Corruption, Public Debt, and Economic Growth

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ABSTRACT

This paper develops a quantitative theory of fiscal policy and economic growth that includes both corruption and tax evasion. Even when the other fundamentals of the economy suggest that the optimal public debt level should be zero, the presence of corruption can cause substantial government borrowing. The government debt resulting from corruption crowds out both private and public capital and significantly reduces output. The corruption-public debt interaction also generates endogenous periodic equilibria, where debt cycles between high and low values. These debt cycles offer a possible explanation for why it is common for countries to accumulate debt for extended periods of time, only to abruptly carry out fiscal reforms designed to reduce government borrowing.
I. INTRODUCTION

This paper develops a quantitative theory that studies how the presence of corruption and tax evasion affects the formation of a country’s fiscal policy. We are particularly interested in the interaction between corruption, tax evasion and public debt. The inclusion of public debt into the analysis is motivated by Figure 1. The figure displays a statistically significant positive correlation between government debt levels and a measure of corruption (see also Kaufmann (2010)). In our quantitative theory, we find a strong interaction between corruption and debt that offers a possible explanation for Figure 1.

The theory we use is an extension of our previous work (Ivanyna et al (2014, 2015)) where we examine the connection between corruption, tax evasion, and several features of fiscal policy. There we found that corruption did not have large negative effects on output. In contrast, when corruption interacts with government debt, we find large negative effects are possible.

There are three main components to the theory. First, there is an interaction between corruption and tax evasion with causation running in both directions. We introduce a “culture of corruption” effect where the average level of government corruption affects an individual’s willingness to engage in illegal behavior-- in particular a households’ willingness to evade taxes and an individual government official’s willingness to be corrupt. Slemrod (2003) emphasizes, and provides evidence for, the notion that tax evasion is affected by household’s distaste for illegal activity and by their perceptions of government performance. Tax evasion, in turn, influences corruption by limiting the government's ability to raise funds that may be diverted for private use.

Second, we follow Tanzi and Davoodi (1997) and focus on the corruption associated with implementing public investment projects. Much of the previous work on corruption focuses primarily on bribes that entrepreneurs must pay bureaucrats to avoid regulation. The corruption associated with public investment projects would seem to be at least as important for economic growth.

Third, we examine how the presence of corruption and evasion affects the determination of a country’s fiscal policy. In particular we study how tax rates, public investment budgets, and public debt are set when the government takes into account how its choices affect both
corruption and tax evasion. As suggested by Tanzi and Davoodi (1997), and more recently and generally by Kaufman (2010), there may be direct connections between corrupt activity by the government and various aspects of their fiscal policy, not working through bribes and “petty” corruption of bureaucrats, but through the formation of policies themselves or “grand” corruption. We focus on grand corruption in our paper within a dynamic general equilibrium model that can be used to examine the macroeconomic consequences of corruption.²

Given our focus on public debt, we first specify a model without corruption where the fundamentals of the economy cause the optimal debt level to be zero. Next, we introduce a theory of both corruption and tax evasion, two illegal activities connected by a "culture of corruption" effect. The opportunity for corruption creates an incentive for public officials to enlarge budgets by raising tax rates and issuing public debt. The quantitative question is how much public debt can be generated from the corruption mechanism alone.

We calibrate institutional safeguards against corruption in order to target the range of tax evasion estimated across developed countries. Even the relatively modest implied differences in institutional safeguards needed to target the range of tax evasion in developed countries are shown to generate a wide variation in public debt to private capital ratios, ranging from zero to over 100 percent. Thus, variation in corruption that is consistent with observed variation in tax evasion has the potential to generate significant variation in debt policy across countries as suggested by Kaufmann (2010). In our model the increase in public debt associated with weaker institutional safeguards against corruption crowds out private and public capital and reduces output.

In addition, the model exhibits interesting dynamic properties caused by the interaction between corruption and public debt. de La Croix and Michel (2002) discuss situations where cycles occur in overlapping generations models, including models with public debt. Corruption offers a new reason for cycles. The dynamics in our model includes periodic debt cycles, where the economy moves between periods of relatively high and relatively low levels of public debt. A high debt period is followed by a low debt period because the obligation to pay off old debt constrains the discretionary spending of the government, requiring higher tax rates and higher new borrowing, to maintain the same level of discretionary spending. The high tax rates and high debt levels are too costly in terms of reduced private capital accumulation and growth, and so discretionary spending is cut. A drop in discretionary spending reduces corruption and further
reduces the incentive to issue new debt, causing debt levels to fall below those of the previous period. Thus, the model offers a fully endogenous explanation of why countries often build up public debt only to abruptly reform policies so as to bring debt back to more sustainable levels (Alesina and Drazen (1991) and Alesina et al (2006)).

II. RELATED LITERATURE
There is a literature that focuses on the factors that determine the level of the public debt. Battaglini and Coate (2008) offer a recent contribution and literature review. They identify three general explanations for the level of public debt. In addition to these, we found a fourth explanation for debt accumulation in the literature, based on delays in responses to fiscal shocks.

The first explanation is Barro’s (1979) idea of tax smoothing. He argues that, in the face of exogenous shocks to tax revenue or to the productivity of public goods, the government may want to issue debt in order to keep marginal tax rates stable. Our analysis does not contain this feature because we do not introduce exogenous shocks or the deadweight losses from marginal tax rates. Empirical support for Barro's tax smoothing explanation is mixed (Barro (1986), Bizer and Durlauf (1990), and Roubini and Sachs (1989)) which provided motivation to search for alternative explanations.

A second explanation for public debt comes from a dynamic version of the common revenue pool problem (Velasco (1999, 2000)). When central government spending is influenced by fragmented interest groups, a spending and deficit bias results because the groups see the full benefits of increased local spending but only bear a fraction of the tax costs that are spread across all households. In our model, increased public investment increases the opportunity for corruption. Issuing public debt is a way to increase public investment budgets. Thus, corruption offers an incentive to issue debt, even if no incentive exits in the absence of corruption.

The common pool explanation and our corruption explanation both create a bias toward spending and debt, but differ in other ways. In the common pool model an increase in the number of interest groups causes decision making to become more fragmented and worsens the spending bias. In our model an increase in the number of public officials reduces the size of the budget that any one official manages or implements. This reduces the temptation for corruption and weakens the spending bias. Of course there are also costs to increasing the number of public officials so this is not necessarily a good way to reduce corruption.
A second difference is that in the common pool model in order to reverse the accumulation of debt something must cause the interest groups to coordinate and recognize the full cost of their spending choices. In our model there are equilibria with endogenous debt cycles where reversals in the accumulation of public debt occur automatically and repeatedly.

The possibility of endogenous debt cycles relates to a third explanation for public debt that is based on slow responses to permanent negative shocks that raise spending and lower tax revenue (Alesina and Drazen (1991)). In this theory an economy is hit with a negative exogenous shock that puts it on an unstable fiscal path. Delays in responding to the resulting fiscal imbalance result from a political conflict between two groups that differ on how the government should respond. A game of attrition ensues until the weaker group concedes and fiscal reform takes place. In this theory, economies with strong executive branches or strong majorities will reform more quickly, a prediction that is consistent with the data (Alesina et al (2006)). Our endogenous debt cycles offer a complementary explanation for periods of debt accumulation followed by periods of reform and fiscal consolidation.

