Public Debt Levels and Corruption in High-Income Economies

Daryna Grechyna*
February 2012

Abstract

This paper proposes a possible explanation of different government debt levels observed in developed economies. It builds a model that relates the level of government debt to the degree of corruptness of the public officials in the country. Public corruption results in higher public debt levels in the steady state. The model explains about 40% of variation in debt to GDP levels in a sample of 23 high-income countries, given the measure of public corruption, public spending and GDP in these countries.

Keywords: public debt; corruption; time-consistent fiscal policy.

JEL Classification Numbers: E61; E62; H11; H63.

*I am especially grateful to Francesc Obiols, Juan Carlos Conesa, Nezih Guner, and other participants of Macroeconomic Lunch Meetings at the Universitat Autònoma de Barcelona, as well as to Xavier Mateos-Planas, Salvador Ortigueira, Hugo Rodríguez, Christopher Telmer, Mehmet Ugur and Harrie Verbon.
1 Introduction

According to literature, some amount of positive public debt may be preferable to a balanced budget for essentially two reasons. The first is the so-called fluctuations-smoothing role of public debt, as defined and empirically supported by Barro (1979). The second is the wealth-redistributive role of public debt, as explained, for example, by Diamond (1965) and Cukierman and Meltzer (1989). The wealth-redistributive role of debt may be at odds with the dynamics of falling population levels and growing debt-to-GDP levels observed in developed economies.\(^1\)

The tax-smoothing optimal fiscal policy under the benevolent government assumption leads to the long-run optimal debt level being zero (Debortoli and Nunes, 2008) or, in a stochastic setup, fluctuating around zero or even tending to large negative values (Aiyagari, Marcet, Sargent and Seppälä, 2002).\(^2\) Therefore, alternative explanations of the observed patterns of public debt have been popular recently. First, positive public debt can be an outcome of political games (see Alesina and Perotti, 1994 for a critical survey of related literature and Battaglini and Coate, 2008 for recent implementation). Second, the time-consistent fiscal policy can deliver positive public debt if the government operates more than one asset (debt and money or debt and physical capital, as in Martin, 2009, Ortigueira and Pereira, 2009, and Niemann, 2011).

This paper intends to explain variability in public debt levels observed in advanced economies by different levels of corruption among the governmental officials of these economies. Public corruption has been commonly considered as an innate characteristic of the developing world. However, the traditional corruption perception indices have not assigned a no-corruption grade (for at least three subsequent years) to any country in the world (see Transparency International Reports, various years). While not so severe in developed as in developing countries, public corruption can still influence countries’ economic performance, in particular, government debt levels.

A brief examination of the possible relationship between public debt and the Transparency International Index of Corruption (scaling from 10, meaning no public corruption, to 0, meaning complete public corruption) from a sample of European countries is presented in Figure 1. It seems that the countries characterized by higher corruption level have, on average, higher public debt to GDP ratios.

\(^1\)The correlation between growth in public debt and population growth in OECD countries is close to zero and negative during 1995-2010.

\(^2\)Unless some friction is added, such as a debt transaction cost as in Kumhof and Yakadina (2007).
Note, that the presence of public corruption need not necessarily be reflected in higher public spending, the item reported in the fiscal budget of the country. Governmental officials may expropriate public funds indirectly through, for example, the legislative support of their political parties, the choice of sellers in the tenders for government purchases, and the power to set personal salaries and benefits and regulate self-protection and the protection of their families. The distorting effect of taxation may make it unaffordable for the government to keep deficit levels low by way of increased income taxes. Thus, the expropriated resources may result in higher public debt levels than in the absence of public corruption.

The model considered in the paper intends to relate the level of public debt to the degree of public corruption in a general equilibrium framework. The model features a neoclassical economy with a discretionary government able to run an unbalanced budget, as considered by Ortigueira and Pereira (2009). The existence of public corruption among the authorities is incorporated by the assumption that the government is only partially benevolent. It maximizes the utility of the representative household by choosing the level of public spending and fiscal policy (debt and taxes); it also maximizes its own utility by choosing how much of resources to expropriate. This paper asserts that all authorities care about the same quantity and quality of public good, regardless of the party to which they belong. All government officials are assumed to be corrupted to some extent and thus overaccumulate public debt holdings in favor
of private rent extraction. It is assumed that the degree of corruption is exogenous. The
strategic complementarity makes all competing parties equally corrupt, and in equilibrium, the
country is characterized by some stationary level of public corruption and debt. The model
explains about 40% of variation in debt to GDP levels in a sample of 23 high-income countries,
given the measure of public corruption, public spending and GDP in these countries.

The related literature stresses the importance of political factors of public debt overaccumu-
lination. Alesina and Tabellini (1990) and Persson and Svensson (1989) develop a positive
debt theory, stating that high public debts exist only because of the impossibility of consensus
among the ruling politicians. Battaglini and Coate (2008) provide a political theory of public
debt overaccumulation caused by pork-barrel spending. Roubini and Sachs (1989), de Haan and
Sturm (1997), Woo (2003), Perotti and Kontopoulos (2002) are examples of empirical studies
that analyze the effect of political factors of fiscal policy outcomes.

This paper may be characterized as an attempt to study the same issue from a different
perspective. It uses public corruption as a broad measure of the political factors that may
have negative influence on fiscal policy. The comparison is possible if it is true that the further
the legislature of the country is from perfection, the higher is the perceived index of public
corruption in the country. Excellent studies by Yared (2010) and Caballero and Yared (2010)
have discussed the effect of rent-seeking activities on public debt and taxes, but in the stochastic
setup. The authors concluded that a non-benevolent government overaccumulates public debt
in the long run and is not able to smooth the intertemporal fluctuations as a benevolent
government would do.

The rest of the paper is organized as follows. Section 2 proposes a model that relates public
corruption to public debt. Section 3 attempts to use the model developed in section 2 to
replicate debt-to-GDP ratios in a sample of the most developed OECD countries. Section 4
concludes.

