Corruption: Political Determinants and Macroeconomic Effects

by

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Abstract

Two aspects of corruption are examined theoretically: its effect on macroeconomic variables, and its determination from the political environment. Corruption is defined in an occupational choice model as the extra fees or bribes that must be paid by some entrepreneurs. Even in an environment of perfect information and well-defined property rights, wages and total output decrease with the level of corruption. Inverted-U relationships of income inequality with both corruption and output are calculated. Second, two types of decentralization, regional and bureaucratic, are analyzed. The effects depend crucially on agents' mobility across regions. Under imperfect mobility assumptions, corruption decreases with regional decentralization and increases with bureaucratic decentralization. Two methods of controlling corruption are analyzed in this setting: democratic accountability and incentive payments. The same factor that makes bureaucratic decentralization more corrupt makes it more resistant to efforts to rein in corruption; the reverse is true for regional decentralization. This model matches emerging stylized facts relating corruption to output, inequality, and decentralization, and reinterprets findings linking bureaucratic wage levels and corruption.

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1 Introduction

Talk to a citizen of any developing country about what is responsible for holding his country's economy back, and the chances are high that corruption will enter the conversation. Stories of uneven application of laws, of a ruling class enriching itself through its political power, and of restricted occupational possibilities will likely surface. Running a business will be regarded as a choice only for those with connections to power, with the legal system as anything but a recourse for the average citizen.

Recent surveys have shown this to be a common perception in developing countries worldwide. For example, Brunetti et al (1997) survey over 3600 entrepreneurs from 69 countries, 58 of which are considered less developed. Respondents were asked to choose from a menu of fifteen potential obstacles to doing business. Corruption was indicated to be a serious obstacle by a majority of businessmen in 35 countries, all less developed (about 60% of the represented LDC's.) Corruption was second only to "tax regulations and/or high taxes" as an obstacle to doing business, outstripping other factors such as lack of infrastructure, financing, and various types of regulation.

Corruption's prevalence and its impact on entrepreneurship throughout the developing world make it a vital issue to understand. This paper sets up a general equilibrium, occupational choice model that features the level of corruption as a key variable. The model is used to analyze the effect of corruption on macroeconomic variables such as wages, total output, occupational patterns, and income inequality.

The level of corruption is then endogenized in the model in an attempt to understand some determinants of corruption. Decentralization of power along two lines, which we call bureaucratic and regional, is examined. This political organization structure is analyzed in isolation, as well as in the presence of two methods for controlling corruption: democratic accountability and wage payments. These set up a principal-agent relationship between those vulnerable to corruption and those in power.

Theoretical work on corruption to date has focused largely on specific questions and answered them in partial equilibrium models. This is no doubt due in part to the complex, multi-faceted nature of corruption, which makes it hard to capture in the macroeconomy by a single variable. Nevertheless, scalar measures of corruption are multiplying and being used in empirical macroeconomic studies. There is likely much to be gained by taking the same step in theory, however imperfectly. This paper defines corruption in an attempt to incorporate the most salient features of the phenomena from an economic point of view, that is, with the goal of matching aggregate data.

Corruption in this paper is the power of some to collect and keep a fee[1] for operation of an official business by others. This is both a narrowing and a broadening of the common definitions in the literature, representative of which is the World Bank's (1997): "the abuse of public office for private gain". Ours is broader in that the power may or may not come from occupying a public office (although we do focus on the political interpretation). Also, there is nothing a priori that classifies this action as "abuse". Nowhere is a benevolent principal assumed,[2] a feature that is realistic but absent in much of the literature.

[1] In this paper, 'fee' will be synonymous with 'bribe'.

[2] A principal is endogenously derived in Section 4, which deals with controlling corruption.

Our definition is narrower in only considering direct extraction from firms. This leaves out many high-profile corruption phenomena, such as rigged privatization schemes and diversion of foreign aid. Clearly these have significant economic consequences. However, many practitioners feel that it is the systemic, often petty corruption that affects people most. This is the approach of this paper, which derives implications for aggregate economic behavior by focusing on bribes that must be paid to operate a business.

The *level of corruption* is defined as the amount of extra fees that some people must pay in order to operate a business. This definition should be distinguished from one that focuses on the total value of bribes changing hands in the economy. Under our definition, corruption may be very high even though few bribes change hands: the fee can be so high that it shuts most people out of entrepreneurship.[3]

In the model, total output and wages are (weakly) decreasing functions of the level of corruption. Wages decrease because the higher is corruption, the less attractive is the entrepreneurial profession to those who must pay the extra fees; their willingness to undertake wage labor thus becomes greater, swelling labor supply and driving down the wage.

There are two forces leading to lower output. The first is that corruption lowers the average skill level of active entrepreneurs by substituting politically 'connected' entrepreneurs for skilled ones. This is because corruption affects the population differentially: it raises the ability level needed to make entrepreneurship profitable for those with less political protection and lowers the ability level needed to make entrepreneurship profitable for the politically connected. The second force at work is the substitution of people toward small-scale, unspecialized subsistence technologies as corruption increases. These have a comparative advantage in avoiding the need to pay extra fees, but are less productive. Examples are home production of food and small-scale retail activity.

Inequality as measured by the gini coefficient follows an inverted-U relationship with the level of corruption.[4] The logic behind this involves a Laffer curve characterizing total income from bribes. If the bribe level is either too high or too low, bribe income will be low, and there will be minimal redistribution through corruption. Since output is monotone in corruption, output also obeys an inverted-U relationship with inequality.

The paper turns next to the determination of the corruption level, modelling simultaneously the effects of two types of decentralization. *Bureaucratic* decentralization captures the case of overlapping jurisdictions: for example, the existence of multiple independent agencies with which a firm must interact in order to operate openly. *Regional* decentralization involves the dividing up of the economy into regions, each with its own business climate. Each bureaucracy in each region sets its fee optimally, taking as given other bureaucracies' fees.

If agents are perfectly mobile across regions and there is more than one region, there is no corruption in equilibrium, regardless of the degree of bureaucratic decentralization. This is due to what is essentially Bertrand competition. On the other hand, if agents are perfectly immobile across regions, then regional decentralization is immaterial. Corruption is positive and is increasing in the degree of bureaucratic decentralization. The reason is a negative

[3]Bardhan (1997) makes a similar point.

[4]This is true under plausible parameter assumptions: the size of the population vulnerable to corruption must be large enough relative to the number collecting bribes.

externality between bureaucracies: the more one charges, the less another can extract, since entrepreneurs must pay each one. These results are not very new, but are mentioned in order to clarify two different perspectives on decentralization in the literature, represented by Shleifer and Vishny (1993) and Weingast (1995), for example.

More interesting is the case of imperfect mobility. An illustrative example is analyzed, in which agents can work for wages in any region but operate a business only in their own. This assumption ensures there is no direct competition between the powerful for the exploitable factor, entrepreneurs, removing the main force by which regional decentralization eliminates corruption. Unsurprisingly, bureaucratic decentralization increases corruption in this setup. The reasoning is the same as stated above, though there is a general equilibrium wage effect that mitigates the result. More interesting is that regional decentralization continues to decrease corruption. This is true because of a positive externality across regions operating through the wage: the higher is one region's corruption, the lower is the economy-wide wage, and thus the number of exploitable entrepreneurs in other regions at any level of corruption is higher.

Taking the structure of decentralization as given, two methods of controlling corruption are analyzed: democratic accountability and incentive payments. In both cases, those vulnerable to corruption choose their strategy to reduce it as much as possible.[5] It turns out that the optimal reduction of corruption is increasing in the degree of regional decentralization and decreasing in the degree of bureaucratic decentralization. In fact, the reduction approaches zero as the degree of bureaucratic decentralization increases. The logic behind this result has to do with the same externalities discussed above and the way they affect a bureaucracy's deviation payoff.

An interesting implication of these results is that countries with low-corruption political structures (regional decentralization) have the potential to make most use of anti-corruption measures and reduce corruption even more; while countries with high-corruption political structures (bureaucratic decentralization) will find it too costly to reduce corruption significantly. In other words, the clean can get (or are getting) cleaner, while the more corrupt stay that way.

The economic analysis of corruption dates back at least several decades to Leff's work in 1964. Little has been done to analyze its macroeconomic effects, however, with the exception of the effect on output growth. Our results on wages and inequality appear to be new. The result on output levels adds new insight into the static inefficiency resulting from corruption. In many views, corruption is primarily detrimental to dynamic efficiency, due to its information asymmetries and uncertain property rights. In this model, corruption is perfectly observed and property rights are well-defined; nevertheless, the use of less productive, more corruption-proof technologies, as well as the talent misallocation resulting from uneven barriers to business operation, result in inefficiency. The idea of corruption causing substitution toward less efficient technology is present but unexplored in Tirole (1996). Talent misallocation is the focus of Murphy et al (1991), who show that the best talent can be drawn into rent-seeking, leaving less talent in entrepreneurship. In our model, even though rent-seekers have the same talent distribution as the rest of the population, misallocation of talent occurs because political connections matter.

[5] It is shown that they unanimously prefer lower corruption.

These predictions have strong empirical backing. Recent empirical work by Li et al (2000) finds the predicted inverted-U relationship between corruption and inequality. Gupta et al (1998) find a positive linear relationship between corruption and inequality, but they do not check for a non-linear one. Less has been done on corruption's relationship with output and wages, but a significant negative correlation does exist between virtually all published measures of corruption and GDP.

The paper's conclusions regarding decentralization clarify a tension in the literature. Since Shleifer and Vishny (1993), it has been common to view centralized power as less corrupt than decentralized (see, for example, Bardhan (1997)). The authors point to the post-Soviet states as prime examples of the effects of decentralized corruption. However, Weingast (1995) and others have argued that decentralization improves governance, for example by creating competition across regions for factors of production. Weingast cites the transitional experience of China as an example. The idea in this paper is that theirs are two different types of decentralization. We model the two types simultaneously. Mobility of economic agents across regions determines which view is correct. Under limited mobility, both views hold true, though in the case of regional decentralization, for different reasons than are found in the literature.

Empirical evidence on regional decentralization supports these predictions. Huther and Shah (1998) report a significant positive cross-country correlation of fiscal decentralization with lack of corruption. Fisman and Gatti (2000) find similar results that are robust to controlling for other determinants of corruption and to correcting for the endogeneity of decentralization.[6] Empirical work on what is here termed bureaucratic decentralization is yet to be done.

Finally, the analysis of democratic accountability and wage schemes offers new insight into the control of corruption. It shows that the same political organization factors that make a country ripe for corruption can render policies to control it ineffectual.

Democracy's link to corruption has been largely untouched by theory. A notable exception is Myerson's (1993) examination of different voting systems' effects on the level of corruption, when ex post behavior of elected politicians is fixed. Our approach is complementary in looking at incentives to deviate once in office.

Since Becker and Stigler (1974), much theoretical work has looked at optimal compensation of corruptible agents. We embed this issue in a general equilibrium model and find that wages can always be employed to reduce corruption, but to a degree that is highly dependent on the strategic interaction between the parties being compensated.

There is empirical support that high government wages help reduce corruption, at the macro level in Van Rijckeghmen and Weder (1997) and at the micro level in DiTella and Shargrodsky (2000). This is predicted by our model. However, the model suggests that societies that are highly corrupt absent any corruption control strategy will find it optimal to use compensation as such a tool very sparingly. If this is true, a selection bias problem plagues the results: corrupt countries are optimally not compensating very much. The relationship found in the data may then be overstated. In addition, policy implications

[6] It should be noted that the measure of decentralization used in these studies, subnational expenditures, is not exactly what we model. However, it can be seen as a proxy for the degree of regional control over firms' activities.

are hard to draw since it may very well be that corrupt countries are compensating at the optimal, low level given their political structure.

In this paper, we introduce the basic model and examine economic effects of given levels of corruption in Section 2. In Section 3, the level of corruption is endogenized and its dependence on the degree of bureaucratic and regional decentralization is examined. Section 4 analyzes democratic accountability and wage incentives. Section 5 concludes.

2 Macroeconomic effects of corruption

In this section, the economic environment is outlined and the level of corruption is related to key macroeconomic variables such as output and wages. Here the level of corruption is taken as given; in later sections it is endogenized.[7]

The population is a continuum of measure one, indexed by i. Each agent maximizes consumption of the single good. Technologically, the model is a simple occupational choice model. Each agent is endowed with one unit of labor per period, which he can supply in one of three occupations.

He can 'work' for an official firm, earning the market-clearing wage, w. Alternatively, he can 'subsist', using a free technology to produce $\underline{w} > 0$. A subsister works alone. This occupation is intended to represent the fall-back option of small scale, unspecialized private production, from roadside retail to family food plots. Finally, he can work as an entrepreneur, using a potentially costly technology that requires a second worker. Thus, entrepreneurship involves registering an official firm and hiring one worker.

The population differs in entrepreneurial ability; output of a firm run by agent i is y_i. Ability y_i is distributed in the population over $(\underline{y}, \overline{y})$ according to $F(\cdot)$. For simplicity, we assume that $F(\cdot)$ corresponds to the uniform distribution. Let $L \equiv \overline{y} - \underline{y}$, and $y_{med} \equiv F^{-1}(1/2)$ be the median ability.

Further, it is assumed that $\underline{y}$ equals $2\underline{w}$. This implies that subsistence is less productive than entrepreneurship, regardless of the ability level of the entrepreneur.[8] Taken together, the assumptions create two professions differing in productivity due to scale and scope for specialization (here entrepreneurship is favored), as well as in the ability to avoid paying fees for technology use (here subsistence is favored).

The population is assume heterogeneous along a second dimension, which can be thought of as political capital or connectedness. Technically, this dimension specifies property rights over the entrepreneurial technology. The population is classified into three types as follows.[9]

[7] The full model involves those in power setting the level of corruption in order to maximize their income. It is convenient, both analytically and expositionally, to analyze first the macroeconomic effects of a given corruption level, and then step backwards to ask what corruption level will result from the optimizing political actors, given the macroeconomic effects.

[8] Note that the least able entrepreneur and his worker would produce slightly above $\underline{y}$. If these two subsisted instead, they would produce a total of $2\underline{w}$.

[9] Each type contains agents of entrepreneurial ability distributed according to $F(\cdot)$; thus political type and entrepreneurial ability are assumed independent. Clearly there are reasons to think they might be positively correlated, which would dampen results obtained later on talent misallocation. However, there are also reasons to think they might in fact be negatively correlated. The independent case is interesting as a benchmark.

- Type A — a measure $\alpha \in (0, 1)$ are 'in power' and can thus charge a fee to some or all registered firms for the right to operate. (This is costless in terms of labor.)[10] They need not pay if they operate a firm.

- Type C — a measure $\gamma \in (0, 1-\alpha]$ are 'unprotected' and must pay $c \in [0, \infty)$[11] if they wish to operate a firm.