The final explanation for public debt is based on political instability and strategic competition between political parties. This argument is built on the idea that debt issued today constrains the policies of future governments. In the literature, political parties are assumed to differ either in their preferences for the level of public consumption (Persson and Svensson (1989)) or in its composition (Alesina and Tabellini (1990)). With the possibility that the other party will assume office in the future, it is optimal for the current party to constrain the choices of its rival by issuing debt.

This strategic mechanism is not present in our model because the current government does not account for the consequences of their choices on the policies of the next government. However, public debt does cause fiscal policies to be connected across governments because the greater the debt hangover from the previous government, the less discretionary spending on public investment, and the less corruption, by the current government. Thus, the behavior of past governments constrains the behavior of the current government even without explicit strategic intentions.
III. A BENCHMARK ECONOMY WITHOUT CORRUPTION-EVASION

For comparative purposes, in this section we develop a baseline model without corruption and evasion. The model is a standard overlapping-generations model of private capital accumulation that is extended to include a government sector that raises taxes and issues government debt to finance the salaries of public officials and public investment projects.

1. Private Households

There are $N$ young households in each period. The households are standard two-period life-cycle savers. They work to earn wages ($w_t$), consume ($c_{1t}$), and save ($s_t$) in the first period to finance second period retirement-consumption ($c_{2t+1}$). In addition to their own consumption, household’s also care about the general state of the economy, which we characterize by the average level of worker productivity during both periods of their lives ($y_t, y_{t+1}$). The last assumption is a form of altruism. We introduce altruism so that households that become public officials have concerns about the current and future state of the economy, or equivalently the economic opportunities of future generations, and not only their own consumption. This type of altruism helps to limit public debt because of concerns that government borrowing reduces private capital accumulation and economic growth.

Household preferences are represented by the following utility function

$$
\ln c_{1t} + \beta \ln c_{2t+1} + \gamma (\ln y_t + \beta \ln y_{t+1}),
$$

where $\beta$ and $\gamma$ are parameters that gauge the relative weight placed on private future consumption and the general state of the economy relative to private current consumption. The household’s lifetime budget constraint is given by

$$
c_{1t} + \frac{c_{2t+1}}{1 + \tau_{t+1}} = (1 - \tau_t)w_t,
$$
where $r$ is the rate of return to households saving and $\tau$ is the tax rate on wage income. We assume that interest income is not taxed to avoid the problem of time inconsistency when choosing the optimal tax on capital income (Kydland and Prescott (1978)). Maximizing (1) subject to (2) yields

$$c_{1t} = \frac{(1 - \tau_{t})w_{t}}{1 + \beta}$$

(3a)

$$c_{2t+1} = \beta(1 + r_{t+1})c_{1t}.$$  

(3b)

The consumption equations imply that household saving can be written as

$$s_{t} = \frac{\beta(1 - \tau_{t})w_{t}}{1 + \beta}.$$  

(3c)

2. Public Officials

As in most models of the government we assume that there is a fixed number of public officials that set and carry out fiscal policy ($\varepsilon N$). We do not model the politics of how the officials are elected or appointed to their government positions. Instead we assume that the public officials are exogenously selected from the population of private sector households. The public officials have preferences that are identical to the private households, so the process through which they are selected is not as important as when one assumes that public officials are different types that self-select into office. When the possibility of corruption is introduced, it will stem from opportunities that would tempt the average household, and not because corrupt types run the government.

The wage paid to public officials is proportional to the private sector wage, i.e. the public official’s wage is $\eta w_{t}$ where $\eta$ is an exogenous parameter that determines the relative public sector wage. Public officials pay taxes on their wages at the same rate as private sector households and work only when young. In the benchmark economy the institutional parameters
that characterize the government are then (i) the relative size of public employment ($\varepsilon$) and (ii) the relative pay of public officials ($\eta$).  

The private choices of the public officials are of the same form as for private households

\begin{align*}
(4a) & \quad c_{it}^g = \frac{(1 - \tau_t)\eta w_t}{1 + \beta} \\
(4b) & \quad c_{2t+1}^g = \beta(1 + r_{t+1})c_{it}^g \\
(4c) & \quad s_t^g = \frac{\beta(1 - \tau_t)\eta w_t}{1 + \beta}.
\end{align*}

Collectively the public officials also choose the current tax rate, the level of public debt ($B_{t+1}$), and next period’s public capital ($G_{t+1}$), in order to maximize their common preferences subject to the government budget constraint,

$$\tau_t w_t (1 + \varepsilon \eta)N + B_{t+1} = \eta w_t \varepsilon N + G_{t+1} + B_t (1 + r_t),$$

where we assume, as we will in the case private capital, that public capital depreciates fully after one period.

3. Firms

Production takes place within standard neoclassical firms that combine physical capital and human capital to produce output from a Cobb-Douglas technology

\( Y_t = K_t^\alpha (D_t N)^{1-\alpha}. \)

However, the productivity index ($D$) is a function of disembodied technology ($A$) and public capital per adult worker ($G/(1 + \varepsilon) N$) and is given by
where $0 < \mu < 1$ is a constant parameter. We assume that $A$ progresses at the exogenous rate $d$. This specification captures the idea that public infrastructure raises the productivity of the private sector and that public capital is subject to crowding.

Firms operate in perfectly competitive factor and output markets. This implies the profit-maximizing factor mix must satisfy

$\text{(7a)} \quad r_t + \delta = \alpha g_t^{\mu(1-\alpha)} k_t^{\alpha - 1}$

$\text{(7b)} \quad w_t = (1 - \alpha) A_t g_t^{\mu(1-\alpha)} k_t^{\alpha}$

where $\delta$ is the rate of depreciation on physical capital, which we take to be one for simplicity, $g \equiv G / A(1 + \varepsilon)N$, and $k \equiv K / AN$.