2 The model

This section develops a simple model that relates public corruption to public debt in a general
equilibrium framework. The model features a traditional approach to the optimal fiscal policy:
the economy consists of the government and identical households; the households consume and
save in the form of financial (government bonds) and physical (capital) assets; the function of
the government is to tax households optimally and use tax revenues and possibly debt issues to
optimally provide public goods. The government is discretionary. It is not able to follow a fiscal
plan developed for a long period of time; instead, it optimally deviates from that plan whenever it is beneficial to do so (every period). This paper restricts analysis only to the set of Markov perfect equilibria. The simplest possible sequence of events in every period is considered: the government and households simultaneously make their choices about the variables that they can control. To incorporate public corruption, the following assumptions are made:

- The government is not benevolent. It cares about the utility of the households, but also wants to maximize its utility while being in power.
- All authorities that may be elected in the given country are equally corrupted.

The corruption is modeled as a choice by the government of some part of the economy’s output for its own consumption. The weight the government imposes on expropriated consumption depends on the degree of the public corruptness of the country, and is given exogenously. Similarly, the weight on traditional public consumption and total factor productivity are exogenously given and may differ across countries. These three parameters will be calibrated given the data on the advanced OECD economies, and the model outcomes will be compared with the actual debt levels observed in the developed world. The performance of the model is discussed in the next section.

Below, the structure of the economy and the decisions of economic agents are described in more detail.

The problem of the households given the policy of the government

Households are identical; they live an infinite number of periods of time, consume every time period, save in the form of financial and physical assets, and supply labor inelastically. Aggregate labor is normalized to 1. The households are indifferent between the two forms of assets, because a no arbitrage condition equates the rates of return. The optimization problem of a representative household, given the expected fiscal policy of the government, as reflected in income taxes $\tau$, government expenditures $g$, and issues of government bonds $b'$ and given

---

3 The main justification to exclude the complete set of the sustainable equilibria from the consideration is as follows: 1 - reputation mechanisms in the same way as commitment may not be accessible by the government (Klein and Rios-Rull, 2003); 2 - the Markov strategies prescribe the simplest form of behavior that is consistent with rationality (Maskin and Tirol, 2002).

4 An alternative sequence of events, when the government acts as a Stackelberg leader, results in the same steady states, and thus in the same qualitative and quantitative conclusions (the proof is available from author upon request).
the aggregate stock of physical capital \( k \), may be written in a recursive form as follows:

\[
v(a, k, b) = \max_{c, a'} \{u(c, g) + \beta v(a', k', b')\} \tag{1}
\]

s.t.

\[
c + a' = a + (1 - \tau)(w(k) + R(k)a), \tag{2}
\]

\[
k' = H(k, b, b', \tau), \tag{3}
\]

\[
b' = B(k, b), \tag{4}
\]

\[
\tau = \Upsilon(k, b), \tag{5}
\]

Where \( \beta \) is a discount factor; \( c \) denotes private consumption of a representative household; \( a \) and \( a' \), it’s current and next period level of assets consisting of private capital and government debt holdings; \( R(k) \), gross return on assets and \( w(k) \), wage rate of a representative household.

The policy of the government is expected to be conducted according to \( \Upsilon(k, b) \), \( G(k, b, b', \tau) - \hat{G}(k, b) \) and \( B(k, b) \). The aggregate stock of physical capital is expected to evolve according to \( H(k, b, b', \tau) \). In equilibrium, all expected functions coincide with the actually implemented ones. These functions will be described in more detail below.

The instantaneous utility function of the households \( u(c, g) \) is assumed to satisfy the concavity and Inada conditions.

The first-order condition combined with the Envelope condition at an interior solution of the households’s problem dictates:

\[-u_c + \beta u'_c(1 + (1 - \tau')R(k')) = 0. \tag{6}\]

Let \( c = C(a, k, b) \) and \( a' = A(a, k, b) \) denote the solution to (1).

The problem of the competitive firms is static:

\[
\max_{k, l} f(k, l) - wl - rk - \delta k \tag{7}
\]

f.o.c. : \( r(k) = f_k(k) - \delta \), \( w(k) = f(k) - f_k(k)k. \tag{8}\]

The no arbitrage condition requires equalization of returns to physical and financial assets. Therefore

\[
R(k) = r(k) = f_k(k) - \delta. \tag{9}\]
The problem of the government

The government is partially benevolent in the sense that it aims to maximize utility of the households. However, it is also corrupted in the sense that it aims to maximize its utility while being in power. The maximization problem of the government combines both objectives:

\[ U(c, g, \hat{g}) = u(c, g) + \bar{\gamma}u(\hat{g}), \]  

where \( \bar{\gamma} \) reflects the degree of corruptness of the government. The total government expenditures are split between those going to the public, and those expropriated by the public officials:

\[ G = g + \hat{g}. \]  

The government budget constraint is:

\[ G = \tau(w(k) + r(k)(k + b)) + b' - (1 + r(k))b. \]  

The aggregate resource constraint of the economy is:

\[ k' + G + c = f(k) + (1 - \delta)k. \]  

At the beginning of each period the government chooses the level of income taxes, expropriated public spending, and the level of newly issued debt. At the same time the households choose the level of their private consumption and assets. The level of public spending and aggregate capital stock are then determined so that the budget constraint of the government and the resource constraint of the economy are satisfied.

Definition:

A recursive economic equilibrium for government policy rules \( \{\tau, \hat{g}, b'\} \), is a set of functions \( \{v(a, k, b), H(k, b, b', \tau), G(k, b, b', \tau), C(a, k, b), A(a, k, b)\} \) such that

1. Functions \( \{v(a, k, b), C(a, k, b), A(a, k, b)\} \) solve the household’s problem (1) given functions \( \{H(k, b, b', \tau), G(k, b, b', \tau), \tau, \hat{g}, b'\} \).

2. Assets market clears: \( A(a, k, b) = H(k, b, b') + b' \) - the asset portfolio of the representative household in every period consists of physical capital available in the economy and government bonds.

3. Government budget constraint is satisfied: \( G(k, b, b', \tau) = \tau(w(k) + r(k)(k + b)) + b' - (1 + r(k))b \).

4. No arbitrage condition is satisfied: \( R(k) = r(k) = f_k(k) - \delta. \)
Note that private consumption may be equivalently rewritten as a function of aggregate physical capital and public debt only: $C(k, b)$, and the latter notation will be used in the rest of the paper.

Further discussion will be concentrated on the problem of the government.

