Corruption and Disposable Risk

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Abstract

Corrupt bureaucrats manipulate rules and regulations to coerce the private agents to pay bribes. In such an environment the cost of dealing with the public sector is uncertain as the regulations are not observed as they are originally defined. Combined with weak enforcement and compliance, predation of corrupt bureaucrats makes private disposable income volatile. We study this uncertainty within a stochastic dynamic growth model framework, where we generalize the corruption caused uncertainty as a shock to disposable income of agents. Consequently, corruption creates two adverse effects in the economy: higher risks associated with private investments and lower returns on private capital due to increased public burden. Both effects tend to lower the demand for investments, thus long run growth is compromised in the economy with the corrupt public sector.

Key words: Corruption, public input, growth, burden
JEL classification: H21

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1. Introduction

In economies with weak institutions, public officials apply rules and regulations subjectively. This leads to increased uncertainty for the private agents, as their disposable income may vary depending on the interactions with the public officials. In this chapter, we would like to investigate how this type of uncertainty affects economic growth.

Bewley (1977) gives a start to a large body of literature that studied growth impact of the labour income risk. The most recent Bewley–type models include Aiyagari (1994), Huggett (1997), Calvet (2001). These models mainly focus on the precautionary saving and wealth distribution caused by the individual labour income uncertainty. These models assume no aggregate uncertainty, however, allowing risk at the individual level. These studies find that the labour-income risk leads to lower interest rates and over-saving in the steady state.

A natural extension of Bewley-type models is to investigate the impact of idiosyncratic risk in production and investment. This new line of literature initiated by Angeletos (2007), Angeletos and Calvet (2005). Their finding differs from the original Bewley models in that they predict both lower interest rates and lower capital accumulation due to investment risk. In other words, in the presence of production uncertainty, risk aversion dominates over the precautionary saving behaviour of the agents. [2]

The results of the above-mentioned research show that volatility might stem from different facets of economic activity. In line with this, Denizer et al. (2000) state that corruption can be also an important factor contributing to volatility. Campos (2001) argues that not only the level of corruption is important, but also its predictability plays significant role in determining its growth impact. This finding is in concordance with Shleifer and Vishny (1993), who state that the secrecy stemming out of the illegal nature of corruption imposes an additional burden on the economy. It is clear that the secrecy adds to the uncertainty associated with corruption, and thus, it can contribute to overall volatility in the economy. However, the literature lacks a model that incorporates corruption

[2] The other strand of studies aim at laying down the theoretical basis of the relationship between risk and growth at the aggregate level. See e.g Eaton (1981), Gertler and Grinols (1982), Grinols and Turnovsky (1993, 1998), Krusell and Smith (1998). Examples of empirical analysis include Kormendi and Meguire (1985), Grier and Tullock (1989), Tsai et al. (1997), Corsetti et al. (1999), Easterly et al. (2000), Ramey and Ramey (1995), Aizenman and Marion (1993, 1999).

caused uncertainty.

There are a significant body of literature dedicated to the investigation of growth impact of corruption, however, the literature on corruption has neglected the growth impact of the uncertainty created by corruption.[3] An attempt to account for the uncertainty stemming out of the institutional structure of the economy has been done by Lin and Yang (2001). They investigate a stochastic growth model with the uncertainty caused by tax evasion.

I model uncertainty caused by institutions like in Lin and Yang (2001) and Eichhorn (2006), albeit from a broader perspective by taking account of both taxation and public good provision. For this purpose I apply the underlying idea of the Bewley-Angeletos type models to analyse the effects of such uncertainty on saving and investment. In particular, I adjust the growth model developed by Angeletos and Calvet (2006) for the production with idiosyncratic risk to the case, when disposable income bears the idiosyncratic risk caused by corruption. It is shown that the idiosyncratic risk reflected by disposable income negatively affects evolution of the economy.

The structure of the chapter is as follows: first,the intuition of the model is outlined, then a brief description of the tools used in dynamic optimization is presented, next the set-up of the model is described, then the implications based on the optimal solution obtained for the model are analysed.

2. Stochastic disposable income

Corruption usually implies deviation from what is considered to be normal or required by regulations or law. In other words, corrupt public officials distort rules and regulations. They do it in order to create and capture private rents for themselves. Corrupt transactions are clandestine and therefore, associated with risk. In the environment with corrupt bureaucracy the allocation of government contracts and licenses is unpredictable, as the rules of game are not clear. Therefore, the private firms' output depending on such contracts and licenses are also subject to uncertainty. The poor tax administration and corruption of tax inspectors also lead to uncertain outcomes for the taxpayers.

