Threshold effects in the income-corruption relationship: Evidence from long-run panel data*

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Abstract

Corruption—the abuse of public office for private gain—is closely associated with economic development. Yet, economic theory predicts multiple corruption equilibria separated by well-defined income thresholds, implying a non-linear relationship. Using long-run panel data and a regression kink model with unknown thresholds and two-way fixed effects, we test whether the income–corruption gradient changes across development regimes. We find robust evidence of a single threshold, located around USD 1,500–2,000 per capita (PPP). Below this level, income growth is not systematically associated with corruption control; above it, the relationship becomes negative and statistically significant. The single-kink model also generally outperforms linear and quadratic alternatives. However, we find no robust evidence of a second threshold, providing only partial support for existing multiple-equilibrium theories.

JEL Codes: D50, D73, O11, P48.

Keywords: Corruption, Economic Development, Regression Kink

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Abstract

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1 Introduction

It is now well established that the relationship between political corruption and economic development is negative and two-way causal. While extensive evidence shows that corruption hampers economic growth [e.g. Mauro (1995); Gründler and Potrafke (2019); Uberti (2022)], a large body of research demonstrates that corruption is itself shaped by the level of development [e.g. Gundlach and Paldam (2009); Bai et al. (2017)]. Together, these bi-directional effects imply a transition from corruption to honesty in the course of economic development (Paldam, 2021).

Existing models of corruption account for both sides of this relationship (Ehrlich and Lui, 2017; Sarte, 2000). Yet, they also show that economies may settle into multiple corruption equilibria separated by well-defined income thresholds (Blackburn et al., 2006). Typically, multiple equilibria arise because corrupt behaviour exhibits strategic complementarities: the incentive for a public agent to request or accept bribes depends on economy-wide variables, which in turn depend on the number of other public agents who behave similarly (Bruno, 2019). Yet, there is no systematic evidence that such income thresholds actually exist in the data. This limitation makes it difficult to validate and extend existing theories of corruption.

In this paper, we search for income thresholds by combining long-run historical data on the incidence of corruption from the Varieties of Democracy (V-Dem) project with the econometric methodology proposed by Hansen (2017). V-Dem publishes an expert-coded indicator of corruption at the country-year level with extensive historical coverage (Coppedge et al., 2020), allowing us to use within-country variation in the empirical analysis. Hansen (2017) develops methods for estimation and inference in a regression kink model with piecewise linear segments. This framework allows the income–corruption relationship to exhibit different linear slopes on either side of unknown thresholds. It also permits estimating and testing for one or more thresholds based on the data.

We make two empirical contributions to the existing literature on the relationship be-

tween income and corruption. First, in contrast to previous studies, which rely on cross-country regressions, we exploit *within-country* variation over a long historical span, holding time-invariant country characteristics constant. Second, we estimate a regression kink model with *unknown* threshold(s) (Hansen, 2017), allowing the income–corruption gradient to change discretely at endogenously estimated income levels. This approach maps closely to threshold predictions implied by economic theories of corruption while remaining fully data-driven.

We show that the transition from corruption to honesty is characterized by *a single* threshold occurring an income level of around USD 1,500–2,000 per capita: below it the income–corruption relationship is essentially flat, while above it the relationship becomes significantly negative. We find no robust evidence of an additional (higher-income) threshold consistent with a complete "honesty" regime, perhaps because no country has yet reached that stage. Our findings therefore provide only partial support for existing multiple-equilibrium theories of corruption and development. Beyond testing these theories, our findings are also relevant because they help identify which countries are most likely to experience improvements in corruption control as their economies develop.

The rest of the paper is organized as follows. Section 2 briefly reviews the literature. Section 3 presents the data, while section 4 outlines the empirical methods. The empirical results are reported in section 6.

2 Existing literature and contribution

A large empirical literature documents a strong, negative association between political corruption and economic development. Using cross-section data and perception-based indicators of corruption,[1] income per capita alone accounts for a substantial share of the cross-country variation in the perceived incidence of corruption (Ades and Di Tella, 1999; La Porta

[1] E.g., Transparency International's Corruption Perception Index (CPI) and the International Country Risk Guide's index.

et al., 1999; Treisman, 2000; Fisman and Gatti, 2000). Other contributions suggest that this relationship may be non-linear: for example, Saha and Gounder (2013) estimate a quadratic specification and find that corruption declines with income more strongly at higher levels of development, while Herzfeld and Weiss (2007) document a bimodal distribution of corruption indicators consistent with "corruption clubs" or multiple regimes. However, this empirical evidence remains largely indirect: it does not test whether distinct corruption regimes are separated by *income thresholds*, nor does it exploit within-country dynamics over long horizons.

