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Abstract

We investigate how corruption affects credit markets. We distinguish between roving-bandit corruption by disbursing bureaucrats who extract bribes from entrepreneurs before realization of project returns, and high-level officials who can act as stationary bandits in predicating bribes on realized project returns. Corruption reduces financial mediation and increases risk in the pool of domestic investment projects that receive credit financing, and compounds adverse selection due to high initial intrinsic risk in domestic investment. We also examine interdependencies between bribes that are extracted from entrepreneurs before and after realization of project returns, and demonstrate the incentives of high-level government officials, who are themselves corrupt, to cooperate in anti-corruption programs directed at lower-level bureaucracies.

Keywords: Corruption; Bribery; Adverse selection; Credit markets; Bureaucracy; Development failure

JEL classification: O16, G21, P37

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"The ineffectiveness of the banking and financial system, and not corruption, underlies development problems in my country." Official, from one of the world's poorest countries

1. Introduction

Economic growth through private sector development in low-income countries requires domestic entrepreneurs to have access to credit for financing of investment projects.[1] At the most elementary level, the credit is provided by bank loans. Banking systems and credit markets in low-income countries are however often fragile, lenders are exposed to high-risk, and financial mediation is limited (King and Levine, 1993; Levine and Zervos; 1998; Calderon and Liu, 2003).[2] Development assistance responds to these circumstances by providing liquidity for subsidized loans to domestic entrepreneurs. However, development-assistance banking and credit market programs have also in general not been successful in overcoming the fragility and ineffectiveness of credit markets in low-income countries (see Demirguc-Kunt and Maksimovic, 1996; Batra and Mahmood, 2003).

Low-income countries tend also to be endemically corrupt (see for example Tanzi, 1998; van der Walle, 2001; Easterly 2001). There is a positive relation between corruption and financial stability, as shown in figure 1 for 58 low-income countries.

The relation expressed in figure 1 is open to different interpretations. Corruption and ineffectiveness of the financial system may have common origins in the absence of the rule of law in low-income countries (Hillman, 2003, 2004).

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[1] While growth requires functioning credit functions, demand for credit increases with growth. On the relation between growth and financial markets at different levels of development, see Rajan and Zingales (1998), Beck et al. (2000), Arestis et al. (2001), and Levine (1998, 1999, 2005).

[2] Credit markets fragility is high when financial mediation is subject to high agency costs, as when low initial personal wealth of entrepreneurs limits collateral and thereby self-participation in investment. Bernanke and Gertler (1990) elaborate on the concept of credit-market fragility.

Ineffective credit markets on the other hand cause corruption if impediments to obtaining finance for private-sector investments direct entrepreneurial talent toward rent-seeking and rent-extraction activities in government employment (see Acemoglu, 1995; Debla-Norris and Wade, 2002; and the evidence in Baldacci, Hillman, and Kojo, 2004). We can also envisage that corruption may be the cause of fragile high-risk credit markets in poor countries. We shall show how corruption indeed underlies fragility and instability of credit markets. Adverse consequences in credit markets are thereby added to the various ways (see Abed and Gupta, 2002; Aidt, 2003) in which corruption is known to disadvantageous for economic growth and economic development.

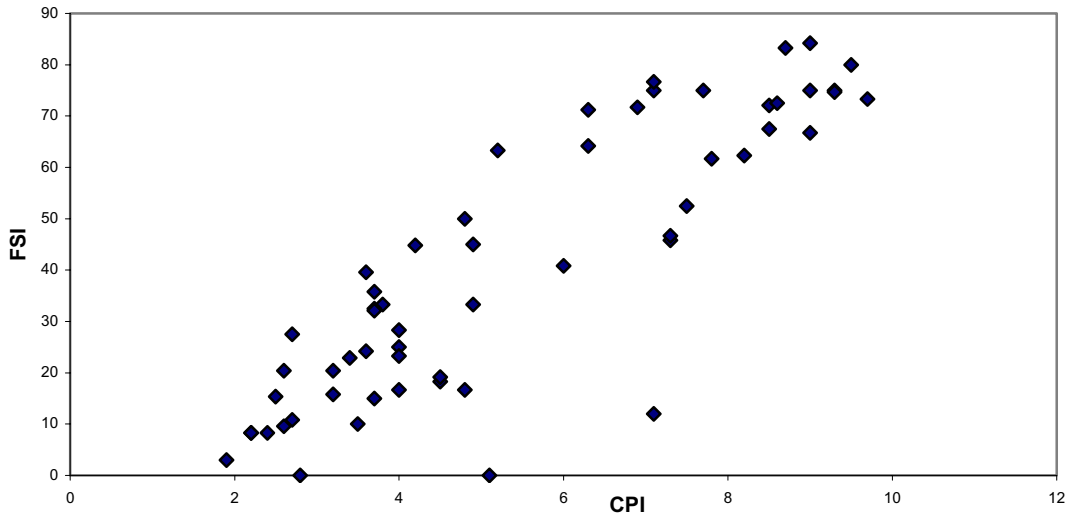

Figure 1

CPI - Source: Transparency International Corruption Perceptions Index 2002. 0 indicates the highest level of corruption and 10 indicates the lowest level of corruption.