- Type B — $1-\alpha-\gamma$ are 'connected' and cannot charge fees but need not pay to operate a firm.[12]

These assumptions capture not only explicit property rights over technology, but the much broader problem where the property rights are only implicit, though acknowledged by all. For example, they can arise from sufficiently discretionary regulatory power, which can be manipulated for the purposes of bribe extraction from businesses; or from weak rule of law, when political power is openly abused but the judicial system provides no recourse for a portion of the population; or from private power groups who use threats of violence to extract fees.[13]

The parameters α and γ are thus meant to capture the legal environment. One might expect γ to be near zero in a country with an independent, equitable judiciary and a high degree of press freedom. The 'level of corruption' will be synonymous with the variable c, the amount a legally unprotected entrepreneur must pay to operate a business. The relationship of c to wages, occupational choices, output and inequality is our focus in this section.

Each agent chooses the occupation that maximizes income, taking as given the wage and in the case of type C, the bribe c. Earned income of an agent of entrepreneurial ability y, based on type and profession is as follows:

Agent type	As Entrepreneur	As Worker	As Subsister
A,B	$y - w$	w	$\underline{w}$
C	$y - w - c$	w	$\underline{w}$

Given ability, all that distinguishes agents' earned incomes is whether a bribe must be paid to operate a business. Thus earned incomes for two agents of equal ability from types A and B, respectively, are identical.

[10] Here the paper diverges from the significant literature examining rent-seeking and directly unproductive activities, where the main efficiency loss is typically due to resources wasted on redistribution. In this model, those collecting rents spend the same time in an occupation as all others; nevertheless, other inefficiencies appear.

[11] This fee is interpreted as the amount above and beyond what types A and B have to pay to operate a business. One could include in the model an official tax τ that all types pay, in which case type C people must then pay $\tau + c$. In this paper τ is normalized to zero.

[12] This ability to avoid the fee is assumed non-transferable. It could be thought of as a personal favor from those who collect the fees. If they could sell their right to type C agents, the talent misallocation that we will show occurring would be mitigated.

[13] There is an important literature that endogenizes the choice to become a rent-seeker versus a productive citizen. The approach here is to think of the power to extract rents as having to do with some stock of political capital inherited or built up, rather than existing as an option equally available to all.

An occupational equilibrium consists of a wage w, and functions for each type, G_τ for τ=A,B, and C, that map ability to a probability distribution over the three occupational choices. That is, $G_\tau : (\underline{y}, \overline{y}) \longrightarrow \triangle^2$. These functions must maximize (expected) earned income for each type and ability level by choice of occupation, given the wage. In addition, labor supplied by workers must equal labor demanded by entrepreneurs.

Maximizing agents of types A and B will choose entrepreneurship if and only if $y_i - w > \max\{w, \underline{w}\}$[14]. Similarly, those of type C will be entrepreneurs if and only if $y_i - w - c > \max\{w, \underline{w}\}$. Since each entrepreneur needs one worker, this gives labor demand equal to

$$\gamma[1 - F(\max\{w, \underline{w}\} + w + c)] + (1-\gamma)[1 - F(\max\{w, \underline{w}\} + w)]. \tag{1}$$

The same reasoning gives that labor supply is

$$\gamma F(2w + c) + (1-\gamma)F(2w) \tag{2}$$

if $w > \underline{w}$. If $w = \underline{w}$, labor supply is any amount q_S such that

$$q_S \in [0, \gamma F(2\underline{w} + c) + (1-\gamma)F(2\underline{w})]$$

This is because a measure $\gamma F(2\underline{w}+c) + (1-\gamma)F(2\underline{w})$ of people are indifferent between wage labor in a firm and subsistence. If $w < \underline{w}$, wage labor is strictly dominated by subsistence, so labor supply is zero.

The equilibrium wage is calculated by equating labor supply and demand. Several facts about the wage are immediate, most importantly its uniqueness and that it decreases in the level of corruption, c. The intuition is simple and crucial to several results of this paper. Corruption makes the entrepreneurial profession less profitable for the unprotected. Consequently, they are willing to work at a lower wage, and labor supply swells. The mirror image is that less of them find it profitable to become entrepreneurs, so labor demand shrinks. Thus the equilibrium wage is driven down. This result is pictured in Figure 1 and shown in the following proposition:

Proposition 1. *For a given level of corruption, a unique equilibrium wage exists. The equilibrium wage is decreasing*[15] *in the level of corruption.*

Proof. To show existence and uniqueness, consider two cases. First, if labor demand exceeds the highest possible value of labor supply at $w = \underline{w}$,[16] then there exists a unique equilibrium wage on $(\underline{w}, y_{med}/2]$. Existence is from the intermediate value theorem, which applies because labor supply and labor demand are continuous functions on $(\underline{w}, y_{med}/2]$; labor demand exceeds labor supply when $w = \underline{w}$, and thus also when w is slightly above $\underline{w}$[17]; and labor supply exceeds labor demand at $y_{med}/2$. Thus supply and demand must

[14] We can ignore the case when this expression holds with equality, since it does for a measure zero of the population.

[15] Absent any qualifier, 'decreasing' and 'increasing' will be meant in the weak sense.

[16] Labor supply is any amount in $[0, \gamma F(2\underline{w} + c) + (1-\gamma)F(2\underline{w})]$ at $w = \underline{w}$.

[17] In other words, an $\epsilon > 0$ can be found such that labor demand exceeds labor supply when $w = \underline{w} + \epsilon$. This is because labor supply is a continuous function on $[\underline{w}, y_{med}/2]$ if we choose its maximum value at $w = \underline{w}$.

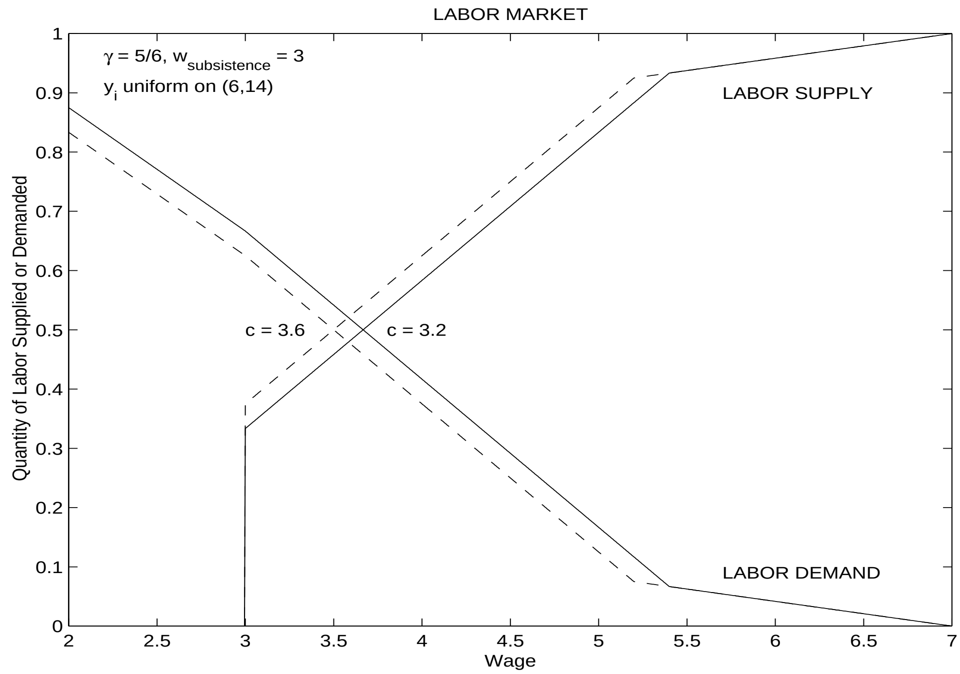

Figure 1: The labor market.

intersect on $(\underline{w}, y_{med}/2]$. Uniqueness is from the fact that labor supply and labor demand are strictly increasing and decreasing functions, respectively, on $(\underline{w}, y_{med}/2]$, and because they are weakly decreasing everywhere. Therefore, there can be only one intersection.

Second, if labor demand does not exceed the highest possible value of labor supply at $w = \underline{w}$, then the unique equilibrium wage is $\underline{w}$. Clearly this is an equilibrium wage, because demand is no greater than the maximum admissible value of supply at $w = \underline{w}$, by assumption; because it is no less than the minimum value of supply, zero; and because labor supply at $w = \underline{w}$ can take any value from a convex set. Uniqueness is because labor supply is zero for $w < \underline{w}$ while labor demand is strictly positive there; and because labor supply exceeds labor demand when $w > \underline{w}$.[18] Thus there can be no intersection above or below $\underline{w}$.

To show that the wage is decreasing in c, note from equation 1 that labor demand is decreasing in c. Note also that the expressions for labor supply in equation 2 and following are increasing in c. Further, since supply and demand are increasing and decreasing in w, respectively, the unique intersection can never move to the right when c increases. ◯

A unique equilibrium wage in $[\underline{w}, y_{med}/2]$ is thus assured. Given the equilibrium wage, the occupational choice functions are determined by finding cutoff ability levels. For those with ability higher than the cutoff, entrepreneurship dominates and is chosen with probability one. For those with lower ability, wage labor dominates.

Recall that an agent of type A or B will choose entrepreneurship if and only if $y_i - w > \max\{w, \underline{w}\}$. Since $w \geq \underline{w}$, this condition reduces to $y_i > 2w$. Thus the cutoff ability for

[18] This is because labor demand is decreasing, while labor supply is always strictly greater at $w > \underline{w}$ than at $w = \underline{w}$, no matter which labor supply is chosen at $w = \underline{w}$.

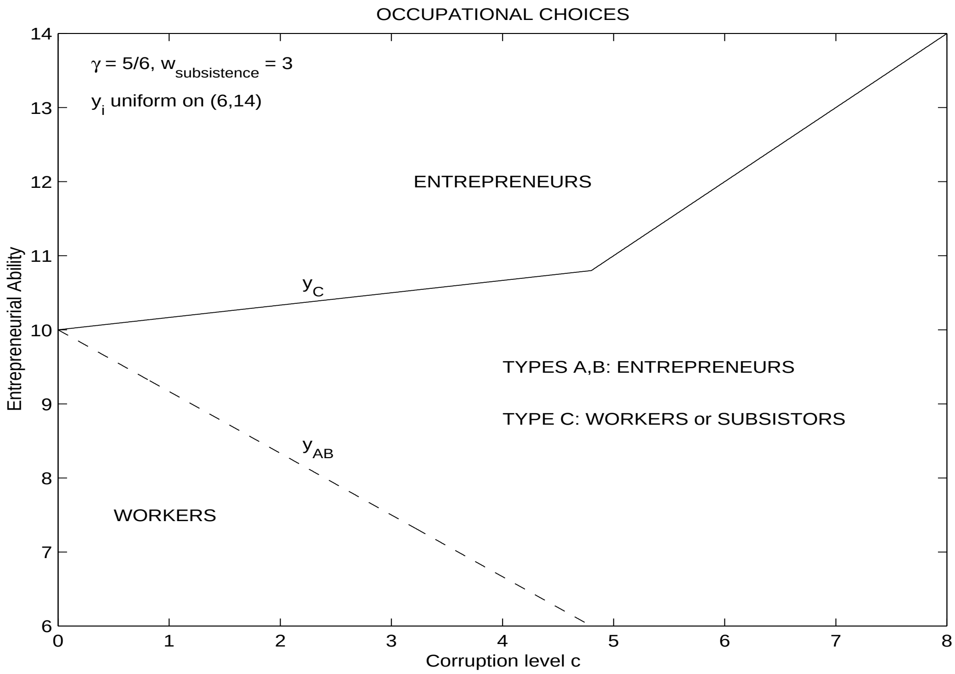

Figure 2: Occupational choice and the level of corruption.

types A and B is $2w$. Similar reasoning shows it to be $2w + c$ for type C. Call these cutoffs y_{AB} and y_C, respectively. Since $y_C > y_{AB}$ for $c > 0$, it is clear that corruption raises the bar of entry into entrepreneurship higher for the unprotected population than for those in power or connected to it. This is evident in Figure 2, which shows the divergence across political types in ability levels needed to make entrepreneurship profitable.

Only a measure zero of agents can be indifferent between entrepreneurship and either other profession, since they must have ability exactly equal to the cutoff to be indifferent. There can be a positive measure of agents indifferent between wage labor and subsistence, however, when $w = \underline{w}$. For these agents, the occupational choice function must put the correct probability on subsistence and wage labor, in order to equate labor supply to labor demand.[19] Therefore, the occupational choice functions are completely and uniquely defined (up to population sets of measure zero) by the corruption level and the equilibrium wage, which itself is uniquely defined by the corruption level. Thus each level of corruption c gives rise to exactly one equilibrium.

Other key economic variables can be calculated by using the wage.[20] As discussed above,

[19] The probability of working in a firm, call it p, must satisfy

$$p = \frac{\gamma[1 - F(2\underline{w} + c)] + (1 - \gamma)[1 - F(2\underline{w})]}{\gamma F(2\underline{w} + c) + (1 - \gamma)F(2\underline{w})},$$

which is the ratio of labor demand at c and $\underline{w}$ to the measure of agents indifferent between working and subsisting at c and $\underline{w}$. This fraction of indifferent agents will satisfy firms' labor demand and the remaining will use the subsistence technology.

[20] Dependence on c by the variables in the following text is suppressed.

the cutoff ability levels are

$$y_{AB} = 2w, \quad y_C = 2w + c. \tag{3}$$

Let the total number of entrepreneurs of types A or B and type C, respectively, be e_{AB} and e_C. Then

$$e_{AB} = (1-\gamma)[1 - F(y_{AB})], \quad e_C = \gamma[1 - F(y_C)]. \tag{4}$$

The measure of agents subsisting, call it S, satisfies

$$S = 1 - 2(e_{AB} + e_C).$$

This is the total population minus the number working as entrepreneurs or as the worker for an entrepreneur. The average ability of entrepreneurs, call it y_{avg}, is

$$y_{avg} = \frac{e_{AB}E(y_i|y_i > y_{AB}) + e_C E(y_i|y_i > y_C)}{e_{AB} + e_C}.$$

Here $E(y_i|y_i > y_C)$ and $E(y_i|y_i > y_{AB})$ are the average ability of type-C and type-A or type-B entrepreneurs, respectively. Total output, call it Y, satisfies

$$Y = (e_{AB} + e_C)y_{avg} + S\underline{w}.$$

The first term is output using the entrepreneurial technology, while the second term accounts for output from the subsistence technology. Straightforward calculation gives the following proposition.

Proposition 2. *The number of subsisters S is increasing in the level of corruption. For $\gamma \leq \frac{3}{4}$, average entrepreneurial ability y_{avg} is decreasing in the level of corruption. Total output Y is decreasing in the level of corruption.*

Proof. Given the assumption that ability is distributed uniformly on $(\underline{y}, \overline{y})$, explicit equilibrium wages and occupational choices can be calculated. From those come S, Y, and y_{avg}. It can be checked that the following are occupational equilibria, depending on values of γ.