### 2.1 Markov-perfect equilibrium

The problem of the government is to choose the income taxes, expropriated public spending and the government debt issues given the expected reaction of households, captured by their choice of private consumption, and given the budget constraint and the evolution of the aggregate capital stock of the economy:

\[
V(k, b) = \max_{\tau, \hat{g}, b'} \{U(c, g, \hat{g}) + \beta V(k', b')\}
\]

\[s.t.
\]
\[
k' = k + b + (1 - \tau)(f(k) - \delta k + r(k)b) - b' - C(k, b),
\]
\[
G = \tau(f(k) - \delta k + r(k)b) + b' - (1 + r(k))b,
\]
\[
G = g + \hat{g}.
\]

Under the notion of Markov perfect equilibrium, the policy of the government depends only on the current states of the economy, which are $b$ and $k$. The policy functions of the government in equilibrium will be those expected by the households:

\[
b' = B(k, b), \tau = \Upsilon(k, b).
\]

From the government and feasibility constraints of the economy the aggregate savings and public consumption functions are defined as follows:

\[
H(k, b, b', \tau) = k + b + (1 - \tau)(f(k) - \delta k + r(k)b) - b' - C(k, b),
\]
\[
G(k, b, b', \tau) = \tau(f(k) - \delta k + r(k)b) + b' - (1 + r(k))b.
\]

Given the households’ consumption function $C(k, b)$, as defined by the household’s optimality condition (6), the problem of the government can be formulated recursively:

\[
\{B(k, b), \Upsilon(k, b), \hat{G}(k, b)\} \in \arg\max_{\hat{b}', \tau, \hat{g}} U(C(k, b), G(k, b, b', \tau) - \hat{g}, \hat{g}) + \beta V(H(k, b, b', \tau), b').
\]
This study concentrates only on the differentiable Markov perfect equilibria.

Definition:

An interior differentiable Markov perfect equilibrium is a value function \( V \) and differentiable policy functions \( B, \Upsilon, \hat{G} \), such that:

1. For all \( k \)'s and \( b \)'s, policy functions solve the government maximization problem,

\[
\{ B(k, b), \Upsilon(k, b), \hat{G}(k, b) \} \in \arg\max_{\tilde{\nu}', \tilde{\tau}, \hat{g}} U(C(k, b), G(k, b, \tilde{\nu}', \tilde{\tau}) - \hat{g}, \hat{g}) + \beta V(H(k, b, \tilde{\nu}', \tilde{\tau}), \tilde{\nu}').
\]

where

\[
G(k, b, \tilde{\nu}', \tilde{\tau}) = \tau(f(k) - \delta k + r(k)b) + \tilde{\nu}' - (1 + r(k))b,
\]

\[
H(k, b, \tilde{\nu}', \tilde{\tau}) = k + b + (1 - \tau)(f(k) - \delta k + r(k)b) - \tilde{\nu}' - C(k, b),
\]

\[
r(k) = f_k(k) - \delta.
\]

2. For all \( k \)'s and \( b \)'s, the first order condition of a household’s problem is satisfied,

\[
u_c(C(k, b)) \equiv \beta \nu_c(C(H(k, b, B(k, b), \Upsilon(k, b)), B(k, b))
\]

\[(1 + (1 - \Upsilon(H(k, b, B(k, b), \Upsilon(k, b)), B(k, b)))\{f_k(H(k, b, B(k, b), \Upsilon(k, b))) - \delta\}),
\]

3. For all \( k \) and \( b \), value function satisfies the functional equation:

\[
V(k, b) = \ U(C(k, b), G(k, b, B(k, b), \Upsilon(k, b)) - \hat{G}(k, b), \hat{G}(k, b)) + \beta V(H(k, b, B(k, b)), B(k, b)).
\]

The optimality conditions (see derivations in appendix):

the Generalized Euler Equations

\[
U_x - \beta[U'_x C'_x + U'_x (1 + f'_k - \delta - C'_k)] + \beta[U'_x C'_x - U'_x C'_x] = 0,
\]

\[
U_y G_x - \beta[U'_y C'_y + U'_y (1 + f'_k - \delta - C'_k)]G_x = 0.
\]
and the equalities that must be satisfied at optimum

\begin{align*}
  u_c(c(b, k)) &= \beta u'_c(c(b', k'))[1 + (1 - \tau(b', k'))(f_k(k') - \delta)], \\
  k' &= (1 - \delta)k + f(k) - C(k, b) - G, \\
  G &= \tau(k, b)(f(k) - \delta k + r(k)b) + b'(k, b) - (1 + r(k))b, \\
  G &= g + \hat{g}, \quad r(k) = f_k(k) - \delta.
\end{align*}

(30)

(31)

(32)

(33)

The Generalized Euler Equations (28)-(29) have the following interpretation: The first equation sets public debt issues to equate the marginal value of increase in public debt level \((U_g + \beta[U'_cC'_b - U'_gC'_b])\) to the marginal value of investing in physical capital \((\beta[U'_cC'_k + U'_g(1 + f'_k - \delta - C'_k)])\). The second equation sets optimal taxes to equate the marginal value of raised public spending through increased taxation \((U_g)\) to the marginal value of investing in physical capital.

The equations (28)-(29) and (30)-(33) characterize the politico-economic equilibrium for this economy, and can be used to solve for unknown policy functions. The solution method and equilibrium outcomes are discussed in section 4.

2.2 Steady states

The steady state of the Markov-perfect equilibrium is defined as an infinite sequence of capital stocks and public debt levels, public and private consumption levels, and taxes, that are generated by Markov-perfect equilibrium and are constant over time: \(k' = k, b' = b, c' = c, g' = g, \hat{g}' = \hat{g}, \tau' = \tau\).

The optimality conditions (28)-(29) dictate three possible cases:

1. \(G_x = 0\). In this case government expenditures do not depend on taxes, the resulted public debt is defined by the stock of capital each period of time: \(b = -(f(k) - \delta k)/(f_k(k) - \delta)\), and consumption is defined by \(c = (f(k') - f'_k(k')k')/(f'_k(k') - \delta) - (f(k) - f_k k)/(f_k(k) - \delta)\). The steady state consumption is equal to zero. Thus, the case \(G_x = 0\) does not imply a sustainable equilibrium.

