and 95% confidence intervals of a regression of $\ln(\text{GDP})$ on the triple interaction of $\ln(\text{lights})$ with FWI and with separate yearly dummies in a 10-year window around the crossing of the GNI threshold for IDA eligibility [Omitted category is the year before crossing]. Other regressors not reported include $\ln(\text{lights})$, FWI , FWI squared, a full set of dummies for all years before and after crossing (-11 to +11), as well as all second-order interactions between $\ln(\text{lights})$, FWI and the full set of event-year dummies. Regression also includes country and year fixed effects. Sample includes all IDA eligible countries that cross the threshold once at the most and that are observed for the entire 10-year window if crossing: 1,063 observations from 66 countries. Standard errors are clustered by country.

Autocracy gradient larger with weak checks and balances

	Dependent variable: $\ln(\text{GDP})_{i,t}$				
	Elected legislature (1)	Elected executive (2)	Central bank authority (3)	Constitutional court (4)	Communist history (5)
$\ln(\text{lights})_{i,t}$	0.098 [0.102]	0.220*** [0.040]	0.194*** [0.046]	0.225*** [0.032]	0.203*** [0.032]
$\ln(\text{lights})_{i,t} \times \text{FWI}_{i,t}$ [a]	0.049** [0.021]	0.019*** [0.006]	0.025*** [0.008]	0.024*** [0.007]	0.011** [0.004]
$\ln(\text{lights})_{i,t} \times x_{i,t}$	0.168* [0.092]	0.041** [0.020]	0.025 [0.025]	0.021 [0.016]	0.032 [0.057]
$\ln(\text{lights})_{i,t} \times \text{FWI}_{i,t} \times x_{i,t}$ [b]	-0.040* [0.022]	-0.012** [0.006]	-0.011** [0.005]	-0.013* [0.007]	0.022** [0.010]
Observations	2,451	2,490	2,073	2,416	2,914
Countries	153	154	139	152	179
(Within country) R^2	0.793	0.788	0.798	0.792	0.783
p-value $H_0: a + b = 0$	0.074	0.124	0.010	0.003	0.001

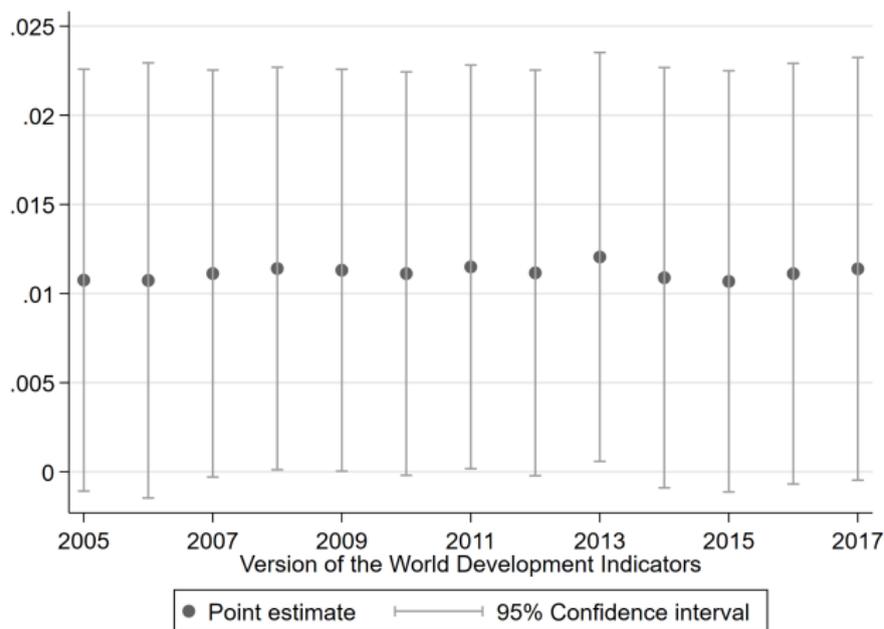
Notes: Dependent variable is $\ln(\text{GDP})$ in constant local currency units. $\ln(\text{lights})$ is the natural logarithm of the area-weighted average of grid-level lights digital number (0-63). The adjusted Freedom in the World Index (FWI) ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Each column includes the binary variable in the header (x) and all its interactions with $\ln(\text{lights})$ and FWI. In column 1, $x_{i,t}$ is a dummy indicating whether the country holds national elections for the legislature. In column 2, $x_{i,t}$ is a dummy indicating whether the country holds national elections for the executive. In column 3, $x_{i,t}$ is a dummy indicating whether the central bank has authority over monetary policy. In column 4, $x_{i,t}$ is a dummy indicating whether the country has a national constitutional court. In column 5, $x_{i,t}$ is a dummy indicating whether the country had had a communist regime at some point in time. These variables are time-varying with the exception of the dummy for communist history in column 5. All regressions include country and year fixed effects. Only the estimates for $\ln(\text{lights})$ and its interactions are shown in the table. See the online appendix for full results. Robust standard errors, clustered by country, are shown in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Not all autocracies (or democracies) are made equal