- When $\gamma < 1/2$, $w = max\{\frac{y_{med} - \gamma c}{2}, \frac{y_{med} - \gamma\overline{y}}{2(1-\gamma)}\}$.[21] Agents of types A and B choose entrepreneurship w.p.1 if $y_i > 2w$ and work w.p.1 otherwise. Type C agents choose entrepreneurship w.p.1 if $y_i > 2w + c$ and work w.p.1 otherwise.

- When $\gamma \geq 1/2$, $w = max\{\frac{y_{med} - \gamma c}{2}, \underline{w}\}$. Agents of types A and B choose entrepreneurship w.p.1 if $y_i > 2w$ and work w.p.1 otherwise. Type C agents choose entrepreneurship w.p.1 if $y_i > 2w + c$. Otherwise if $w > \underline{w}$, they work w.p.1; if $w = \underline{w}$, they work w.p. $max\{1/\gamma, \frac{L}{c\gamma}\} - 1$ and subsist w.p. $2 - max\{1/\gamma, \frac{L}{c\gamma}\}$.

[21] Recall that $L \equiv \overline{y} - \underline{y}$ and $y_{med} = \frac{\underline{y} + \overline{y}}{2}$.

Using these equilibrium wages, it is possible to calculate Y, S, and y_{avg}. As above, the functions vary depending on the value of γ, so we will list two cases.

When $\gamma < \frac{1}{2}$,

- $Y(c) = \frac{y_{med}+L/4}{2} - min\{\frac{\gamma(1-\gamma)c^2}{2L}, \frac{\gamma L}{8(1-\gamma)}\}$
- $S(c) = 0$
- $y_{avg}(c) = y_{med} + \frac{L}{4} - min\{\frac{\gamma(1-\gamma)c^2}{L}, \frac{\gamma L}{4(1-\gamma)}\}$

When $\gamma \geq \frac{1}{2}$,

- $Y(c) = \begin{cases} \frac{y_{med}+L/4}{2} - \frac{\gamma(1-\gamma)c^2}{2L} & , \quad c \in [0, \frac{L}{2\gamma}] \\ \frac{y_{med}+L/4}{2} + \frac{L}{8} - min\{\frac{\gamma c^2}{2L}, \frac{\gamma L}{2}\}, & c \in [\frac{L}{2\gamma}, \infty) \end{cases}$
- $S(c) = \begin{cases} 0 & , \quad c \in [0, \frac{L}{2\gamma}] \\ min\{\frac{2\gamma c}{L}, 2\gamma\} - 1, & c \in [\frac{L}{2\gamma}, \infty) \end{cases}$
- $y_{avg}(c) = \begin{cases} y_{med} + \frac{L}{4} - \frac{\gamma(1-\gamma)c^2}{L}, & c \in [0, \frac{L}{2\gamma}] \\ y_{med} + \frac{\gamma c(1-c/L)}{2(1-\gamma c/L)} & , \quad c \in [\frac{L}{2\gamma}, L] \\ y_{med} & , \quad c \in [L, \infty) \end{cases}$

Regardless of the value of γ, all the functions above are continuous. Further, inspection reveals that each piece of Y is decreasing in c and each piece of S is increasing in c. It can be checked that average ability decreases everywhere except for $c \in (\frac{L}{2\gamma}, \frac{L}{1+\sqrt{1-\gamma}})$ when $\gamma > 3/4$. ○

This proposition highlights two sources of static inefficiency associated with corruption, even in a setting of perfect information and well-defined property rights. First, corruption generally lowers ability levels of active entrepreneurs by making political connectedness an important part of the occupational decision, rather than just ability. Thus it misallocates talent by barring some of the more capable entrepreneurs and substituting for them politically connected agents of lower productivity. The mechanism is as follows: As c rises, marginal type C entrepreneurs leave the profession. At the same time, the wage declines to bring in marginal entrepreneurs of types A or B. With c close to zero, the ability levels of those trading places are similar. However, as c moves higher, unprotected entrepreneurs of higher and higher skill are being replaced by connected ones of lower and lower skill.[22] Thus use of the entrepreneurial technology is misallocated across entrepreneurs due to the differing costs of operation.[23]

[22] This explains, for some ranges of c, the concavity of Y(c).

[23] Average ability is generally decreasing in c, since usually unprotected agents are replaced in entrepreneurship one for one by less skilled, connected agents. However, an exception to this exists (when $\gamma > 3/4$, as noted in proposition 2). A point can be reached when type-C agents driven out are not replaced at all, since all agents of types A and B are already in entrepreneurship. In this case, those leaving entrepreneurship are more skilled than the average current entrepreneur of type A or B, but at the bottom of the type-C

Similar observations have been made by Lloyd-Ellis and Bernhardt (2000) in the context of credit market imperfections. These are shown to lead to talent misallocation. Murphy et al (1991) examine a model where rent-seeking can draw the best talent away from productive entrepreneurship. The approach here is different and complementary. We show that even when the rent-takers have the same ability distribution as the rest of the population, misallocation arises from the comparative advantage in running businesses political connections can give.

The second source of inefficiency is seen when γ and c are high enough and agents begin to enter subsistence. This substitution away from the more productive technology to the more protected one is greater the higher is corruption: less and less find entrepreneurship profitable, and labor supply is greater than the labor demand of official businesses. Those who are not employed by firms are left to engage in small-scale, secretive productive activities, and total output decreases.

Having analyzed the efficiency consequences of corruption, we turn to the distributional effects. Earned income of each agent is readily calculated by using the equilibria outlined in the proof of proposition 2. For type A agents, there is a second component of income, coming from rents. Total rent income of type A agents is simply equal to $e_C c$. In attributing rent income, we assume that total rents $e_C c$ are divided evenly among type A agents. The gini coefficient as a function of corruption and several values of γ and α is graphed in Figure 1. It is shown as a function of output in Figure 2. Evidently, inequality exhibits an inverted U-shaped relationship with both corruption and output.

The key mechanism behind this result is a Laffer curve applied to corruption. When c is low ($c = 0$) or high ($c = L$), few rents exchange hands. In the former case, there are many type-C businesses and no bribes; in the latter case there are no type-C businesses and large bribes demanded. Some intermediate value of c maximizes total rent income. If γ is large enough relative to α, rent incomes of type A agents are the chief source of inequality. Thus the inverted-U relationship between inequality and corruption is observed.

Interestingly, the relationship of inequality to output implied by this model is also an inverted-U shape. This stems from the inverted-U of inequality with corruption, coupled with the result that output is monotone in corruption.

The relationship obtained between inequality and corruption depends on γ, α, and the distribution of entrepreneurial ability assumed. It is possible that the decline in inequality at higher levels of corruption can be mitigated or reversed by an alternative assumption on distribution of entrepreneurial ability. Nevertheless, our results suggest that a nonlinear relationship should be looked for when relating corruption to inequality, an approach not attempted by Gupta et al (1998). In addition, legal system quality should be controlled for (being reflected in α and γ.) Confirming results are found in Li et al (2000), who document an inverted-U relationship of inequality with corruption, controlling for other determinants of inequality.

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current entrepreneur skill range. The relative size of the groups determines whether the overall average goes up or down. However, the interval of c where average ability is increasing in c, quantified in the proof of proposition 2, is the exception. For c not in this interval, average ability is decreasing, and it ends up at $c \geq L$ lower than at $c = 0$.

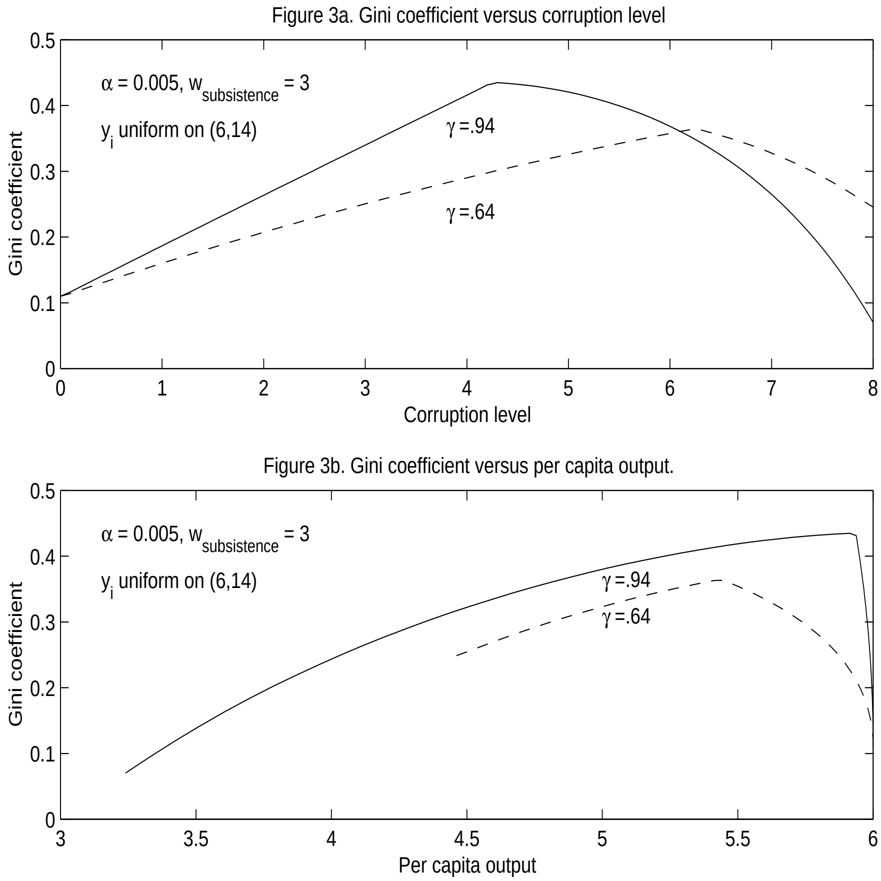

Figure 3: Inequality versus the corruption level and output.

3 Corruption and decentralization

Recent trends toward centralization of power in Russia and decentralization in China raise an interesting question: what is the effect of power decentralization on the level of corruption?

The subject of decentralization and corruption has been considered before. Shleifer and Vishny (1993) have argued that decentralization increases corruption. In their paper, corruption is viewed as monopolists selling complementary public goods; under decentralization, independent monopolists sell them, while under centralization a joint monopoly does. The joint monopoly charges less. Others have argued that decentralization can be a positive force for governance. Weingast (1995), for example, has argued that competition between regions for factors of productions can improve governance and preserve the market.

The goal of this section is to analyze these arguments about decentralization in a single model. This is accomplished by endogenizing c based on underlying political organization. We find that the validity of the two views depends crucially on factor mobility between regions; in a case of imperfect mobility, both views are confirmed simulataneously, though for some different reasons than seen in the literature.

The following political structure is assumed. The economy is divided into M regions, identical in population size and distribution of political type and entrepreneurial ability. In each region, those in power are divided into N identical power groups, which will be called bureaucracies.[24] It is assumed that type C entrepreneurs operating in a given region must pay all N bureaucracies in that region. The idea is that multiple regulatory agencies, officials, or even private bandits have effective veto power over a firm's operation and can thus sell it the right to operate.

M and N are both strictly positive integers, and are intended to capture the degree of regional and bureaucratic decentralization, respectively. The case where M and N are both one corresponds to complete centralization of control. Notationally, the index $j \in \{1, ..., M\}$ will refer to the region and both j and $k \in \{1, ..., N\}$ to the bureaucracy.

Each agency[25] jk maximizes its total income by setting the bribe level it charges, $\tilde{c}_{jk} \geq 0$. Thus a type C entrepreneur operating in region j must pay $c_j \equiv \sum_{k=1}^{N} \tilde{c}_{jk}$. For notational purposes, we will equivalently consider the agencies as maximizing over c_{jk}, where $c_{jk} \equiv N\tilde{c}_{jk}$ is the charge faced by a type C firm if all agencies in region j charge as much as agency jk. The charge faced by a type C agent in region j can thus also be written as $(1/N)\sum_{k=1}^{N} c_{jk}$.

The fees charged by all other agencies except jk will be denoted as c_{-jk}. Since we restrict attention to symmetric Nash equilibria, c_{-jk} will be considered a scalar. Similarly, the scalar c_{-j} will denote the total amount of fees charged in each region except j.

The firm's output level, y_i, is assumed to be known only by the entrepreneur. Consequently, those in power cannot condition the fee they charge on output.[26] They set the fee knowing that higher fees will mean less type-C businesses.

The effects of decentralization depend on factor mobility between regions. In sections 3.1 and 3.2, no mobility and perfect mobility, respectively, will be assumed. In section 3.3, an intermediate case is considered.

3.1 No Mobility

If agents cannot move at all between regions, each region is an identical economy of population $1/M$ and can be analyzed in isolation. Each region contains $N \geq 1$ power groups of equal sizes, or 'agencies', each of whom must be paid by any type C agent who operates a business.

Define $\Pi_{jk}(c_{jk}, c_{-jk})$ to be the total income of agency jk given its fee and the others'. Then

$$\Pi_{jk}(c_{jk}, c_{-jk}) = \frac{c_{jk}}{N} e_{C,j} + e_{A,jk}[E(y_i|y_i > y_{A,j}) - w_j] + (\alpha/MN - e_{A,jk})w_j. \tag{5}$$

The first term is rent income: the agency charges c_{jk}/N to a measure $e_{C,j}$ entrepreneurs in region j. The second is earned income of the agency's entrepreneurs. The third is earned income of the agency's workers, whose number equals the total size of the agency, α/MN,

[24] A power group can be interpreted more loosely than the term bureaucracy suggests. For example, it could be a privately organized crime ring that extracts bribes from businesses.

[25] Agency will be used synonymously with bureaucracy.

[26] In reality, it is likely the case that bribes demanded depend to some degree on a firm's output. However, firm's also are able to hide output in various ways, making perfect price discrimination by a power group impossible. We conjecture the qualitative results of the section go through as long as there is some inability to fully extract every entrepreneur's surplus.

minus its number of entrepreneurs.[27] Here $e_{C,j}$ is indexed by j and not k, since unprotected firms must pay each agency in the region. Similarly the cutoff ability level $y_{A,j}$ is indexed by j because it depends only on the regional wage, w_j.