This is an important gap in empirical evidence because economic theory predicts precisely such threshold effects. Dynamic general-equilibrium models such as Blackburn et al. (2006) (and extensions in Blackburn et al. 2008 and Haque and Kneller 2009) examine strategic complementarities in corrupt behaviour leading to multiple corruption equilibria separated by well-defined income thresholds.[2] These effects arise through mechanisms linked to public-sector incentives and wages, consistent with evidence that better-paid bureaucrats face weaker incentives to accept bribes (Rauch and Evans, 2000; Rijckeghem et al., 2001). Related frameworks generate history dependence or frequency dependence via alternative channels – e.g., monitoring and punishment (Andvig and Moene, 1990), entrepreneurial returns (Acemoglu, 1995), or collective reputation (Tirole, 1996).[3]

While these theories are useful for organizing intuition, there is still little or no systematic evidence on whether (and how many) income thresholds can be identified in the data.

[2] Blackburn et al. (2006) demonstrate that below a first threshold of per-capita income, it pays off for public agents to be corrupt irrespective of the decisions of other agents. For all income levels up to this threshold, there exists a pure-strategy equilibrium in which all agents are corrupt. As per-capita income rises beyond the first threshold, the incentive to engage in corruption is gradually eroded, producing a negative correlation between income and corruption. When income reaches a second threshold level, the incentive condition for corruption is violated regardless of how many public agents are corrupt. Beyond this threshold, another pure-strategy equilibrium emerges in which no public agent engages in corruption.

[3] These general-equilibrium theories build on a long tradition of partial-equilibrium models of corruption in micro-economics [see Aidt (2003) for a comprehensive review].

3 Data

We use data from V-Dem, which provides information on most countries worldwide since year 1900, or 1789 for some countries (Coppedge et al., 2020).[4] We focus on an index of political corruption (*v2x_corr*), computed as an unweighted average of four sub-components measuring corruption across the executive, administrative, legislative and judicial branches of the state. Thus, *v2x_corr* measures the pervasiveness of corruption, "tap[ping] into several [distinct] types of corruption: both 'petty' and 'grand'; both bribery and theft; both corruption aimed [at] influencing law-making and that affecting implementation." (Coppedge et al., 2020, 279).[5] The index runs approximately from 0 to 10, with 0 signifying no corruption and 10 denoting the greatest incidence of corruption. In our estimation sample, the index mean (standard deviation) is 4.86 (2.93) and its distribution is clearly bimodal (Figure 1), consistent with multiple equilibria. While the V-Dem index has much greater historical coverage than all other indicators of corruption, it is highly correlated with them.[6]

Income per capita is measured using the historical GDP series constructed by Fariss et al. (2017). They employ a dynamic latent-trait model that combines long-run GDP and population data to reduce measurement error and impute missing observations. The resulting dataset covers the period 1789–2014 and reports GDP per capita in constant 2011 PPP dollars. These historical GDP series have been widely used in recent empirical research, including Hummel et al. (2021) and Dahlum et al. (2022).

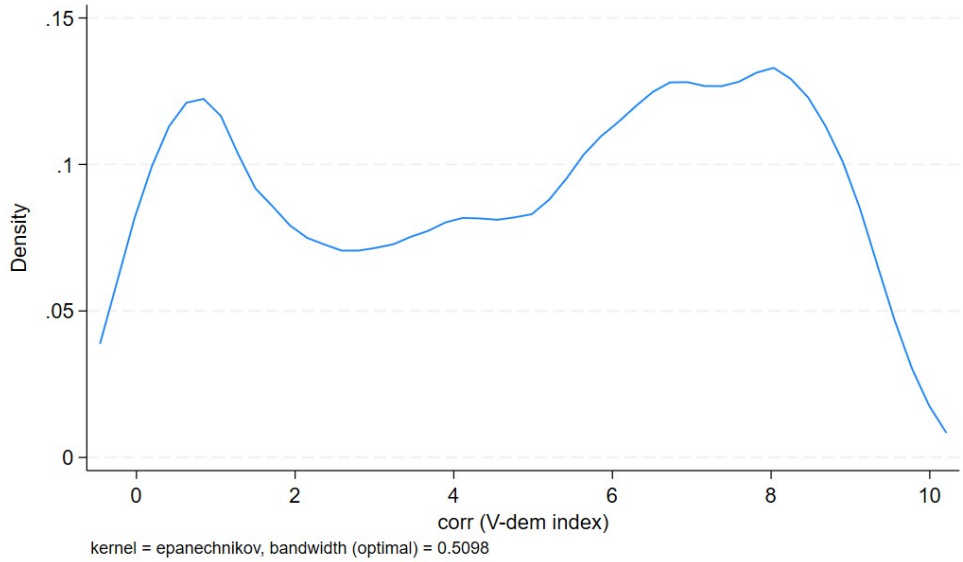
We also use other time-varying co-variates, including: a democracy index from V-Dem (polyarchy), population size from Fariss et al. (2017), life expectancy as a proxy for human

