Corruption and Supply-Side Economics

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Abstract

Corrupt countries tend to have low tax rates and income, which confounds the observed cross-country relation between taxation and income. Controlling for corruption, there is a robust negative relation between tax rates and income across countries. These results are explained in a model in which taxes distort the incentive to work and people are averse to paying taxes to a corrupt government. The aversion to paying taxes to a corrupt government exacerbates the distortionary effects of taxation and explains why corrupt governments choose to tax at low rates with nevertheless disastrous economic consequences.

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1 Introduction

This paper shows that, controlling for the level of corruption, countries with high income tax rates have significantly lower per-capita income than countries with low income tax rates. Controlling for corruption is important, as corruption tends to be associated with low per capita income and low income tax rates. Indeed, without controlling for corruption, there is no significant correlation between income tax rates and per-capita income across countries. These results are explained in a model in which taxation reduces the incentive to work, and corruption magnifies the disincentive effects of taxation so corrupt countries find it “optimal” to tax at relatively low rates. Legitimate governments are able to tax at higher rates and choose to do so in pursuit of a social good but at the expense of per-capita income.

The literature on the aggregate effects of taxation is vast and varied. Ideas underlying supply-side economics and the disincentive effects of taxation are as old as economics itself, and indeed played a prominent role in Adam Smith’s Wealth of Nations. However, systematic evidence supporting a strong connection between tax rates and income is at best a mixed bag. Cross-country studies of Easterly and Rebelo (1993) and Piketty, Saez, and Stantcheva (2014) find no strong evidence linking high tax rates to low growth. Using a structural vector-autoregression setup for post-war U.S. data, Blanchard and Perotti (2002) find a small effect of taxation on output, but Romer and Romer (2010, 2014) and Mertens and Ravn (2014) find a large effect. There are of course a great many papers that fall on each side of the fence. Gale and Samwick (2016) provide an extensive review of the empirical literature on the effects of changes in the income tax on economic growth.

The contribution of this paper is to consider corruption as an important confounding variable in the relation between taxation and income, and to show that controlling for corruption makes the cross-country relation between taxation and income more robust. In The Origins of Political Order, Fukuyama (2011) provides a good, early example of the relation between corruption and taxation. According to Fukuyama, legitimacy gained after the Glorious Revolution permitted England to raise additional tax revenue and thereby defeat absolutist France led by Louis XIV, which lacked the legitimacy to raise revenue under the feudal Ancien Régime.2 England was richer and taxed more! As another example, a common explanation for the lack of correlation between tax rates and income across countries is that

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1 See Keleher (1982) for a history of the origins of supply-side economics.
2 Fukuyama (2011), p. 419, “One of the Glorious Revolution’s main accomplishments was to make taxation legitimate because it was henceforth clearly based on consent.” See also North and Weingast (1989), who stress the importance of credibility of government commitments following the Glorious Revolution.
many northern European countries are wealthy but tax at high rates. This paper argues that the legitimacy of their governments allows them to tax at high rates without the disastrous consequences that a less legitimate government would suffer under high tax rates, but given the level of legitimacy, or corruption, both countries may be taxing at levels such that a rise in tax rates would destroy wealth.

The model developed in this paper combines elements in which the balance between the benefits of public infrastructure and public goods against the distortionary effects of taxation leads to an optimal rate of taxation, but the presence of a corrupt government that diverts tax revenue for personal gain enhances the distortionary effects of taxation and leads to both low income and low tax rates. As tax revenue is in part used to finance essential infrastructure, a rise in tax rates from very low levels promotes wealth creation because the benefits of infrastructure spending outweigh the disincentive effects of taxation, but a rise in tax rates from very high levels inhibits wealth creation because the disincentive effects of taxation outweigh the benefits of infrastructure spending. A preference for public goods pushes tax rates beyond the level that maximizes output, and a difference across countries in the preference for public goods leads to differences in levels of taxation and income. Workers are averse to paying taxes to a corrupt government, which magnifies the disincentive effects of taxes, so a corrupt government attempting to maximize tax revenue for personal gain chooses low tax rates with nevertheless significant adverse income consequences. The model provides a framework to disentangle the effects of corruption and public-good preference on the relation between rates of taxation and income.

Prior literature lends support to the modeling assumptions underlying this paper. Mauro (1995), Johnson, et. al., (1997), Friedman, et. al., (2000), Alm, et. al., (2016) and Baum, et. al., (2017) have previously documented various aspects of the relation between corruption, growth, tax evasion, and the size of the unofficial economy. Kessler and Norton (2016) provided fascinating experimental evidence that subjects react more adversely to a reduction in after-tax wages due to a rise in taxation than an equivalent fall in productivity. Tanzi and Davoodi (1997) documented that corruption leads to a lower quality of public infrastructure. Del Monte and Papagni (2001) and Aghion, et. al., (2016) developed models with growth, taxation, public infrastructure, and corruption, which Del Monte and Papagni applied to Italian data and Aghion, et. al., applied to U.S. state data. In terms of the model, this paper is perhaps closest to Aghion, et. al., but differs in some important respects. Most

Although the mechanism is very different, this imparts a nonlinear relation between income and taxation as in Jaimovich and Rebelo (2017).
notably, Aghion, et. al., thought of optimal tax rates as maximizing private welfare taking as given the level of corruption, whereas this paper thinks of optimal tax rates as chosen by a corrupt government subject to a reaction by the private sector to corruption and taxation. An insightful alternative approach is Acemoglu (2005), who modeled low taxes as stemming from weak, failed states (presumably corrupt) in which higher taxes would lead to an overthrow of the regime, and high taxes as stemming from either consensually strong states in which spending on public goods averts an overthrow of the regime or unilaterally strong states (also presumably corrupt) that do not fear an overthrow.

The first part of this paper develops the model and derives some important qualitative results. The second part summarizes an empirical examination of tax rates, corruption, and income across countries. The third part uses McFadden’s (1989) Simulated Method of Moments procedure to estimate parameters of the model with a latent variable that captures cross-country differences in the preference for public goods. The fourth part concludes.

2 A Model of Corruption and Taxation

2.1 Households

Identical, infinitely-lived households of mass one inelastically supply one unit of labor each period, which they allocate to taxed and non-taxed sectors. The taxed sector comprises a private and government sector. The taxed, private sector produces output using labor with constant-returns-to-scale and productivity $A$, hence the prevailing wage is also $A$ that is paid either by the private or government sector. Allocating $n$ units of labor to the taxed sector thus generates pre-tax income equal to $An$. Allocating $m$ units of labor to the non-taxed sector produces

$$\begin{cases} 
A\left(m - \frac{\nu}{2}m^2\right) & \text{if } m \leq \frac{1}{\nu} \\
\frac{1}{2\nu} & \text{if } m > \frac{1}{\nu}
\end{cases}$$

units of output, where $0 \leq \nu < 2$ and $n + m = 1$. Clearly no household would choose $m > 1/\nu$, which is a condition that will be imposed throughout the remainder of this paper. Specifying such a production function that includes a range $1 < \nu < 2$ will be important for some of the estimation results.