After de-trending all variables for exogenous technological progress and population growth, the government budget constraint with variables expressed on a per capita basis is

$\text{(8)} \quad \frac{\tau_t (1 + \eta \varepsilon)(1 - \alpha) k_t^{\alpha} g_t^{\mu(1-\alpha)}}{1 + d} + b_{t+1}(1 + \varepsilon)$

$= \eta \varepsilon \frac{(1 - \alpha) k_t^{\alpha} g_t^{\mu(1-\alpha)}}{1 + d} + g_{t+1}(1 + \varepsilon) + \frac{\alpha g_t^{\mu(1-\alpha)} k_t^{\alpha - 1}}{1 + d} b_t(1 + \varepsilon)$,

where $b \equiv B / A(1 + \varepsilon)N$. The left-hand side represents the sources of funds: tax revenue and new borrowing. The right-hand-side gives the uses of funds: salaries of government officials, government investment, and interest and principle payments on past debt.
The capital market equilibrium condition requires that the sum of private capital and public debt be financed out of household retirement saving.

\[ K_{t+1} + B_{t+1} = Ns_t + \varepsilon Ns_t^g. \]

De-trending (9), substituting (8) into (9), and collecting terms, gives us the transition equation for private physical capital in the presence of public debt

\[ k_{t+1} = \frac{k_t^\alpha g_t^{\mu(1-\alpha)}}{1+d} \left[ \frac{(1-\alpha)(\beta - \eta \varepsilon + (1 + \eta \varepsilon)\tau_t) - \alpha g_t^b}{1+\beta} - \frac{g_{t+1}^b}{k_t^\alpha g_t^{\mu(1-\alpha)} (1 + \varepsilon)(1 + d)} \right]. \]

5. Optimal Fiscal Policy

Public officials have identical preferences and opportunities, resulting in a common preferred tax rate. In voting on fiscal policy, whether it is the entire group of officials that vote or some subset, they will be in complete agreement. Finding the preferred tax rate of an individual official is then sufficient to determine the country's fiscal policy.

We find the optimal fiscal policy by writing out the representative public official’s preferences in terms of the choice of fiscal policy. Including only those components of the public official's preferences that are affected by their fiscal policy choice gives us the following objective function to be maximized

\[ (1 + \beta)\ln(1 - \tau_t) + \beta \mu (1 - \alpha)(1 + \gamma) \ln g_{t+1} + \beta(\alpha - 1 + \alpha \gamma) \ln k_{t+1}. \]

Substituting (10) into the objective function above, maximizing with respect to the choice of tax rates and government investment, solving the first order conditions, and combining with (8) and (10) generates the following solutions

\[ \frac{b_{t+1}(1 + \varepsilon)}{k_{t+1}} = \frac{b(1 + \varepsilon)}{k} = \frac{1 + \beta}{\alpha(1 + \gamma) - 1} - 1. \]
An important expression in the solution is the ratio \((1 + \beta) / (\alpha(1 + \gamma) - 1)\). The numerator \((1 + \beta)\) measures the negative effect of taxation on the after-tax wage and lifetime consumption of the current generation.

The denominator \((\alpha(1 + \gamma) - 1)\) gives the effect of private capital accumulation on (i) the return to private capital and (ii) worker productivity in the next period. Greater private capital accumulation lowers the return to capital and the welfare of the current generations whose retirement consumption depends on income from savings \((\alpha - 1)\). So, for private capital accumulation to be valued by the current generation, the altruistic benefit of higher future worker productivity in the economy \((\alpha \gamma)\) must exceed the negative effect of lower return to savings \((\alpha(1 + \gamma) - 1 > 0)\).

When private capital accumulation is valued, there is a benefit to current period taxes because greater tax revenue reduces public borrowing and the crowding out of private investment. The higher is the ratio \((1 + \beta) / (\alpha(1 + \gamma) - 1)\), the lower is the net benefit of taxes, the higher is public debt, and the lower is private capital accumulation. Positive levels of public debt are optimal if the ratio is sufficiently high, as indicated in (11a). Also note that the optimal ratio of public debt to private capital is time invariant, which implies a time invariant tax rate given in (11b).

In (11c), the transition equation for the evolution of the private capital stock simplifies to a standard concave form with capital accumulation positively affected by after-tax household wages that determine saving. However, there is a multiplicative coefficient that adjusts for the presence of public debt and the crowding out of private investment. A higher debt to capital
ratio shifts the transition equation for private capital downward. Finally, (11d) tells us the optimal stock of public capital is proportional to the private capital stock with the factor of proportionality determined by the parameters that determine the two stocks relative importance on welfare.

6. Baseline Calibration

To calibrate the benchmark model, we start with conventional estimates for the output elasticities of private and public capital: \( \alpha = 0.33, \mu = 0.30 \) (see Mourmouras and Rangazas (2007) for a survey and discussion). Assuming that each period in the model last 20 years and the annualized growth in labor productivity due to exogenous technological change is 2 percent we have

\[
d = (1.02)^{20} - 1 = 0.4859
\]

From our working paper, we set \( \varepsilon = 0.1429 \) and \( \beta = 0.1983 \), and initially we also set \( \eta = 1 \) (Ivanyua et al (2014)). These parameters were set in our previous work so that (i) half of the net tax rate finances government consumption (wages of public officials in our setting) and (ii) the rate of return to capital is reasonable. The parameter values serve the same purpose here.

To isolate the role played by corruption in generating public debt, we eliminate all other motives for borrowing. We consider an economy that is made up of “staunch fiscal conservatives,” households whose preference is to have no government debt, in the absence of the opportunity for corruption. From (11a), the optimal debt ratio without corruption is zero when

\[
1 + \beta = \alpha(1 + \gamma) - 1
\]

This staunch fiscal conservative condition implies \( \gamma = 5.59556 \).

The no debt economy generates a tax rate of 26 percent and steady state annualized marginal product of capital of 8.7 percent. This value for the marginal product is within the range of estimates for the pre-tax marginal product of capital in the rich countries (Caselli and Feyrer (2007, Table II)).

IV. AN ECONOMY WITH CORRUPTION-EVASION

We now introduce the possibility that households will engage in illegal activity. Households employed in the public sector consider diverting public funds, earmarked to finance investment projects, for their own private use. Households employed in the private sector consider hiding income from the government to avoid taxation. Following Slemrod (2003), all households are
modeled as having some aversion to illegal activity and the aversion varies inversely with the average level of corruption by government officials. We call this a “culture-of-corruption” effect—the average level of corruption among government officials reduces guilt associated with the illegal activity of individual households. In Ivanya et al (2015) we provide direct and indirect evidence supporting the importance of guilt and the presence of a culture-of-corruption effect. Here we extend the model we use there to include an interaction between corruption and government borrowing.

1. Private Choices

The preferences of private households and public officials are written as

\[
\ln c_{1t} + \beta \ln c_{2t+1} + \gamma (\ln y_t + \beta \ln y_{t+1}) - \frac{\phi}{2\tilde{u}_t} v_t^2
\]

and

\[
\ln c_{1t}^g + \beta \ln c_{2t+1}^g + \gamma (\ln y_t + \beta \ln y_{t+1}) - \frac{\phi}{2\tilde{u}_t} u_t^2.
\]

The illegal activity of private households is measure by \( v \), the fraction of their income that is not reported for tax purposes. The illegal activity of public officials is measured by \( u \), the fraction of the public investment budget that is diverted for private use. The last term in each expression captures the disutility of engaging in illegal activity. Higher values of the parameter \( \phi \) imply a stronger distaste for illegal activity. The disutility of illegal activity is inversely related to the average level of corruption in the economy (\( \tilde{u}_t \)). The preference specification captures two points stressed by Slemrod (2003): (i) explaining tax evasion requires households to have an aversion to illegal activity given the relatively small probability of being penalized and (ii) household’s willingness to evade is influenced by their perception of government performance.