FSI – Source: IMF Global Financial Stability Report: Market Developments and Issues, April 2004. FSI is a financial strength index compiled by the IMF report based on Moody's weighted average bank ratings by country. 0 indicates the lowest possible rating and 100 the highest rating.

2. Encounters with corruption

Entrepreneurs seeking credit for investment can encounter corruption at two occasions, (1) when seeking approval for subsidized loans provided as directed credits, and (2) when disbursement is sought of the credits that have been approved. The encounters with corruption typically involve different levels or types of officials

in a hierarchy of officialdom. Approval for access to directed or subsidized credit is often provided at higher levels of government: for example, in some low-income countries, the ruler or cabinet ministers are actively involved in assignment of private-sector credits.[3] At lower levels of the bureaucracy, other officials, often at a state-owned or state-influenced bank, can harass borrowers and impede disbursement of loans. Opportunities for personal gain differ at the different levels of official hierarchy extend over different time horizons. At higher levels of government, where approval is given for access to directed credit, a sense of permanence and tenure of authority of officials is consistent with time horizons that extend over the duration of an investment project. Payments to government officials by entrepreneurs can consequently be deferred until the realization of project returns. In a disbursing bureaucracy, where procedural interpretations can be used to delay loans, officials lack the means available to higher-level officials for enforcing informal contracts that make future payments from entrepreneurs contingent on project returns. Rent-extraction or bribe opportunities in the disbursing bureaucracy are consequently subject to limited time horizons. Officials in the disbursing bureaucracy thus take their bribes immediately in the manner of roving bandits, while higher-level officials can act as more patient stationary bandits in awaiting realization of project returns before expropriating parts of investors' returns. Higher-level officials can also, if they wish, choose to emulate roving-bandit behavior and take bribes before all project returns are have been realized.[4]

We shall show how stationary-bandit corruption is distributional whereas roving-bandit incentives create adverse selection in project financing. The extent of adverse selection depends on initial intrinsic risk in domestic investment. Corruption in low-income countries is therefore especially disadvantageous in compounding already-present high intrinsic risk. Returns from roving and stationary bandit corruption are at interdependent, and underlie incentives of high-level government

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[3] The loans can be in undervalued foreign exchange and may include state loan guarantees The regulatory mechanism to justify the need for official approval for credit for project financing can be make use of lists of "national priorities" set out in a "development program".

[4] On roving and stationary bandits, see McGuire and Olson (1996) and Olson (2000).

officials who are themselves corrupt to cooperate in donor-sponsored programs directed at eliminating corruption in lower-level implementing bureaucracies. Thus, for example, Johnson and Kpundeh (2004) propose that, if anti-corruption coalitions are to succeed, "leaders must have a genuine intent to govern well". The incentives of "leaders" to cooperate in programs seeking to end corruption at lower levels of bureaucracy are however also present in the absence of "a genuine intent to govern well".

3. The model

We describe an economy in which the population consists of the following decision makers:

(1) Savers who, because of financial repression, can only place deposits with a domestic bank.

(2) Private-sector entrepreneurs who are risk neutral and are endowed with an investment project and a fraction of the capital required to carry the project out: initially an entrepreneur has 1 unit of income, while a project requires 2 units of investment, and can be carried out only by receiving credit from the domestic bank.

(3) Officials in the disbursing bureaucracy (acting as roving bandits, perhaps within the bank itself) who are limited to seeking bribes before the realization of project returns.

(4) A high-level government official who provides approval for credit and can extract bribes contingent on realization of project returns (and so who acts as a stationary bandit); but who also in principle has the option of seeking bribes before a project is implemented (and so acting as a roving bandit).

Through state-guaranteed directed credits, an entrepreneur who has received approval for project financing is directed to a bank for disbursement. A project with credit approval is undertaken at that start of each period and the returns to the project are realized and can be reinvested at the end of each period. The bank is risk-neutral and maximizes expected profits. Savers seek to deposit one unit of savings with the bank for which they would receive a positive risk-free rate of return $r_d > 1$ per period.

The bank however accepts deposits only in the amount required to fund loans.[5] The bank sets an interest rate on loans r_L. Repayment of loans to the bank is guaranteed.