Let us first describe how corruption can enter the interactions between the private and public sectors. Assume that each infinitely-living individual owns a

[3]For example, Leff (1964), Huntington (1968), Liu (1985, 1996), Mauro (1995, 1998, 2004), Rose-Ackerman (1998, 1999, 2002, 2004), Barreto (2000), Barelli and Pessoa (2002), Rivera-Baitiz (2002), Acconcia (2006), have studied growth effects of corruption.

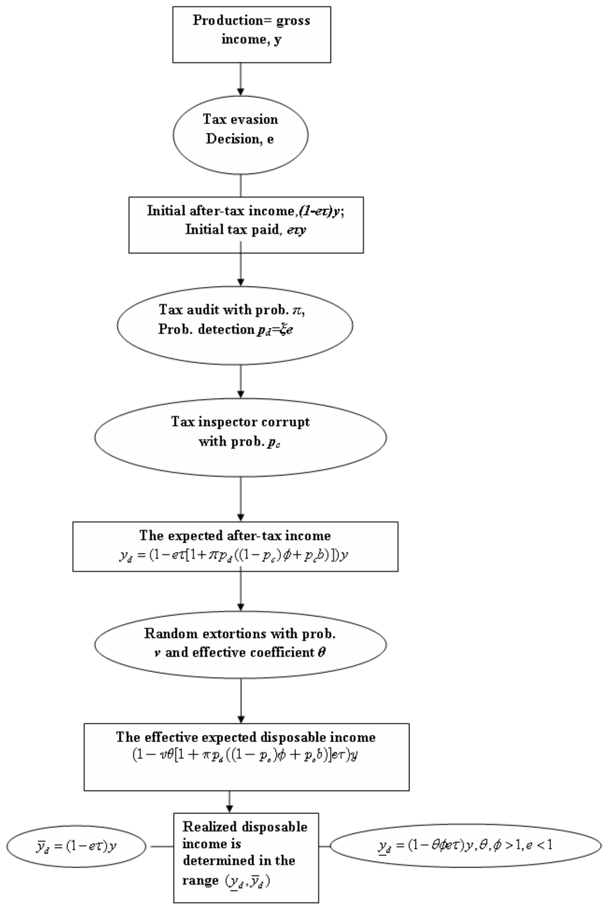

Figure 1: Mechanics of disposable income determination

firm and produces a single good, and this process of production is deterministic. The government imposes income tax with a flat rate. The firms try to maximize their expected disposable income by evading taxes.

The possible outcomes for the interaction between the private and public sectors are illustrated by a tree (See Figure 1). The following is the description of those interactions and outcomes.

- The agent produces output equal to y, but reports only $(1-e)y$ and thus pays the tax equal to $(1-e)\tau y$. As we earlier indicated the evasion rate , e is random and determined in $(0, 1)$.

- Tax auditors randomly select firms and examine their tax returns. The probability of being audited is given by π. The auditors can reveal tax evasion with the probability given by $p_d = \xi e$, where ξ is a parameter of tax administration efficiency. It is also possible that the extent of tax evasion is revealed in a range of (0, 1).

- If not detected taxpayer's after-tax income is $(1 - e\tau)y$. If detected then it depends on whether the tax inspector is corrupt or not.
  - The honest tax inspector would make the taxpayer to pay the unpaid tax with a surcharge. That would leave the taxpayer with after-tax income equal to $(1 - e\phi\tau)y, \phi > 1$.
  - The corrupt tax inspector would get a bribe amount, which is less than the sum of penalty for tax evasion and unpaid tax. In this case the taxpayers after-tax income is given by $(1 - eb\tau)y, b < 1$.
  - The expected after tax income is $1 - e\tau\{1 + \pi p_d[(1 - p_c)\phi + p_c b]\}y$.
- We assume that the predatory public officials, who regulate the economy, extract a fraction of firms' (a.k.a. taxpayers) income with probability v. In this case the expected disposable income of the firm is given by $(1 - v\theta[1 + \pi p_d((1 - p_c)\phi + p_c b)]e\tau)y$, where θ is a coefficient that reflects an effective increase in the burden for the firm due to extortion.