The private household maximizes utility subject to the lifetime budget constraint

\[
c_{1t} + \frac{c_{2t+1}^g}{1 + r_{t+1}} = (1 - \tau_t)w_t(1 - \nu_t) + \theta^T w_t v_t, \text{ where } \theta^T \text{ is a parameter, that lies between zero and one, reflecting the fraction of unreported income that the household can recover for private use.}
\]
The parameter captures the traditional monetary deterrent to tax evasion. The more difficult it is
 to hide income the less can be recovered and the lower is the benefit of evasion.\(^9\)

The maximization problem generates the following equation for tax evasion and private household saving

\[
(12a) \quad v_t = \frac{1}{2} \left[ \left( T^2 + \frac{4(1 + \beta)\bar{\tau}_t}{\phi} \right)^{1/2} - T \right], \quad \text{where} \quad T \equiv \frac{1 - \tau_t}{\theta^\tau - (1 - \tau_t)}
\]

\[
(12b) \quad s_t = \frac{\beta}{1 + \beta} \left[ 1 - \tau_t + \left( \theta^\tau - 1 + \tau_t \right) \bar{\tau}_t \right] v_t.
\]

Naturally, evasion is increasing in \( \tau_t \) and \( \theta^\tau \).\(^{10}\) Evasion is also increasing in \( \bar{\tau} \). In fact, as \( \bar{\tau} \) goes to zero so does \( v \). If the government officials are not corrupt, then they will act in the private household best interests (since they have the same preferences), reducing the household's incentive to evade taxes.\(^{11}\) The term \( (1 + \beta) / \phi \) is a measure of "greed" because it is a measure of the value of consumption relative to the disutility of being dishonest. Tax evasion is increasing in greed, other things constant.

Next, we move to the behavior of the public official. In the case of uncoordinated or decentralized corruption each public official takes the average level of corruption, the tax rate, and the total public investment budget as given when making their private choices. The public official’s private choices now include what fraction of their project budget to divert for their own private use. The budget allocated to each public official is \( \hat{G}_{t+1} / \varepsilon N \), where \( \hat{G}_{t+1} \) is the amount of recorded or planned investment that appears in the official budget and not the actual investment that takes place. As in section III, \( G_{t+1} \) is the expenditure on infrastructure, net of diverted or “wasted” funds. Actual expenditures are the only ones that increase productivity through \( D \).

The officials maximize utility subject to their public budget and private lifetime budget constraint, \( c_t^g + \frac{c_{t+1}^g}{1 + r} = \eta(1 - \tau_t)w_t + \theta^g u_t(\hat{G}_{t+1} / \varepsilon N) \), where \( \theta^g \) is a parameter, that lies between zero and one, reflecting the fraction of diverted public funds that the official can recover.
for private use. The parameter captures the effect of institutional safeguards that make it difficult to steal public funds and use them openly without detection. As with tax evasion, the more difficult it is to hide income the less can be recovered and the lower is the benefit of corruption. We assume that public officials do not have the opportunity to avoid taxation on their official salary but, of course, they pay no taxes on the income they obtain by diverting funds from public investment projects.

The public official's maximization problem generates the following equations for the public officials decentralized corruption activity and the public official’s private saving behavior

$$u_t = \frac{1}{2} \left[ \Gamma - \left( \Gamma^2 + \frac{4(1+\beta)u_t}{\phi} \right)^{1/2} \right], \text{ where } \Gamma = \frac{(1-\tau_t)\eta w_t}{\theta g (\hat{G}_{t+1}/\varepsilon N)}$$

$$s^g_t = \frac{\beta}{1+\beta} \left[ (1-\tau_t)\eta + \theta g w_{t+1}/N \right] w_t.$$

As with tax evasion, corruption is increasing in $\tau_t$ and $\theta g$. The larger is the budget that the official manages, relative to his official after-tax wage, the more tempting it is to be corrupt. This is also why corruption is decreasing in $\eta \varepsilon$--the larger is the official wage (increasing in $\eta$) relative to the official’s budget (decreasing in the number of officials or $\varepsilon$), the less corruption. An increase in the official’s wage raises consumption and lowers the value of additional consumption gained by diverting public funds. However, the larger is the size of the public budget, the greater is the benefit of diverting a higher fraction of it. Note that, other things constant, tax evasion lowers corruption because it reduces the size of the official’s budget. In this way evasion places a check on corruption. Finally, if the ratio of wages to government investment remains bounded, as is true in long-run equilibrium, then corruption can persist unless sufficient improvements in institutional safeguards occur. This helps explain why corruption exists and varies in magnitude across the richest countries today.

2. Corruption and Evasion for a given Tax Rate and Debt Level

We now solve for the level of corruption and evasion for given values of the tax rate and government debt levels. Again, we begin by writing out the government budget constraint to
establish a connection between tax evasion, tax revenue, borrowing, and the budget available for public investment,

\[ G_{t+1} = \tau_t \left( w_t (1 - v_t) N + \eta v_t \epsilon N \right) - \eta v_t \epsilon N + B_{t+1} - (1 + r_{t+1}) B_t \]

The government budget constraint implies that

\[ \frac{\dot{G}_{t+1}}{w_t \epsilon N} = \tau_t \left( \frac{(1-v_t)}{\epsilon} + \eta \right) - \eta + \frac{1+\epsilon}{(1-\alpha)\epsilon} \left( \frac{(1+d)b_{t+1}}{k_t g_t^{(1-\alpha)}} - \frac{b_t}{k_t} \right). \]

Substituting this expression into (13a), noting that \( u_t = \bar{u}_t \) in both (12a) and (13a), and then solving for \( u_t \) in (13a) allows us to write evasion and corruption as

\[ v_t = \frac{1}{2} \left[ \left( \frac{T^2 + 4(1+\beta)u_t}{\phi} \right)^{1/2} - T \right], \quad \text{where} \quad T = \frac{1 - \tau_t}{\theta^\phi - (1 - \tau_t)} \]

\[ u_t = \frac{1+\beta}{\phi} - \frac{\eta(1-\tau_t)}{\theta g^\gamma B_t}, \]

where \( B_t = \frac{r_t (1-v_t)}{\epsilon} - \eta (1-\tau_t) + \frac{1+\epsilon}{(1-\alpha)\epsilon} \left( \frac{(1+d)b_t}{k_t g_t^{(1-\alpha)}} - \frac{b_t}{k_t} \right) \), is the discretionary budget, taxes net of payroll and debt repayment obligations, managed by each public official.

The government budget managed by each official is increasing in newly issued debt and decreasing in previously issued debt. Everything else constant, new borrowing increases corruption, as well as tax evasion through the culture of corruption effect, and past debt obligations reduce corruption by lowering the discretionary budget, other things constant.