The government taxes household income at rate $\tau$, generating tax revenue

$$R = \tau An,$$
and private consumption
\[ C = A \left( (1 - \tau)n + m - \frac{\nu}{2} m^2 \right). \]

Households value private consumption \( C \) as well as a public good \( G \). In addition, governments can be corrupt, and households perceive tax payments to a corrupt government as a negative in utility. Household preferences are time-separable with constant discount factor \( 0 < \beta < 1 \) and a Cobb-Douglas period utility function given by
\[ (C - \xi \theta \tau An)^{1-\sigma} G^\sigma \]
for \( 0 \leq \sigma < 1, \xi \geq 0, \) and \( 0 \leq \theta \leq 1, \) where \( \theta \) measures the degree of corruption (\( \theta = 0 \) for a purely benevolent government and \( \theta = 1 \) for a purely corrupt government) and \( \xi \) measures the aversion to paying taxes to a corrupt government.

Households, since they do not face an important inter-temporal choice in this set-up, maximize period preferences by choosing a labor allocation
\begin{align*}
    n &= \max \left\{ 0, 1 - \frac{(1 + \xi \theta) \tau}{\nu} \right\}, \quad (1) \\
    m &= \min \left\{ 1, \frac{(1 + \xi \theta) \tau}{\nu} \right\}. \quad (2)
\end{align*}

To simplify the notation and the following analysis, I will assume \( (1 + \xi \theta) \tau / \nu \leq 1 \), which is a condition I will check when examining any equilibrium. GDP will be thought of as output in the market sector (including government services), given by
\[ Y = A \left( 1 - \frac{(1 + \xi \theta) \tau}{\nu} \right). \]

Tax revenue is given by
\[ R = A \tau \left( 1 - \frac{(1 + \xi \theta) \tau}{\nu} \right). \]

To simplify the notation, define
\[ \Omega(\tau) = 1 - (1 + \xi \theta) \tau + \frac{(1 + \xi \theta)^2 \tau^2}{2\nu}. \]
At optimal household choices, period utility is in part derived from

\[ C - \xi \theta \tau A n = A \Omega(\tau). \]

### 2.2 Government Objective

Each period, a government collects tax revenue and chooses to spend this on a public good \( G \), consumption by the political elite \( \hat{E} \), or towards hiring workers at the prevailing wage rate \( A \) to provide services to improve the efficiency of the economy (adequate legal system, public education, infrastructure, basic research, etc.), denoted by \( h \). The mass of political elite is \( \psi \), so consumption of each member of the political elite is \( E = \hat{E}/\psi \), thus

\[ G + \psi E + Ah = R. \]

Note that this equation can be used to derive the overall goods-clearing condition

\[ C - A \left( m - \frac{\nu}{2} m^2 \right) + G + \psi E = A(n - h), \]

which can be interpreted as the economy-wide consumption of market-produced goods equals its supply. A government’s period preferences are a geometric weighted average of household period utility and utility from the consumption by the political elite, given by

\[ \left( (A \Omega(\tau))^{1-\sigma} G^\sigma \right)^{1-\theta} E^\theta, \]

where \( 0 \leq \theta \leq 1 \). The government’s utility is the discounted sum of its period preferences over the infinite future with constant discount factor \( \beta \). The current government only chooses current actions \( \tau, G, E, \) and \( h \) and has no ability to commit actions of future governments. The current government must thus make rational forecasts of future government behavior.

### 2.3 Productivity

Productivity will be modeled so that countries with different levels of corruption and taxation grow at the same rate, although at any point in time will enjoy different levels of income. All countries are influenced by a base, world technology \( A_w \) that evolves exogenously according to

\[ A'_w = \omega A_w, \]
where $\omega \geq 1$. A country deviates from this base technology by a factor $a > 0$,

$$A = aA_w.$$ 

Next period’s value $a'$ depends on government investment $h$,

$$a' = \varphi h^\alpha,$$

where $\varphi > 0$, $\alpha > 0$. Differences in $\varphi$ across countries could capture cross-country differences in the efficiency of infrastructure investment.

Define $c = C/A$, $g = G/A$ and $e = E/A$. With these transformations,

$$c - \xi \theta \tau n = \Omega(\tau),$$

$$g + \psi e + h = \tau \left(1 - \frac{(1 + \xi \theta)\tau}{\nu}\right),$$

$$a' = \varphi h^\alpha. \quad (5)$$

I will search for an equilibrium and examine the steady state in which $a$, $\tau$, $c$, $g$, $e$, $h$ (and $Y/A$ and $R/A$) are constant over time. In a steady state, note that

$$A' = \omega A,$$

hence all countries grow at the same rate. Cross-country differences are captured by differences in income along the steady-state path.

### 2.4 Optimal Government Choices

The government’s optimal choice can be characterized by the dynamic programming problem

$$V(a) = \max_{\tau, g, e, h} \left\{ a \left(\Omega(\tau)^{1-\sigma} g^\sigma\right)^{1-\theta} e^\theta + \beta \omega V(\varphi h^\alpha) \right\},$$

subject to

$$g + \psi e + h = \tau \left(1 - \frac{(1 + \xi \theta)\tau}{\nu}\right). \quad (6)$$

From Blackwell’s (1965) Theorem 5, there exists a unique value function $V$ that solves this
equation, which leads to policy functions $\tau(a), g(a), e(a), h(a)$ and an evolution of the state variable $a$ given by $a' = \varphi h(a)^\alpha$.