Analogous to equation 3 in section 2, we have that $y_{A,j} = 2w_j$ and $y_{C,j} = 2w_j + c_j$. From these cutoff ability levels come that $e_{A,jk} = (\alpha/MN)[1 - F(2w_j)]$, which is the population in agency jk multiplied by the fraction above the cutoff; and that $e_{C,j} = (\gamma/M)[1 - F(2w_j + c_j)]$, which is the total type C population in region j multiplied by the fraction above the cutoff. Incorporating these facts, the payoff of agency jk can be written as

$$\begin{aligned}\Pi_{jk}(c_{jk}, c_{-jk}) =& \frac{\gamma}{MN} c_{jk}[1 - F(2w_j + c_j)] \\ &+ \frac{\alpha}{MN}\{[1 - F(2w_j)][E(y|y > 2w_j) - w_j] + F(2w_j)w_j\}.\end{aligned} \tag{6}$$

Given the lack of mobility, each region has its own labor market. Clearly each market is analyzable exactly in the same way as shown in section 2; the population scaling by 1/M makes no difference. Thus c_j delivers a unique wage w_j in each region, and these are the wages outlined in the proof of proposition 2. Using these expressions and the uniform distribution, it is straightforward to calculate best responses and solve for symmetric Nash equilibria. The results under a minor assumption are contained in proposition 3.

Assumption 1. *Any agency jk indifferent between a set of fees $\{c_{jk}\}$ will choose the smallest (if it exists).*

Proposition 3. *Under Assumption 1 and no interregional mobility, the unique symmetric Nash equilibrium level of corruption is increasing in the degree of bureaucratic decentralization N and independent of the degree of regional decentralization M.*

Proof. *See Appendix.*

The result that regional decentralization does not affect the corruption level under lack of mobility is not surprising. More interesting is that bureaucratic decentralization increases corruption. The logic here is that one agency exerts a negative externality on other agencies by increasing its fee, since the marginal type C agents who then decide against business stop paying all agencies. Since this externality is not accounted for, agencies will charge more than if they could cooperate.

There is a second, positive externality exerted by one agency on the others. By increasing its fee, an agency lowers the wage, which makes type C agents more willing to be entrepreneurs at any level of corruption. The increased supply of entrepreneurs benefits every agency and is thus undervalued by a single agency. This positive externality is of second order, however; the overall effect of bureaucratic decentralization is still to increase corruption.

The story is similar to that of independent monopolies selling complementary goods, who charge more than a joint monopolist would because they fail to internalize the effect of their own price on the demand for the other goods. Shleifer and Vishny (1993) make this exact point about corruption. Here it is confirmed in a general equilibrium setting in which there are two opposing externalities.

[27] We know from section 2 that type A agents never choose subsistence.

The equilibrium corruption levels outlined in the proof of proposition 3 yield some insight. The completely cooperative case is captured by $N = 1$. This level of corruption maximizes total income of those in power. But as N gets large, if $\gamma > 1/2$, $c \to L$. When $c \geq L$, no type C agents find entrepreneurship profitable and thus zero rents are collected. Thus a high degree of bureaucratic decentralization, or overlapping power groups, can serve as the explanation for extremely high levels of corruption where little rent income is being collected and many are using informal subsistence technology.

Assumption 1 plays a simple role. Without it, there are equilibria where all agencies are charging fees so high that no type C entrepreneur will ever start a business. The fees also must be high enough that no single agency can deviate downward and succeed in drawing in type C entrepreneurs. This type of equilibrium exists for any $N \geq 2$. For example, consider $c_{jk} = NL$. Every agency is charging L, and there is nothing a single agency can do to reduce the total fees below L. No rents are collected in these equilibria. This is a story of rampant corruption that would exist no matter what certain officials do and thus encourages them to take part in it. However, these equilibria are in some sense less stable than the ones described in the proof of proposition 3: agencies are equally happy with any c_{jk}, whereas above, they charge their uniquely preferred fee. Assumption 1 gets rid of these equilibria by making it optimal for an agency to deviate to $c_{jk} = 0$. It allows us to focus on the (minimum-corruption) equilibria delineated above, where $c < L$.

3.2 Perfect Mobility

Assume that agents can freely move among regions to pursue their chosen occupations. If they are indifferent, assume they stay in their own region.[28] In this case, it is clear that there will be a single economy-wide wage and that type-C entrepreneurs will go to the region(s) that charge the least amount of fees. Thus power groups will be competing Bertrand-style and the analysis is mostly straightforward.

Proposition 4. *Under Assumption 1 and perfect interregional mobility, the unique symmetric Nash equilibrium level of corruption is decreasing in the degree of regional decentralization M and independent of the degree of bureaucratic decentralization N.*

Proof. See Appendix.

Assumption 1 is used in the proof for convenience, but its necessity is actually more modest. It rules out equilibria that can occur when $N \geq 2$ similar to those ruled out in section 3.1. In these equilibria, every region has such high corruption that no type C agents enter business, yet no single agency can lower the corruption level enough to change this. For example, $c \geq NL/(N-1)$[29] are such equilibria. Every region will have $c \geq L$ even if one agency deviates to zero. With these levels of rampant corruption, competition leads nowhere because no single agency can make a big enough dent in the regional corruption level.

There is a second type of equilibrium ruled out by assumption 1. In this asymmetric outcome, one region j is acting according to the equilibrium outlined in proposition 3, and

[28] They could also flip a fair coin.

[29] Recall that c refers to the amount an agency charges multiplied by N. For notational purposes, we consider agencies choosing not their actual fee $\tilde{c}$, but $c \equiv N\tilde{c}$, the amount that would be faced by a type C entrepreneur if every other agency in the region charged what they are.

each other region faces a high enough corruption level that no single agency can bring it below region j's. In particular, it is an equilibrium if region j sees corruption level c_{nm} and all other regions exhibit $c > Nc_{nm}/(N-1)$. In this equilibrium type C entrepreneurs are active, all operating in region j, and region j's agencies collect rents. The remaining regions are too corrupt to attract any type C entrepreneurs. The interesting feature of this equilibrium is that even under perfect mobility, corruption persists in equilibrium, rents are collected, and corruption is increasing in the degree of bureaucratic decentralization N.

Agencies in both types of equilibria are charging very high fees yet earning zero rents. Assumption 1 ensures these agencies would prefer to deviate away from this.

3.3 Imperfect Mobility

Two very different results are obtained in the past two sections under extreme and opposite assumptions about mobility. In this section, we consider an intermediate case in which agents can work in any region but only operate a business in their own. This kind of assumption may have some empirical validity in a country with significant interregional variation in law, language, and culture. It is analytically interesting because it shuts down competition between regions for entrepreneurs: each region has a monopoly on its type C entrepreneurs, since they can only start businesses in their own regions. The regions are connected only by a national labor market.

Under these assumptions, there is one economy-wide wage. Total income for agency jk is then

$$\Pi_{jk}(c_{jk}, c_{-jk}) = \frac{c_{jk}}{N} e_{C,j} + e_{A,jk}[E(y_i|y_i > y_A) - w] + (\alpha/MN - e_{A,jk})w. \tag{7}$$

This is similar to equation 6 which gives an agency's payoff when there is no mobility. The difference is that the wage is not indexed by j here, since it is determined by nation-wide supply and demand; neither is y_A, which only depends on the wage.

Now we can write the cutoff ability levels as $y_A = 2w$ and $y_{C,j} = 2w + c_j$. From these come that $e_{A,jk} = \alpha/MN[1 - F(2w)]$, which is the population in agency jk multiplied by the fraction above the cutoff; and that $e_{C,j} = \gamma/M[1 - F(2w + c_j)]$, which is the total type C population in region j multiplied by the fraction above the cutoff. Incorporating these facts, the payoff of agency jk can be written as

$$\begin{aligned}\Pi_{jk}(c_{jk}, c_{-jk}) = \frac{\gamma}{MN} c_{jk}[1 - F(2w + c_j)] \\ + \frac{\alpha}{MN}\{[1 - F(2w)]E(y|y > 2w) + F(2w)w\}.\end{aligned} \tag{8}$$

The following result can be shown:

Proposition 5. *Under assumption 1 and labor mobility but not entrepreneurial mobility, the unique symmetric Nash equilibrium level of corruption is decreasing in the degree of regional decentralization M and increasing in the degree of bureaucratic decentralization N.*

Proof. *See Appendix.*

From the equilibria outlined in the proof, it is clear that corruption in general varies continuously with both M and N, unless N gets too large. The mechanism driving the result on bureaucratic decentralization is exactly the one described in section 3.1.

Most interesting is that regional decentralization continues to decrease corruption even in the absence of any competition between regions for exploitable factors. The reason is that there is an externality operating through the wage (also discussed in section 3.1). When an agency in region j increases c_j, the economy-wide wage drops (see proposition 1). This increases the willingness of type C agents to work as entrepreneurs in all regions, and thus other agencies' potential payoffs increase. This positive externality is not internalized by agency j, leading to a lower equilibrium c than if there were more centralized decision-making.[30]

Thus regional decentralization has an effect even when factor mobility is limited. Further, there is no direct competition here for rents. This distinguishes the results from the ideas of Weingast (1995), Shleifer and Vishny (1993) and Rose-Ackerman (1978), for whom competition among agencies or regions is the key to reducing corruption or misgovernance. The basic idea of this section is that there need not be direct competition; sufficient for lower corruption is some mechanism which ensures that one group's corruption makes corruption by another group more profitable.

The results also clarify and confirm simultaneously ideas of Shleifer and Vishny (1993) and Weingast (1995) on decentralization. The crucial distinction is whether power is decentralized in such a way that creates overlapping jurisdictions, as with our bureaucratic case and the Shleifer and Vishny model, or whether each group has undivided control over its constituents, as in the case of our regional decentralization and Weingast. We also show that the regional decentralization results are robust to weakened mobility assumptions.

Several papers find negative correlation between measures of corruption and regional decentralization, confirming our theoretical results. Huther and Shah (1998) find a significant bivariate correlation, while Fisman and Gatti (2000) confirm this result with a richer set of control variables, including an instrument.

4 Controlling Corruption

The aim of this section is to examine how effective two methods of controlling corruption – electoral accountability and compensation schemes – can be in mitigating the extent of corruption. The two are very similar in one major respect. They set up the unprotected class as a principal over those in power, who are then the agents. The agents weigh the payoff of the behavior prescribed by the principal against the payoff of deviation from this behavior. Thus the crucial determinant of the effectiveness of control methods will be how the deviation payoff changes as the symmetric level of corruption is lowered.

It might be natural to think that in a low-corruption political environment, programs designed to reduce corruption would garner low marginal returns. Conversely, one might think that high-corruption political environments provide better opportunities on the margin

[30] In this paper we consider equal-size regions and symmetric equilibria. The model could quite easily accommodate regions of different sizes. It seems clear that in this case, bigger regions would have higher corruption, due to their greater influence on the wage.

for corruption reduction. In this model, the opposite turns out to be true. The very factors that make regional decentralization less corrupt also make it amenable to the eradication of corruption, while the factors that make bureaucratic decentralization more corrupt make it more resistant to measures taken to reduce corruption. Namely, it is the positive net externality in the first case and the negative net externality in the second that are driving the results of sections 3 and 4.

4.1 Optimal Compensation Schemes

Since the study of Becker and Stigler (1974) on optimal compensation of corruptible law enforcers, high bureaucratic wages have been seen as a key tool that can be used to mitigate corruption.[31] If bureaucrats are paid more than they can earn elsewhere, and if there is a threat of losing these wages when dishonest behavior is discovered, then corruption can be held in check. Becker and Stigler showed how this sort of policy can be implemented, with rising wages over time and a lump-sum payment of the worker at the beginning of his career to neutralize any distributional consequences of such a policy.

That paper has spawned other theoretical work examining optimal compensation schemes under various informational assumptions (see for example Besley and McLaren 1993, and Mookherjee and Png 1995). It has also led to empirical work asking whether high bureaucratic wages do in fact decrease corruption (see Van Rijckeghem and Weder 1997, and also DiTella and Schargrodsky 2000). These contain at least some evidence that high wages do decrease corruption.

However, the literature to date ignores a fundamental feature of the problem: strategic interaction between corrupt agents. For example, in Becker and Stigler 1974, police officers are assumed to collect some bribery payoff b if they act corruptly, *independent* of what any other police officer is doing. In reality, however, one agent's payoff from corruption may be a function of the extent of corruption of other agents.[32] If this is true, each agent will optimize taking other agents' behavior into account, and strategic interaction will enter the equilibrium analysis.

The model of this paper features strategic interaction between decentralized corrupt agencies. In this section, we introduce the possibility of paying bureaucratic wages into that context. Solving for optimal compensation schemes will bring new insights into when and to what extent high bureaucratic wages are good policy tools when there is strategic interaction between corrupt agents.

Our basic finding is that the more negative the externality imposed by agents' corruption on other corrupt agents' potential earnings, the more limited is compensation as an anti-

[31] The paper also addressed the issue of private versus public enforcement of the law. Qualifications to their results on this topic can be found in Landes and Posner (1975), who show that a profit-maximizing enforcement industry may over-enforce the law relative to the social optimum. Landes and Posner consider the case of competitive firms, which could in principle be similar to the overlapping bureaucratic jurisdictions we analyze. However, their results come from features other than the common pool aspect of the problem, while this aspect is crucial to our results.

[32] If we were to extend the Becker-Stigler model, for example, we might want the bribery payoff available to an officer to be an increasing function of the honesty his co-workers, since their honesty leaves more and better opportunities for him. On the other hand, the corrupt officer's expected payoff might be a decreasing function of others' honesty if it increases his probability of getting caught in any given act of corruption.

corruption tool. An example of this negative externality is police officers extracting from a common pool of bribe opportunities, or in our model, bureaucracies extracting from the same firms. On the other hand, if there are positive externalities of agents' corruption on other corrupt agents, then compensation schemes can be more effective. An example of a positive externality is police officers who are less likely to be caught or disciplined the more corrupt are other officers; or in our model, regional authorities who can earn more from corruption if other regions are also corrupt and thus depress the market wage.

In this section we retain the imperfect mobility assumptions of section 3.3: agents can work in any region but operate a firm only in their own. We then examine what happens if type C agents have the ability to act collectively and commit to paying wages to type A agencies conditional on their level of corruption. In particular, under what conditions will a policy of rewarding non-corrupt behavior with higher wages be optimal? This is similar to the Becker-Stigler setup in that wages higher than the alternate use of time[33] will be paid when proper behavior is observed, and withheld when not. It differs in that the presence of corruption is fully known here, so the probability of getting caught is one. Nevertheless, we assume that while wages associated with the bureaucratic position can be confiscated, bribery earnings cannot. Thus agents may find it optimal to engage in corruption even if they will be caught with certainty. A second difference is that this model is static while theirs was dynamic. However, a static setup is sufficient to get at the interesting implications of strategic interaction.

The setup in this section is as follows. At the beginning of the period, type C agents choose and commit to a wage schedule (conditioned on the corruption level) that they will pay type A agencies at the end of the period. We assume type C agents can freely side contract among themselves, which means they will maximize group income.[34] Next, bribe levels are set by the agencies, and production and corruption take place. Finally incomes are realized by all agents, and wages are paid from type C to type A agencies according to the pre-announced wage scheme.