All projects have a stochastic return $\tilde{y}$, with the same mean return $E(y)>1$ and different levels of risk σ. The risk level of a project is private information of individual entrepreneurs and direct flows of funds from individual savers to individual entrepreneurs do not take place because of asymmetric information. The returns on projects are distributed normally within the interval $\left[\underline{y}_i, \overline{y_i}\right]$, for project *i.* An entrepreneur borrows 1 unit from the bank and invests 2 units in the project (the own unit plus the borrowed unit). A standard debt contract is signed with the bank, such that in the case of bankruptcy, where the entrepreneur is unable to repay the bank, the bank receives all proceeds from the 1 borrowed unit invested in the project. The bank thus has a claim on returns that is proportional to the share of borrowed funds in financing the project.

With entrepreneurs unable to credibly communicate the risk level of projects, the bank, acting under asymmetric information, sets a uniform borrowing rate, $r_L > r_d$. The risk level of the return σ on an entrepreneur's project is distributed over $\left[\underline{\sigma}, \overline{\sigma}\right]$. The bank knows the probability distribution function $f(\sigma)$ and the cumulative distribution function $F(\sigma)$ over all projects.

In the absence of corruption, the expected return for an entrepreneur on a project over one period of investment is denoted by *R* and is determined as:

$$R = E(y) + \int_{r_L}^{\bar{y}} (y - r_L) f(y) dy = E(y) + \frac{1}{2}(\bar{y} - r_L)^2 f(y) \qquad (1)$$

Since $\bar{y} = E(y) + \sqrt{3}\sigma$ the expected return is increasing with risk. The entrepreneur will carry out a project only if the expected return on borrowed funds is positive. Otherwise he or she will seek to invest wealth in a bank deposit, and the project is not carried out. Thus, a critical risk level exists below which projects are not carried out:

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[5] Saving is rationed if there is excess supply of deposits. Savers who are unable to make deposits with the bank consume immediately or store savings privately with zero return.

$$\sigma^* = (r_L - E(y))\frac{1}{\sqrt{3}}. \tag{2}$$

Entrepreneurs are not corrupt. Loans are used for the intended investments, and entrepreneurs do not abscond with the loan, nor is there collusion between the bank and the borrower to appropriate the borrowed funds. After the loan has been repaid, entrepreneurs can borrow again and reinvest their retained profit. The behavior of the bank and of entrepreneurs in the absence of corrupt officials provides a benchmark case.

The bank specializes in creating information and faces no risk due to the loan guarantee. The value of a project to the risk-neutral bank is $E(y)$. Private savers can in principle choose to become direct shareholders in a project, receiving compensation for the resources invested in identifying projects and for the risk of the project. When the bank offers a risk-free deposit rate equal to the return on projects $r_d = E(y)$, this ensures that savers never waste resources in obtaining information to directly lend their 1 unit to entrepreneurs. Thus, the bank faces the following maximization problem:

$$\underset{r_L}{Max}\ \Pi_{FI} = \int_{(r_L - r_d)}^{\bar{\sigma}} (r_L - r_d) f(\sigma) d\sigma \tag{3}$$

The solution gives:

$$r_L = \frac{\bar{\sigma} f(\bar{\sigma})}{2 f(\sigma^*)} + r_d \tag{4}$$

$$\sigma^* = \frac{\bar{\sigma} f(\bar{\sigma})}{2 f(\sigma^*)} \tag{5}$$

Bribes to a lower-level implementing bureaucrat to allow disbursement of funds are given before realization of project returns. The bureaucrat therefore faces the same asymmetric information as the bank and sets a payment *C* on each unit of loan as the immediately taken bribe.

A higher-level government official who certifies credit approval can enforce an informal contract to share future realized project returns and so can specify bribes as a share $C_p \leq 1$ of the realized excess return (after payment of interest) on a project. The higher-level official therefore faces project risk while also incurring the cost of

deferring income to the future. However, by predicating bribes on realized returns, the higher-level official can receive higher future payments from entrepreneurs whose projects have higher realized returns.

The bribe C before project implementation is paid at time $t=0$. With disbursement facilitated, the bank takes deposits from savers to finance the loan. The higher-level government official receives the deferred bribe at time $t=1$. After realization of the project return, the entrepreneur pays the higher-level official, the loan is repaid to the bank, and the bank repays savers.

An entrepreneur who has not defaulted on the loan is able to borrow again. The entrepreneur then reinvests the equity under the same conditions as previously, taking a loan equal to his or her own equity, while facing the two types of corrupt officials. The returns on the projects in each period are independently identically distributed.