[4]The dataset also covers defunct polities (e.g. Kingdom of Prussia, Kingdom of Piedmont-Sardinia). In the analysis, we focus on currently existing polities. Each country-year observation combines independent information from at least five expert coders – typically recognised experts in a country's political history. The experts' ordinal ratings are then aggregated into a standardize continuous scale (Pemstein et al., 2020).

[5]The V-Dem political corruption index is now used extensively in both political science and economics. Recent empirical applications in economics include Wang et al. (2023) and Omar et al. (2026).

[6]For instance, *v2x_corr* is positively correlated with both Transparency International's Corruption Perception Index ($coeff. = 0.89, N = 1,371$, during 2012-2019) and the International Country Risk Guide's index ($coeff. = 0.69, N = 3,659$, during 1984-2012).

Figure 1: Probability density function of V-Dem corruption index



Notes: The Kernel estimates are based on the estimation sample, and use an optimal bandwidth. Using smaller bandwidths does not change the interpretation.

capital (Coppedge et al., 2020, 342), the number of legislative and presidential elections held in a given country in year t and $t+1$ (Coppedge et al., 2020), and an indicator for having experienced at least one civil or inter-state armed conflict in the previous five-year period (Brecke, 2001).[7] Lastly, we use V-Dem information to construct a set of time-varying indicators for the periods during which a country was continuously under the same political regime (Coppedge et al., 2020, 40).[8] This variable controls for 'critical junctures' (socialist revolutions, decolonization episodes, etc.) taking place during a country's history.[9]

4 Empirical methods

We estimate a version of the regression kink model introduced by Chan and Tsay (2009) and popularized by Card et al. (2012) for the special case of a known threshold. Hansen (2017)

[7]Corruption has been found to be more difficult to repress in larger countries (Goel and Budak, 2006) and to increase during election periods (Potrafke, 2019)

[8]For example, China is coded as: 'Great Qing Empire' during 1789-1910, 'Republic of China (Warlord China)' during 1911-1927, 'Republic of China (Nationalist China)' during 1928-1948 and 'People's Republic of China' (that is, socialist China) after 1949.

[9]See Acemoglu et al. (2009) for a review of the "critical junctures" hypothesis.

formulates a general model with *unknown* thresholds and provides complete asymptotic theory and inference procedures. Zhang et al. (2017) derive extensions for panel data.

In this model, the regression function is continuous but the slope has a discontinuity at a point γ:

$$corr_{it} = \beta_-(\ln Y_{it-1} - \gamma)_{(-)} + \beta_+(\ln Y_{it-1} - \gamma)_{(+)} + \mathbf{x}'_{it}\phi + \alpha_i + \tau_t + \varepsilon_{it} \tag{1}$$

where *corr* represents corruption, and $(\ln Y_{it-1} - \gamma)_{(-)} = \min(\ln Y_{it-1} - \gamma, 0)$ and $(\ln Y_{it-1} - \gamma)_{(+)} = \max(\ln Y_{it-1} - \gamma, 0)$ denote, respectively, the "negative" and "positive part" of the real number $\ln Y_{it-1} - \gamma$. i denotes countries and t represents five-year periods.[10] $\mathbf{x}_{it}$ is a vector of co-variates; α_i and τ_t are country and time effects, respectively. This specification allows the average within-country relationship between $\ln Y_{it-1}$ and *corr* to be different on either side of the threshold γ, which is itself an unknown parameter to be estimated.