Using $\lambda$ as the multiplier for eq. (6), the first-order conditions are

$$0 = a(1 - \theta)(1 - \sigma)\Omega(\tau)^{(1-\theta)(1-\sigma)-1} g^{(1-\theta)\sigma} e^{\theta} \Omega'(\tau) + \lambda \left( 1 - \frac{2(1 + \xi \theta)\tau}{\nu} \right),$$  \hspace{1cm} (7)

$$0 = a(1 - \theta)\sigma\Omega(\tau)^{(1-\theta)(1-\sigma)} g^{(1-\theta)\sigma-1} e^{\theta} - \lambda$$  \hspace{1cm} (8)

$$0 = a\theta\Omega(\tau)^{(1-\theta)(1-\sigma)} g^{(1-\theta)\sigma} e^{\theta-1} - \lambda \psi$$  \hspace{1cm} (9)

$$0 = \beta \omega V'(\varphi h^\alpha) \varphi \alpha h^{\alpha-1} - \lambda,$$  \hspace{1cm} (10)

and the envelope condition is

$$V'(a) = (\Omega(\tau)^{1-\sigma} g^\sigma)^{1-\theta} e^\theta.$$  

As mentioned, I will focus on the steady state for which

$$a = \varphi h^\alpha.$$  

The equilibrium conditions in steady state can be written as

$$\frac{\sigma}{1-\sigma} \left( 1 - \frac{2(1 + \xi \theta)\tau}{\nu} \right) = \frac{-g\Omega'(\tau)}{\Omega(\tau)}$$  \hspace{1cm} (11)

$$\theta g = (1 - \theta)\sigma \psi e,$$  \hspace{1cm} (12)

$$(1 - \theta)\sigma h = \beta \omega \alpha g,$$  \hspace{1cm} (13)

$$g + \psi e + h = \tau \left( 1 - \frac{(1 + \xi \theta)\tau}{\nu} \right).$$  \hspace{1cm} (14)

Use eqs. (12) and (13) to write

$$\frac{e}{h} = \frac{\theta}{\beta \omega \alpha \psi},$$  \hspace{1cm} (15)

$$\frac{g}{h} = \frac{(1 - \theta)\sigma}{\beta \omega \alpha}.$$  \hspace{1cm} (16)
Substituting these results into eqs. (11) and (14) yield that \( h \) and \( \tau \) solve

\[
\begin{align*}
h &= \frac{\beta \omega \alpha}{1 + \beta \omega \alpha - (1 - \theta)(1 - \sigma)} \tau \left(1 - \frac{(1 + \xi \theta)\tau}{\nu}\right), \\
h &= \frac{\beta \omega \alpha}{(1 - \theta)(1 - \sigma)} \left(1 - (1 + \xi \theta)\tau + \frac{(1 + \xi \theta)^2 \nu^2}{2\nu} \right) - \frac{1}{1 - (1 + \xi \theta)\tau}.
\end{align*}
\]

(17)

(18)

The right side of eq. (17) is a convex function of \( \tau \) that equals 0 for both \( \tau = 0 \) and \( \tau = \frac{\nu}{(1 + \xi \theta)} \) and reaches its maximum at \( \tau = \frac{\nu}{2(1 + \xi \theta)} \). Note in particular that the right side of eq. (17) is a strictly-increasing function of \( \tau \) for \( 0 < \tau < \frac{\nu}{2(1 + \xi \theta)} \). The right side of eq. (18) is a strictly-positive and strictly-decreasing function of \( \tau \) in the range \( 0 < \tau < \frac{\nu}{2(1 + \xi \theta)} \) and equals 0 for \( \tau = \frac{\nu}{2(1 + \xi \theta)} \). Fig. 1 displays functions with these features, which prove the following proposition.

**Proposition 1:** For any \( 0 < \beta, \theta, \sigma, \nu < 1, \omega \geq 1, \alpha > 0, \xi \geq 0 \), there exists a unique solution \( h > 0 \) and \( 0 < \tau < \frac{\nu}{2(1 + \xi \theta)} \) to eqs. (17)-(18).

**Proof:** Follows from Fig. 1. Q.E.D.

Note that for \( h \geq 0 \) it must be that \( 1 - \frac{(1 + \xi \theta)\tau}{\nu} \geq 0 \), which validates the simplifying
assumptions regarding eqs. (1)-(2). Also, since $\tau < \frac{\nu}{2(1+\xi)}$ it follows that $m < \frac{1}{\nu}$ for any $\nu < 2$.

### 2.5 The Composition of Government Spending

The government optimally allocates tax revenue $R$ to the purchase of a public good $G$, consumption by the political elite $\psi E$, and infrastructure investment at an expense $Ah$. This allocation is given by

$$\frac{G}{R} = \frac{(1 - \theta)\sigma}{1 + \beta\omega\alpha - (1 - \theta)(1 - \sigma)}, \quad (19)$$

$$\frac{\psi E}{R} = \frac{\theta}{1 + \beta\omega\alpha - (1 - \theta)(1 - \sigma)}, \quad (20)$$

$$\frac{Ah}{R} = \frac{\beta\omega\alpha}{1 + \beta\omega\alpha - (1 - \theta)(1 - \sigma)}. \quad (21)$$

As a fraction of total government spending, spending on the public good falls as the index of government corruption $\theta$ rises and rises as the preference for public goods $\sigma$ rises. For related reasons, as a fraction of total government spending, consumption by the political elite rises as the index of government corruption rises and falls as the preference for public goods rises. More corrupt governments allocate more spending to themselves and less to the provision of a public good, but an overall concern for public welfare leads all types of governments to spend more on the public good with a higher preference for public goods by the private sector (except totally corrupt governments, which allocate no resources to the public good). Both higher levels of corruption and preference for public goods leads to a lower fraction of government revenue spent on public infrastructure. Here, though, even a totally corrupt government will allocate some spending on infrastructure, as infrastructure spending enhances overall output.

### 2.6 Output, Tax Revenue, and Tax Rates

In addition to characterizing the equilibrium relation between $h$ and $\tau$, eq. (17) also gives a government’s optimal choice of $h$ for an arbitrary choice of $\tau$ (and associated optimal choices for $g$ and $e$). This relation can be used to trace out a dependence of steady-state market
output and tax revenue on tax rates, which is given by

\[
Y = A_w \varphi \left( \frac{\beta \omega \alpha}{1 + \beta \omega \alpha - (1 - \theta)(1 - \sigma)} \right)^{\alpha} \tau^\alpha \left( 1 - \frac{(1 + \xi \theta)\tau}{\nu} \right)^{1+\alpha}, \quad (22)
\]

\[
R = A_w \varphi \left( \frac{\beta \omega \alpha}{1 + \beta \omega \alpha - (1 - \theta)(1 - \sigma)} \right)^{\alpha} \left( \tau \left( 1 - \frac{(1 + \xi \theta)\tau}{\nu} \right) \right)^{1+\alpha}. \quad (23)
\]

In terms of a dependence on \( \tau \), tax revenue \( R \) inherits similar properties as the dependence of \( h \) on \( \tau \) captured in eq. (17), with a maximum at \( \tau = \frac{\nu}{2(1 + \xi \theta)} \), but market output \( Y \) is shifted to the left with a peak at

\[
\tau = \frac{\alpha}{1 + 2\alpha} \frac{\nu}{\nu} < \frac{\nu}{2(1 + \xi \theta)}. \]