Note: Graph shows point estimates and 95% confidence intervals of a regression of $\ln(\text{GDP})$ on the interaction of $\ln(\text{lights})$ and five regime-type dummies. Other regressors include $\ln(\text{lights})$ and the five regime-type dummies (estimates not reported). These regime types correspond to the classification in the DD dataset by Cheibub et al. (2010). The omitted category is 'parliamentary democracy'. Reported next to each marker is the average value of FWI for that regime type. The regression also includes country and year fixed effects. Sample includes 2,911 observations from 179 countries. Standard errors are clustered by country.

Autocracy gradient does not disappear with GDP data revisions



Note: The figure shows point estimates and 95% confidence intervals for a set of fixed-effects regressions (country and year) of $\ln(\text{GDP})$ on $\ln(\text{lights})$ [not reported], FWI [not reported], and its interaction. Each estimate shown corresponds to a separate regression using GDP figures from a different version of the World Development Indicators (2005-2017). All regressions were estimated with a fixed sample of 1,970 observations from 173 countries between 1992 and 2003. Standard errors clustered by country.

Autocracy gradient not present among SDDS subscribers

	Dependent variable: $\ln(\text{GDP})_{i,t}$			
	Selection		Treatment effect	
	(1)	(2)	(3)	(4)
$\ln(\text{lights})_{i,t}$	0.231*** [0.040]	0.262*** [0.035]	0.242*** [0.040]	0.272*** [0.036]
$\ln(\text{lights})_{i,t} \times \text{D(SDDS country)}_i$	0.070 [0.055]	0.012 [0.051]	0.011 [0.053]	-0.038 [0.048]
$\ln(\text{lights})_{i,t} \times \text{FWI}_{i,t}$ [a]	0.013** [0.005]		0.012** [0.005]	
$\ln(\text{lights})_{i,t} \times \text{FWI}_{i,t} \times \text{D(SDDS country)}_i$ [b]	-0.016 [0.011]		-0.013 [0.012]	
$\ln(\text{lights})_{i,t} \times \text{D(Partially Free)}_{i,t}$		0.017 [0.014]		0.016 [0.014]
$\ln(\text{lights})_{i,t} \times \text{D(Not Free)}_{i,t}$		0.024 [0.016]		0.023 [0.016]
$\ln(\text{lights})_{i,t} \times \text{D(Partially Free)}_{i,t} \times \text{D(SDDS country)}_i$		-0.013 [0.026]		-0.012 [0.035]
$\ln(\text{lights})_{i,t} \times \text{D(Not Free)}_{i,t} \times \text{D(SDDS country)}_i$		0.023 [0.040]		0.037 [0.049]
$\ln(\text{lights})_{i,t} \times \text{D(SDDS)}_{i,t}$			0.010 [0.015]	0.009 [0.013]
$\ln(\text{lights})_{i,t} \times \text{FWI}_{i,t} \times \text{D(SDDS)}_{i,t}$ [c]			-0.007 [0.009]	
$\ln(\text{lights})_{i,t} \times \text{D(Partially Free)}_{i,t} \times \text{D(SDDS)}_{i,t}$				0.013 [0.025]
$\ln(\text{lights})_{i,t} \times \text{D(Not Free)}_{i,t} \times \text{D(SDDS)}_{i,t}$				-0.086** [0.035]
Observations	2,914	2,914	2,914	2,914
Countries	179	179	179	179
(Within country) R^2	0.778	0.775	0.781	0.778
p-value $H_0: a + b = 0$	0.289		0.980	
p-value $H_0: a + b + c = 0$			0.869	

Back

Notes: Dependent variable is $\ln(\text{GDP})$ in constant local currency units. $\ln(\text{lights})$ is the natural logarithm of the area-weighted average of grid-level lights digital number (0-63). Adjusted Freedom in the World Index (FWI) ranges from 0 to 6, with lower values corresponding to greater enjoyment of civil liberties and political rights. Country is "Free" if $\text{FWI} < 2$, "Partially Free" if $2 \leq \text{FWI} < 4$ and "Not Free" if $\text{FWI} \geq 4$. D(Free) and its interactions is omitted in even-numbered columns. D(SDDS country) ; is a dummy equal to one for countries that joined the SDDS during the sample period. $\text{D(SDDS)}_{i,t}$ is a dummy equal to one following subscription to the SDDS. All regressions include country and year fixed effects. They also include all lower order interactions (see Appendix for the full table). Robust standard errors, clustered by country, are shown in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$