Therefore, we conclude that in a corrupt environment, depending on the outcomes in tax evasion and regulations, the disposable income of the taxpayers is stochastic, and may vary in a range of $(1 - e\tau)y$ and $(1 - \theta\phi e\tau)y$. The former is the best outcome, while the latter is the worst outcome with respect to disposable income of an agent.

3. The model

3.1. The Agents

We assume continuum of infinitely-living households. There are two types of households: i) producers, ii) bureaucrats. Each producer-household owns a firm and produces a single good using its labour. The bureaucrat households supply labour to the public sector.

3.2. *The public budget*

The stochastic nature of the tax collections results not only in uncertainty for the individuals, but certainly the government faces uncertainty in collecting tax revenue from the individuals. However, we assume that the public sector first pools all the funds collected then uses it for the public goods production. Therefore, for the public sector only the aggregate tax revenue is important.

With corruption tax evasion is higher, which leads to lower tax revenue being collected. With weak institutions the government budget is inefficiently and inappropriately utilised. This situation results in a fraction of the public funds being wasted on unproductive activities such as excessive red tape creation or extortions for the self-benefit of the bureaucrats. Ultimately, the productive input provided by the public sector is lower in the environment with corrupt bureaucracy.

Denote the income of agent j effectively taxed by y_τ. Then at the aggregate level public funds are just the sum of the tax revenues paid by each taxpayer,

$$T = \tau \mu_{y_\tau} N$$

where μ_{y_τ} the average income taxed, N is the total number of taxpayers. Tax evasion with corruption results in that the average income taxed is less than the average true income, $\mu_{y_\tau} < \mu_y = \frac{\sum_{j=1}^{N} y_j}{N}$. In other words, the tax revenue in the environment with corruption is lower than the potentially attainable amount.

We can assume that on average a fraction of this revenue is misused and therefore, the government's productive input into the private production is given by:

$$g(t) = \zeta T(t), \zeta < 1 \tag{1}$$

The assumption here is that the budget is balanced and without corruption the efficiency coefficient satisfies $\zeta = 1$. The conclusion we can draw from this condition is that corruption ridden governments provide less productive input into private production.

3.3. *Individual Preferences*

As it is argued earlier, disposable income of the agents are stochastic due to corruption and given by $y_d = A \cdot h \cdot f(k, g)$. To this type of stochastic process we can apply the model developed by Angeletos and Calvet (2006). The main idea behind this approach is to formulate the individual agent's choice in such a manner that the tendency to intertemporal substitution and risk aversion can be separated. Our model differs from the case modelled by Angeletos and Calvet (2006) in that the uncertainty in our case is caused by corruption, while Angeletos and Calvet investigated the uncertainty in production. Their production function has the following form:

$$y = A_t f(k_t) \tag{2}$$

The technological coefficient A_t is a stochastic variable, thus captures production uncertainty. It is assumed that A_t follows Gaussian (normal) distribution and *i.i.d* across agents and periods, that is $A_t \sim N(1, \sigma^2)$.

Instead of technological shock, we assume institutional shocks, which then replaces A_t in (2) with $A \cdot h_t$. That is we are assuming $h_t \sim N(\mu_h, \sigma_h^2)$, whereas the the technology is deterministic. It is assumed that time is discrete and infinite. We consider a continuum of infinitely living household-producers with possibility of short-term asset holding. That is the agents can borrow and lend at economy-wide interest rate r, and sum of all assets equal to zero. Borrowed money is always repaid and no-Ponzi game is assumed.

We also should have some ideas about what the expected value for $h(t)$ should be. In the first-best world $\mu_h = (1-\tau)$ should hold as the firms in their interaction with the public sector have only to give a part of their income in the form of taxes. However, in the world with corrupt bureaucrats, as we discussed in the foregoing, $h(t)$ is a distribution, with different realized values for each private agent in the given period of time. Due to this fact we can state that the expected value for the institutional-shock function $\mathbb{E}[h(t)] = \mu_h = (1-\varepsilon\tau)$, where $\varepsilon = \mathbb{E}[(e, \theta\phi e)]$. In the environment with predatory public sector, the burden of extortion can over-weigh the gains from tax evasion, thus $\varepsilon > 1$ is possible.