2. \(U_g - \beta[U'_cC'_b + U'_g(1 + f'_k - \delta - C'_k)] = 0\). This case can be further characterized by two following subcases:

   (a) \(U'_c = U'_g\). In this case the steady state income tax is zero, and government finances all its expenditures by the interest earned on its holding of positive assets (negative
debt). This steady state is equivalent to the equilibrium outcome of the corresponding Ramsey problem when the government is functioning under full commitment.

(b) $C'_y = 0$. In this case the steady state (calculated numerically) is characterized by positive public debt and positive income taxes in equilibrium.\(^5\) Note, that though consumption does not depend directly on debt in this case, the indirect effect through the adverse impact of debt on public capital prevents the government from accumulating infinite debt and financing all its expenditures from public debt issues.

Taking into account that positive taxes and debt levels is a more realistic description of the current fiscal policy in the majority of countries in the world, the subsequent analysis is only concentrated on this last steady state, with distortionary taxation. This steady state cannot be obtained from the corresponding Ramsey problem with the government functioning under full commitment.

### 3 Debt levels and corruption

This section will use the model developed above to examine the relationship between debt and corruption levels in the countries characterized by the (near) steady state growth path. To facilitate further discussion, a particular form will be imposed on the utility function and technology.

Consider the utility function of the government of the CES form\(^6\):

\[
U(c, g, \hat{g}) = \ln(c) + \varphi \ln(g) + \bar{\gamma} \ln(\hat{g}) \tag{34}
\]

The weights $\varphi$ and $\bar{\gamma}$ on public and expropriated public consumption can be calibrated given the data for a particular country.

The technology is Cobb-Douglas:

\[
y = A k^a, \tag{35}
\]

where $A$ is a "TFP" parameter that can be normalized to match the output in the particular country.

\(^5\)Ortigueira and Pereira (2009) propose a detailed characterization and comparison of cases 2a and 2b. Debortoli and Nunes (2008) study stability of the similar problem in the economy without capital and with endogenous labor. In their setup stable steady state delivers public debt equal to zero.

\(^6\)Utility functions, separable in all arguments, give quantitatively similar results for elasticities different from 1.
Given the functional form of utility and the constraint $G = g + \hat{g}$, the optimal allocation of $g$ and $\hat{g}$ on the part of the government requires:

$$U_g = U_{\hat{g}}. \tag{36}$$

For the considered functional form, the equality of marginal utility of public vs expropriated consumption means:

$$g = \frac{\varphi}{\varphi + \bar{\gamma}} G, \quad \hat{g} = \frac{\bar{\gamma}}{\varphi + \bar{\gamma}} G. \tag{37}$$

The total government expenditures are split proportionally between spending enhancing social utility and spending expropriated by the corrupted government. A higher degree of corruption $\bar{\gamma}$ leads to fewer public goods available for households. Note that from the representative household viewpoint, the level of public spending is $g$. This paper interprets $g$ as government consumption declared in the official budget of the country.

### 3.1 The effect of corruption

Under a mild assumption that holds for a wide range of calibration parameters, the effect of the preference for corruption $\bar{\gamma}$ on the steady state with distortionary taxation may be characterized by proposition 1 stated below.

**Assumption 1.** Assume that $C_k > f_k - \delta$ or, equivalently, $G_k > 0$.

This assumption insures that an increase in aggregate capital has a positive net effect (due to an increase in the tax base minus a drop in taxes due to higher capital) on public spending.

**Lemma 1.** Under assumption 1, $1 - \beta(1 + f_k - \delta) + \beta C_k > 0$, $1 - \beta(1 + f_k - \delta) < 0$.

**Proof:** comes from the Euler equation of the household, evaluated at the steady state with distortionary income taxation, under assumption 1.

**Proposition 1.** Given government policy, at the steady state with positive income taxes,

$$k_\gamma < 0, c_\gamma < 0, \tau_\gamma > 0, G_\gamma > 0, b_\gamma > 0.$$ 

**Proof:** is relegated to appendix.

That is, the higher the level of public corruption is, the lower is the economy’s capital, output and private consumption and the higher is the level of public debt, expenditures and income taxes at the steady state.
The intuition behind this result is quite simple. The increase in public spending is financed partially through a rise in income taxes and partially through a rise in newly issued public debt. From the feasibility constraint of the economy, higher public spending also crowds out investment and thus decreases capital stock and output. Lower output leads to lower private consumption.

Note that an increase in public debt may be both due to a rise in spending on public goods and rise in the amount of public resources expropriated by the government. It turns out that official public consumption (as declared by the fiscal deficit of the countries) does not induce significant variation in public debt levels among developed countries. The variation in $\hat{\gamma}$’s (determined by $\bar{\gamma}$’s) adds significant explanatory power to the model.

Given that the model predicts positive influence of public corruption on public debt levels, it can be used in an attempt to replicate public debt to GDP shares in the countries characterized as "close to their steady state growth path", given the public corruption and several macroeconomic indicators for these countries.

### 3.2 Parametrization and calibration

This subsection describes how the model parameters are linked to corresponding macroeconomic data in a sample of highly developed countries. The sample consists of the Development Assistance Committee members, a group of 23 of the world’s major donor countries that discuss issues surrounding development aid and poverty reduction. The countries considered are listed in Table 2.

The model is defined by the following set of parameters:

- technology related: $A_i$, $a_i$,
- parameters of the utility function: $\varphi_i$, $\bar{\gamma}_i$.
- the discount rate and depreciation: $\beta_i$, $\delta_i$.

where $i = 1, \ldots, 23$, denotes the country.

Capital share, discount factor, and depreciation rate are assumed to be the same for all countries in the sample. Therefore, parameters that are taken to be the same for all countries and prescribed the conventionally accepted values are: $\beta$, $\delta$, $a$.