For a given \( \theta \), these responses can be thought of as the response of market output and tax revenue to an arbitrary change in tax rates, but with an optimal allocation of tax revenue to \( g, h, \) and \( e \). Using these relations, Fig. 2 summarizes the relation between tax rates, market output, tax revenue, infrastructure investment, and consumption by the political elite, with an optimal allocation of labor by households between the market and non-market sectors and the optimal allocation of tax revenue by the government between expenditures on public infrastructure, a public good, and consumption by the political elite. As tax rates initially rise from 0, infrastructure investment, spending on the public good, and consumption by the political elite rise. Due to the rise in infrastructure investment, initially market output rises too. At some point output begins to fall with a further rise in tax rates, as the negative effects of tax rates outweigh the benefits of more infrastructure investment. Tax revenue peaks at a higher rate than at which market output peaks, though, as the rise in the tax rate still dominates the fall in the tax base at the tax rate that maximizes market output.

The optimal tax rate for a purely corrupt economy maximizes tax revenue, which thus occurs at a level such that market output is falling with a rise in tax rates. Infrastructure investment, public good spending, and consumption by the political elite are proportional to tax revenue, so they too peak at the optimal tax rate. However, in general optimal tax rates are lower than the rate that maximizes tax revenue. Substituting the tax rate that maximizes output into eqs. (17)-(18) reveals that tax rates are on the declining portion of the market-output curve if

\[
\frac{(1 - \theta)(1 - \sigma)}{1 + \beta \omega \alpha - (1 - \theta)(1 - \sigma)} \leq \left( \frac{(1 + 2\alpha)^2}{\alpha \nu} - \frac{2 + 3\alpha}{2} \right) \frac{1}{(1 + \alpha)^2}. \]
From this relation it is clear that the optimal tax rate will be on the declining portion of the market output curve for $\alpha$ or $\nu$ sufficiently close to 0 or $\sigma$ or $\theta$ sufficiently close to 1. Thus, the optimal tax rate will be on the declining portion of the market-output curve if infrastructure investment is not too important for growth (low $\alpha$), there is a large value to the public good (high $\sigma$), there is a low cost to avoiding the tax rate (low $\nu$), or the government is sufficiently corrupt (high $\theta$).

### 2.7 Tax Rates, Public Goods, and Corruption

To use this setup to study how variation in tax rates is related to variation in output across countries in the data, consider two sources of variation in tax rates and output in the model. Variation in $\theta$ will trace out a curve that relates changes in tax rates to changes in market output due to variation in the level of corruption. Variation in $\sigma$ will trace out a curve that relates changes in tax rates to changes in market output due to variation in the preference for public goods. Understanding these relations in the model may help in disentangling the relation between output, tax rates, and corruption in the data.

To examine the dependence on $\theta$, consider comparing the equilibrium for $\theta = 0$ (purely...
benevolent government) to the equilibrium for \( \theta = 1 \) (purely corrupt government). Fig. 3 displays eqs. (17)-(18) for \( \theta = 0 \) and \( \theta = 1 \). Denote the solution for \( \tau \) for \( \theta = 0 \) as \( \tau_{\theta=0} \) and the solution for \( \theta = 1 \) as \( \tau_{\theta=1} \), and similarly for other variables. The solution for \( \theta = 1 \) has a closed form for \( \tau \) and \( h \):

\[
\tau_{\theta=1} = \frac{\nu}{2(1 + \xi)}, \tag{24}
\]

\[
h_{\theta=1} = \frac{\beta \omega \alpha \nu}{1 + \beta \omega \alpha \cdot 4(1 + \xi)}. \tag{25}
\]

The following proposition establishes that infrastructure investment will always be lower under the purely corrupt government versus the purely benevolent government.

Figure 3: Equilibrium Comparison: Benevolent vs. Corrupt

**Proposition 2:** \( h_{\theta=1} \leq h_{\theta=0} \).

**Proof:** Note that

\[
h_{\theta=1} \leq \frac{\beta \omega \alpha \cdot \nu}{1 + \beta \omega \alpha \cdot 4}.
\]
Define $\hat{\tau}$ such that
\[
\frac{\beta \omega \alpha}{1 + \beta \omega \alpha} \frac{\nu}{4} = \frac{\beta \omega \alpha}{\sigma + \beta \omega \alpha} (1 - \frac{\hat{\tau}}{\nu}),
\]
which is given by
\[
\frac{\hat{\tau}}{\nu} = 1 - \sqrt{\frac{1 - \sigma}{1 + \beta \omega \alpha}}.
\]
Per Fig. 3, the condition $h_{\theta=1} \leq h_{\theta=0}$ holds if
\[
\frac{\beta \omega \alpha}{\sigma + \beta \omega \alpha} \hat{\tau} \left(1 - \frac{\hat{\tau}}{\nu}\right) \leq \frac{\beta \omega \alpha}{1 - \sigma} \left(1 - \frac{\hat{\tau}}{\nu} + \frac{\hat{\tau}^2}{2\nu}\right) \frac{1 - \frac{2\hat{\tau}}{\nu}}{1 - \frac{\hat{\tau}}{\nu}}.
\]
Substitute in the value of $\hat{\tau}$ and simplify to show that this inequality is satisfied if
\[
\frac{8}{\nu} - 3 + \sqrt{\frac{1 - \sigma}{1 + \beta \omega \alpha}} \geq 0,
\]
which holds since $\nu \leq 1$, $\sigma \leq 1$, and $\beta \omega \alpha \geq 0$. Q.E.D.

The following corollary establishes that steady-state market output will be lower under a purely corrupt government than under a purely benevolent government.

**Corollary 3:** $Y_{\theta=1} < Y_{\theta=0}$.

**Proof:** In steady state $Y = A_w \varphi h^\alpha n$. From Proposition 2 $h_{\theta=1} \leq h_{\theta=0}$. Eq. (1) determines $n$ as a function of $\tau$. From Proposition 1 $\tau_{\theta=0} < \nu/2$, so from eqs. (1) and (24) and it follows that $n_{\theta=1} < n_{\theta=0}$. Q.E.D.

Consider next how optimal tax rates depend on the level of corruption. Define $\bar{\xi}$ such that
\[
\frac{\nu}{2(1 + \bar{\xi})} = \tau_{\theta=0}.
\]
The following proposition establishes that tax rates will be lower under a purely corrupt government if and only if the aversion to paying taxes to a corrupt government is sufficiently high.