### 3. Capital Accumulation

We need to establish new transition equations with public debt, corruption, and evasion. The capital market equilibrium condition (9) gives us the transition equation for private capital and the government budget constraint (14) gives us the transition equation for public capital,
4. Optimal Fiscal Policy

As in the baseline model without corruption, to find the optimal fiscal policy, we begin by writing out the representative government official’s preferences for generation-$t$, including only those terms that are influenced by the choice of the current period tax rate and the new debt level,

$$
(16a) \quad k_{t+1} = \frac{\beta}{1 + \beta} \left[ 1 - \tau_t + \left( \tau_t + \theta^\tau - 1 \right) \right] + \eta \epsilon \left( 1 - \tau_t + u_t \theta^g \overline{B}_t \right) \frac{(1 - \alpha) k_t^{\alpha} g_t^{\mu(1 - \alpha)}}{1 + d} \\
- b_{t+1} (1 + \epsilon)
$$

$$
(16b) \quad g_{t+1} = \frac{\epsilon (1 - u_t) \overline{B}_t (1 - \alpha) k_t^{\alpha} g_t^{\mu(1 - \alpha)}}{1 + \epsilon}.
$$

Substituting (15) and (16) into (17), to eliminate $u_t$, $k_{t+1}$, and $g_{t+1}$, reduces the problem to choosing $\tau_t$ and $b_{t+1}$ given the values of $k_t$, $g_t$, and $b_t$. The resulting solutions for $\tau_t$ and $b_{t+1}$ depend on the state variables $k_t$, $g_t$, and $b_t$. The optimal choice for $\tau_t$ and $b_{t+1}$, along with transition equations for private and public capital ((16a) and (16b)), define a system of three difference equations in the three state variables.

An important feature of the dynamic system is the interaction between corruption and public debt. Recall that corruption is increasing in the size of the discretionary budget available for public investment (see (15b)). As the size of the discretionary budget increases, the marginal benefit of increasing $u$ becomes greater—large discretionary budgets for public investment budgets create opportunities for corruption. Thus, an increase in newly issued debt to finance public investment will increase corruption. The increase in corruption will also increase tax evasion through the culture of corruption effect, thereby reducing tax revenue and further increasing government borrowing.
In the future, when the past debt and interest must be paid, the discretionary funds available for public investment are reduced. Smaller public investment budgets reduce the marginal benefit of corruption. The increase in spending obligations also increase the cost of maintaining a discretionary budget of given size because it now requires more borrowing. While there is the option to simply escalate the borrowing to pay past debt, this tends to be too costly (at least for most of our calibrations). Thus, the overhang from past debt accumulation reduces corruption, evasion, and public debt. These complimentary interactions can be strong enough to create a debt-corruption cycle; debt and corruption are relatively high one period, only to fall to lower levels the next period.\textsuperscript{12} From (15b), one can also see that the strength of the debt-corruption interaction is determined by $\theta^g$.

5. Calibration and Numerical Equilibria

In applying the model our focus is on debt creation in larger developed countries. We do this for three reasons. First, we are interested in understanding the differences in debt accumulation across the developed world in recent decades. Second, developed countries have more independent central banks. Fiscal consolidations, rather than inflation, are more commonly used to reduce debt levels in developed economies. Finally, we assume a closed economy and so do not allow for the foreign borrowing that is important for smaller and developing countries.\textsuperscript{13}

We calibrate the model with corruption using the same parameters as in the no-corruption economy along with the three new parameters $\theta^g$, $\theta^\tau$, and $\phi$. The calibration of the three new parameters is guided by three objectives. First, we set a target range for evasion based on estimates of tax evasion in developed countries. LaPorta and Schleifer (2008) report various measures of tax evasion suggesting that 10 to 20 percent of income goes unreported across developed countries. Second, we want to exhibit all of the different types of long-run equilibrium possibilities caused by the debt-corruption interaction. We do this by considering the entire range of values for $\theta^g$. Finally, we want the optimal tax rates on wage income to be reasonable because they are important determinants of the levels of tax evasion that we seek to target. The marginal tax rates on wages are high in developed countries, varying from 40 to 65 percent (Prescott (2004)). However, we do not include transfer payments in our model and while government investment can be interpreted broadly to include all spending related to human
capital formation, we do not want spending and tax rates to be too high. We choose calibrations that generate optimal tax rates between 26 and 66 percent, but most values are between 45 and 50 percent.

Table 1 reports long-run equilibria for $\phi = 1.3$, $\theta^t = 0.7$, and a complete set of values for $\theta^g$ that range from 0 to 1. When there are two rows associated with a given value of $\theta^g$, the long-run equilibrium is a periodic cycle. The last column gives the short-fall in the economy's worker productivity relative to the no-corruption economy. Figure 2 gives a diagrammatic depiction of the different variety of long-run equilibria that arise as we vary $\theta^g$ in Table 1.

The average level of debt rises with $\theta^g$, as the checks against corruption weaken. In addition we see an interesting pattern in the dynamics. As corruption increases, we go from witnessing small periodic cycles, to unique steady states, and then back to periodic cycles. Thus, the model predicts a U-shaped pattern in the volatility in debt as one goes from less corrupt to more corrupt economies.

At low values of $\theta^g$, between 0 and 0.39 in Table 1, there is insufficient motivation for officials to be corrupt causing corruption and debt to be zero—i.e. $u$ is at a corner in (15b) thereby eliminating any incentive for borrowing. As $\theta^g$ increases, and becomes sufficiently high, corruption appears but only when the discretionary budget $(\bar{B}_t)$ is sufficiently large. The discretionary budget is larger when the obligations to repay past debt are smaller. When past debt levels are zero, there is sufficient incentive to be corrupt and to borrow. However, in the period following the borrowing, the debt repayment obligations reduce $\bar{B}_t$ and lower the incentive for corruption and new borrowing. For sufficiently low values of $\theta^g$, the reduction in $\bar{B}_t$ is enough to drive $u$ and new borrowing back to zero. This gives rise to an equilibrium cycle defined by discontinuous jumps from an equilibrium with positive corruption and borrowing to an equilibrium with zero corruption and borrowing. This type of equilibrium cycle occurs when $\theta^g = 0.42$ in Table 1 and in Figure 2.

At higher values of $\theta^g$, there is sufficient incentive to be corrupt even when $\bar{B}_t$ is relatively small (i.e. even when debt repayment obligations are relatively high). This creates the possibility that corruption and debt are strictly positive throughout, creating a continuous
transitional dynamic for the economy where the economy oscillates between high and low positive values of debt. The exact nature of the dynamics depends on the particular values of $\theta^g$. For values of $\theta^g$ between 0.46 and 0.53, the oscillations dampen and converge to a unique steady state level (see Table 1 and Figure 2 for $\theta^g = 0.53$). Near $\theta^g = 0.56$, small changes in $\theta^g$ lead to bifurcations or qualitative changes in the economy's dynamic behavior (Azariadis (1993, pp.90-104) and Galor (2007, p.21 and 76)). For values of $\theta^g$ between 0.56 and 0.65 the periodic cycles reappear, but with positive values of corruption, evasion, and public debt in both periods of the cycle. Finally, when $\theta^g$ exceeds 0.65, we find two periods cycles with wild swings in behavior; an absence of corruption, evasion and public debt in one period, followed by high values for each in the next.