4. The consequences of corruption in the disbursing bureaucracy

When confronted by the need to pay a bribe in the disbursing bureaucracy, the entrepreneur requires for each unit of equity a loan of $(1+C)$ to finance the bribe as well as the additional capital required to carry out the project. The expected return from a project over one period is

$$\hat{R} = E(y) + \int_{r_L(1+C)}^{\bar{y}} (y - r_L(1+C)) f(y) dy = E(y) + \frac{1}{2}(\bar{y} - r_L(1+C))^2 f(y) \,, \quad (6)$$

which defines a critical level of risk $\hat{\sigma}$ below which the project will not be proposed for financing as

$$\hat{\sigma} = (r_L(1+C) - E(y)) \frac{1}{\sqrt{3}} . \quad (7)$$

The bank sets the loan rate to maximize expected profits

$$\Pi_{FI} = \int_{\hat{\sigma}}^{\bar{\sigma}} (r_L - r_d)(1+C) f(\sigma) d\sigma \quad , \quad (8)$$

where $r_d = E(y)$, which results in a loan rate

$$r_L = \frac{r_d}{2} + \frac{r_d}{2(1+C)} + \left(\frac{\bar{\sigma} f(\bar{\sigma}) \sqrt{3}}{2(1+C) f(\hat{\sigma})} \right) \tag{9}$$

From (9), we have:

Lemma 1

(1) The profit-maximizing loan rate increases with the upper limit of risk

(2) The higher the bribe set by the roving bandit, the lower the profit-maximizing loan rate.

Given the loan rate, the critical risk level below which projects are not financed is

$$\hat{\sigma} = \frac{r_d C}{2\sqrt{3}} + \frac{\bar{\sigma} f(\bar{\sigma})}{2 f(\hat{\sigma})}. \tag{10}$$

If the official were not corrupt,

$$\hat{\sigma} = \frac{\bar{\sigma} f(\bar{\sigma})}{2 f(\hat{\sigma})}.$$

Thus it follows that:

Lemma 2

Adverse selection increases with the bribe set by the roving bandit and with the upper limit of risk.

With the loan rate set by the bank and the critical level of risk below which projects will not be financed determined, the official in the disbursing bureaucracy sets the bribe to maximize the expected return

$$\Pi_C = \int_{\hat{\sigma}}^{\bar{\sigma}} C f(\sigma) d\sigma \,. \tag{11}$$

The bribe that the entrepreneur is obliged to pay is consequently

$$C = \frac{\bar{\sigma} f(\bar{\sigma}) \sqrt{3}}{r_d f(\hat{\sigma})(1+\Omega)}. \tag{12}$$

where $\Omega = \left[1 + \frac{\bar{\sigma} f(\bar{\sigma}) \left(\partial f(\hat{\sigma}) / \partial \hat{\sigma} \right)}{2 (f(\hat{\sigma}))^2} \right]^{-1}$.[6]

Both the bank and the disbursing official therefore impose a cost on entrepreneurs before the realization of project returns. The bank disregards project risk because it can diversify risk and is risk neutral, while the roving bandit faces no project risk.

We shall identify the level of corruption with the magnitude of a bribe. That is, the higher the bribe indicated by (12), the greater is the level of corruption. Hence we conclude with respect to the level of corruption in the disbursing bureaucracy:

Lemma 3

The level of corruption of in the disbursing bureaucracy increases with the upper level of risk at which projects are financed.

The bank's profit-maximizing loan rate is:

$$r_L = \frac{r_d (1+\Omega) \left[\sqrt{3} \bar{\sigma} f(\bar{\sigma}) + r_d f(\hat{\sigma}) \right]}{2 \left(\sqrt{3} \bar{\sigma} f(\bar{\sigma}) + r_d f(\hat{\sigma})(1+\Omega) \right)} + \frac{r_d}{2} \tag{13}$$

The critical risk level below which projects will not be financed is

$$\hat{\sigma} = \frac{\bar{\sigma} f(\bar{\sigma})}{2 f(\hat{\sigma})} \left(1 + (1+\Omega)^{-1} \right). \tag{14}$$

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[6] With a uniform distribution, $\Omega = 1$.

The critical level of risk is thus a function of the properties of the distribution function of σ.

With a uniform distribution,[7] the consequence of an increase in the riskiness of the pool of investments can be evaluated by increasing only $\overline{\sigma}$. An increase in $\overline{\sigma}$ increases corruption (expressed as the value of the bribe). The bank's loan rate also increases when projects are more risky. Therefore:

Lemma 4

When entrepreneurs face corruption in the disbursing bureaucracy, the level of corruption (measured as the magnitude of the immediate bribe paid) and loan rate are greater when the pool of investment opportunities available is riskier (reflected in a high upper limit of project risk)

Appendix A1 provides an outline of the proof of the lemmas. The lemmas allow us to state:

Proposition 1

(a) Corruption before the realization of project returns is a source of adverse selection.