The weight on the expropriated public consumption $\gamma_i$ can be extracted from the data, given the measure of public corruption for every country in the sample. So, the parameters given and fixed from the data are:

---

7 Allowing $a_i$, $\beta_i$ to vary with country has insignificant effect on the performance of the model.
\[ \beta, \delta, a, \bar{\gamma}_i. \]

The parameters left to be calibrated are the weight on public expenditures, and TFP factor:

\[ \varphi_i, A_i. \]

The calibration targets are government consumption to GDP ratio and relative level of GDP correspondingly:

\[ \varphi_i \rightarrow \bar{g}_i, A_i \rightarrow y_i. \]

Given these parameters, the debt levels generated by the model are compared with the actual debt to GDP ratios in the considered 23 OECD member states.

As the analysis performed in this paper assumes that the country under consideration is at the steady state, the following measures of the "steady state" output, government expenditures and debt shares are considered:

**Output:**

1. Take the country’s average GDP per capita over the years 1995-2010 for each country in the sample: \[ \bar{Y}_i = \frac{\sum^T Y_{it}}{T}, i = 1,..N, \] where \( Y_{it} \) is GDP per capita for country \( i \) in the year \( t \), \( N = 23 \) is the number of countries, and \( T = 16 \) is the number of time periods.

2. Calculate the average of averages over the whole sample: \[ \bar{Y} = (\sum^N \bar{Y}_i)/N = (\sum^N \sum^T Y_{it})/N. \]

3. Re-scale the calculated average of averages \( \bar{Y} \) to 1: \( \bar{y} = \frac{\bar{Y}}{\bar{Y}} = 1 \).

4. For every country calculate the relative average GDP per capita by re-scaling: \( y_i = \frac{\bar{Y}_i}{\bar{Y}}. \)

**Government expenditures to GDP shares:**

Take the country’s average government consumption to GDP shares over the years 1995-2010 for each country in the sample: \[ \bar{g}_i = \frac{\sum^T g_{it} y_{it}}{T}, i = 1,..N, N = 23, T = 16, \] where \( g_{it} y_{it} \) is the government consumption to GDP share for country \( i \) in the year \( t \).

**Debt to GDP shares:**

Take the country’s average public debt to GDP shares over the years 1995-2010 for each country in the sample: \[ \bar{b}_i = \frac{\sum^T b_{it} y_{it}}{T}, i = 1,..N, N = 23, T = 16, \] where \( b_{it} y_{it} \) is the central government debt to GDP share for country \( i \) in the year \( t \).

**Preference for corruption:**

Take the country’s minimum index of public corruption from the Transparency International Reports over the years 1995-2010 for each country in the sample: \( CPI_i = 1 - \)
0.1 \text{Min}(\text{Corruption}_i), i = 1, \ldots, N, N = 23, T = 16$. The minimum is taken instead of the average to preclude underestimation of public corruption in highly corrupted economies.

The parameters $\varphi_i$ and $A_i$ are chosen for every country so that the government expenditure shares $\frac{\bar{g}}{\bar{y}_i}$ and relative outputs $y_i$ generated by the model are matched with those calculated from the data as described above.

Given that the public corruption index takes values in the range (0-10), re-scaling to the range (0-1) is necessary for the application to the model considered. Moreover, the fit of the model proved to be better for the quadratic function of the expropriated expenditures given the corruption perception index. Therefore, the parameter used in the model is:

$$\bar{\gamma}_i = (1 - 0.1 \cdot CPI_i)^2. \quad (38)$$

Table 1 proposes a summary of the parameters and their values, together with the sources.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a$</td>
<td>0.30</td>
<td>Caselli and Feyrer (2007)</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.94</td>
<td>data on average real interest rate over the sample</td>
</tr>
<tr>
<td>$\delta$</td>
<td>0.10</td>
<td>set to match average debt share in average country</td>
</tr>
<tr>
<td>$\bar{\gamma}_i$</td>
<td>$(1 - 0.1 \cdot \text{CorrData})^2$</td>
<td>data on public corruption</td>
</tr>
<tr>
<td>$\varphi_i$</td>
<td>[0.067; 0.237]</td>
<td>set to match average government expenditure share</td>
</tr>
<tr>
<td>$A_i$</td>
<td>[0.606; 1.963]</td>
<td>set to match average output</td>
</tr>
</tbody>
</table>

Note that the depreciation rate is consistent with the average investment share observed in developed countries during the last two decades and that its value is such, that given the ”average country” with the average level of output $\bar{y} = 1$, average level of government expenditures $\bar{g} = \left( \frac{\bar{g}}{\bar{y}} \right) = \sum_i^N \frac{g_i}{Y_i}/N$, and average corruption index $\bar{\gamma} = \sum_i^N \bar{\gamma}_i/N$, the debt share $\bar{b} \bar{y}$ produced by the model with parameters $\bar{y}, \bar{g}, \bar{\gamma}, a, \beta, \delta$ is matched with the average debt to GDP in the sample of observed countries: $\sum_i^N \frac{b_i}{Y_i}/N$.

The values of country-specific data incorporated in the model are given in Table 2.
Table 2: The model calibration targets

<table>
<thead>
<tr>
<th>Country</th>
<th>$\bar{\gamma}_i$</th>
<th>$y_i$</th>
<th>$\bar{\gamma}_{y_i}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>0.029</td>
<td>1.078</td>
<td>0.095</td>
</tr>
<tr>
<td>Austria</td>
<td>0.082</td>
<td>1.046</td>
<td>0.090</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.226</td>
<td>0.978</td>
<td>0.108</td>
</tr>
<tr>
<td>Canada</td>
<td>0.026</td>
<td>1.033</td>
<td>0.083</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.005</td>
<td>1.012</td>
<td>0.104</td>
</tr>
<tr>
<td>Finland</td>
<td>0.012</td>
<td>0.892</td>
<td>0.099</td>
</tr>
<tr>
<td>France</td>
<td>0.137</td>
<td>0.900</td>
<td>0.107</td>
</tr>
<tr>
<td>Germany</td>
<td>0.073</td>
<td>0.949</td>
<td>0.114</td>
</tr>
<tr>
<td>Greece</td>
<td>0.423</td>
<td>0.714</td>
<td>0.094</td>
</tr>
<tr>
<td>Ireland</td>
<td>0.096</td>
<td>0.968</td>
<td>0.065</td>
</tr>
<tr>
<td>Italy</td>
<td>0.491</td>
<td>0.874</td>
<td>0.089</td>
</tr>
<tr>
<td>Japan</td>
<td>0.176</td>
<td>0.967</td>
<td>0.105</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>0.032</td>
<td>2.038</td>
<td>0.068</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.020</td>
<td>1.120</td>
<td>0.155</td>
</tr>
<tr>
<td>New Zealand</td>
<td>0.006</td>
<td>0.765</td>
<td>0.094</td>
</tr>
<tr>
<td>Norway</td>
<td>0.044</td>
<td>1.402</td>
<td>0.084</td>
</tr>
<tr>
<td>Portugal</td>
<td>0.197</td>
<td>0.581</td>
<td>0.060</td>
</tr>
<tr>
<td>South Korea</td>
<td>0.384</td>
<td>0.628</td>
<td>0.070</td>
</tr>
<tr>
<td>Spain</td>
<td>0.324</td>
<td>0.794</td>
<td>0.088</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.013</td>
<td>0.975</td>
<td>0.110</td>
</tr>
<tr>
<td>Switzerland</td>
<td>0.026</td>
<td>1.123</td>
<td>0.050</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>0.058</td>
<td>0.958</td>
<td>0.085</td>
</tr>
<tr>
<td>United States</td>
<td>0.084</td>
<td>1.206</td>
<td>0.072</td>
</tr>
<tr>
<td>Average</td>
<td>0.129</td>
<td>1.000</td>
<td>0.091</td>
</tr>
</tbody>
</table>