The rich dynamic behavior of the economy is closely related to the responsiveness of corruption to changes in the discretionary budget as past debt levels increase and decrease. The more responsive corruption is to changes in the discretionary budget the more volatile is the dynamics. We quantify the responsiveness of corruption by computing the “budget elasticity of corruption,” $E_t = \frac{\partial u_t}{\partial \theta_t} \frac{\bar{B}_t}{\bar{u}_t}$.

Table 2 provides the budget elasticity of corruption for a range of $\theta^g$ values. For low values of $\theta^g$, between 0.46 and 0.49, the elasticity remains relatively constant. As $\theta^g$ increases above 0.49 the elasticity begins to increase. At higher elasticities, the responsiveness of corruption to changes in the budget becomes strong enough to prevent convergence to a unique steady state and two-period cycles reappear. In the presence of two period cycles, Table 2 reports the elasticity when the discretionary budget is both low and high. When the discretionary budget is low, because of high levels of past borrowing, the elasticity is high causing corruption and new borrowing to also be much lower. The drop in corruption and new borrowing force debt levels well below their past values, creating the oscillation in debt levels. The much lower elasticity, when the discretionary budget is high, implies that corruption and new borrowing does not increase so much as to prevent convergence to an equilibrium cycle.

To draw out the empirical implications of the model, we now discuss the conclusions from Table 1 in more detail. The first conclusion is that variation in institutional safeguards against corruption can generate significant variation in debt ratios. Perhaps the most reasonable
settings for $\theta^g$ are those between 0.42 and 0.65, where there are at least some temporary episodes of corruption, evasion, and public debt, and where tax rates are reasonable. Even in this limited range, the debt ratio varies between 0 and 0.60. Thus, corruption is a potentially important determinant of the observed differences in public debt across developed countries.

As $\theta^g$ ranges between 0.42 and 0.65, corruption ranges from 0 to 0.55, i.e. 0 to 55 percent of funds allocated to government programs are appropriated for private use by public officials. As a point of reference for these estimates, Tanzi and Davoodi (1997) suggest that diverted funds from some public investment projects in Italy, a high corruption developed economy, were between 50 and 60 percent.

A second conclusion is that higher debt reduces output significantly in our model. The differences in corruption and public debt, as $\theta^g$ ranges between 0.42 and 0.65, result in significant differences in worker productivity and private household's welfare. Average worker productivity when $\theta^g = 0.65$ is 26 percent less than when $\theta^g = 0.45$ and 34 percent less than the no corruption baseline. Average private household welfare is 38 percent less than when $\theta^g = 0.42$ and 54 percent less than in the no corruption baseline.

It should also be noted that there is little variation in tax rates as $\theta^g$ ranges between 0.45 and 0.65. The increasing magnitude of the negative effect on output as corruption increases is due to a rise in the average level of public debt that crowds out private investment. In fact, the higher debt also crowds out public investment. One way to finance interest and principle repayment on public debt is to reduce spending on public capital.

A more complete depiction of the debt dynamics leading to lower average output is given in Figure 3. It shows the path of several key variables in two settings: one with weak corruption safeguards, $\theta^g = 0.62$, and one with relatively stronger safeguards, $\theta^g = 0.46$. As noted above, the first panel shows that the tax rate is similar across both institutional regimes.

The second and third panels of Figure 3 show that with weaker institutional safeguards against corruption, cycles in both corruption and debt are present with large swings in both variables. However, the average corruption is similar across the regimes, while the average debt is much higher with weak institutions. This is because one way of financing the high debt repayment obligation from past governments is to issue new public debt (although significantly
less than that issued in the previous period). The positive interaction between past debt and newly issued debt causes the average debt level to rise when $\theta^g = 0.62$, even though average corruption is similar across the two cases.

From panels four and five, we see that a higher average debt level reduces the average value of both private and public capital. The crowding out of private capital results from private saving being diverted to purchases of government debt. The crowding out of public capital results from budget pressures associated with debt repayment. The lower average levels of private and public capital cause a lower average value for worker productivity, as seen in panel 6 of Figure 3.

The third conclusion from Table 1 is the prevalence of two-period debt cycles. As discussed in the introduction and literature review, it is common for countries to accumulate debt for long periods of time, often at an unsustainable pace, before abruptly carrying out reforms designed to reduce debt levels. The endogenous two-period cycles offer a possible explanation for this behavior. The accumulation of obligations to repay past debt directly constrains discretionary budgets. The cost of attempting to expand discretionary budgets further, by issuing even more debt, increases because of the further crowding out of private investment. Both of these considerations serve to reduce the incentive for corruption, evasion, and new borrowing. Thus, there is a natural limit to debt accumulation that leads to a reversal of the government’s past behavior. However, once public debt levels are reduced the incentives again swing toward encouraging corruption, evasion, and new borrowing.

An interesting observation about the debt cycles is that they do not cause output to vary. Output does not vary because when debt is high, private investment is crowded out but public investment is higher—note that public and private capital are negatively correlated in Figure 3 when $\theta^g = 0.62$. The higher debt finances both more corruption and greater actual public sector investment. Public investment and private investment are then inversely related. Thus, debt variation within a country with given institutional safeguards is not associated with a variation in output.

This feature of the model has important implications for empirical work that attempts to identify a causal effect of government debt on output. Variation in debt across countries with different institutional safeguards against corruption is predicted to be negatively correlated with output. However, variation in debt within a country with fixed institutional safeguards will not
be associated with output changes. Time series or panel data may have difficulty identifying a negative effect of debt, despite the fact that improved institutional safeguards reduce the average values of both corruption and debt and thereby raise output.

A fourth conclusion is that the model predicts a U-shaped pattern in debt volatility as the corruption level of the country increases. This unexpected prediction offers a particularly strong test of the model that we explore in the next section.

Finally, the presence of corruption brings into question the “golden rule of public finance” where borrowing to finance public investment is viewed as reasonable. Our results suggest that, even when borrowing is used to finance public investment projects, it can lead to lower long-run worker productivity. In addition, borrowing for public investment can be a perpetual source of long-run volatility.

V. EMPIRICAL EVIDENCE

In this section we explore three key empirical connections of the theory: the presence of low-frequency public debt cycles, the influence of corruption on public debt, and the effect of both corruption and public debt on economic growth. As discussed our theory is designed to study debt in large developed economies so our main focus is to check the model’s predictions for a set of large high-income countries (HIC), where the assumption that the economy is closed is likely to be the best approximation (as opposed to a small-open economy model). Given that the dividing line of when an economy is large enough for a closed economy model to be a better approximation than a small open economy model is unclear, we also include large upper-middle income countries (UMIC). This helps to increase our sample size when doing regression analysis. We exclude resource-rich countries (RRC). In RRC, high-level corruption will likely be focused on revenue flows from the resources themselves and not necessarily the normal fiscal budget for general infrastructure projects. See the Appendix for a list of the countries and a summary of the data.

In all of our regressions we control for the country’s initial state of development by including initial real GDP per capita. Recall that our theory focuses on institutional determinants of corruption, which may or may not be closely connected to the country’s level of development. Variation in corruption, holding constant the country’s state of development, captures variations in these institutional determinants. In addition, some of the UMIC may not
be close to their steady state potential and including initial GDP per capita would help control for this possibility.