**Proposition 4:** $\tau_{\theta=1} < \tau_{\theta=0}$ if and only if $\xi > \bar{\xi}$.

**Proof:** Note that the graphs of eqs. (17)-(18) for $\theta = 0$ in Fig. 3 do not depend on $\xi$, so the result follows from this figure. Q.E.D.

Thus, for sufficiently high aversion to paying taxes to a corrupt government, tax rates
and market output are lower for an economy under a purely corrupt government versus a purely benevolent one. Even though the purely corrupt government attempts to maximize tax revenue, they choose lower tax rates because the distortionary effects of taxation are sufficiently exaggerated due to an aversion of paying taxes to a corrupt government.

Consider how tax rates and market output depend on the preference for public goods. Consider again two cases, one in which \( \sigma = 0 \) (no preference for the public good) versus \( \sigma = 1 \) (no preference for private consumption). As before, \( \sigma = 1 \) yields closed-form solutions for \( \tau \) and \( h \).

\[
\tau_{\sigma=1} = \frac{\nu}{2(1 + \xi \theta)}, \quad (26)
\]

\[
h_{\sigma=1} = \frac{\beta \omega \alpha}{1 + \beta \omega \alpha} \frac{\nu}{4(1 + \xi \theta)}. \quad (27)
\]

The following proposition establishes that tax rates are higher and market output is lower in an economy where private consumers only value public goods versus one in which they only value private goods.

**Proposition 5:** \( \tau_{\sigma=0} \leq \tau_{\sigma=1} \) and \( Y_{\sigma=0} \geq Y_{\sigma=1} \).

**Proof:** From Proposition 1 it follows that \( \tau \leq \frac{\nu}{2(1 + \xi \theta)} \), so from eq. (26) it follows that \( \tau_{\sigma=0} \leq \tau_{\sigma=1} \). Note that \( Y = A_w \phi h^\alpha n \). From eq. (1) and the result just established that \( \tau_{\sigma=0} \leq \tau_{\sigma=1} \), it follows that \( n_{\sigma=0} \geq n_{\sigma=1} \). Hence, \( Y_{\sigma=0} \geq Y_{\sigma=1} \) if \( h_{\sigma=0} \geq h_{\sigma=1} \). Define \( \hat{\tau} \) such that

\[
\frac{\beta \omega \alpha}{1 + \beta \omega \alpha} \frac{\nu}{4(1 + \xi \theta)} = \frac{\beta \omega \alpha}{1 + \beta \omega \alpha} \hat{\tau} \left( 1 - \frac{1 + \xi \theta}{\nu} \right),
\]

which yields

\[
\frac{1 + \xi \theta}{\nu} \hat{\tau} = 1 - \sqrt{\frac{1 - \theta}{1 + \beta \omega \alpha}}.
\]

It thus follows from Fig. 1 and the construction of \( \hat{\tau} \) that \( h_{\sigma=0} \geq h_{\sigma=1} \) if

\[
\frac{\beta \omega \alpha}{1 + \beta \omega \alpha} \frac{\nu}{4(1 + \xi \theta)} \leq \frac{\beta \omega \alpha}{1 - \theta} \left( 1 - \frac{(1 + \xi \theta)^2 \hat{\tau}^2}{2 \nu} \right) \frac{1 - \frac{2(1 + \xi \theta) \hat{\tau}}{\nu}}{1 - \frac{(1 + \xi \theta)^2}{\nu}}.
\]

After some manipulation, this inequality holds if

\[
\sqrt{\frac{1 - \theta}{1 + \beta \omega \alpha}} \left( \frac{1}{2} - \sqrt{\frac{1 - \theta}{1 + \beta \omega \alpha}} \right) \leq \frac{4}{\nu},
\]

14
which follows trivially. Q.E.D.

The lesson of this exercise is that the relation between tax rates and market output depends on whether the variation in tax rates is due to variation in the preference for public goods or the level of corruption. Variation in tax rates and market output due to variation in the preference for public goods tends to lead to an inverse relation between tax rates and market output. For a sufficiently high aversion to paying taxes to a corrupt government, variation in tax rates and market output due to variation in the level of corruption tends to lead to a positive relation between tax rates and market output. Any observed relation between tax rates and GDP will have to disentangle these two forces.

Figure 4: Corruption Perception Index by Country in 2018

3 Empirical Results

Various agencies attempt to measure the degree of corruption in the public sector in different countries based on surveys that measure the perception of various forms of public corruption, ranging from bribery, diversion of public funds, using public office to pursue private gain, lack of transparency and accountability, and a wide variety of other features broadly associated with corruption. Transparency International aggregates 13 of these surveys into one Corruption Perception Index (CPI). The index is scaled from 0 to 100, with 100 being
the least corrupt country. For ease of interpretation, especially as it relates to the interaction with other variables, in the statistical analysis I will refer to an inverted Corruption Perception Index (iCPI), which is simply 100 - CPI. With this scale, a higher value of the index is associated with more corruption. Fig. 4 presents a histogram of scores for 180 countries in 2018. The iCPI in 2018 ranges from 12 (Denmark) to 90 (Somalia), with a median of 62 (the value for the U.S. is 29).

Data on per-capita GDP PPP in constant 2011 international dollars is obtained from the World Bank’s World Development Index Database. Income tax rates are estimates of the top income tax rate obtained from the Heritage Foundation’s Index of Economic Freedom Database. All the regression results are computed separately for two recent years, 2017 and 2018, as well as a combined regression using year as a dummy.

Table 1: Regression of GDP on Income Tax Rate

<table>
<thead>
<tr>
<th></th>
<th>Dependent variable:</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>per-capita GDP PPP in constant 2011 international dollars (log)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2017</td>
<td>2018</td>
<td>2017-18</td>
<td></td>
</tr>
<tr>
<td>Income Tax (%)</td>
<td>−0.007</td>
<td>−0.005</td>
<td>−0.006</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.005)</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td></td>
<td></td>
<td>0.019</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.128)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>9.564***</td>
<td>9.533***</td>
<td>9.539***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.213)</td>
<td>(0.215)</td>
<td>(0.163)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>169</td>
<td>168</td>
<td>337</td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>0.006</td>
<td>0.004</td>
<td>0.005</td>
<td></td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.0004</td>
<td>-0.002</td>
<td>-0.001</td>
<td></td>
</tr>
</tbody>
</table>

Note: *p<0.1; **p<0.05; ***p<0.01

Table 1 presents results from regressing per-capita GDP on income tax rates. This table verifies that there is no significant linear bi-variate relationship between these two variables. The hypothesis of this paper is that countries differ along levels of corruption and that countries with high levels of corruption exhibit low per-capita GDP and low tax rates, thus confounding the relationship between per-capita GDP and tax rates. Table 2 presents results from regressing the income tax rate on the inverted Corruption Perception Index,
which verifies that indeed corrupt countries tend to exhibit low income tax rates. The lack of an inverse relationship between per-capita GDP and tax rates may thus be due to the effects of corruption: countries with high levels of per-capita GDP may tend to have low levels of corruption and correspondingly high levels of taxation and countries with low levels of per-capita GDP may tend to have high levels of corruption and correspondingly low levels of taxation.