The question is how much of observed public debt shares the model is able to explain, given these characteristics of the countries under study. The answer is proposed after a brief description of the numerical strategy.
3.3 Numerical algorithm

The solution of the model was obtained by two different methods, the global and the local, which delivered very close estimates. The reported results, however, are calculated by the local method of approximation at the steady state, due to the significant gain in the speed of calculations by this method.

The local method of approximation relies on the approximation of unknown functions by the polynomials using only steady state information, as described in Klein, Krusell and Ríos-Rull (2008). Namely, given the unknown functions

\[ b' = B(k, b), \tau = \Upsilon(k, b), c = C(k, b) \] (39)

and the steady state conditions

\[ b' = b, k' = k, \]

the solution to the government problem may be approximated by evaluating the optimality conditions (28)-(29) and (30)-(33) at the steady state with the unknown functions defined as:

\[ b' = \sum_i^n \sum_j^n a_{bij} k^i b^j, \tau = \sum_i^n \sum_j^n a_{\tau ij} k^i b^j, c = \sum_i^n \sum_j^n a_{cij} k^i b^j, \] (40)

with \( n \) being the order of approximation, and \( a_{bij}, a_{\tau ij}, a_{cij} \) the coefficients that can be found by differentiating the equations (28)-(29) and (30)-(33) necessary number of times with respect to the states \( k \) and \( b \).

The global method, based on the projections of first-order conditions (28)-(29) and (30)-(33) on the grid of the two states around the steady state, as explained in Judd (1992), delivers very similar estimates.

3.4 Results

The results of the steady-state model evaluation, given the set of calibrated parameters discussed above, are presented in Figure 2. Figure 3 reports the regression lines obtained from the model versus the ones from the data, of the average debt levels regressed on the corruption indices. The model augmented with corruption still slightly underestimates debt levels in the highly indebted countries and overestimates the debt levels in the countries characterized by low public debts. The goodness of fit is about 42%, when the actual debt shares of GDP are regressed on the debt shares of GDP predicted by the model.
The results do not change significantly when the different time period is considered. However, the model performs much worse with an attempt to replicate debt levels in the rest of the OECD countries. The reason is that the "new" states, such as for example Poland, Hungary, Slovakia and Czech Republic, have significantly lower GDP and public debt levels when compared with the Development Assistance Committee members, and cannot be considered as those operating near their steady state growth path.

Figure 2 shows that the public debt in Spain, South Korea, Norway, Australia and Luxembourg is significantly overestimated, which may be a signal that either these countries have not reached their steady state development path or these economies are affected to a higher extent than other considered states, by the factors omitted in the estimation.

Among the highly-indebted countries, the model falls short in replicating the public debt share in Belgium and Japan, due to relatively low public corruption indices in these countries. Given its high simplicity, the model leaves disregarded many other factors, which may affect public debt accumulation, besides public corruption.\(^8\) Purely exogenous shocks such as wars or natural disasters would probably account for another significant part of average public debt levels in the considered sample of the countries.

A positive relationship between public corruption and public debt observed in the data is successfully captured by the model (see figure 3). The regression of public debt on public

\(^8\)One possible extension is to include the political instability (political turnover) in the model. Another important factor excluded here is the risk-premium for highly indebted countries.
corruption, given the data on public debt, generates a constant equal to 0.35 and a slope equal to 1.21. The regression of public debt on public corruption, given public debt shares produced by the model, generates a constant equal to 0.33 and a slope equal to 1.19.

Consider other predictions of the model, given the calibrated data on output and government spending. Table 3 proposes the correlation coefficients between the variables in the data (the averages over 1995-2010) and the correlation coefficients between the variables in the model (below the main diagonal). According to the model, higher corruption provokes higher taxes through a decrease in aggregate capital and through the negative relationship between capital and taxes (correlation between tax revenues and corruption in the model is 0.930). In reality, the relationship between income taxation and aggregate capital may be more complicated (correlation between tax revenues and corruption in the data is -0.292). In particular, when higher public corruption crowds out investment because of higher public spending, the government might decide to decrease income taxes to attract more labor force (which is assumed exogenous in the model) as a substitute of capital in the production process.
Table 3: Correlation coefficients between the variables in the model and in the data