It is not clear a priori that the type C population will want to pay bureaucrats wages in exchange for decreasing bribe levels. Both paying wages and paying bribes result in redistribution from type C to type A.[35] However, as we will see, paying bureaucratics wages that are at least slightly above opportunity cost is optimal. This is because self-collection of money for wages is like a lump-sum tax here, whereas bribes distort several margins. Thus wages can enhance overall efficiency and result in Pareto-improvement.

Denote the total income of the type C population when corruption is c as $\Pi_C(c)$; let $\Pi_A(c)$ and $\Pi_B(c)$ be defined similarly. Further, denote the total wages that will be paid to an agency charging c as $v(c) \geq 0$.[36] Agencies will now take the wage schedule as given when

[33] In this model, there is no alternate use of time, so any positive wage provides some incentive.

[34] These assumptions may be extreme, but the model will nevertheless highlight some useful issues. Further, the results that will be obtained on the *limits* of compensation schemes are put in greater relief. The assumption on commitment ability could be discarded in a dynamic model; we keep this one static for simplicity.

[35] In this paper, we take the ability to collect bribes as given, so there is no scope for asking type A agents to pay for their position at the outset, a la Becker-Stigler. This could be easily introduced, however.

[36] The wage function is assumed anonymous because all agencies are identical and we are focusing on symmetric equilibria.

they decide what bribes to charge. As before, we focus on symmetric Nash equilibria.

The type C population will maximize their total income $\Pi_C(c)$ net of total wages paid to agencies. One way to solve for the optimal wage scheme is to do so in two stages. The first stage is to determine the minimum wages that must be paid to implement a given corruption level c as a Nash equilibrium. The second stage is to maximize over choice of c the type C income net of wage payments needed to implement c as an equilibrium.

Consider the first stage. For c to be an equilibrium,[37] it must be that no agency wants to deviate away from it, accounting for its income and the wage scheme:

$$\frac{\Pi_A(c)}{MN} + v(c) \geq \Pi_{jk}(c_{jk}, c) + v(c_{jk}), \ \forall c_{jk} \geq 0. \tag{9}$$

The left side of 9 represents the payoff to an agency of charging c, given all other agencies are. It earns the wage $v(c)$ as well as the total type A earnings $\Pi_A(c)$ divided by MN, the number of agencies. The right side of 9 represents the payoff of charging c_{jk} when other agencies are charging c, and receiving wages $v(c_{jk})$. This constraint makes clear that in order to implement c, type C can do no better than setting $v(c_{jk}) = 0$ for all $c_{jk} \neq c$, since this minimizes the right side of inequality 9. In other words, they give no reward for deviating from c. This policy allows us to write the equilibrium constraint 9 as

$$\frac{\Pi_A(c)}{MN} + v(c) \geq \Pi_{jk}(c_{jk}, c), \ \forall c_{jk} \neq c. \tag{10}$$

Define $\Pi^*_{jk}(c)$ to be the best response of agency jk when all other agencies are charging c and wages are not paid. Technically, $\Pi^*_{jk}(c)$ is the maximum over $c_{jk} \geq 0$ of $\Pi_{jk}(c_{jk}, c)$. [38] Since $\Pi^*_{jk}(c)$ is the highest obtainable payoff given other agencies are charging c, constraint 10 can then be rewritten as

$$v(c) \geq \Pi^*_{jk}(c) - \frac{\Pi_A(c)}{MN}. \tag{11}$$

The intuition of this condition is very simple: agencies must be paid enough to cover the gains from deviation to their preferred bribe level. This gives the minimum wage that must be paid each agency to maintain c as an equilibrium. Given compensation is costly, constraint 11 will hold with equality in equilibrium.

The second stage of the problem is the maximization of type C population's income net of wage payments:

$$\Pi_C(c) - MNv(c), \tag{12}$$

where $v(c)$ comes from condition 11 at equality. Substituting it in, we have that the type C population chooses c to maximize

$$\Pi_C(c) + \Pi_A(c) - MN\Pi^*_{jk}(c). \tag{13}$$

[37] We will assume the type C population is content to implement c as a Nash equilibrium that is not necessarily unique.

[38] $\Pi^*_{jk}(c)$ is well-defined because $\Pi_{jk}(c_{jk}, c)$ is continuous in c_{jk} and because c_{jk} can be thought of as being restricted to a compact set. Actually, any $c_{jk} \in [0, \infty)$ is allowed; however, $\Pi_{jk}(c_{jk}, c)$ gives the same value for every $c_{jk} \geq NL$, since this guarantees zero rents to agency jk and no effect on the wage. Thus the choice set is effectively $[0, NL]$, a compact set.

Since total output $Y(c)$ equals the sum of incomes of the three types of agents, $\Pi_A(c) + \Pi_B(c) + \Pi_C(c)$, the objective function can also be written as

$$Y(c) - \Pi_B(c) - MN\Pi^*_{jk}(c). \tag{14}$$

This formulation makes clear some possibilities and pitfalls of compensation. From proposition 2, we know that total output $Y(c)$ is decreasing in c, due to corruption's several distortions. We also know that the income of type B agents, $\Pi_B(c)$, is increasing in c.[39] Thus the first two terms of expression 14, $Y(c) - \Pi_B(c)$, are together decreasing in c.

The key term in objective function 14 is thus $\Pi^*_{jk}(c)$. Recall that $\Pi^*_{jk}(c)$ is the payoff one agency can receive given all other agencies are charging c. If $\Pi^*_{jk}(c)$ is increasing in c, this means that other agencies' corruption increase the payoffs that this agency can get, that is there are positive externalities of corruption on other agencies. On the other hand, if $\Pi^*_{jk}(c)$ is decreasing in c, payoffs of one agency go down the more other agencies are charging. This is the case of negative externalities across agencies.[40] From equation 14, we see that as long as $\Pi^*_{jk}(c)$ is not decreasing in c, the whole expression is decreasing in c. Thus the optimal compensation equilibrium will set wages at $w(0)$ to enforce zero corruption.[41] The following proposition results:

Proposition 6. *If there are not negative externalities of corruption across agencies, that is if $\Pi^*_{jk}(c)$ is not decreasing in c, an optimal compensation scheme pays wages that can enforce zero corruption.*

Proof. We claim that the derivative of type C's objective function 14 is always negative. Thus the optimal c under compensation is at the corner 0.

The proof of proposition 2 gives that $Y(c)$ is decreasing in c, and strictly so at $c = 0$. Our hypothesis gives that $-\Pi^*_{jk}(c)$ is not increasing in c. Finally, we must show that $-\Pi_B(c)$ is decreasing in c, that is, that $\Pi_B(c)$ is increasing in c. The expression for $\Pi_B(c)$ is

$$F(2w)w + [1 - F(2w)]E(y|y > 2w).$$

Note that it only depends on c through the w's dependence on c. Thus when the wage hits its lower bound and is no longer responsive to increases in c, $\Pi_B(c)$ has a zero derivative with respect to c. The case where the wage is above its upper bound is contained in equation 41, in which $\Pi_B(c)$ is proportional to the term enclosed in braces and multiplied by α. This term is the per capita earned income (as opposed to rent income) of type A agents, which equals that of type B agents. Differentiating this with respect to c gives $\gamma^2 c/L$; thus the derivative of $\Pi_B(c)$ with respect to c is clearly positive. We have shown that whatever the wage, the derivative of $\Pi_B(c)$ with respect to c is zero or positive. ○

[39] This is because the wage is decreasing in c, which helps type B agents: they predominate as entrepreneurs since they are exempt from extra fees.

[40] The Becker-Stigler model would correspond to $\Pi^*_{jk}(c)$ having a derivative of zero, that is, no strategic interaction between corrupt agents.

[41] It turns out that the optimal c under compensation may not be the unique Nash equilibrium given the compensation scheme. In particular, c_{im} calculated in section 3.3 may remain a Nash equilibrium. This is the case where the agencies believe all other agencies are ignoring the incentive scheme, and thus find it optimal to do so themselves. For this reason, proposition 6 is not worded as strongly as it might be.

A non-decreasing $\Pi^*_{jk}(c)$ corresponds to a positive (or zero) externality of agencies' fees on other agencies. In our model with imperfect mobility this takes place under regional decentralization ($M > 1$, $N = 1$), as discussed in section 3.3, and under complete centralization ($M = N = 1$). Thus these political structures which are less corrupt of themselves, as shown in section 3.3, are also very amenable to compensation schemes.

The intuition for this result is that compensation here is like a Coase bargain between type C and type A agents.[42] Corruption causes inefficiency due to its unequal targeting and its tax on the entrepreneurial profession. If the total earnings from corruption could be paid to type A agents in a non-distortionary way, and in a way that leaves them no incentive to act corruptly, efficiency gains would cause the bargain to take place. This first condition is met because compensation schemes are non-distortionary in our formulation: type C agents are assumed to write costless side-contracts in order to collect the money.

The second condition is whether compensation, of the amount agencies would earn without the bargain, will give them enough incentive to remain honest. Consider wages paid to induce a zero-corruption equilibrium, in a setting of positive externalities across agencies. Deviating away from zero corruption, given other agencies are charging zero, will bring a lower payoff than what would have been made in the equilibrium without compensation. This is because agencies benefit from other agencies' corruption. Since compensation is made based on potential deviation payoffs (see condition 11), and the deviation payoff is less than the agency's payoff without any compensation scheme, the wage bill will be less than or equal to the amount being extracted in the absence of the bargain. Given this, we know the bargain will be optimal.

However, if there are negative externalities across agencies, then deviation payoffs away from zero corruption will be higher than what would be earned in the absence of the bargain. This is because agencies benefit from others' lack of corruption. Thus the total required compensation is higher than what was being lost in the absence of the bargain. If the externalities are strong enough, the compensation bill is sufficiently higher than what was being lost, and full elimination of corruption will not be optimal.

As explained in sections 3.1 and 3.3, there are net negative externalities between agencies under bureaucratic decentralization ($M = 1$, $N > 1$), since they are extracting from a common pool. This led to higher corruption. It also leads to minimal elimination of corruption by compensation schemes, as we show now.

Proposition 7. *The fraction of corruption eliminated by an optimal compensation scheme goes to zero as the number of bureaucracies gets large.*

Proof. The basic idea of this proof is that the deviation payoffs get extremely large as N goes to infinity, making compensation less and less attractive.

First consider the case of $\gamma > 1/2$. Type C agents will choose c to maximize expression 13, which divided by MN equals

$$\Pi_C(c)/MN + \Pi_A(c)/MN - \Pi^*_{jk}(c). \tag{15}$$

[42]To be complete, we might want to include type B agents in the bargain. They would be willing to compensate type A agents to maintain *high* levels of corruption. However, nothing would change qualitatively, since there is a net inefficiency in the economy that could be bargained away. Quantitatively there would be some change; in particular, the $\Pi_B(c)$ term in expression 14 would be missing.

Note that for $c = c_{im}$,[43] this expression simply equals $\Pi_C(c_{im})/MN$, which is strictly positive. This is because c_{im} is a Nash equilibrium and thus the optimal payoff given others are playing c_{im}, $\Pi^*_{jk}(c_{im})$, is simply $\Pi_A(c_{im})/MN$. This corresponds to paying zero wages regardless of corruption and just allowing the agencies free rein. Also note that for N high enough, $c_{im} = NL/(N+1)$, as shown in the proof of proposition 5. Thus for any finite value of M and N, type C agents can ensure a positive payoff at $c_{im} < L$.

Next we show that for any $\hat{c} < L$, there exists a value $N_{\hat{c}}$ such that for $N \geq N_{\hat{c}}$ and $c \in [0, \hat{c}]$, payoff 15 is negative. Take some $\hat{c} < L$ and some c in $[0, \hat{c}]$. Consider objective function 15. Note that for any value of c, $\Pi_C(c) + \Pi_A(c)$ are bounded above by total output, $Y(c)$. Further, by proposition 2, $Y(c)$ is maximized at $c = 0$. Therefore showing $Y(0)/MN - \Pi^*_{jk}(c)$ is strictly negative for N large enough is sufficient for showing the same of 15. Clearly $Y(0)/MN$ goes to zero. We will show $\Pi^*_{jk}(c)$ is bounded below by a strictly positive number for any $c \in [0, \hat{c}]$ as $N \to \infty$.

Instead of finding $\Pi^*_{jk}(c)$ directly, we will find a c_{jk} that causes $\Pi_A(c_{jk}, c)$ to converge to some strictly positive number. Since $\Pi^*_{jk}(c)$ is the optimal payoff and thus $\Pi^*_{jk}(c) \geq \Pi_A(c_{jk}, c)$, it therefore cannot converge to anything non-positive, if it converges. Let c_{jk} be set according to

$$c_{jk} = \frac{N(L+c)}{2} - (N-1)c. \tag{16}$$

Note that this c_{jk} is positive, since $c < L$. It also ensures that c_j, the regional corruption level, equals $(L+c)/2$ regardless of N. Thus there is a constant wage corresponding to $(c_j, c_{-j}) = ((L+c)/2, c)$, independent of N, that should be used in evaluating $\Pi_A(c_{jk}, c)$. Using the payoff equation 8 of section 3.3, $\Pi_A(c_{jk}, c)$ can be written as

$$\begin{aligned} &\frac{\gamma}{MN}[\frac{N(L+c)}{2} - (N-1)c][1 - F(2w + \frac{L+c}{2})] \\ &\qquad + \frac{\alpha}{MN}\{[1 - F(2w)]E(y|y > 2w) + F(2w)w\}. \end{aligned} \tag{17}$$

The first line is rent income at (c_{jk}, c), while the second line is earned income at (c_{jk}, c). Note that as $N \to \infty$, the second line goes to zero since the wage is independent of N. The first line goes to

$$\frac{\gamma}{M}[\frac{L-c}{2}][1 - F(2w + \frac{L+c}{2})].$$

As long as $F[2w + (L+c)/2]$ is strictly less than 1, the whole expression is strictly positive, because $c < L$; this fact is easily verified.[44] Therefore, $\Pi_A(c_{jk}, c)$ approaches a strictly

[43] Recall that c_{im} is the equilibrium level of corruption in the absence of compensation, derived in section 3.3.

[44] There are three possible expressions for w: $\underline{w}$, $(y_{med} - \gamma\overline{c})/2$, and

$$\frac{y_{med} - (\gamma/M)\overline{y} - \gamma(M-1)c/M}{1 - \gamma/M}.$$

These correspond to areas D, A, and B described in the proof of proposition 5, respectively. One can check positive number as N gets large. This is sufficient for $\Pi^*_{jk}(c)$ to be bounded below by a strictly positive number as $N \to \infty$.