1. Public Debt Cycles

We begin by checking for the presence of long-run cycles in the data. As indicated in Figure 4, it is clear that there are countries where public debt moves in cycles of large amplitude and low frequency. Due to the low frequency of these long cycles it is unlikely that there are driven by business cycles as explained by Barro (1979).

We examine the presence of low-frequency public debt cycles more generally by netting out cycles of business cycle frequency (1 to 8 years) in the public debt data from 37 high HIC and 35 UMIC income countries over the 1970 to 2011 period. To eliminate the business cycle component we use the Hodrick-Prescott filter on annual debt data with a smoothing parameter of 6.25. After the business cycles are removed, the public debt trend in many of the countries contain cycles of larger amplitude and lower frequency, as seen in Figure 5 for the three countries from Figure 4.

To find the frequency and amplitude of these longer-run cycles we remove the linear trend from the data and locate all local minima (troughs of the cycles) and maxima (peaks of the cycles). We find 137 local extrema in the 37 HIC from 1970 to 2011. The average time from trough to peak is 11 years. In the 35 UMIC, the number of extrema is 113 with an average time from trough to peak of 12.7 years. The average amplitude of a cycle, the change in debt from trough to peak, is 17 percentage points of GDP. It varies from 0.02 to 82 percentage points. Of the OECD countries the biggest change is 66 percentage points for Ireland from 1993 to 2005. The median change in the HIC countries is 12 percentage points, but 25 percent of the cycles have an amplitude greater than 24 percent of GDP. The amplitudes are larger in UMIC where the average amplitude is 24 percentage points and 25 percent of the cycles have an amplitude greater than 34 percent of GDP.

Overall, the data reveals the presence of long-term public debt cycles of significant magnitude.
2. Corruption and Debt

We now move to the empirical relationship between public debt and corruption. Our model produces two testable predictions about the corruption-public debt interaction. First, there should be a positive relationship between the long-term averages of corruption and debt. Second, there should be a U-shaped relationship between the amplitude of debt cycles and long-term average corruption. Empirical evidence on the first relationship is provided in Table 3 and evidence for the second relationship in Table 4.

Our corruption measure is the control of corruption dimension of the Worldwide Governance Indicators formed by Daniel Kaufman of the Brookings Institution and Aart Kray and Massimo Mastruzzi of the World Bank. Their control of corruption index is based on survey data from enterprises, citizens, and experts. Their measure is inversely related to the level of corruption, so the predicted relationship between the control of corruption and public debt is negative. The predicted relationship between the amplitude of public debt cycles and the control of corruption remains U-shaped.

As shown in Table 3, the negative relationship between the strength of controls on corruption and public debt is highly significant. The U-shaped relationship between the size of the debt cycles and the level of corruption is also present in the data as revealed in Table 4. The coefficient on the control of corruption is negative and the coefficient on the control squared is positive. However, the quadratic relationship is not statistically significant at the levels commonly used to declare a relationship exists with confidence.

From Table 1, we see that to detect a clear U-shaped relationship requires that the sample provides significant variation in $\theta^g$ when $\theta^g$ is relatively high. This may not be the case in our sample. In addition, the absence of a clear U-shaped relationship could be because the empirical measure of corruption reflects the average level of actual corruption in a country, rather than giving a direct indication of the fundamental institutional controls on corruption. From Table 1 we see that the average level of corruption does not vary much once $\theta^g$ exceeds 0.50, yet debt volatility varies dramatically as $\theta^g$ increases from 0.50 to 1.

If we look at the data more directly we see some evidence for the corruption-debt cycle prediction. For HIC, the mean size of the debt cycle is 21 percentage of GDP. For the 8 least corrupt countries the average is higher at 23.7 percent (Switzerland-19.5, Sweden-23.7,
Public debt in the next tier of countries, ranked by corruption, is more stable. The stability of debt is especially true for Germany, Austria, Australia, and the UK, but is less so for the U.S. and Japan. Debt cycles then become more volatile as we move to the more corrupt countries.

3. **Public Debt, Corruption, and Growth**

We have provided evidence for a positive association between corruption and public debt. However, we need to demonstrate a negative effect of corruption and public debt on output. A negative effect on output has proved elusive in previous empirical work. For example, see Mauro (1995) for the corruption-growth connection and Kumar and Woo (2010) for the public debt-growth connection.

As our model suggests, it may be hard to detect a negative effect of corruption and debt given that corruption and debt vary across the debt cycles with little change in output (see again Table 1). Instead of looking at annual or 5-years averages, as is common in growth regressions, we run cross-country growth regressions over two ten year periods: 1991-2001 and 2001-2011. This approach should help capture the average level of debt across the debt cycles. The results are presented in Table 5. We regress growth in GDP per capita on initial GDP per capita, public debt as a fraction of GDP, the control of corruption measure, and an interactive term that is the product of debt and corruption controls.

The regression shows a negative and statistically significant effect of debt on growth. Increasing controls on corruption has a positive effect on growth, but one that is not statistically significant at the usual levels. However, the interaction term has a positive and statistically significant effect on growth. A given level of debt has a smaller negative effect on growth the stronger are the controls on corruption. This supports the idea that it’s the combination of debt and corruption that is most detrimental to growth because this combination causes more of the borrowed funds to be diverted from public investment.

VII. **POLICY REFORMS**

The two-period cycles can be interpreted as a government carrying out endogenous reforms in its behavior for a given institutional structure. After periods of relatively high corruption and public
debt, the government has the incentive to behave better, even dramatically so, resulting in reduced corruption and debt.

However, we can also consider how exogenous changes in institutions affect the equilibrium outcomes. Table 1 already demonstrates that lower values of $\theta^g$, stronger checks on corruption, lower the average level of corruption and debt. We also experimented with two other institutional changes: a reduction in $\theta^\tau$, tighter safeguards against tax evasion, and an increase in $\eta$, higher pay for public officials.

We find that reducing evasion, without also addressing corruption, is a bad idea. As mentioned above, in countries without strong safeguards against corruption, tax evasion provides a useful check against government abuses. The fact that households can avoid taxation, prevents tax rates from being raised even higher. Also, for a given tax rate, less revenue is collected and thus less is stolen by public officials. Making tax evasion harder would reduce this important check on the government and lead to higher tax rates, more corruption, and less economic growth. Corruption should be brought under control before the country worries about collecting more tax revenue and making the government larger.

A frequent suggestion in the fight against corruption is to raise the pay of public officials in the hopes of reducing the temptation to engage activity to supplement official wages (Becker and Stigler (1974) and Di Tella and Schrgrodsky (2003)). In our model, we find that increases in $\eta$ reduce corruption. This happens because with higher wages there is less need, and thus less will, to steal (regardless of the threat of being caught). Of course, increasing the threat of being caught would also reduce corruption. In fact, the two policies will reinforce each other because the officials have more to lose if they are caught and fired when their salary is higher. Because of these reinforcing "carrot and stick" effects, it is likely that the most efficient way to stop corruption would include both tougher laws/better detection and higher pay.