<table>
<thead>
<tr>
<th>Data\Data</th>
<th>B/Y</th>
<th>C/Y</th>
<th>G/Y</th>
<th>TR/Y</th>
<th>Y</th>
<th>Corruption</th>
</tr>
</thead>
<tbody>
<tr>
<td>B/Y</td>
<td>1</td>
<td>0.202</td>
<td>0.196</td>
<td>0.125</td>
<td>-0.418</td>
<td>0.708</td>
</tr>
<tr>
<td>C/Y</td>
<td>-0.996</td>
<td>1</td>
<td>-0.311</td>
<td>-0.632</td>
<td>-0.302</td>
<td>0.421</td>
</tr>
<tr>
<td>G/Y</td>
<td>0.130</td>
<td>-0.133</td>
<td>1</td>
<td>0.760</td>
<td>-0.263</td>
<td>-0.215</td>
</tr>
<tr>
<td>TR/Y</td>
<td>0.996</td>
<td>-0.989</td>
<td>0.096</td>
<td>1</td>
<td>0.060</td>
<td>-0.292</td>
</tr>
<tr>
<td>Y</td>
<td>-0.414</td>
<td>0.342</td>
<td>-0.078</td>
<td>-0.458</td>
<td>1</td>
<td>-0.375</td>
</tr>
<tr>
<td>Corruption</td>
<td>0.916</td>
<td>-0.907</td>
<td>-0.166</td>
<td>0.930</td>
<td>-0.436</td>
<td>1</td>
</tr>
</tbody>
</table>

In the model, consumption does not depend directly on income taxes because of simultaneous choice of taxes by the government and consumption by the households. However, consumption decreases with higher income taxes because of positive effect of capital on consumption and negative effect of capital on taxes. The negative relationship between taxes and private consumption is observed in reality as well (see figure 4).

Figure 4: Private consumption versus tax revenues, model and data.

The next subsection proposes a robustness check, consisting of the application of the model considered above to a different set of economies, namely, the states of the USA.
3.5 Debt and corruption in the states of the US

This subsection applies the model developed above to an alternative set of economies, namely, the states of the USA. Each of the states of the US is characterized by some degree of independence of local authorities, local budget, legislation, and local governance and satisfies the requirement of the (near) steady state development path. Given the otherwise relatively homogeneous characteristics of the states of the US, they constitute an ideal sample for the robustness check of the results reported for the OECD countries.

The calibration proceeds in the same way as before. Given the data on GDP and government expenditures for each state of the USA, \( \varphi_i, A_i \) are set so that the model generates output and government expenditures the same as in the data. The debt levels from the model are then compared with those in the data.

The economic indicators for the USA are available from the CENSUS dataset. It reports the total state and local government expenditures by state. The measure of public consumption was constructed, similar to Barro (1990), by subtracting the expenditures on public investment, transfers, education and defense (the last item is zero in the state and local budgets) from the total government expenditures. The calibration relies on the cross-section data on GDP, government expenditures and public debt, the total of the state and local values, for the year 2002.

The USA data sources do not report any indices of public corruption by state. As a measure of public corruption, they use the number of convictions of the state and local public officials per year. The shortcomings of this measure are evident: the estimates are biased downwards and may be affected by political factors. However, the only available alternative is the "Integrity Index" of the states by the Better Government Association (BGA), which ranks the states according to the estimates of the quality of their legislature as a way of protection against public corruption. Surprisingly, the correlation between the BGA measure of corruption and the one obtained from the number of convictions is negative. As the Corporate Crime Reporter (2004) explains, "If a public official wants to violate his or her trust, the laws don’t stand in the way". Therefore, the number of convictions (sum over the decade 1993-2002), normalized by the state population in 2002, is used as a proxy for corruption:

\[
\bar{\gamma}_i = \frac{\# \ of \ convictions}{population}, \ i = 1,..50. \tag{41}
\]

The average and std. deviation values for the data incorporated into the model are presented in table 4.
The model does not reproduce perfectly the debt level in each particular state. However, as can be seen from Figure 5, the regression line, fitting the public debt levels in the USA states as a function of the measure of public corruption, when taken from the model, coincides almost perfectly with the line obtained from the data.

Figure 5: The regression lines of model \((0.14 + 5.00 \times)\) vs data \((0.14 + 5.29 \times)\): debt shares on the corruption levels for the USA states.

Note that this subsection considers an absolutely different measure of corruption as the previous ones, and still finds a positive relationship between public corruption and public debt share. That is, given that public corruption is an unobservable and difficult to measure phenomenon, the relative public debt levels might signal relative differences in the corruptness of the public officials in the regions (countries) of investigation.
4 Conclusions

The simple model developed in this paper is able to deliver relatively high (up to 100\% of GDP) debt levels in the countries characterized by significant corruption of the public officials, while it prescribes positive moderate (about 50\% of GDP) public debt levels in the countries with low or absent public corruption. When applied to a sample of 23 most advanced countries, the model predicts the public debt shares quite close to those actually observed. The conclusions of this paper may be used as a bulk for legislative modifications of public policy fundamentals, aimed to decrease the possibilities of public corruption of government officials in developed countries. This work suggests that such modifications, among other welfare-improving consequences, would lead to a substantial drop in public debt levels in developed economies in the long run.

The results reported here may be viewed both as alternative and as supplementary to the political disagreement arguments used in previous studies as an explanation of public debt levels in high-income countries.

The assumptions imposed throughout the paper insure the simplicity of the model and allow to concentrate on one particular source of public debt accumulation: public corruption. Relaxing some of the assumptions could potentially improve the model performance, at the cost of additional computational complications. Several examples of such complications are as follows. In the model it is assumed that labor is exogenous. Endogenizing labor choice would lead to higher public debt levels in the economy studied in this paper, if the substitution effect on leisure choice is larger than its income effect. In that case the government would not be able to tax households by the same amount as in inelastic labor case, so it would have to rely more on public debt accumulation to finance its corrupt activities. In the economy studied in this paper the steady state interest rate on debt is determined by the capital stock and does not depend explicitly on the amount of debt outstanding. A risk-premium for highly indebted countries could account for another significant part of government indebtness in the studied economies.