We assume that the agents' expected utility function is given by

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t) \tag{3}$$

where $u(c) = -\psi \exp\left({}^{-c}\!/\!_{\psi}\right)$, and subject to budget constraint. The budget constraint in period t is given by

$$c_t + i_t + a_t = y_{dt} + (1 + r_{t-1})a_{t-1} \tag{4}$$

where c_t is consumption, i_t is capital investment a_t is asset holdings, y_{dt} is disposable income from production, r is rate of return on assets. The capital accumulation evolves according to the rule:

$$k_{t+1} = (1 - \delta)k_t + i_t \tag{5}$$

Combining (4) and (5) yields a budget constraint in a stock variable form:

$$c_t + k_{t+1} + a_t = z_t, \tag{6}$$

where z_t is the state variable given by,

$$z_t = h_t f(k_t, g_t) + (1 - \delta)k_t + (1 + r_{t-1})a_{t-1} \tag{7}$$

It is assumed that the coefficient of technology in the production function is given by $A = 1$ for simplicity.

The household chooses a contingent plan $\{c_t, k_{t+1}, a_t\}_{t=0}^{\infty}$ that maximizes expected lifetime utility (3) subject to (6). Given the uncorrelated nature of the idiosyncratic risks over time, the state of the household in period t is characterized by the individual wealth z_t.

3.4. Individual choice

The utility maximization problem leads to the Bellman equation

$$u[V_t(x_t)] = \max_{c_t, k_{t+1}, a_t} u(c_t) + \beta u[\mathbb{CE}_t]. \tag{8}$$

As the random variable h_t is assumed to be normally distributed, the state variable z_t is also normal.

In (8) the concept of certainty equivalent is used . The certainty equivalent is the constant amount of wealth $\mathbb{CE}(Y)$ the utility of which is the same as the expected utility of a random variable Y: $U(\mathbb{CE}(Y)) = \mathbb{E}[U(Y)]$. As we know, for the concave utility functions the Jensen's inequality holds: $U(\mathbb{E}[Y]) \geq \mathbb{E}[U(Y)]$. From this risk-aversion property, a risk-averse agent always prefers a sure amount of cash to the expected income that satisfies the condition: $\mathbb{CE}(Y) \leq \mathbb{E}[Y]$. The difference $\mathbb{E}[Y] - \mathbb{CE}(Y)$ can be treated as risk premium. This risk premium can be approximated. Let us denote $\mu_Y = \mathbb{E}[Y]$. Applying Taylor's expansion to the utility function we can write an approximation

$$U(Y) \approx U(\mu_Y) + (Y - \mu_Y)U'(\mu_Y) + \tfrac{1}{2}(Y - \mu_Y)^2 U''(\mu_Y). \tag{9}$$

Taking expectations of (9) yields

$$\mathbb{E}[U(Y)] \approx U(\mu_Y) + \tfrac{1}{2}Var[Y]U''(\mu_Y) \tag{10}$$

Taking into account the definition of the certainty equivalent and using Taylor's expansion once more we obtain

$$\mathbb{E}[U(Y)] = U[\mathbb{CE}(Y)] \approx U(\mu_Y) + [\mathbb{CE}(Y) - \mu_Y]U'(\mu_Y). \tag{11}$$

Using (10) and (11) we get the expression for the risk premium

$$\mu_Y - \mathbb{CE}(Y) \approx \frac{1}{2}\frac{U'(\mu_Y)}{U''(\mu_Y)}Var[Y]. \tag{12}$$

In our case the certainty equivalent of V_{t+1} is given by $\mathbb{CE}_t = V_{t+1}(\mathbb{E}_t z_{t+1} - \frac{\Gamma_t}{2}Var_t z_{t+1})$. Here Γ_t is a measure of risk aversion; a higher values for Γ_t imply higher risk aversion. The certainty equivalent is a value function of the difference of the expected value of z_{t+1} and the product of the variance of z_{t+1} and a risk aversion measure.