Parameter estimation uses a combination of concentration and grid search. Let vector $X_{it}(\gamma)$ be:

$$X_{it}(\gamma) = \begin{pmatrix} (\ln Y_{it-1} - \gamma)_{(-)} \\ (\ln Y_{it-1} - \gamma)_{(+)} \\ \mathbf{x}_{it} \end{pmatrix}$$

so that model (1) can be written as

$$corr_{it} = X'_{it}\theta + \alpha_i + \tau_t + \varepsilon_{it}$$

with $\theta = (\beta_-, \beta_+, \phi')'$. Define $S_n(\theta, \gamma, \alpha_i, \tau_t)$ as the sum-of-squared residuals from least-squares dummy variable (LSDV) estimation of equation (1):

$$S_n(\theta, \gamma, \alpha_i, \tau_t) = \frac{1}{n}\sum_{i,t}(corr_{it} - X'_{it}\theta - \alpha_i - \tau_t)^2$$

[10] We construct the panel using five-year intervals to smooth out short-term fluctuations in the dependent variable and reduce error autocorrelation.

with n equal to the total number of observations. By concentration, it is possible to write

$$\hat{\gamma} = \arg\min_{\gamma} S_n(\theta, \gamma, \alpha_i, \tau_t) = \arg\min_{\gamma} S_n^*(\gamma)$$

where $S_n^*(\gamma)$ denotes the concentrated sum-of-squared errors function. Estimation proceeds by first obtaining the optimal value of γ by grid search, and then applying the OLS estimator to equation (1), treating γ as a fixed constant.

To test for the presence of a kink, Hansen (2017) and Zhang et al. (2017) propose a sup-Wald test that compares model (1) with a linear model under the null hypothesis of no kink ($\beta_- = \beta_+$). In addition, Hansen (2017) shows that if $\beta_- = \beta_+$, the threshold parameter is not identified, leading to test statistics with nonstandard asymptotics. Thus, inference is based on standard errors computed with a wild-bootstrap procedure.

In line with theoretical predictions (Blackburn et al., 2006), we also consider a more flexible version of equation (1) that allows for two income thresholds. To understand this specification, let us first consider a different parametrization of model (1), obtained by noting that $(\ln Y_{it-1} - \gamma)_{(-)} = \ln Y_{it-1} - \gamma - (\ln Y_{it-1} - \gamma)_{(+)}$, so that we can also write

$$corr_{it} = \beta_-(\ln Y_{it-1} - \gamma) + (\beta_+ - \beta_-)(\ln Y_{it-1} - \gamma)_{(+)} + \mathbf{x}_{it}'\phi + \alpha_i + \tau_t + \varepsilon_{it}$$

where a kink is present if $(\beta_+ - \beta_-) \neq 0$.

We therefore specify the two-kink model as:[11]

$$corr_{it} = \delta(\ln Y_{it-1} - \gamma_1) + \delta_1(\ln Y_{it-1} - \gamma_1)_{(+)} + \delta_2(\ln Y_{it-1} - \gamma_2)_{(+)} + \mathbf{x}_{it}'\phi + \alpha_i + \tau_t + \varepsilon_{it} \quad (2)$$

where γ_1 and γ_2 denote the two thresholds (with $\gamma_2 > \gamma_1$), and δ_1 and δ_2 represent the change in regression slope across the thresholds.

However, since we find no robust evidence of a second threshold in the data, we present

[11] See Hansen's specification of the multi-kink models at https://economics.ucr.edu/wp-content/uploads/2020/10/11-06-20-Hansen.pdf.

estimates of equation (1) and report tests of the null of no kink at the second threshold ($\delta_2 = 0$).

5 Results

The regression kink estimates for the single-threshold model (equation 1) are shown in Panel A of Table 1, whereas Panel B reports key diagnostics for the model with two thresholds.[12] We report point estimates and confidence intervals obtained via wild-bootstrap. For each specification, the corresponding criterion function, $S_n(\theta, \gamma, \alpha_i, \tau_t)$, is plotted in Figure 2 as a function of γ, and the estimated threshold is reported in Table 1. For comparison, Panel C reports the estimates of a linear specification subject to the constraint that ($\beta_- = \beta_+ = \beta$), as in previous empirical studies (e.g. Treisman (2000)). We also experiment with a quadratic specification in $\ln Y_{it}$, as in Saha and Gounder (2013), and report its fit to the data in Panel C.[13]