(b) The greater is corruption (expressed as a higher immediate bribe), the greater the severity of adverse selection.

(c) The greater is the risk profile of private entrepreneurs' investment projects, the greater is adverse selection.

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[7] We shall return to show that effects are similar when skewness is increased with fixed $\overline{\sigma}$. Section 8 uses the Weibull distribution to demonstrate consequences of an increased risk profile of domestic investment opportunities as expressed by the level of skewness of the distribution function.

The exclusion of low-risk projects through adverse selection reduces deposit opportunities for domestic savers who are denied a positive return on their savings. Because of the corruption, gains are forgone from financial intermediation. Adverse selection results in only investment projects that have sufficiently high risk being financed. Investment is in general intrinsically more risky in low-income countries, and corruption in the disbursing bureaucracy makes the projects that are financed riskier on average still. Hence, countries where intrinsic risk in domestic investment opportunities is higher in the first place confront greater compounded severity of the effects of adverse selection, and are also more seriously disadvantaged through reduced deposit opportunities for domestic savers.

5. The consequences of corruption by higher-level officials

High-level officials acting as stationary bandits wait until project returns are revealed to receive a bribe conditional on the project's realized return. Such officials have an infinite time horizon during which the greater the share of returns allocated to bribes, the lower the growth in capital for reinvestment and hence the lower the future income from which bribes can be extracted. The official acting as a stationary bandit sets a bribe in the first period and thereafter does not change this level of bribe. Committing and adhering to a bribe preserves the official's reputation, thus avoiding sanctions on the part of entrepreneurs.

When the only bribes that entrepreneurs pay are to higher-level officials contingent on realization of project returns, the expected return from a project in each period is:

$$\hat{\hat{R}} = E(y)(1-C_p) + \int_{\frac{r_L}{(1-C_p)}}^{\bar{y}} \left(y(1-C_p) - r_L\right) f(y)dy \,. \tag{15}$$

With the bank setting a deposit rate equal to the expected return in the presence of a stationary bandit $r_d = (1-C_p)E(y)$, the critical value of risk below which projects will not be carried out follows as

$$\hat{\hat{\sigma}} = \left(\frac{r_L - r_d}{(1-C_p)}\right)\frac{1}{\sqrt{3}} \,. \tag{16}$$

The bank sets the loan rate to maximize expected profits from projects that are financed in having levels of risk at least equal to the risk level (16):

$$\Pi_{FI} = \int_{\hat{\sigma}}^{\bar{\sigma}} (r_L - r_d) f(\sigma) d\sigma . \tag{17}$$

The bank thus sets the loan rate

$$r_L = r_d + \frac{\bar{\sigma} f(\bar{\sigma}) (1 - C_p) \sqrt{3}}{2 f(\hat{\hat{\sigma}})} . \tag{18}$$

This loan rate also increases when the upper limit of risk is higher and when the bribe taken by the high-level official is lower. Substituting the loan rate into (16), we have

$$\hat{\hat{\sigma}} = \frac{\bar{\sigma} f(\bar{\sigma})}{2 f(\hat{\hat{\sigma}})} \qquad . \tag{19}$$

The critical level of risk is not a function of the level of corruption. Furthermore, adverse selection is the same as in the case where there is no corruption. Now, the high-level official sets his or her bribe taking into consideration the effect of this decision on future income. Although the high-level official does not create adverse selection, he or she erodes the returns to the bank (reducing the incentive for honest investors to seek bank charters in corrupt economies). The official knows that at t=1 his or her expected income is equal to:

$$2 C_p E(y) \tag{20}$$

At t=1 an entrepreneur's expected new equity is $\hat{\hat{R}}$, which is reinvested if no default has occurred. Thus at t=2 the official expects an income equal to:

$$2 \hat{\hat{R}} C_p E(y) . \tag{21}$$

The probability of receiving this income is equal to the probability that there was no bankruptcy in the previous period. The probability of no bankruptcy in any period is denoted by H and defined as:

$$H = \frac{\bar{y}_i - \frac{r_L}{1 - C_p}}{\bar{y}_i - \underline{y_i}} . \tag{22}$$

Denote the discount rate of the high-level official by *r*. The present value of expected bribes from a project, denoted by I_σ, is defined as:

$$I_\sigma = \sum_{t=1}^{\infty} \frac{2E(y)C_p}{r^t} H^{t-1} \hat{\hat{R}}^{t-1} \tag{23}$$

This can be written as follows:

$$I_\sigma = \frac{2E(y)C_p}{r - H\hat{\hat{R}}} \tag{24}$$

We now have a growth model where growth opportunities are reflected in *HR*. The optimal bribe for the high-level official therefore depends on the discount rate *r*, which we assume is high enough so that for any C_p, $r > H\hat{\hat{R}}$.