We have shown that for any $c \in [0, \hat{c}]$, a number N_c can be found that such that for $N \geq N_c$, payoff 15 is negative. In general, N_c varies with c in $[0, \hat{c}]$. But we are interested in a single value for N, call it $N_{\hat{c}}$, above which payoff 15 is negative for all c in $[0, \hat{c}]$. Consider payoff 17. Rent income is minimized at $c = \hat{c}$ for $N \geq 2$, since this minimizes both the fee and the number of entrepreneurs from whom it is collected. Earned income is minimized when $w = y_{med}/2$. Using these lower bounds in the payoff, it is clear that it still converges to a strictly positive number as N gets large. Thus there exists an $N_{\hat{c}}$ such that for $N \geq N_{\hat{c}}$, $Y(0)/MN$ minus this lower-bound payoff is strictly negative. Clearly this $N_{\hat{c}}$ also works for every c in $[0, \hat{c}]$, since payoff 17 is at least as great there.

Thus for any $\hat{c} < L$, there exists a value $N_{\hat{c}}$ such that for $N \geq N_{\hat{c}}$ and $c \in [0, \hat{c}]$, payoff 15 is negative. This fact means that for N large enough, no value in $[0, \hat{c}]$ can be optimal, since c_{im} yields a positive payoff. Now we know the optimal c is bounded above by L. This is because it is bounded above by c_{im},[45] and $c_{im} = NL/(N+1) < L$. But since we can rule out optimality of any c less than L, for N large enough, we know the optimal c is converging to L as $N \to \infty$. Since c_{im}, the equilibrium level without compensation is also converging to L, the fraction by which corruption is reduced by compensation must be going to zero.

The case of $\gamma \leq 1/2$ is proved with exactly analogous arguments to the above. The differences are that the deviation c_{jk} is set to

$$\frac{NL}{2(1-\gamma)} - (N-1)c$$

instead of as in equation 16; and the bound that both compensation and non-compensation equilibria both approach is $L/[2(1-\gamma)]$. ○

The intuition behind this result is that the stronger is the negative externality across agencies, that is the higher is N, the more deviation payoffs are increasing as corruption is reduced away from the non-compensation equilibrium level. Since compensation must take place based on potential deviation profits, it quickly becomes very costly to use wage incentives.

It is not difficult to imagine the same forces at work in the Becker-Stigler model. If we modify their model to one period, N officers have to be paid enough so that they are content

that at each of these expressions for the wage, $F[2w+(L+c)/2]$ is less than one. In fact, it equals $(L+c)/2L$,

$$1 - (\gamma - 1/2)(c/L) - \gamma(L-c)/2ML,$$

and

$$1 - \frac{(\gamma - 1/2)(c/L) - \gamma(L-c)/2ML}{1-\gamma/M},$$

respectively, which are all less than one because $c < L$ and $\gamma > 1/2$.

[45] It is clear that type C agents would never use wages to enforce a higher level of corruption than c_{im}, the level that would exist without compensation. This is because $\Pi_C(c)$ is decreasing in c, strictly so on $(0, L)$. Recall that $c_{im} \in (0, L)$. Also, positive wages may have to be paid to enforce a non-equilibrium level of corruption, as seen in incentive constraint 11, while zero wages are paid at c_{im}.

not to collect bribes worth amount b. If all N officers are paid this amount and there is no strategic interaction, then there will be zero corruption at a cost of Nb. However, imagine a scenario where each officer can collect bribes worth xb, with $x \in (1, N]$; for comparison, restrict the total bribes collected to equal Nb. This is a case of negative externalities, since the police officers have overlapping jurisdictions and the more others collect, the less remain for one. Now to enforce zero corruption, the compensation bill is xNb, since each officer must be paid enough xb. Clearly, the stronger the externality (that is, the higher is x), the greater the compensation bill must be. At some point, it may be more costly than allowing bribery.[46]

Thus strategic interaction can significantly affect the effectiveness and optimality of compensation schemes. In particular, in a setting of negative externalities across corrupt agents, compensation is more expensive and may be used extremely sparingly, to the point of eliminating very little corruption relative to the case where no efficiency wages are used.

Proposition 7 shows that the negative externalities associated with bureaucratic decentralization lead not only to high corruption levels without compensation, but also to the relative inability of compensation schemes to make a dent in the corruption levels. By contrast, regional decentralization leads to low levels of corruption without compensation and creates a climate in which compensation schemes can be very effective in reducing corruption. Although this is a static model, the results are suggestive on the topic of the persistence of corruption, also addressed by Tirole (1996). It appears that the clean get cleaner and the corrupt stay that way.

This idea also points to problems in empirical tests of the effectiveness of compensation schemes. First, the results are likely to be overstated, because it is the countries which are already less corrupt that can effectively use these schemes, while those with more corrupt structures cannot. Second, the policy implications are unclear. One cannot be sure that a compensation policy that worked in one environment will work in another. It may be that highly corrupt countries which make minimal use of wage incentives are making the optimal choice, given the structure of power.

4.2 Democratic Accountability

In this section, the type C population is assumed to be a majority and endowed with the power to vote out any agency they choose. We analyze how effective this electoral accountability is in reducing corruption in the same model analyzed in section 3.3. Voting sets up the unprotected population as a principal over those in power, who are then agents. Their choice is whether to abide by the electorally permissible level of corruption for a long tenure in office,

[46]Another simple example involves 5 children in a room with 5 candy canes that a parent prefers will remain there till the end of the party. If she does not compensate the children, they will take on average 1 candy cane each, and 5 candy canes are lost. But to ensure that all candy canes remain, each child must be promised 5 candy canes, for a net loss of 25 candy canes. This is because each child could take all the candy canes, given the others are not taking any; so each must be given 5. The common pool aspect makes compensation more costly. In the Becker/Stigler 1974 paper, it is as if each child is in separate rooms with 1 candy cane, since each one's payoff is independent of what anyone else does. Only 5 candy canes need be disbursed as compensation to retain all of them. (Of course in Becker/Stigler, there is imperfect observability, that is a probability the child will steal unobserved, and this will push up the compensation. This is not the focus here.)

or to deviate and face early removal from office. As with compensation schemes, electoral accountability is less effective the greater the degree of bureaucratic decentralization. But we find it cannot reduce corruption to zero no matter what the political organization.

Democratic accountability is modeled as follows. We assume that agencies commit to a given c at the beginning of the period. Production and rent-collection occur continously throughout the period. Partway through the period, a majority vote determines which agencies are removed from office. We assume $\gamma > 1/2$, so it is the type C agents who determine the vote. This assumption focuses our results on many less developed, fledgling democracies, where the recourse of citizens against misgovernance includes voting but few judicial remedies.

Any agency removed by the vote enjoys type B status thereafter. It is replaced by a randomly chosen equal measure of type B agents from the same region, with identical ability distribution. Thus the measure and ability distribution of all political types in each region are constant in the period. Under these assumptions, any shuffling of political status occurs between types A and B. Democracy yields type C agents no political mobility, just the power to distribute political power between others.[47] This is probably a good assumption for most developing countries, if not developed ones also, given high barriers to political entry. For simplicity, we assume that the newly empowered type B agents automatically carry on the corruption level committed to by the agency they replace.

In order to ensure enough type B agents in each region to replace any single agency removed from office, we make the following minor assumption:

$$(1 - \alpha - \gamma)/M \geq \alpha/MN.$$

The left side is the measure of type B agents in a given region. The right side is the measure of a single type A agency.[48] As in section 4.1, it is also assumed that type C agents can side contract. Thus they will maximize group income. This is merely a simplifying assumption, because they have unanimous preferences over symmetric corruption outcomes. In particular, they want the level of corruption to be minimized. A higher corruption level lowers wages, as shown in proposition 1. It also lowers type C profit income $y - w - c$: although the wage is decreasing in c, the absolute value of its slope is at most $\gamma/2$. Since a higher c lowers (at least weakly) the payoffs of every type C occupation, they will coordinate their voting strategy to minimize corruption.

The voting is assumed to take place after some fraction $\nu \in (0, 1)$ of the period has elapsed. Thus an agency is guaranteed some time in power before a vote determines its remaining existence as type A or B. Let p be the agency jk's probability of being voted out of power. Then the agency's payoff can be written as[49]

$$\nu\Pi_{jk|A}(c_{jk}, c_{-jk}) + (1 - \nu)[p\Pi_{jk|A}(c_{jk}, c_{-jk}) + (1 - p)\Pi_{jk|B}(c_{jk}, c_{-jk})]. \tag{18}$$

[47] We also assume there is no way to enforce contracts between type B and C agents. Thus the latter cannot directly profit from enabling agents of type B to ascend to power.

[48] Since the type C agents will implement a Nash equilibrium and thus are only concerned with a unilateral deviation, we only need enough type B agents to replace one agency rather than all agencies. In particular, the voting strategy of type C is free not to punish agencies in the case of multiple deviations from prescribed behavior.

[49] We now subscript the payoff to agency jk with A or B also, to distinguish from the payoff of the same group of agents, given corruption levels, when they exist as type A or B agents.

Here $\Pi_{jk|A}(c_{jk}, c_{-jk})$ is the payoff to the agency when in power and charging c_{jk} while all others charge c_{-jk}, and $\Pi_{jk|B}(c_{jk}, c_{-jk})$ is the agency's payoff if they exist as type B in region j and agencies are charging (c_{jk}, c_{-jk}). Thus $\Pi_{jk|B}(c_{jk}, c_{-jk})$ contains exactly the same earned income as $\Pi_{jk|A}(c_{jk}, c_{-jk})$, but none of the rent income. Note that in the absence of voting, that is when $p \equiv 1$, the payoff function reduces to that of section 3.[50] With voting, the agency takes into account its corruption on the probability of staying in office and being able to charge rents for a longer length of time.[51]

The unprotected class will use their electoral power to minimize the equilibrium level of corruption.[52] They do this by choosing a voting strategy from the space of all functions $p : [0, \infty)^{MN} \longrightarrow [0, 1]^{MN}$. These functions take the corruption level of every agency into probabilities of staying in power for each agency. Assume for the moment the unprotected class wants to implement (symmetric) corruption level $\hat{c}$. A necessary and sufficient condition for this to be possible is the following incentive constraint, $\forall j, k, c_{jk} \neq \hat{c}$:

$$\begin{aligned} &\nu\Pi_{jk|A}(\hat{c}, \hat{c}) + (1-\nu)\{p_{jk}(\hat{c}, \hat{c},)\Pi_{jk|A}(\hat{c}, \hat{c}) + [1 - p_{jk}(\hat{c}, \hat{c})]\Pi_{jk|B}(c_{jk}, \hat{c})\} \geq \\ &\quad \nu\Pi_{jk|A}(c_{jk}, \hat{c}) + (1-\nu)\{p_{jk}(c_{jk}, \hat{c})\Pi_{jk|A}(c_{jk}, \hat{c}) + [1 - p_{jk}(c_{jk}, \hat{c})]\Pi_{jk|B}(c_{jk}, \hat{c})\}. \end{aligned} \tag{19}$$

Note that both sides of 19 are decreasing in $p_{jk}(c, \hat{c})$. This is because $\Pi_{jk|A}(c, \hat{c}) \geq \Pi_{jk|B}(c, \hat{c})$; the former contains rent and earned income at $(c, \hat{c})$, while the latter contains only the earned income. Thus it must be an optimal strategy for the unprotected class to set $p_{jk}(c_{jk}, \hat{c}) = 0$ for $c_{jk} \neq \hat{c}$, and $p_{jk}(\hat{c}, \hat{c}) = 1$. This maximizes the left-hand side and minimizes the right-hand side, with respect to voting strategy. It fully rewards agencies that charge $\hat{c}$, by keeping them in office, and fully punishes agencies that deviate from $\hat{c}$, by removing them with probability one. These implications give rise to a simplified incentive constraint:

$$\Pi_{jk|A}(\hat{c}, \hat{c}) \geq \nu\Pi_{jk|A}(c_{jk}, \hat{c}) + (1-\nu)\Pi_{jk|B}(c_{jk}, \hat{c}), \ \forall j, k, c_{jk} \neq \hat{c}, \tag{20}$$

which is a necessary and sufficient condition for $\hat{c}$ to be an equilibrium.

Since the unprotected class aims to minimize the corruption level, the equilibrium[53] is simply the minimum $\hat{c}$ that satisfies constraint 20. Constraint 20 depicts those in power deciding whether to charge the electorally permissible level of corruption and enjoy type A payoffs for the whole period or to charge whatever they want and face removal from office prematurely. Type C's ability to punish is restricted to removal from office; punishments like confiscation of earnings or imprisonment are not considered. In this sense, the effects of *electoral accountability* on reducing corruption are isolated from other judicial system improvements and analyzed.

[50] Note that this is basically equivalent to a dynamic model with discounting in which a vote occurs at the end of each period to determine which agencies remain in office into the next period. Though cleaner, the dynamic model introduces a whole range of new equilibria not present in the static model, even without voting. Only if agencies are assumed to have no memory in the dynamic model are the models without voting comparable. Thus we analyze a stylized, static version which is identical to that of section 3 when voting is shut down.

[51] The model is also equivalent to one in which type C agents have the power costlessly to destroy (but not steal) some fraction of agencies' rent income if they desire.

[52] As in section 4.1, we assume they are content to implement the level of corruption as a Nash equilibrium.

[53] Attention continues to be restricted to symmetric equilibria.

What can be said about the minimum level of corruption that can be obtained with electoral accountability? Not surprisingly, it is below the equilibrium level that would occur in the absence of voting, denoted c_{im} as in section 3.3. This is because the threat of being removed from office at $\hat{c} = c_{im}$ is potent. Agencies cannot gain by a deviation, since c_{im} is a Nash equilibrium; on the other hand, removal from office leads to a strict loss since they were earning positive rent income. Thus they strictly prefer to stay in office at $\hat{c} = c_{im}$. Given continuity of all payoff functions, $\hat{c}$ can thus be lowered below c_{im} with the incentive constraint 20 still holding.

On the other hand, corruption cannot be reduced to zero. If it were, then the threat of being removed from office would be empty, since no one collects rents whether in or out of power. In other words, type A and type B incomes are equal when $\hat{c} = 0$. With no effective electoral threat against them, any group in power would deviate from zero corruption and earn strictly positive rents in the current period. Thus zero corruption cannot be an equilibrium in this democracy. A proof of these results follows.