Table 2: Regression of Income Tax Rate on Corruption

<table>
<thead>
<tr>
<th></th>
<th>Income Tax Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2017</td>
</tr>
<tr>
<td>Corruption (iCPI)</td>
<td>-0.146***</td>
</tr>
<tr>
<td></td>
<td>(0.052)</td>
</tr>
<tr>
<td>2018</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>36.525***</td>
</tr>
<tr>
<td></td>
<td>(3.099)</td>
</tr>
<tr>
<td>Observations</td>
<td>174</td>
</tr>
<tr>
<td>R²</td>
<td>0.044</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.038</td>
</tr>
</tbody>
</table>

Note: *p<0.1; **p<0.05; ***p<0.01

Table 3 presents results from regressing per-capita GDP on the inverted Corruption Perception Index and income tax rates. The results exhibit a statistically significant negative association between per-capita GDP and the inverted corruption index and a statistically significant negative association between per-capita GDP and income tax rates. The regression coefficient on the income tax rate is consistently about -.021 for various years, which implies that a 10 percentage point reduction in tax rates (from, say, 40 percent to 30 percent, which is slightly less than one standard deviation (standard deviation = 13.2 for 2018)) is associated with a 20 percent rise in per-capita GDP. The regression coefficient on the corruption index is consistently about -0.049, which means that a 20 point fall in the inverted Corruption Perception Index (which is about one standard deviation (standard deviation = 19 for 2018)) is associated with a 166 percent rise in per-capita GDP.

To view this relation graphically, Fig. 5 displays the relation between the log of GDP
Table 3: Regression of GDP on Income Tax Rate and Corruption

<table>
<thead>
<tr>
<th>Dependent variable: per-capita GDP PPP in constant 2011 international dollars (log)</th>
<th>2017</th>
<th>2018</th>
<th>2017-18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income Tax (%)</td>
<td>$-0.021^{***}$</td>
<td>$-0.021^{***}$</td>
<td>$-0.021^{***}$</td>
</tr>
<tr>
<td>Corruption (iCPI)</td>
<td>$-0.048^{***}$</td>
<td>$-0.049^{***}$</td>
<td>$-0.049^{***}$</td>
</tr>
<tr>
<td>2018</td>
<td>0.014</td>
<td>(0.083)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>12.681^{***}</td>
<td>12.699^{***}</td>
<td>12.683^{***}</td>
</tr>
<tr>
<td></td>
<td>(0.250)</td>
<td>(0.254)</td>
<td>(0.182)</td>
</tr>
</tbody>
</table>

Observations: 169 168 337
R^2: 0.579 0.577 0.578
Adjusted R^2: 0.574 0.571 0.574

Note: *p<0.1; **p<0.05; ***p<0.01

per capita, PPP adjusted, and the inverted Corruption Perception Index for 2018. Fig. 6 displays the relation between the residual from regressing the log of GDP per capita (PPP) on the inverted Corruption Perception Index for 2018 and the top income tax rate for 2018. Here we see the relationship is not dominated by a small cluster of points. There is a fairly robust relationship between this residual and income tax rates.

Table 4 summarizes the magnitude of the relationships documents in Table 3 for 2018. Here we see the significant dependence of real per-capita GDP on both corruption and income tax rates. For an income tax rate of 40 percent, as the iCPI index rises from 10 to 90, real per-capita GDP falls from $86,595 to $1,718. For an iCPI of 50, as the income tax rate rises from 20 to 60 percent, real per-capita GDP falls from $18,564 to $8,014. Both income tax rates and corruption are important determinants of real per-capita GDP.

The model developed in this paper focused on the effects of corruption and tax rates on the allocation of labor between taxed and non-taxed sectors. Empirically, one could use official employment numbers to measure labor allocated to the taxed sector, with the non-taxed sector capturing all other uses of labor, such as illegal activity, a black market, barter, and household production. Table 5 presents results from regressing the employment/population
ratio on the inverted Corruption Perception Index and income tax rates. Since the employment/population ratio is likely heavily influenced by the role of women in society, included in the regression is the ratio of female to male workers in the labor force. Employment in the agriculture sector may also affect the overall employment/population ratio in a way that is largely unrelated to the issue of corruption and tax rates, so the fraction of employment in the agricultural sector is also included in the regression. Data on employment, population, and the labor force are obtained from the World Bank’s World Development Index Database. Controlling for these two effects, Table 5 reveals that countries with either high levels of corruption or high income tax rates tend to have low employment/population ratios, which is interpreted here as having a larger fraction of the population allocated to a non-taxed sector.

Although the focus of this paper is on the effects of an income tax, governments typically raise revenue through a variety of means. This section considers the robustness of the results to a broader definition of tax rates. In addition, the empirical literature
Table 5: Regression of Employment/Population Ratio on Income Tax Rate and Corruption

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Employment/Population Ratio (%)</th>
<th>2017</th>
<th>2018</th>
<th>2017-18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income Tax (%)</td>
<td></td>
<td>−0.216***</td>
<td>−0.219***</td>
<td>−0.217***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.062)</td>
<td>(0.062)</td>
<td>(0.043)</td>
</tr>
<tr>
<td>Corruption (iCPI)</td>
<td></td>
<td>−0.199***</td>
<td>−0.197***</td>
<td>−0.198***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.057)</td>
<td>(0.057)</td>
<td>(0.040)</td>
</tr>
<tr>
<td>Agr. Emp.¹</td>
<td></td>
<td>0.265***</td>
<td>0.255***</td>
<td>0.260***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.049)</td>
<td>(0.049)</td>
<td>(0.034)</td>
</tr>
<tr>
<td>LF Ratio²</td>
<td></td>
<td>0.159***</td>
<td>0.167***</td>
<td>0.163***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.038)</td>
<td>(0.037)</td>
<td>(0.026)</td>
</tr>
<tr>
<td>2018</td>
<td></td>
<td></td>
<td>0.343</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(1.038)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>57.344***</td>
<td>57.271***</td>
<td>57.131***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4.667)</td>
<td>(4.593)</td>
<td>(3.289)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>172</td>
<td>172</td>
<td>344</td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>0.316</td>
<td>0.316</td>
<td>0.316</td>
<td></td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.300</td>
<td>0.300</td>
<td>0.306</td>
<td></td>
</tr>
</tbody>
</table>

¹Agriculture/Total Employment (%). ²Female/Male Labor Force (%).