The high-level official faces an expected income of:

$$\Pi_{C_p} = \int_{\hat{\hat{\sigma}}}^{\bar{\sigma}} \left[\frac{2E(y)C_p}{r - g_i(1 - C_p)} \right] f(\sigma) d\sigma \tag{25}$$

Where, $g_i = E(y) z_i f(y) + 0.5 z_i^3 f(y)^2$, and $z_i = \sqrt{3}\left(\sigma - \frac{\bar{\sigma} f(\bar{\sigma})}{2 f(\hat{\hat{\sigma}})} \right)$.

The optimal bribe level solves the following:

$$\int_{\hat{\hat{\sigma}}}^{\bar{\sigma}} \left[\frac{2E(y)(r - g_i)}{(r - g_i(1 - C_p))^2} \right] f(\sigma) d\sigma = 0 \tag{26}$$

As the discount rate *r* increases, the bribe level also increases. That is, the higher the cost of waiting for future returns, the more is extracted by the high-level official from the returns on the project and the fewer are the resources available for further investment and growth. The stationary bandit does not steal all income at *t*=1 (or in other words does not act as a roving bandit at *t*=1) because of the prospect of future income from future bribes. Furthermore, the greater the bribe, the lower the return to the bank. Thus, less patient high-level officials cause more harm to the stability and integrity of banks, in the sense that banks have lower profit opportunities. We conclude:

Proposition 2

(a) Corruption by higher-level officials who wait until realization of project returns to receive payments is redistributional and does not impart adverse selection to project financing.

(b) Corruption by higher-level officials increases as the discount rate of the official is higher.

For the proof, see appendix A2.

6. Entrepreneurs facing both roving and stationary-bandit corruption

Entrepreneurs may have the misfortune to face both roving and stationary-bandit corruption as they seek finance for their investment projects. In this case a new and different roving bandit appears in each period. Entrepreneurs face a return from a project in each period $\hat{R}$ established as follows:

$$\hat{R} = E(y)(1-C_p) + \int_{\frac{r_L(1+C)}{(1-C_p)}}^{\bar{y}} [y(1-C_p) - r_L(1+C)] f(y). \tag{27}$$

The critical risk level below which projects are not financed is

$$\hat{\sigma} = \frac{r_L(1+C) - r_d}{(1-C_P)\sqrt{3}}. \tag{28}$$

The bank's profit-maximizing loan rate is

$$r_L = \frac{\bar{\sigma} f(\bar{\sigma})(1-C_P)\sqrt{3}}{2 f(\hat{\sigma})(1+C)} + \frac{r_d}{2} + \frac{r_d}{2(1+C)}. \tag{29}$$

For this loan rate and critical risk level, the implementing bureaucrat acting as roving bandit chooses the bribe:

$$C = \frac{\bar{\sigma} f(\bar{\sigma})(1 - C_P)\sqrt{3}}{(1 + \Psi) f(\hat{\sigma}) r_d}. \tag{30}$$

where

$$\Psi = \left[1 + \frac{\bar{\sigma} f(\bar{\sigma}) \partial f(\hat{\sigma}) / \partial \hat{\sigma}}{2(f(\sigma))^2} \right]^{-1}.$$

Substituting (25) and (26) into (24) gives the critical risk level as

$$\hat{\sigma} = \bar{\sigma} \frac{f(\bar{\sigma})}{2 f(\hat{\sigma})} \left(1 + (1 + \Psi)^{-1}\right). \tag{31}$$

This is the same critical risk level as when an entrepreneur is required to pay *only* the roving-bandit bribe. Thus, the roving bandit faces that same set of projects as in the case where he or she acts alone in the absence of the higher-level stationary bandit. However, now that a stationary bandit is also present, the roving bandit extracts a lower bribe, *C*, which decreases with an increase in C_p.

The higher-level official acting as a stationary bandit sets the return-contingent bribe to maximize expected income, given the roving-bandit bribe *C,* the critical level of risk, and the loan rate. Since the roving bandit has increased the level of adverse selection, the high-level official faces a smaller set of projects than when acting alone. The stationary bandit also takes a lower bribe rate in the presence of a roving bandit when the investment opportunity set is composed mainly of very high risk projects. In this case the high-level official's income is reduced.

Proposition 3

Adverse selection due to roving-bandit corruption in the disbursing bureaucracy imposes a disadvantageous externality on higher-level

government officials: payments from entrepreneurs to a higher-level official are lower and are from a smaller group of entrepreneurs with on-average higher risk projects.

We therefore conclude regarding the simultaneous presence of roving and stationary bandits that:

Proposition 4

(a) The presence of a high-level government official acting as a stationary bandit when there is roving bandit corruption in the implementing bureaucracy does not change adverse selection from that where the roving bandit alone is present.