References


Appendix

Derivation of the necessary optimality conditions for the definition of Markov-perfect equilibrium (28)-(29)

From the household’s optimization problem

\[ u_c(c(b, k)) = \beta u'_c(c(b', k'))[1 + (1 - \tau')(f_k(k') - \delta)]. \] (42)

From the government optimization problem:

\[ [b'] : \quad U_g(G_{y'} - \hat{g}_{y'}) + U_{g'} - \beta V'_{k'}G_{y'} + \beta V'_{y'} = 0, \] (43)

\[ [\tau] : \quad U_g G_{\tau} - \beta V'_{k'}G_{\tau} = 0, \] (44)

\[ [\hat{g}] : \quad U_g - U_{\hat{g}} = 0. \] (45)

Simplifying and noting that \( G_{y'} = 1 \):

\[ U_g - \beta V'_{k'} + \beta V'_{y'} = 0, \] (46)

\[ U_g G_{\tau} - \beta V'_{k'} G_{\tau} = 0. \] (47)

Combining with the Envelope Theorem:

\[ V_k U_c C_k + U_g G_k + \beta V'_{k'}(1 + f_k - \delta - C_k - G_k) + U_g G_{y'} b'_k - \beta V'_{k'}G_{y'} b'_k + \beta V'_{y'} b'_k \] (48)

\[ = 0 \text{ from f.o.c.} \]

\[ V_b = U_c C_b + U_g G_b + \beta V'_{k'}(-C_b - G_b) + U_g G_{y'} b'_b - \beta V'_{k'}G_{y'} b'_b + \beta V'_{y'} b'_b \] (49)

\[ = 0 \text{ from f.o.c.} \]

\[ V_k = U_c C_k + U_g G_k + \beta V'_{k'}(1 + f_k - \delta - C_k - G_k), \] (50)

\[ V_b = U_c C_b + U_g G_b + \beta V'_{k'}(-C_b - G_b). \] (51)

Forwarding the latter two equations one period and plugging the government optimality conditions, obtain the Generalized Euler Equations (28)-(29).

Proof of Proposition 1:

The equalities that must be satisfied at optimum with the imposed steady state condition
Given that at the steady state with distorting taxation, private consumption is a function of one variable – physical capital – and given that marginal property to consume for this economy is defined as $C_k^a$, $0 < C_k^a < 1$ and is positively related to the derivative of private consumption with respect to physical capital, $C_k^a = C_ka k^{a-1}$, the following inequality holds:

$$C_k = C_k(k) > 0. \quad (52)$$

The system above, given the level of public corruption $\bar{\gamma}$, may be rewritten as:

$$U_g(f(k) - \delta k - C(k)) = \beta (U_c(C(k))C_k + U_g(f(k) - \delta k - C(k))(1 + f_k - \delta - C_k)), \quad (53)$$

$$f(k) - \delta k - C(k) = (1 - (1 - \beta)/(\beta(f_k - \delta))(f(k) - \delta k + (f_k - \delta)b) - (f_k - \delta)b. \quad (54)$$

which defines a system of two equations in two unknowns: $k$ and $b$.

Plugging the functional forms of utility and considering the first equation (denote $\Gamma = (\phi + \bar{\gamma})/\phi$):

$$\phi \Gamma C(k) = \beta (C_k(k)(f(k) - \delta k - C(k)) + \phi \Gamma C(k)(1 + f_k(k) - \delta - C_k(k))), \quad (55)$$

which implicitly defines physical capital as a function of the level of public corruption:

$$F(\bar{\gamma}, k(\bar{\gamma})) = \phi \Gamma C(1 - \beta(1 + f_k - \delta - C_k)) - \beta C_k(k)(f(k) - \delta k - C) = 0. \quad (56)$$

Applying the implicit function theorem:

$$k_{\bar{\gamma}} = -\frac{\phi \Gamma \phi C(1 - \beta(1 + f_k - \delta - C_k))}{\phi \Gamma C_k(1 - \beta(1 + f_k - \delta - C_k)) - \phi \Gamma C\beta(f_{kk} - C_{kk}) - \beta C_{kk}(f(k) - \delta k - C) - \beta C_k(f_k - \delta - C_k)}. \quad (57)$$

From Lemma 1 in the main text, the nominator is positive. Consider the denominator:

$$\phi \Gamma C_k(1 - \beta(1 + f_k - \delta - C_k)) - \phi \Gamma C\beta(f_{kk} - C_{kk}) - \beta C_{kk}(f(k) - \delta k - C) - \beta C_k(f_k - \delta - C_k)$$

The first term is positive by assumption. The second and third terms give together:

$$-\phi \Gamma C\beta(f_{kk} - C_{kk}) - \beta C_{kk}(f(k) - \delta k - C) = -\phi \Gamma C\beta f_{kk} + \beta C_{kk}(\phi \Gamma C - G). \quad (59)$$
$G$ may be expressed using the generalized Euler equation evaluated at the steady state:

$$G = [\varphi \Gamma C(1 - \beta(1 + f_k - \delta - C_k))] / (\beta C_k).$$

(60)

Plugging this expression for $G$ back into the sum of the second and third terms:

$$-\varphi \Gamma C \beta f_{kk} + \beta \varphi \Gamma C C_{kk}(-1 + \beta(1 + f_k - \delta))/ (\beta C_k) > 0,$$

(61)

given that the production function $f(k)$ is concave and that $-1 + \beta(1 + f_k - \delta) < 0$ (see Lemma 1) at the steady state with positive distortionary taxation.

So, the first three terms of the denominator are positive expressions. The fourth one $-\beta C_k (f_k - \delta - C_k)$ is positive by assumption 1.

Therefore, $dk/d\gamma < 0$; higher public corruption leads to lower capital accumulation.

Given that at the steady state consumption is a function of capital, with $C_k > 0$,

$$C_{\gamma} = C_k k_{\gamma} < 0.$$

(62)

Given the expression defining the steady state income taxes:

$$\tau_{\gamma} = (1 - \beta) f_{kk} k_{\gamma} / (\beta (f_k - \delta)^2) > 0.$$

(63)

Given the expression for public expenditures and using again assumption 1:

$$G_{\gamma} = (f_k - \delta - C_k) k_{\gamma} > 0.$$

(64)

Finally, to find out how the steady state government debt depends on the level of corruption, consider the second equation of the system defining $k$ and $b$:

$$f(k) - \delta k - C(k) = (1 - (1 - \beta) / (\beta (f_k - \delta)) (f(k) - \delta k + (f_k - \delta)b) - (f_k - \delta)b.$$

(65)

Expressing $b$ and evaluating $b_{\gamma}$:

$$b_{\gamma} = \left( (f(k) - \delta k) f_{kk} / (f_k - \delta)^2 + C_k - 1 \right) k_{\gamma} > 0,$$

(66)

given that $C_k < 1$, $f(k) - \delta k > k(f_k - \delta) > 0$. ■