*p<0.1; **p<0.05; ***p<0.01
typically attempts to separate out the effects of government spending from taxation. In this largely static model they are one and the same thing, but here I will incorporate government spending in the regression analysis as in the data they can be quite different. Table 6 reports regression results for 2018 where tax revenue as a percent of GDP is used as a broad measure of tax rates, and government spending as a fraction of GDP is an additional right-hand-side variable.\(^4\) For the most part, the results are robust to the broader definition of tax rates, and incorporating government spending as a fraction of GDP strengthens the adverse effects of tax rates. However, estimating a significant adverse effect on GDP of a broad measure of tax rates seems to requiring controlling for government spending. Note too that the coefficient on government spending is positive and significant, which validates the assumption in the model regarding the positive output benefits of infrastructure investment.

4 Estimation of Parameters

Due to the latent variable ($\sigma$), the Simulated Method of Moments (SMM) procedure will be used to estimate the model’s parameters. The random inputs consist of simulations of $\theta$ and $\sigma$.\(^5\) The corruption variable $\theta$ will be drawn from a beta distribution defined on $[0, 1]$ fitted

\(^4\)Due to better data availability (55 more countries than the World Bank dataset), the Heritage Foundation Index of Economic Freedom Database is used as a source for this data.

\(^5\)I experimented with adding measurement error to the income tax rate, but this proved inconsequential to the results.
Table 6: Regression of GDP on Tax Rates, Corruption, and Spending

2018

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>per-capita GDP PPP in constant 2011 international dollars (log)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income Tax (%)</td>
<td>−0.021***</td>
<td></td>
<td>−0.021***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td></td>
<td>(0.004)</td>
<td></td>
</tr>
<tr>
<td>Tax Revenue/GDP (%)</td>
<td>−0.003</td>
<td></td>
<td>−0.025***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td></td>
<td>(0.008)</td>
<td></td>
</tr>
<tr>
<td>Corruption (iCPI)</td>
<td>−0.049***</td>
<td>−0.046***</td>
<td>−0.044***</td>
<td>−0.044***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.004)</td>
<td>(0.003)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>Govt Spending/GDP (%)</td>
<td></td>
<td></td>
<td>0.021***</td>
<td>0.033***</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.005)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>Constant</td>
<td>12.699***</td>
<td>12.031***</td>
<td>11.719***</td>
<td>11.371***</td>
</tr>
<tr>
<td></td>
<td>(0.254)</td>
<td>(0.344)</td>
<td>(0.354)</td>
<td>(0.351)</td>
</tr>
</tbody>
</table>

Observations: 168 167 168 167
R²: 0.577 0.528 0.611 0.585
Adjusted R²: 0.571 0.522 0.604 0.578

Note: *p<0.1; **p<0.05; ***p<0.01
to match the first two moments of the inverted Corruption Perception Index (scaled from 0 to 1). The mean and variance of the inverted Corruption Perception Index in 2018 are 0.5585 and 0.0360 respectively, which leads to a Beta(3.2647, 2.5808) distribution. The public good preference variable $\sigma$ will be drawn from a Uniform[0, 1] distribution. To capture that the quality of infrastructure could depend on the degree of corruption, as documented empirically by Tanzi and Davoodi (1997) and modeled by Del Monte and Papagni (2001), the parameter $\varphi$ will be modeled as

$$\varphi = \varphi_0 e^{\varphi_1 \theta},$$

where $\varphi_0 > 0$. Given an estimate of $\varphi_1$ and the other parameters, $\varphi_0$ will be chosen so that simulations of the model match the average real per-capita GDP observed in the data for 2018. The parameters to be estimated are thus $\alpha$, $\nu$, $\xi$, and $\varphi_1$. These parameters will be chosen to minimize the distance between the following simulated and observed moments: (1) the variance of tax rates, (2) the variance of real per-capita GDP, (3) the covariance between tax rates and the corruption index, and for a regression of log real per-capita GDP on tax rates and the corruption index, (4) the coefficient on tax rates and (5) the coefficient on corruption. The weighting matrix $W$ used in the SMM procedure is the inverse of the variance-covariance matrix of moments computed using a bootstrap procedure (as in Winker, et. al. 2007) with 10,000 samples based on draws of 2018 data.

Two versions of the model are estimated: Model 1 in which $\varphi_1 = 0$ and Model 2 where $\varphi_1$ is unrestricted. Table 7 summarizes the parameter estimates. The fit of the model is presented in Table 8. Overall, the model is able to match the sign of the coefficients in a regression of log real per-capita GDP on tax rates and corruption, with Model 1 coming closer to matching the magnitudes. The largest shortcoming of the model, reflected also in a difference between Model 1 and Model 2, is that the variance of tax rates in the model is smaller than that observed in the data. Especially as it regards Model 1, there seems to be a tension between attempting to match the variability of tax rates versus the variability of income across countries. If the variation in tax rates, in concert with varying levels of

---

6Attempts to fit a beta distribution for the simulations of $\sigma$ consistently led to a U-shaped distribution with most of its weight in the tails, as the estimation strategy apparently attempts to maximize the variance of $\sigma$. Imposing a uniform distribution is an attempt to place significant weight in the tails without the questionable U-shape.