(b) A roving bandit in the bureaucracy imposes a disadvantageous externality on the higher-level stationary bandit:

(i) through the adverse selection in project financing, and

(ii) through lowering the bribe extracted from each project when investment opportunities are concentrated in high risk projects .

(c) The higher-level government official acting as a stationary bandit imposes a reciprocal disadvantageous externality on the roving bandit in the implementing bureaucracy only by reducing the bribe extracted from a project.

The proof is in appendix A3.

The interdependencies between returns to corruption affect incentives for high-level government officials to cooperate in anti-corruption programs. Because roving-bandit corruption in the disbursing bureaucracy can reduce payments from entrepreneurs to stationary-bandit government officials, such higher-level government officials, who are themselves corrupt, have incentives to cooperate in anti-corruption programs that are directed at reducing or ending corruption in implementing bureaucracies.[8]

7. The risk profile of domestic investments

We have shown that corruption, measured by the sizes of bribes, depends on the distribution of project risk. We apply the Weibull distribution to demonstrate the consequences of the distribution of risk in domestic investment opportunities. For the Standard Weibull distribution function, adverse selection created by the roving bandit, $\hat{\sigma}^2$, is described by

$$\gamma(\hat{\sigma})^{\gamma-1} e^{\left(-(\hat{\sigma})^{\gamma}\right)} \hat{\sigma} = 0.5\left(1+(\Omega+1)^{-1}\right)\gamma(\overline{\sigma})^{\gamma-1} e^{\left(-(\overline{\sigma})^{\gamma}\right)} \overline{\sigma} . \tag{32}$$

When $\overline{\sigma}^2 = 1$, we obtain

$$\gamma(\hat{\sigma})^{\gamma-1} e^{\left(-(\hat{\sigma})^{\gamma}\right)} \hat{\sigma} = 0.5\left(1+(\Omega+1)^{-1}\right)e^{-1} . \tag{33}$$

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[8] The officials at the different levels of the official hierarchy are here competing with one another. Behavior is non-cooperative and no income transfers take place between the officials. In Hillman and Katz (1987) alternative circumstances are described where lower-level officials extract bribes and are obliged to pass a share of the bribes onto higher-level officials. The aim was to provide values for the resources unproductively used in rent-seeking contests to secure the positions in the official hierarchy to which the bribes accrue.

A higher value of γ implies greater skewness to the left of the distribution, indicating more projects with higher risk and

$$\frac{\partial \hat{\sigma}}{\partial \gamma} > 0, \frac{\partial C}{\partial \gamma} > 0,$$

We therefore conclude that:

Lemma 5

A greater risk profile in domestic investments increases

(a) Adverse selection due to roving bandit behavior

(b) Corruption or the bribe taken by a roving bandit

It follows in particular that:

Proposition 5

Corruption is more harmful through adverse selection when investment opportunities available to the local population are intrinsically more risky.

Since private investment in low-income countries tends to be intrinsically more risky than in high-income countries, corruption is more damaging to credit markets in the very countries where evidence shows corruption is endemically greater.

8. Conclusions

We began with a quote wherein ineffective credit markets and corruption are proposed as distinct reasons for failure of economic growth and lack of economic development. The view that is put forward implies that effectiveness of credit

markets can be improved in low-income countries without addressing issues of corruption. We have shown, however, that ineffectiveness and fragility of credit markets in low-income countries is attributable to corruption. To the impediments to economic growth associated with corruption we add fragility of credit markets and consequent impediments to private sector development.

Corruption is not the only reason for fragile and ineffective credit markets in low-income countries. Political risk is often high (Harms, 2000). There is investment uncertainty because of strategic policy manipulation of donor incentives (van de Walle, 2001). Low initial wealth restricts collateral and limits self-participation in investments, and property rights that may be at best informal inhibit use of assets for collateral and prevent insurance and risk spreading through shared ownership (de Soto, 2000). Limited trust or social capital, including dishonesty of bankers acting in collaboration with dishonest borrowers, adds fragility to the banking system (see Hillman and Ursprung, 1999).[9]

Corruption undermines credit markets beyond these influences. High initial intrinsic risk is moreover compounded through the adverse selection due to corruption. The greater the initial intrinsic risk, the greater the incentives for government officials to act as the roving bandits who are the source of the adverse selection in investment projects. Through adverse selection in project financing due to corruption, the private sector has fewer opportunities to save, productive low-risk investment projects are foregone, and the pool of financed projects is on average of higher risk.