Increasing the number of public officials, and thereby reducing the size of the budget under the control of any one official, would have an effect on corruption similar to increasing a given official's wage. In both cases, the relative value of the income gained through corrupt actions would fall leading to a reduction in corruption. However, increasing the number of officials is more costly to the economy because it lowers the relative size of the work force engaged in production. A decrease in the relative size of the productive work force reduces
output per person, public investment per person, and, indirectly, private capital per worker. To see this, note that the transition equation for public capital per person, (16b), can be shown to be a decreasing function of $\varepsilon$ for a given value of $\eta\varepsilon$. For this reason attacking corruption by offering higher wages is clearly superior to increasing the number of officials and reducing their individual responsibilities. Thus, it would be optimal to reduce public sector employment to some minimal level needed to operate the government, and then use the public sector wage premium to help control corruption.

Through the culture of corruption effect, when corruption falls, tax evasion falls as well causing an increase in tax revenue. With a weaker incentive to engage in corruption, the discretionary budget for public investment also falls. The reduced discretionary spending and the rise in tax revenue serve to reduce public debt levels.

We can also comment about the welfare effects of the various reforms with an eye toward suggesting which reforms will be met with the least resistance. Cutting $\theta^g$ will reduce the welfare of public officials in the short-run but, by promoting growth, will raise their welfare in the new steady state. The opposite is true of cuts in $\theta^T$. Public officials are better off as a result in the short-run but worse off in the new steady state.

The policy that receives support from both private and public households is an increase in public sector wages because it has the effect of raising welfare of all households in the short-run and long-run. The primary drawback of raising public sector wages is that the optimal increase in higher from the perspective of public officials then for private households. Thus, while there is a case for a public sector wage premium, there is also a possibility that the wage premium will be set too high.

We find that most of the growth promoting effects of marginal cuts in $\theta^g$, or marginal increases in $\theta^T$ and $\eta$, work through a reduction in government debt. Corruption, tax rates, and evasion are relatively insensitive to marginal changes in institutions, but public debt is relatively more responsive. Thus, the positive growth effects are primarily working through increased private capital accumulation as public debt is reduced on average.

V. CONCLUSION
Our results show that corruption can be a potentially important determinant of government borrowing, helping to explain differences in public debt levels across developed countries. More corrupt governments will be associated with higher public debt that lowers output and welfare. The corruption-debt interaction also tends to cause periodic equilibria that exhibit cycling of debt levels. This type of equilibrium offers a possible explanation for the commonly observed pattern of debt accumulation followed by reforms that abruptly reduce debt levels. The cycling of debt can even occur when corruption levels are relatively low and thus remain relevant to developed countries with strong safeguards against corruption. Interestingly, variation in public debt across these cycles within a country, with given institutional safeguards, causes little variation in output. Thus, debt and output may be negatively correlated when looking across countries with different institutions but there may be little correlation within a country with given institutions.
FOOTNOTES

1. In Ivanyna et al (2015), we provide new and survey existing evidence supporting a culture of corruption effect.

2. In practice it may be difficult to decompose the negative effects of total corruption according to whether the corruption is bribes to bureaucrats or corruption associated with high public officials and policy makers. Bribes, diversion of public funds for private use, and policy choices are likely to be interconnected.

3. Recent empirical studies indicate that fiscal consolidation via spending cuts may have no (IMF (2010)) or even positive (Alesina and Ardagna (2010)) effects on the aggregate economy. The lack of an aggregate cost to consolidation makes it harder to understand the delays that lead to significant debt accumulation.

4. This type of specification is used in the vast literature on fertility and development where parents choose between the quantity and quality of children. The quality of children is measured by the children’s adult wage, similar to our specification that uses the average product of labor of future generations. See Galor (2005) for a survey.

5. As is well known, assuming Becker-Barro altruism, where the utility of future generations enter the utility function of the current generation, eliminates any effect on the economy from debt accumulation per se. The Ricardian Equivalence theorem that Becker-Barro altruism produces is difficult to reject in macroeconomic data, due to the absence of sufficiently powerful tests (Cardia (1997)), but is clearly inconsistent with microeconomic studies that show (i) excessive sensitivity of consumption to temporary changes in income (see Johnson, Parker, and Souleles (2006) and the references therein) and (ii) consumption effects from the redistribution of resources across generations, even in households that make intergenerational transfers (Altonji, Hayashi, and Kotlikoff (1992, 1997)).
6. This may be a more reasonable assumption in a democracy than in a dictatorship, and this is one reason that we limited our quantitative analysis to developed economies with relatively strong democracies that have some capability of screening out corrupt types.

7. For tractability, some features of the government must be taken as given in our analysis. However, we eventually discuss how changes in exogenous features of the government affect the results. In addition, note that when $\eta = 1$, the households are indifferent about working in the public or private sectors. However, this is not necessarily true after we introduce corruption and evasion. In the presence of corruption and evasion, we find that public officials are better off than private households as along as $\eta \geq 1$ (even though we assume that public officials cannot avoid taxes on their official salaries). Thus, everyone would want a government job.

8. We assume that the fraction of money stolen generates the disutility rather than absolute amount. This specification will generate fractions of income that go unreported and fraction of public budgets that are diverted for private use that are independent of the level of income. This allows us to focus on institutional determinants of corruption because increases in income alone will not alter the rate of illegal activity.

9. One can interpret $\theta^\tau$ as the fraction of the before-tax market wage that a worker can earn in the untaxed underground economy. Too see this, let the technology used in the untaxed sector be the same as in the taxed sector except that the productivity index for labor is $\theta^\tau D_I$ rather than $D_I$. This captures the idea that the government could lower access to productive public services for firms in the underground economy and thus lower the productivity of labor there. In this case, the profit maximizing wage offered in the untaxed sector is $\theta^\tau w_I$, where we have used the fact that if the return to capital is untaxed, then the capital to effective labor ratio must be equal in each sector. As the government clamps down on the untaxed sector by making it more difficult for those firms to use productive public services, $\theta^\tau$ falls and the relative wage earned in the underground economy falls as well.
10. Schneider and Enste (2000) and Johnson, Kaufmann, and Zoido-Lobaton (1998, 1999) provide evidence that higher tax rates increase the underground economy and tax evasion.

11. We considered a preference specification that allowed for some tax evasion when corruption is zero. This specification is somewhat more complicated and its use did not alter our main conclusions. It should also be noted that with the specification used in the text, there is also a no corruption-no evasion equilibrium under the assumption that no one expects the government to be corrupt. The analysis in the text gives the unique equilibrium under the assumption that everyone expects there to be nonzero corruption.

12. For an introduction to endogenous periodic equilibria, see Azariadis (1993, Chapters 8 and 9).

13. See also footnote 6.

14. For recent discussion and analysis of the golden rule of public finance see Brauninger (2005), Buiter (2001), Ghosh and Mourmouras (2004), Greiner and Semmler (2000), and Yakita (2008).
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