Column (1) shows our baseline specifications with country fixed effects. To our knowledge, these are the first estimates documenting the joint evolution of income and corruption within countries over time. The remaining columns use progressively richer specifications. Column (2) adds linear time trends at the geo-political region level[14]; column (3) adds the co-variates described in section 3; column (4) conditions on political-regime fixed effects[15]; column (5) presents a dynamic specification with a lagged dependent variable.[16]

[12] Estimation was performed using R and Stata. R files to reproduce the results of Hansen (2017) were adapted to fit our application. Files were accessed at: https://users.ssc.wisc.edu/~behansen/progs/cthresh.html.

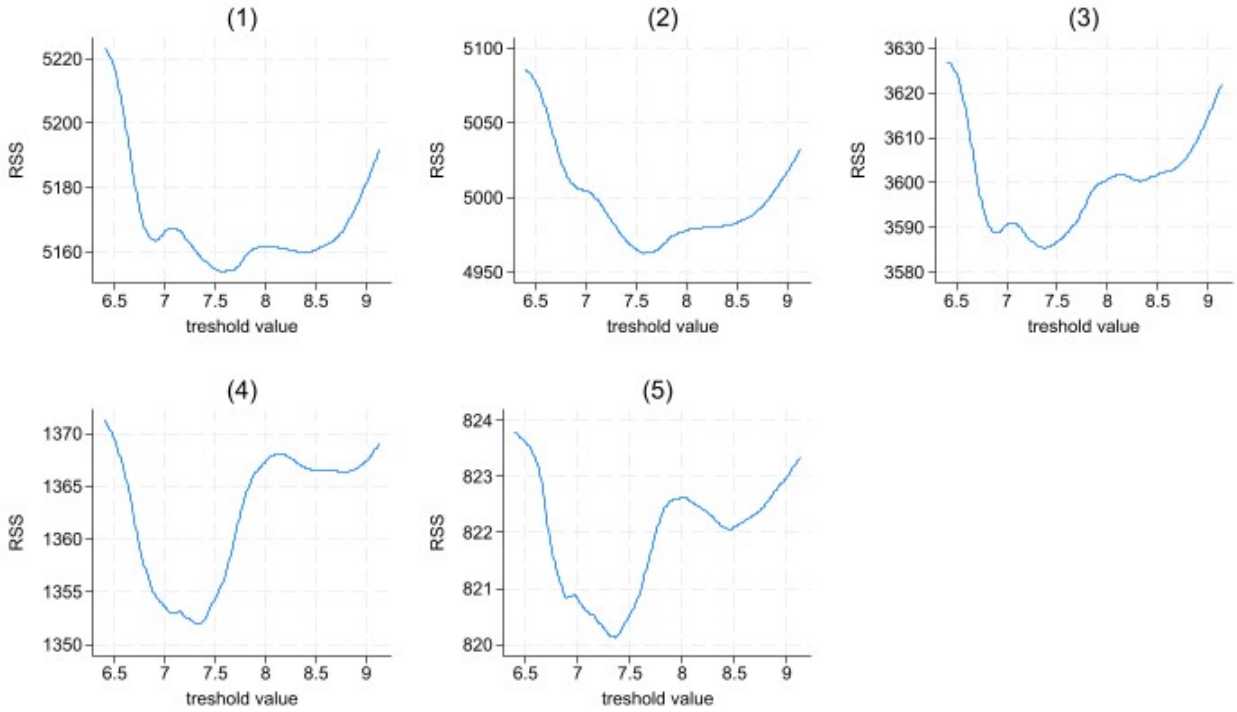
[13] The quadratic specification is: $corr_{it} = \beta_1 \ln Y_{it-1} + \beta_2 (\ln Y_{it-1})^2 + \mathbf{x}'_{it}\phi + \alpha_i + \tau_t + \varepsilon_{it}$. Full results are available upon request.

[14] We consider six geopolitical regions: Eastern Europe and Central Asia, Latin America and the Caribbean, MENA, Sub-Saharan Africa, Western Europe and North America, Asia-Pacific.

[15] Note that the political-regime dummies are perfectly collinear with the country FE. For instance, the dummies indicating China's political regimes during 1789-2010 exactly sum up to the China country indicator.