The expected value of the state variable is given by $\mathbb{E}_t z_{t+1} = \mu_h f(k_{t+1}, g_{t+1}) + (1-\delta)k_{t+1} + (1+r_t)a_t$, and $Var_t z_{t+1} = (\mu_h)^2 f(k_{t+1}, g_{t+1})^2 \sigma_h^2$. Taking this result into account the agent's problem is written as follows:

$$\begin{aligned}&\max u(c_t) + \beta u\{V_{t+1}[\mu_h f(k_{t+1}, g_{t+1}) + (1-\delta)k_{t+1} + (1+r_t)a_t \\ &-\tfrac{\Gamma_t}{2}(\mu_h^2 f(k_{t+1}, g_{t+1})^2\sigma_h^2)]\}\end{aligned} \tag{13}$$

$$\text{subject to } c_t + k_{t+1} + a_t = z_t.$$

The simplest value and consumption function that solves our dynamic problem can be presented by $V_t(z) = \lambda_t z_t + b_t$ and $c_t = \hat{\lambda}_t z_t + \hat{b}_t$.

The FOCs of (13) with respect to k_{t+1} and a_t yield

$$u'(c_t) = \beta u'(V_{t+1})\lambda_{t+1}\{(1-\delta) + \mu_h f'(k_{t+1}, g_{t+1})[1 - \Gamma_t(\mu_h^2 f(k_{t+1}, g_{t+1})\sigma_h^2)]\} \tag{14}$$

$$u'(c_t) = \beta u'(V_{t+1})\lambda_{t+1}(1+r_t) \tag{15}$$

From these two conditions we obtain

$$r_t + \delta = \mu_h f'(k_{t+1}, g_{t+1})[1 - \Gamma_t(\mu_h f(k_{t+1}, g_{t+1})\sigma_h^2)] \tag{16}$$

The envelope condition is given by: $u'[V_t(z_t)]\lambda_t = u'(c_t)$. By substituting our assumed functional forms we obtain, $c_t = \lambda_t z_t + b_t - \psi \ln \lambda_t$ Equating the coefficients on this and the assumed consumption function yields

$$\hat{\lambda}_t = \lambda_t \tag{17}$$

and

$$\hat{b}_t = b_t + \psi \ln \lambda_t \tag{18}$$

Taking account of this and assuming $\Gamma_t = \Gamma\lambda_{t+1}$ we reformulate the FOC with regards to a_t:

$$u'(c_t) = \beta\lambda_{t+1}(1+r_t)u'\left[V_{t+1}\left(\mathbb{E}_t z_{t+1} - \frac{\Gamma_t}{2}Var_t z_{t+1}\right)\right]$$

$$= \beta\lambda_{t+1}(1+r_t)u'\left(\lambda_{t+1}\mathbb{E}_t z_{t+1} - \frac{\Gamma}{2}\lambda_{t+1}^2 Var_t z_{t+1} + b_{t+1} - \psi \ln \lambda_{t+1}\right) \tag{19}$$

$$\tag{20}$$

by accounting for (17) and (18) we reduce the FOC to

$$u'(c_t) = \beta(1+r_t)u'\left[E_t c_{t+1} - \Gamma Var_t(c_{t+1})/2\right] \tag{21}$$

(21) can be re-arranged to yield the Euler equation

$$\mathbb{E}_t c_{t+1} - c_t = \psi \ln\left[\beta(1+r_t)\right] + \Gamma_t^2\left[\mu_h^2 f(k_{t+1}, g_t)^2 \sigma_h^2\right]/(2\Gamma) \tag{22}$$

So, for given interest rate path $\{r_t\}_{t=0}^{\infty}$, the investment demand is determined by (16), and consumption decision is determined by (22).

3.5. Equilibrium

In equilibrium idiosyncratic risks cancel out and thus the aggregate dynamics are deterministic, thus the interest rates are are equalized across the market. Thus an equilibrium in an incomplete market is described by a deterministic interest rate sequence $\{r_t\}_{t=0}^{\infty}$ and a set of plans $(\{c_t^j, k_{t+1}^j, a_t^j\}_{t=0}^{\infty})_{j\in[0,1]}$ chosen by the households contingent on the history of the stochastic shocks to maximize their life-time utility.

At the macro level the path of the economy is deterministic and given by a sequence $\{C_t, K_{t+1}, r_t\}_{t=0}^{\infty}$. It is also assumed that in equilibrium the bond and labour markets are cleared. C_t and K_t denote average consumption and capital stock across the population. As Angeletos and Calvet (2006) show that assumption of CARA preferences ensures that risk-taking is independent of wealth. As the only risk we are assuming here is the risk associated with with the capital income, the investment decision is also independent of wealth. The existence of equilibrium for the current setting has been demonstrated by Angeletos and Calvet (2004).