7The standard errors are square roots of the diagonals of $G'WG)^{-1}$, where $G$ are numerical derivatives of the simulated moments with respect to the parameters (the simulation size correction is small). The parameters seem to be estimated very precisely. As it regards the search routine for optimal parameter estimates, this seems to be reflected in the rather quick and robust convergence of the solution to these parameter estimates.
Table 7: Parameter Estimates

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>time preference</td>
<td>0.95$^1$</td>
<td>0.95$^1$</td>
</tr>
<tr>
<td>$\nu$</td>
<td>non-market production cost</td>
<td>0.75</td>
<td>2.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.03)</td>
<td>(0.77)</td>
</tr>
<tr>
<td>$\xi$</td>
<td>tax aversion to corrupt government</td>
<td>0.50</td>
<td>3.99</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.05)</td>
<td>(1.87)</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>curvature infrastructure function</td>
<td>10.37</td>
<td>2.11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.38)</td>
<td>(0.35)</td>
</tr>
<tr>
<td>$\varphi_1$</td>
<td>infrastructure quality</td>
<td>0.0$^1$</td>
<td>-1.22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.87)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Random Variable</th>
<th>Description</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta$</td>
<td>corruption</td>
<td>Beta(3.26, 2.58)$^2$</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>public good preference</td>
<td>Uniform[0, 1]$^1$</td>
</tr>
</tbody>
</table>

$^1$Not estimated. $^2$Estimated to match first two moments of inverted Corruption Perception Index.

corruption, is the sole source of variation in income, then the potency of tax rates suggests that the optimal tax rate should not vary that much between countries. This is also reflected in Model 2, although to a significantly lesser extent. Fig. 7 compares histograms of tax rates in the data to simulations of Model 2. Surely part of the difference in the distribution of tax rates is due to a shortcoming of the model, as the model may not capture all the reasons a country chooses particular tax rates, but part too is likely due to mis-measurement in the data. On the low end, since income tax rates are not the sole source of government revenue, distortionary tax rates are likely higher than reported. On the high end, tax avoidance other than non-market activity may be prevalent in the data, so distortionary tax rates may be lower than reported. These two features would seem to lead to a smaller variance of distortionary tax rates than income tax rates reported in the data. In this regard, note that for 2018 the cross-country variance of tax revenue as a fraction of GDP is .0102, which is not quite as small as the variance in the model, but smaller than the variance of observed income tax rates.

At the parameter estimates in Table 7 for Model 2, Fig. 8 displays the dependence of market output, tax revenue, public good spending, infrastructure spending, and consumption by the political elite for $\theta = .29$ (the value for the U.S.), and $\sigma = .5$ (the median value in the
Table 8: Comparing Model to Data Moments

<table>
<thead>
<tr>
<th>Moment</th>
<th>Data</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>average: real per-capita GDP (log)</td>
<td>9.38</td>
<td>9.38*</td>
<td>9.38*</td>
</tr>
<tr>
<td>variance: real per-capita GDP (log)</td>
<td>1.38</td>
<td>0.78</td>
<td>0.74</td>
</tr>
<tr>
<td>average: tax rate (decimal)</td>
<td>0.28</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>variance: tax rate</td>
<td>0.0176</td>
<td>0.0005</td>
<td>0.0056</td>
</tr>
<tr>
<td>average: corruption</td>
<td>0.56</td>
<td>0.56*</td>
<td>0.56*</td>
</tr>
<tr>
<td>variance: corruption</td>
<td>0.0353</td>
<td>0.0353*</td>
<td>0.0353*</td>
</tr>
<tr>
<td>covariance: tax rate and corruption</td>
<td>-0.0058</td>
<td>-0.0040</td>
<td>-0.0129</td>
</tr>
<tr>
<td>regression coefficient: tax rate</td>
<td>-2.12</td>
<td>-1.73</td>
<td>-0.63</td>
</tr>
<tr>
<td>regression coefficient: corruption</td>
<td>-4.86</td>
<td>-4.84</td>
<td>-4.74</td>
</tr>
</tbody>
</table>

*Parameters are chosen to match this moment exactly.

The figure also displays the optimal tax rate, which is 41 percent. The optimal tax rate is to the right of the peak of output with respect to tax rates and of course to the left of the peak of tax revenue with respect to tax rates. A rise in tax rates beyond its optimal value would thus lead to a fall in output. The graphs for infrastructure spending, public good spending, and consumption by the political elite inherit the shape of tax revenue, so the optimal tax rate is to the left of their peaks too. The height of consumption by the political elite depends on a choice of \( \psi \) (the size of the political elite population that divide the spoils of rent extraction) and the value of \( \psi = 0.03 \) is simply chosen for illustrative purposes. Most tax revenue is devoted to infrastructure spending, with comparatively little (although not zero) going to public good spending. As can be seen from eqs. (19)-(21), this feature is a reflection of the high estimate for \( \alpha \). Note too that output falls off sharply with tax rates lower than around .25, as taxes generate insufficient revenue for essential infrastructure. This result contrasts sharply with the results of Table 4, which simply reflects an extrapolation of a linear relationship estimated with a regression.

Fig. 9 contrasts the model with two different levels of corruption, \( \theta = 0.25 \) and \( \theta = 0.75 \) (the level of \( \varphi \) is held fixed as \( \theta \) is varied). Here we see the detrimental effect of corruption on market output. A corrupt country underinvests in essential infrastructure because part of tax revenue is allocated to consumption by the political elite and because of the disincentive effects of paying taxes to a corrupt government. Here as well we see that even though a corrupt government sets a tax rate closer to maximizing tax revenue than a benevolent one, tax rates will be lower under the corrupt government due to the stronger disincentive effects.
Figure 7: Comparison of Model and Data Tax Rates

of taxation. Note too that as corruption varies from .25 to .75, which covers most of the variation in the data, optimal tax rates vary from around 34 to 27 percent, which is another reflection of why predicted tax rates in the model vary less than observed tax rates in the data.

5 Concluding Remarks

This paper has argued that the level of corruption is an important variable to control for when examining the relation between rates of taxation and income in the data. Corrupt countries tend to have low rates of taxation and low income, thereby confounding the observed relation between taxation and income. Once corruption is controlled for, there is a robust negative relation between rates of taxation and income. Of course, by itself this is not an argument that observed tax rates are too high, as taxes can be used to finance essential public infrastructure and valued public goods. Indeed, in the model, raising tax rates initially from low levels leads to a rise in income due to the investment in essential public infrastructure. Moreover, this paper is not so much an inquiry into the benefits of moving from observed tax rates to optimal rates, but rather an inquiry into features of
the environment that can explain why observed tax rates are “optimal.”

The results of this paper naturally lead to some questions and directions for future research. I focused on an overall measure of corruption as captured by Transparency International’s Corruption Perception Index aggregate. Countries can be corrupt in a variety of ways, and it may be interesting to examine which other measures of corruption are related to taxation and income. To make the problem tractable, this paper abstracted from issues of capital accumulation, which are clearly very important considerations that contribute to a country’s welfare. Introducing capital accumulation into this type of analysis should be a valuable exercise. Finally, this paper took as given that long-run growth is unaffected by taxation and corruption. Empirically it is difficult to find a robust relation between taxation and growth, and it is not clear that corruption in general varies sufficiently over time to add to this debate, but some isolated studies of countries where the level of corruption has undergone a significant change may contribute to this debate.

References

Figure 9: Model 2 Solution and Corruption
$(\sigma = .5, \text{fixed } \varphi)$