[16] Small sample bias à la Nickell is not expected to be a major issue in this specification since the panel is sufficiently long. Moreover, in unreported simulations calibrated to the data, the coefficient of lagged correlation is always estimated with a bias of less than 10% when regime FE are included. Full results available upon request.

Figure 2: Concentrated least-square criterion for the threshold parameter γ



All specifications provide consistent evidence of a threshold point (γ) at a GDP per capita of \$1,500-2,000 PPP, with a flat or event slightly positive income-corruption relationship below the threshold and a negative and statistically significant relationship above it. Sup-Wald tests always reject the null of no kink at the threshold with 99% confidence. In contrast, similar sup-Wald tests fail to reject the null of no kink at the second threshold (γ_2) in two out of five specifications (Panel B), pointing to the adequacy of a single-threshold model. Moreover, except for column (1), we find that single-kink specifications (Panel A) fit the data better than the corresponding linear and quadratic specifications (Panel C).

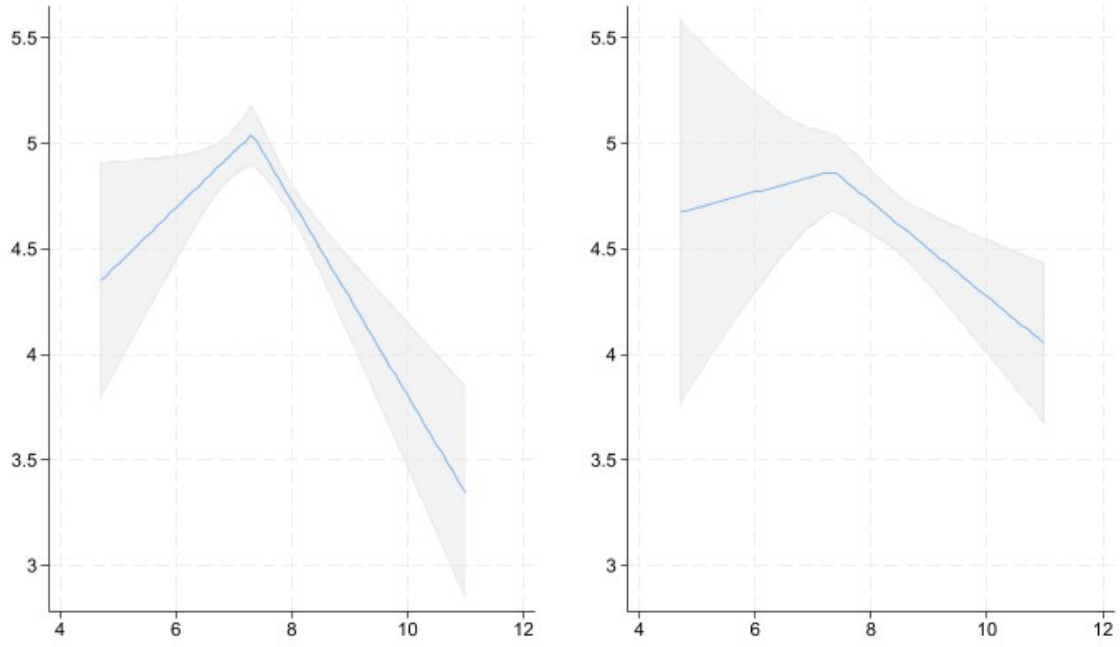
Figure 3 depicts the estimated income–corruption relationship obtained from the most complete specifications including regime dummies – that is, models 4 and 5. For these specifications, the criterion function presents evidence of a well-defined, unique global minimum, supporting a clearly identified threshold (Figure 2). In addition, sup-Wald tests provide clear evidence against a second threshold (γ_2). In model (5), the estimates imply a single

TABLE 1 - Income and corruption (1795-2010)