Proposition 8. *Democracy reduces the minimum symmetric equilibrium corruption level, but not to zero.*

Proof. First we will show that there is a $\hat{c}$ strictly below the minimum corruption Nash equilibrium from Proposition 3.3 (c_{im}) such that all charging $\hat{c}$ is an equilibrium. As argued above, a symmetric equilibrium where all stay in office and charge $\hat{c}$ exists if and only if:

$$\Pi_{jk|A}(\hat{c}, \hat{c}) \geq \nu \Pi_{jk|A}(c_{jk}, \hat{c}) + (1 - \nu)\Pi_{jk|B}(c_{jk}, \hat{c}), \ \forall j, k, c_{jk} \neq \hat{c}.$$

Consider $\hat{c} = c_{im}$ and some j, k, and $c_{jk} \neq c_{im}$. Since c_{im} is a Nash equilibrium and c_{im} is the unique best response, as is seen in the proof of proposition 3.3,

$$\Pi_{jk|A}(c_{im}, c_{im}) > \Pi_{jk|A}(c_{jk}, c_{im}).$$

Further, type A payoffs at a given corruption level are at least as great as type B payoffs. This is because the earned components of A and B incomes are always equal for a given c, while the rent component is zero for type B and at least zero for type A. Thus

$$\Pi_{jk|A}(c_{jk}, c_{im}) \geq \nu \Pi_{jk|A}(c_{jk}, c_{im}) + (1 - \nu)\Pi_{jk|B}(c_{im}, c_{im}).$$

Combining these two inequalities gives:

$$\Pi_{jk|A}(c_{im}, c_{im}) > \nu \Pi_{jk|A}(c_{jk}, c_{im}) + (1 - \nu)\Pi_{jk|B}(c_{jk}, c_{im}).$$

Since all functions in this incentive constraint are continuous in all variables, it will continue to hold with weak inequality for some $\hat{c} < c_{im}$. The choice of j, k, and c_{jk} was arbitrary, so we have shown that the incentive constraint always holds for some $\hat{c} < c_{im}$.[54] This proves the first part.

[54] Actually a possibly different $\hat{c}$ was defined for each c_{jk}. However, given continuity and the effective compactness of the choice set for c_{jk}, as is argued in section 4.1, a maximum of these $\hat{c}$'s is sure to exist.

Second, we show that there exists a c_{jk} such that for $\hat{c} = 0$, the incentive constraint 20 cannot be satisfied. Take any j, k, and $c_{jk} \in (0, L)$. Then the incentive constraint cannot be satisfied, that is:

$$\Pi_{jk|A}(0,0) < \nu\Pi_{jk|A}(c_{jk}, 0) + (1-\nu)\Pi_{jk|B}(c_{jk}, 0). \tag{21}$$

This comes from a few observations. First, note that $\Pi_{jk|A}(0,0) < \Pi_{jk|B}(c_{jk}, 0)$. This is because there is no rent income in either expression, and the earned income is higher in the B payoff, since corruption is higher and thus by proposition 1 the wage is lower. Second, $\Pi_{jk|A}(0,0) < \Pi_{jk|A}(c_{jk}, 0)$. This is because there is no rent income when c_{jk} equals zero, and positive rents at $c_{jk} \in (0, L)$; and earned income is higher at c_{jk} since the wage is lower. These two facts together give inequality 21, which proves that $\hat{c} = 0$ cannot be an equilibrium. ◯

Proposition 8 shows in general terms that electoral accountability reduces corruption, but in a limited way. Next we show just how limited it can be when accompanied by high degrees of bureaucratic decentralization.[55] In fact, the amount by which corruption is reduced approaches zero as N gets large, just as in the case of wage compensation.

Proposition 9. *When $\gamma > 1/2$, the fraction of corruption eliminated by democracy goes to zero as the number of bureaucracies gets large.*

Proof. The basic idea of this proof is that the profit from deviation from the democratic equilibrium level of corruption as N gets large overwhelms the payoff of staying in office. The proof is very similar to the proof of proposition 7. First we will show that for arbitrary $\hat{c} < L$ and any $c \in [0, \hat{c}]$, if N is large enough, there exists a c_{jk} such that

$$\Pi_{jk|A}(c,c) < \nu\Pi_{jk|A}(c_{jk}, c) + (1-\nu)\Pi_{jk|B}(c_{jk}, c). \tag{22}$$

This inequality ensures there is no democratic equilibrium at c.

The left side of 22 simply equals $\Pi_A(c)/MN$, which is the total earnings of type A agents at $\hat{c}$ divided by the number of agencies. Note this is maximized when c is the solution to the centralized case of $N = M = 1$ derived in the solution of proposition 5. Call this value of c, c^*. Thus if we can show the inequality

$$\Pi_A(c^*)/MN < \nu\Pi_{jk|A}(c_{jk}, c) + (1-\nu)\Pi_{jk|B}(c_{jk}, c), \tag{23}$$

holds, then inequality 22 follows. Clearly the left side of this goes to zero as N gets large. If the right side converges to a strictly positive number as N gets large, the result is obtained for c.

Let $\hat{c} < L$ be given, and consider some c in $[0, \hat{c}]$. We will show that when c_{jk} is set according to equation 16 of from the proof of proposition 7, there exists a finite N above which inequality 23 holds for c. As noted in the proof of proposition 7, this c_{jk} is positive and ensures that c_j, the regional corruption level, equals $(c + L)/2$ regardless of N. Thus

[55] Recall that the definition of bureaucratization in this paper focuses on how many independently operating bribe-demanders businessmen must pay to operate a business.

there is a constant wage corresponding to $(c_j, c_{-j}) = ((L+c)/2, c)$, independent of N, that should be used in evaluating the right side of inequality 23 at this c_{jk}. Modifying the payoff equation 8 of section 3.3, the right side of inequality 23 can be written as

$$\begin{aligned} \nu \frac{\gamma}{MN}[\frac{N(L+c)}{2} - (N-1)c][1 - F(2w + \frac{L+c}{2})] \\ + \frac{\alpha}{MN}\{[1-F(2w)]E(y|y>2w) + F(2w)w\}. \end{aligned} \tag{24}$$

The first line is rent income at (c_{jk}, c), collected for a fraction ν of the period. The second line is earned income at (c_{jk}, c), which is enjoyed for the whole period, since earned incomes of types A and B are equal. Note that as $N \to \infty$, the second line goes to zero since the wage is independent of N. The first line goes to

$$\nu \frac{\gamma}{M}[\frac{L-c}{2}][1 - F(2w + \frac{L+c}{2})].$$

As long as $F[2w + (L+c)/2]$ is strictly less than 1, the whole expression is strictly positive, because $\hat{c} \leq c < L$; this fact is easily verified, as noted in the proof of proposition 7. Therefore, the right side of inequality 23 approaches a strictly positive number as N gets large.

Since the left side of inequality 23 is approaching zero and the right side something strictly positive, there exists a finite value N_c, such that for $N \geq N_c$, inequality 23 is satisfied for c and the c_{jk} described. In general, N_c varies with c in $[0, \hat{c}]$. But we are interested in a single value for N, call it $N_{\hat{c}}$, above which inequality 23 holds for all c in $[0, \hat{c}]$. Consider payoff 24. Rent income is minimized at $c = \hat{c}$ for $N \geq 2$, since this minimizes both the fee and the number of entrepreneurs from whom it is collected. Earned income is minimized when $w = y_{med}/2$. Using these lower bounds in the payoff, it is clear that it still converges to a strictly positive number as N gets large. Thus there exists an $N_{\hat{c}}$ such that for $N \geq N_{\hat{c}}$, $Y(0)/MN$ minus this lower-bound payoff is strictly negative. Clearly this $N_{\hat{c}}$ also works for every c in $[0, \hat{c}]$, since payoff 17 is at least as great there.

We have shown that for any value of $\hat{c} < L$, there exists a finite value of N, above which a c_{jk} can be found to satisfy inequality 23 for any $c \in [0, \hat{c}]$. We also know that for every value of N, there exists a democratic equilibrium below L. This is from the fact that the equilibrium without voting is $NL/(N+1)$, from the proof of proposition 5; and that there is always an equilibrium below the non-voting equilibrium, by proposition 8. Thus the minimum equilibrium c with voting is less than L, but can be made arbitrarily close to L by choosing N high enough. In short, it converges to L. Since the equilibrium c without voting, $NL/(N+1)$, is also approaching L, this means the fraction of corruption eliminated is approaching zero. ◯

The intuition of this result is as follows. Democracy attempts to enforce that only a given fraction of equilibrium rents is extracted, say q, while keeping 1-q of the equilibrium rents intact. As N increases, q is divided among more and more groups, while the 1-q which is off limits to these groups remains fixed in size. Since any one group can claim all of the 1-q by deviating, the temptation to deviate becomes overwhelming for N high enough.[56]

[56] The same analogy does not hold for regional decentralization, because groups do not have access to the same rent opportunities.

This proposition offers an explanation for the limited effect democracy in Russia has on reducing corruption compared to the non-democratic China. It shows that democracy can be extremely ineffective the more power is split between groups within a region that have some discretionary power over firms. In fact, a sufficiently bureaucratized, democratic country will experience higher corruption than a completely centralized, non-democratic one. In the latter case, corruption is at most $L/(2\gamma)$, while in the former it approaches L.

The model suggests that democracy is probably reducing corruption in Russia from what would otherwise be higher levels given the same structure of power.[57] But it may not be significantly reducing it. This is because the voting populace must leave the government incentives to mitigate their corruption by ensuring them some rents in office. The more groups there are with overlapping jurisdiction, the more rents must be allowed. This could also help explain why democracy is an imperfect predictor of lack of corruption in general. India too is an example of a high-corruption, heavily bureaucratized democracy, while Singapore is an example of a centralized state with less corruption.

5 Conclusion

This model takes as fundamental the distribution of property rights over productive activity, and the organizational structure of the owners of these rights. It uses these to determine the economy-wide corruption level. It proceeds to take the derived corruption level and examine its implications for aggregate variables such as wages, output, and inequality. Thus there are two links: political organization to corruption levels, and corruption levels to economic aggregates. Combining the two, we are able to examine the effect of given political structures on economic activity through their influence on corruption.

In particular, we find that under limited mobility assumptions, regional decentralization should be associated with higher wages, output, entrepreneurship, while bureaucratic decentralization should cause the opposite. In addition, bureaucratic decentralization is a more resistant structure to attempts to reduce corruption, such as compensation schemes and electoral accountability; the converse is true of regional decentralization.

All of these results are conditional on a given level of protection offered by the judicial system to the average citizen (captured in α and γ). By protecting citizens in their operation of businesses from extortion or the need to pay bribes, the legal system can be the key factor in eliminating corruption.

These predictions can be taken to data. The empirical work that has been done so far seems broadly to confirm our results. The link of lower corruption to regional decentralization and the inverted-U relationship of corruption with inequality are the empirical findings in the literature which most strikingly match the model. Findings on compensation that higher bureaucratic wages go with lower corruption also agree with our model. However, we find the relationship depends crucially on the strategic interaction between the corrupt groups, leading to potential endogeneity problems and difficulty in interpreting results.

[57] We are not comparing pre- and post-Soviet Russia here. With the change in 1991, both decentralization and democracy increased. Rather, we are comparing post-Soviet Russia to what it might be without democracy.

The model suggests that what is most vital for reducing corruption is that the structure of power changes to decrease the number of independent bureaucracies[58] firms have to deal. This will both reduce corruption and making methods of dealing with corruption more effective. Similarly, increasing the number of independent non-overlapping jurisdictions (regions), even if there is imperfect mobility between them, will both reduce corruption and make anti-corruption efforts more productive.

[58] We mean here bureaucracies that have sufficiently arbitrary regulatory power or that operate in a setting of weak rule of law.

A Proof of Proposition 3.

First assume $\gamma > 1/2$ and $N > 1$, and consider region j. Because the wage as a function of c_j[59] is differentiable only piecewise, two regions of non-negative (c_{jk}, c_{-jk}) space[60] must be considered separately. The first is where c_{jk} satisfies

$$c_{jk} \leq NL/(2\gamma) - (N-1)c_{-jk}. \tag{25}$$

Call this area A. If c_{jk} is in A, then $c_j \leq L/(2\gamma)$ and thus $w = (y_{med} - \gamma c_j)/2$, as shown in the proof of proposition 2. Using this wage and the uniform distribution[61] in equation 6, we have:

$$\begin{aligned} MN\Pi_{jk}(c_{jk}, c_{-jk}) &= \gamma c_{jk} \frac{[\overline{y} - (y_{med} - \gamma c_j + c_j)]}{L} \\ &+ \alpha\{\frac{[\overline{y} - (y_{med} - \gamma c_j)]}{L}\overline{y}/2 + \frac{y_{med} - \gamma c_j - \underline{y}}{L}(y_{med} - \gamma c_j)/2\}. \end{aligned} \tag{26}$$

Differentiation of 26 gives that the A-restricted best response function equals

$$c_A^*(c_{-jk}) = \frac{NL/2 - c_{-jk}(N-1)(1 - \gamma - \frac{\alpha\gamma}{N})}{2(1-\gamma) - \frac{\alpha\gamma}{N}}, \tag{27}$$

whenever $c_A^*(c_{-jk})$ is in A. If $c_A^*(c_{-jk})$ exceeds the upper boundary of A described in 25, then the A-restricted best response $c_A^*(c_{-jk})$ is just equal to this boundary. This is because the payoff function 26 is quadratic in c_{jk}, and thus is increasing up to the boundary whenever the calculated best response exceeds the boundary. The symmetric equilibrium using 27, call it $c_{nm,A}$, is then

$$c_{nm,A} = \frac{L}{2[1 - \gamma + \frac{1-\gamma-\alpha\gamma}{N}]}. \tag{28}$$

The symmetric equilibrium corresponding to the best response on the boundary 25 is clearly $L/(2\gamma)$.

If $c_{jk} \geq NL/(2\gamma) - (N-1)c_{-jk}$, we will say it is in area B. Note that B and A would partition non-negative (c_{jk}, c_{-jk}) space if they did not share the common boundary described by 25 at equality. In B, $c_j \geq L/(2\gamma)$ and from proposition 2 we know that $w = \underline{w}$. Using this fact in the payoff equation 6 of agency jk,[62] we find that the best response is

$$c_B^*(c_{-jk}) = \frac{NL - c_{-jk}(N-1)}{2}, \tag{29}$$

which holds if two conditions are met. The first is that $c_B^*(c_{-jk})$ exceeds the boundary common to A and B so that $c_j \geq L/(2\gamma)$. If this does not hold, the best response c_B^* is

[59]Recall $c_j \equiv 1/N \sum_{k=1}^{N} c_{jk}$. Thus c_j is the total fees that must be paid by a type C entrepreneur in region j.

[60]Fees are assumed non-negative. We will picture c_{jk} as on the vertical axis and c_{-jk} as on the horizontal axis in the following discussion.

[61]Specifically, $F(x) = \max\{\min\{(x - \underline{y})/L, 1\}, 0\}$, where $L \equiv \overline{y} - \underline{y}$.