Policies against corruption require cooperation of high-level officials. We have suggested how personal incentives of high-level officials who are themselves corrupt affect resistance to or support for anti-corruption programs. High-level government officials whose corruption is of the stationary-bandit type are expected to welcome anti-corruption programs aimed at roving-bandit behavior in a lower-level implementing or disbursing bureaucracy. Anti-corruption programs are expected to

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[9] Lack of collateral and lack of trust (or absence of personal reputation) underlie reliance on informal credit markets and collective responsibility for loan repayment. See Besley, Coate, and Loury (1993), Besley (1995).

be resisted when higher-level government officials themselves choose to act as roving bandits and take bribes without waiting for realization of project returns.

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Appendix

A1. Roving-bandit corruption

The bank maximizes expected profit, Π_{FI}, to get an optimal loan rate:

$$r_L = \frac{r_d}{2} + \frac{r_d}{2(1+C)} + \left(\frac{\bar{\sigma} f(\bar{\sigma}^2)\sqrt{3}}{2(1+C) f(\hat{\sigma})} \right)$$

Substituting r_L^* back into $\hat{\sigma}$ gives:

$$\hat{\sigma} = \frac{r_d C}{2\sqrt{3}} + \frac{\bar{\sigma} f(\bar{\sigma})}{2 f(\hat{\sigma})}$$

Now, maximize the roving bandit's income, Π_C, as follows:

$$\underset{C}{Max}\ \Pi_C = \int_{\hat{\sigma} = \frac{\bar{\sigma} f(\bar{\sigma})}{2 f(\hat{\sigma})} + \frac{r_d C}{2\sqrt{3}}}^{\bar{\sigma}} C f(\sigma^2) d\sigma^2$$

Using the Leibnitz rule for differentiating an integral and the implicit function rule for differentiating the lower bound of the integral, gives the bribe taken by the roving bandit, C^* as follows:

$$C = \frac{\bar{\sigma} f(\bar{\sigma})\sqrt{3}}{r_d f(\hat{\sigma})(1+\Omega)}, \text{ where } \Omega = \left[1 + \frac{\bar{\sigma} f(\bar{\sigma}) \left(\partial f(\hat{\sigma}) / \partial \hat{\sigma} \right)}{2 (f(\hat{\sigma}))^2} \right]^{-1}.$$

Substituting back into r_L^* and then back into $\hat{\sigma}^2$, gives the following implicit function:

$$\hat{\sigma} = \frac{\bar{\sigma} f(\bar{\sigma})}{2 f(\hat{\sigma})} \left(1 + \frac{1}{1+\Omega} \right).$$

A2. Stationary-bandit corruption

The optimal bribe level of stationary bandit, C_p^* , is defined by the following implicit function which we denote by *G*:

$$G = \int_{\hat{\sigma}}^{\bar{\sigma}} \left[\frac{2E(y)(r - g_i)}{(r - g_i(1 - C_p))^2} \right] f(\sigma) d\sigma = 0$$

Where, $g_i = E(y) z_i f(y) + 0.5 z_i^{\,3} f(y)^2$, and $z_i = \sqrt{3}\left(\sigma - \frac{\bar{\sigma} f(\bar{\sigma})}{2 f(\hat{\hat{\sigma}})} \right)$.

The effect of a change in *r* on C_p^* is:

$$\frac{\partial C_p^*}{\partial r} = -\frac{\partial G / \partial r}{\partial G / \partial C_p^*}.$$

Since at optimum $\frac{\partial G}{\partial C_p} < 0$, $sign \frac{\partial C_p^*}{\partial r} = sign \, \partial G / \partial r > 0$

A3. Simultaneous presence of roving and stationary bandits.

In the case of the simultaneous presence of the two types of corrupt officials the optimal loan rate is:

$$r_L = \frac{\bar{\sigma}^2 f(\bar{\sigma}^2)(1 - C_P)\sqrt{3}}{2 f(\hat{\sigma}^2)(1 + C)} + \frac{r_d}{2} + \frac{r_d}{2(1 + C)}$$

Furthermore, the stationary bandit does not affect the critical level of risk.

Therefore, the stationary bandit solves the same optimization problem that is solved when acting alone such $z^* = \sqrt{3}\left(\sigma - \frac{\bar{\sigma} f(\bar{\sigma})}{2 f(\hat{\sigma})} \left(1 + \frac{1}{\Psi} \right) \right)$.

z^* is greater than z when $f(\hat{\sigma})$ is sufficiently greater than $f(\hat{\hat{\sigma}})$ such that $\frac{\bar{\sigma} f(\bar{\sigma})}{2 f(\hat{\sigma})(1 + C)} \left(1 + \frac{1}{\Psi} \right) < \frac{\bar{\sigma} f(\bar{\sigma})}{2 f(\hat{\hat{\sigma}})(1 + C)}$. Finally, $sign \frac{\partial C_p^*}{\partial z} = sign \, \partial G / \partial z < 0$.