For *ex ante* identical agents we have $\lambda_t^i = \lambda_t$ and $\Gamma_t^i = \Gamma_t$, $\forall i, t$. This implies that $k_{t+1}^i = K_{t+1}$. Then we can write

$$r_t + \delta = \mu_h f'(K_{t+1}, G_{t+1})[1 - \Gamma_t(\mu_h f(K_{t+1}, G_{t+1})\sigma_h^2)] \tag{23}$$

Aggregating the Euler equation (22) across agents we obtain

$$C_{t+1} - C_t = \psi \ln[\beta(1 + r_t)] + \Gamma_t^2 \left[\mu_h^2 f(K_{t+1}, G_{t+1})^2 \sigma_h^2\right] / (2\Gamma) \tag{24}$$

The resource constraint at the aggregate level is given by

$$C_t + K_{t+1} = \mu_h f(K_t, G_t) + (1 - \delta)K_t \tag{25}$$

In the environment without corruption $\sigma_h = 0$, the marginal product of capital is equated with the gross interest rate $r_t + \delta = \mu_h f'(K_{t+1}, G_{t+1})$. However, in the uncertain environment due to corruption the mean return on investment should be rewarded for the risk that is equal to $\Gamma_t \mu_h^2 f'(K_{t+1}, G_{t+1}) f(K_{t+1}, G_{t+1})\sigma_h^2$.

The second adverse effect of corruption stems from the lower productive input provision. In the environment with weak institutions the public input $G_{t+1} = \theta\tau y$ with $\theta < 1$ is lower due to misuse of public funds and tax evasion. In this case, the marginal product of capital $f'(K_{t+1}, G_{t+1})$ is less than in the environment without corruption, where $\theta = 1$.

We also know that in the environment without corruption the burden of the public sector decreases the marginal product of capital by a factor of $(1 - \tau)$. However, based on the earlier results of our analysis we infer that the burden of the public sector with corruption exceeds the burden in the environment without corruption. That is, in fact, equivalent to saying that the effective public burden in the corrupt environment is higher as $\mu_h = (1 - \varepsilon\tau)$, where $\varepsilon > 1$ due to extortion. Therefore, the private return on capital is lower than in the environment with corruption. Hence, corruption further lowers the effective marginal product of capital, which entails lower capital accumulation.

The Euler equation (22) shows, as it was demonstrated by Bewley (1977), Huggett (1997), Angeletos (2007), that the higher uncertainty in disposable income leads to higher precautionary saving.

How is it possible that people save more and at the same time they invest less? However, this contradiction stems from the concept that all savings should be invested in somewhere. In other words, in equilibrium for a closed economy we should observe equality of aggregate investment and saving,

$$I_t = S_t$$

At the same time if saving rate is very high and demand for investment is low then it is possible that the savers can except negative real interest rates. Why will they do that? To smooth out their consumption in the face of income uncertainties. The risk-averse agents can save some resources for the future consumption even though they will loose in real terms.

In fact, in most developing countries with high income uncertainty and developed financial markets, the savings are done as a stash of currency or even just stock of foodstuff and durables. It is clear that as proportion of their income these people may save quite significantly, while their savings do not affect directly the level of investment in the economy. In poor countries people often rely on informal social safety networks to overcome hardships due to income uncertainty. So, the saving of one family is given to other family in the network for consumption, not investment. Therefore, its perfectly possible that due to income uncertainty saving may be higher, whereas investment and thus capital accumulation is lower.

The result is stated as Proposition.

Proposition: *Income uncertainty caused by corruption requires a risk premium and thus leads to lower capital investment. This effect of corruption further amplifies the decrease of capital accumulation caused by corruption induced income redistribution and public sector inefficiency.*

4. Conclusions

An analysis of a simple stochastic model that captures uncertainty in disposable income caused by corruption demonstrates that risk averse agents invest less. This adversely affects growth. By modelling uncertainty created by corruption in the public sector, we find that agents require risk-premiums on the returns on their investment. This leads to less demand for investment and less capital accumulation. Moreover, the expected burden of the public sector is greater in the environment with corruption; consequently, the return on private capital is lower. The lower returns on private capital shall lead to lower investments. Consequently, corruption creates two adverse effects in the economy: higher risks associated with private investments and lower returns on private capital. Both effects tend to lower the demand for investments, thus long run growth is compromised in the economy with the corrupt public sector.

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