Dependent variable: $corr_{it}$	Country FE (1)	Trends (2)	Controls (3)	Regimes (4)	Lag corr. (5)
PANEL A: Regression kink model (one threshold, eq. 1)					
$corr_{it-1}$					0.543**
					(0.49;0.60)
$\hat{\beta}_-$	0.029	0.311**	0.239**	0.265**	0.072
	[-0.15;0.21]	[0.12;0.50]	[0.01;0.47]	[0.01;0.52]	[-0.30;0.45]
$\hat{\beta}_+$	-0.691**	-0.741**	-0.570**	-0.461**	-0.224**
	[-0.80;-0.58]	[-0.88;-0.60]	[-0.72;-0.42]	[-0.62;-0.30]	[-0.35;-0.09]
$\hat{\gamma}$ (income threshold)	7.57**	7.57**	7.38**	7.32**	7.36**
	[7.34;7.81]	[7.45;7.76]	[6.83;7.64]	[6.94;7.48]	[6.74;7.73]
p-value ($H_0 : \beta_- = \beta_+$)	< 0.010	< 0.010	< 0.010	< 0.010	0.040
Adj. within-R^2	0.137	0.168	0.175	0.092	0.444
BIC	12294.8	12193.1	9752.1	6586.9	5058.4
PANEL B: Regression kink model (two thresholds, eq. 2)					
p-value ($H_0 : \delta_2 = 0$)	0.011	< 0.010	0.013	0.202	0.529
Adj. within-R^2	0.139	0.171	0.177	0.093	0.444
BIC	12295.3	12187.9	9753.4	6586.9	5065.3
PANEL C: Linear and quadratic models					
$corr_{it-1}$					0.557***
					(0.040)
$\hat{\beta}$	-0.416***	-0.256**	-0.253*	-0.224	-0.120*
	(0.108)	(0.119)	(0.134)	(0.158)	(0.070)
Adj. within-R^2 (linear)	0.122	0.145	0.162	0.077	0.441
BIC (linear)	12354.3	12291.9	9791.2	6625.3	5064.3
Adj. within-R^2 (quadratic)	0.138	0.168	0.174	0.087	0.443
BIC (quadratic)	12293.6	12195.6	9755.0	6600.0	5063.7
Time-period FE	YES	YES	YES	YES	YES
Country FE	YES	YES	YES		
Region-level trends		YES	YES	YES	YES
Control variables			YES	YES	YES
Regime dummies				YES	YES
Number of countries	172	172	162	162	162
Observations	3,784	3,784	3,143	3,042	3,020

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The estimates are based on a panel dataset with five-year intervals.
Model (4): The control variables are: democracy, ln(population), ln(life expectancy), the number of elections held in the current and subsequent year, and an indicator for the incidence of armed conflict in the previous five years.
Model (5) and (6) includes a full set of political regime dummies instead of country fixed effects.
Panel A and B: OLS regressions with 95% wild-bootstrap confidence intervals in squared brackets.
Panel C: OLS regressions with robust s.e. clustered at the country level in brackets.

Figure 3: Estimated kink regression on the basis of Models 4 and 5 (Table 1)



Vertical axis: corr (V-dem index). Horizontal axis: ln GDP pc.

threshold (γ) at a per-capita income of 1,572 PPP dollars ($e^{7.36}$), which corresponds to the level of development of Italy in 1865, the Philippines in 1970, or Cameroon in 2010. Below this point, the income-corruption relationship is essentially flat; above the point, the relationship is significantly negative (long-run coefficient $= -0.224/(1-0.543) = -0.490$), and almost twice as large in absolute magnitude as the average relationship estimated over the full sample (long-run coefficient $= -0.120/(1-0.557) = -0.271$).

6 Concluding remarks

We show that the joint evolution of income and corruption is characterized by an income threshold. Among low- and middle-income economies, the relationship is essentially flat, consistent with the persistence of a high-corruption equilibrium. Once income exceeds a middle-income threshold, however, the relationship becomes negative, suggesting a gradual weakening of bureaucratic incentives for corruption. We find no evidence of a second thresh-

old beyond which economies stabilize at a low- or no-corruption equilibrium. Our findings are therefore only partially consistent with existing economic theories of corruption. This may be because no economy has yet crossed the second income threshold, or because existing models capture only part of the mechanisms linking development and corruption. A further implication is that economic development alone is unlikely to eliminate incentives for corruption in low-income countries; indeed, at early stages of development, it may even be associated with a modest increase in corrupt behavior.

A limitation of our analysis is that threshold points are constrained to be common across countries, whereas in some theoretical models they depend on parameters such as institutional quality and the cultural tolerability of corruption (Blackburn et al., 2006; Haque and Kneller, 2009). Future research should relax this assumption and examine whether culture and institutional endowments shape the location of income thresholds.

Declaration of generative AI and AI-assisted technologies

During the preparation of this work, the authors used *ChatGPT* in order to help with grammar and style. After using this tool/service, the authors reviewed and edited the text as needed and take full responsibility for the content of the published article.

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