[62]Recall that $\underline{y}$ is assumed equal to $2\underline{w}$.

just equal to the boundary $NL/(2\gamma) - (N-1)c_{-jk}$, for the same reason as above. The second is that $c^*_B(c_{-jk}) \geq 0$. One can check that the violation of this condition means that $c_{-jk} > NL/(N-1)$ and thus $c_j > L$ no matter what agency jk does; and since it can change nothing by its fee, assumption 1 puts the best response at zero. The symmetric equilibrium using 29, call it $c_{nm,B}$, is

$$c_{nm,B} = \frac{NL}{N+1}. \tag{30}$$

As above, the symmetric equilibrium corresponding to the common boundary is $L/(2\gamma)$. There is no symmetric equilibrium when the best response is zero, since $c_{jk} = 0$ and $c_{-jk} \geq NL/(N-1) > 0$.

It can be checked that if and only if $N < (1-\gamma-\alpha\gamma)/(2\gamma-1) \equiv N_1$, $c_{nm,A}$ does not exceed $L/(2\gamma)$, which is necessary for $c_{nm,A}$ to be an equilibrium. Similarly, if and only if $N \geq 1/(2\gamma-1) \equiv N_2$, $c_{nm,B}$ is no less than $L/(2\gamma)$, which is necessary for $c_{nm,B}$ to be an equilibrium. Thus there are three regions of N to consider, since $N_1 < N_2$.

Take $N \leq N_1$ first. In this case, the two candidates for a symmetric equilibrium are $c_{nm,A}$ and $L/(2\gamma)$; $c_{nm,B}$ is ruled out because $N < N_2$. To check that $c_{nm,A}$ is an equilibrium, we must check that a deviation to region B is not a strict improvement; by construction, a deviation within A is not optimal. Sufficient for this is that the B-restricted best response is on the common boundary of A and B. If this is the case, then the agency cannot improve by deviating to B, since the common boundary is already accounted for in the A-restricted best response. Now we argue that the B-restricted best response to $c_{nm,A}$ must be on the common boundary. If it were above, then it would also be above the 45-degree line, since the A-restricted best response is at the 45-degree line and not above the boundary. Notice from equation 29 that the slope of the B-restricted best response function is greater than that of the boundary, and both slopes are negative. Thus the B-restricted best response would be above the boundary at $c_{nm,A}$ and when it crosses the 45-degree line, since its slope is negative but no less than that of the boundary. But this is impossible because $N < N_2$ implies the B-restricted best response crosses the 45-degree line at the boundary. Thus $c_{nm,A}$ is an equilibrium.

The second candidate $L/(2\gamma)$ is clearly an equilibrium if it equals $c_{nm,A}$, which happens when $N = N_1$. But we argue that if $c_{nm,A} < L/(2\gamma)$, then $L/(2\gamma)$ cannot be an equilibrium. This is because the A-restricted best response to $c_{nm,A}$, which is $c_{nm,A}$, is strictly below $L/(2\gamma)$; and since it is decreasing, the A-restricted best response to $L/(2\gamma)$ is also strictly below $L/(2\gamma)$. Now A includes the possibility of responding $L/(2\gamma)$ to $L/(2\gamma)$; this is exactly on the boundary. But as we have argued, the A-restricted best response is below $L/(2\gamma)$, proving that a deviation would make the agency better off. Thus for $N \leq N_1$, the unique symmetric equilibrium is $c_{nm,A}$.

Next consider $N \geq N_2$. In this case, the two candidates for a symmetric equilibrium are $c_{nm,B}$ and $L/(2\gamma)$; $c_{nm,A}$ is ruled out because $N > N_1$. An exactly analogous argument to the one used above where $N \leq N_1$ proves that the unique symmetric equilibrium in this case is $c_{nm,B}$.

Finally consider $N_1 < N < N_2$. The only candidate for a symmetric equilibrium is $L/(2\gamma)$. Arguments used above show that for N in this range, at $L/(2\gamma)$ both restricted best responses are on the boundary. This confirms that $L/(2\gamma)$ is indeed the unique symmetric equilibrium here.

What we have shown is that that for $N > 1$ and $\gamma > 1/2$, the unique symmetric level of corruption under no mobility, call it c_{nm}, is:

$$c_{nm} = \begin{cases} \frac{L}{2[1-\gamma+\frac{1-\gamma-\alpha\gamma}{N}]} & , \quad N \leq \frac{1-\gamma-\alpha\gamma}{2\gamma-1} \\ \frac{L}{2\gamma} & , \quad \frac{1-\gamma-\alpha\gamma}{2\gamma-1} \leq N \leq \frac{1}{2\gamma-1} \\ \frac{NL}{N+1} & , \quad \frac{1}{2\gamma-1} \leq N \end{cases}$$

Solving for the equilibrium level of corruption when $N = 1$, that is under centralization, involves a well-behaved maximization problem, complicated only slightly by the kinked wage function. It turns out that the equilibrium level of corruption under centralization is the same as that given by the above expressions evaluated at $N = 1$. Thus, these are the unique symmetric corruption levels when $\gamma > 1/2$. Since we considered an arbitrary region j, this is the equilibrium in all regions.

By inspection, c_{nm} is continuous in N and strictly increasing everywhere except in the intermediate range for N, where it is constant. Also, c_{nm} is independent of M.

The case of $\gamma \leq 1/2$ is similar to the above except that the wage can never reach the lower bound of $\underline{w}$ if the inequality is strict. Consider region j and $N > 1$. Now the two regions of non-negative (c_{jk}, c_{-jk}) space that must be considered are where c_{jk} satisfies

$$c_{jk} \leq NL/[2(1-\gamma)] - (N-1)c_{-jk} \tag{31}$$

and where reverse weak inequality holds. Call these areas A and B, as above. A and B would partition non-negative (c_{jk}, c_{-jk}) space if they did not contain the common boundary $c_{jk} = NL/[2(1-\gamma)] - (N-1)c_{-jk}$.

If c_{jk} is in B, then the wage is constant at $(y_{med} - \gamma\overline{y})/[2(1-\gamma)]$, and there are no rents collected by type A agents, since all type C agents are workers (as shown in the proof of proposition 2). Thus the agency earns equal profits with any fee in area B, for a given c_{-jk}; assumption 1 puts the B-restricted best response on the boundary then. Since the boundary is also contained in A, we need only be concerned with the A-restricted best response.[63]

If c_{jk} is in A, then $c_j \leq L/[2(1-\gamma)]$ and thus $w = (y_{med} - \gamma c_j)/2$, as shown in the proof of proposition 2. This gives the same payoff as in equation 26, the same best response as in equation 27, and the same potential symmetric equilibrium as in equation 28, $c_{nm,A}$. One can check that for any value of N, $c_{nm,A} < L/[2(1-\gamma)]$. Thus $c_{nm,A}$ is always a Nash equilibrium in A-restricted best responses. This, as argued above, is sufficient for it to be a Nash equilibrium. It is also clear that the boundary $L/[2(1-\gamma)]$ cannot be an equilibrium. This can be seen because the best response to $c_{nm,A}$, which is $c_{nm,A}$, is strictly below $L/[2(1-\gamma)]$; and since the best response is decreasing, the best response to $L/[2(1-\gamma)]$ is also strictly below $L/[2(1-\gamma)]$. Thus it is not an equilibrium.

We have thus shown that for $\gamma \leq 1/2$ and $N > 1$, the unique symmetric equilibrium

[63] Actually, B also has an unshared lower boundary at zero, when $c_{-jk} > NL/[2(N-1)(1-\gamma)]$. When c_{-jk} exceeds this limit, agency jk can change nothing by its fee, so its best response is zero, by assumption 1. There clearly cannot be a symmetric equilibrium here, since $c_{-jk} > 0$.

corruption level satisfies

$$c_{nm} = \frac{L}{2[1-\gamma+\frac{1-\gamma-\alpha\gamma}{N}]}.$$

Substituting $N = 1$ coincides with the corruption level obtained from the optimization problem describing the centralized case. Thus this expression captures every value of $N \geq 1$. Clearly this is increasing in N and independent of M. ○

B Proof of Proposition 4.

When $M = 1$, the analysis is exactly the same as in the proof of proposition 3. In particular, some positive level of corruption results. We will show that for $M \geq 2$, $c = 0$ is the only equilibrium.

Let c be a symmetric equilibrium. A Bertrand-style argument all but pins c down at zero. If it were above zero, one agency could lower its fee infinitesimally and attract all type C entrepreneurs to its region. Instead of splitting rents corresponding to c among MN agencies, rents corresponding to $c - \epsilon$ would be split among N agencies. In particular, if $\Pi_{A,r}(c)$ is total rent income and $\Pi_{A,e}(c)$ is total earned income of type A agents for a corruption level of c, then the deviating agency's profits would go from $[\Pi_{A,r}(c) + \Pi_{A,e}(c)]/MN$ to

$$\Pi_{A,r}(c-\epsilon)\frac{c/N-\epsilon}{c-\epsilon} + \Pi_{A,e}(c-\epsilon),$$

which approaches $\Pi_{A,r}(c)/N + \Pi_{A,e}(c)/MN$ as $\epsilon \to 0$. Since $\Pi_{A,r}(c)$ and $\Pi_{A,e}(c)$ are continuous in c, profits for the deviating agency will certainly increase if ϵ is small enough, $M \geq 2$, and $\Pi_{A,r}(c) > 0$.

If, however, $\Pi_{A,r}(c) = 0$, this argument does not work, but the result remains true. Consider two cases. If $\gamma > 1/2$ and $\Pi_{A,r}(c) = 0$, then it must be true that $c \geq L$, as is evident from the proof of proposition 2. But any agency can lower its fee some positive amount without affecting the wage, since $w = \underline{w}$ for any $c \geq L/(2\gamma)$ and $L/(2\gamma) < L$. If the wage is not affected, neither is $\Pi_{A,e}(c)$, which depends on c only through the wage. Rent income $\Pi_{A,r}(c)$ cannot decrease below zero. Thus there is a decrease in c that leaves the agency no worse off in terms of profits. By assumption 1, this deviation is preferred.

If $\gamma \leq 1/2$, rent income hits zero and the wage reaches its lower bound simultaneously when $c = L/[2(1-\gamma)]$. Clearly any c strictly above this value cannot be an equilibrium, by assumption 1, since there exists a deviation downward that leaves income unchanged. Thus the only candidate for an equilibrium is $c = L/[2(1-\gamma)]$. This is not ruled out by previous arguments because any deviation down will increase the wage, thus decreasing earned income; but rent income increases. We will directly check that if an agency reduces its fee by $\epsilon > 0$ from this equilibrium, the second effect dominates. Modifying equations 6 and 26 to reflect the fact that rents will be shared only with N agencies rather than MN, one can calculate the payoff to the deviating agency as

$$[\frac{L}{2(1-\gamma)N} - \epsilon]\gamma\frac{(1-\gamma)\epsilon}{L} + \frac{\alpha}{2MN}[\frac{\overline{y}+y_{med}}{2} + \frac{\gamma^2 c^2}{L}], \tag{32}$$

where $c = L/[2(1-\gamma)] - \epsilon$. Taking the derivative with respect to ϵ at $\epsilon = 0$ gives

$$\frac{\gamma}{2MN}[M - \frac{\alpha\gamma}{1-\gamma}],$$

which is positive because $\alpha\gamma < 1-\gamma$. Thus there exists a deviation downward that would increase payoffs. ○

C Proof of Proposition 5.

We first consider the case where $M \geq 2$ and $\gamma > 1/2$.

The first step is to partition non-negative (c_{jk}, c_{-jk}) space[64] into areas over which the wage is differentiable in c_{jk}. It turns out there are four such areas. Equating labor supply and labor demand under the assumption that there are no subsistors gives:[65]

$$\begin{aligned}\frac{\gamma}{M}\sum_{j=1}^{M} F(2w+c_j) + \frac{1-\gamma}{M}\sum_{j=1}^{M} F(2w) = \\ \frac{\gamma}{M}\sum_{j=1}^{M}[1-F(2w+c_j)] + \frac{1-\gamma}{M}\sum_{j=1}^{M}[1-F(2w)].\end{aligned} \tag{33}$$

This equation produces a unique wage, and if and only if this wage is less than $\underline{w}$, there will be subsistors in equilibrium. We will first focus on the case where this equation holds and produces $w \geq \underline{w}$.

Using the uniform distribution and our knowledge from the proof of proposition 1 that $w \in [\underline{w}, y_{med}/2]$, equation 33 simplifies to

$$\frac{\gamma}{M}\sum_{j=1}^{M}\frac{\min\{2w-\underline{y}+c_j, L\}}{L} + \frac{(1-\gamma)(2w-\underline{y})}{L} = \frac{1}{2}. \tag{34}$$

The discontinuity of the uniform distribution leads to several cases, depending on which regions satisfy the inequality

$$2w - \underline{y} + c_j \leq L. \tag{35}$$

Fix region j and agency jk. Now it may be that both c_j and c_{-j} satisfy 35, or that one does and not the other.[66] These three cases give rise to three areas of non-negative (c_{jk}, c_{-jk}) space.

[64] Fees are assumed non-negative. We will refer to c_{-jk} as on the horizontal axis and c_{jk} as on the vertical in this proof.

[65] Recall that c_j is the total fees that must be paid in region j; $c_j = \sum_{k=1}^{N} c_{jk}$.

[66] If neither satisfy 35, there is no way to make equation 34 hold unless $w < \underline{w}$. But we are considering the case where the equation produces $w \geq \underline{w}$.

A, where both c_j and c_{-j} satisfy 35, is described by the inequalities

$$c_{jk} \leq \frac{MNL}{2(M-\gamma)} + c_{-jk}[1 - \frac{MN(1-\gamma)}{M-\gamma}], \tag{36}$$

$$c_{jk} \leq \frac{MNL}{2\gamma} - c_{-jk}(MN-1), \tag{37}$$

and

$$c_{jk} \geq [\frac{MN}{\gamma} - (MN-1)]c_{-jk} - \frac{MNL}{2\gamma}. \tag{38}$$

In A, the wage equals $(y_{med} - \gamma\overline{c})/2$, where $\overline{c} \equiv c_{jk}/MN + c_{-jk}(MN-1)/MN$ is just the average of agencies' choices.

Area B is where c_j does not satisfy 35 while c_{-j} does. This area is defined by the inequality identical to 36, except with the weak inequality reversed, and by

$$c_{-jk} \leq \frac{L}{2\gamma}\frac{M-2\gamma}{M-1}. \tag{39}$$

In B, there are no type C entrepreneurs in region j, and the wage is unresponsive to changes in c_j and thus c_{jk}. Therefore, profit to agency jk is the same for any (c_{jk}, c_{-jk}) combination within B. Assumption 1 puts the best response in B at the lower boundary, which is where 36 holds with equality. This boundary is shared with area A. It can be checked that the 45-degree line does not pass through B. Therefore, there are no potential symmetric equilibria there.

Area C is where c_j satisfies 35 while c_{-j} does not. It is defined by the inequality identical to 38, except with the weak inequality reversed, and by

$$c_{jk} \leq \frac{MNL}{2\gamma} - (M-1)NL - (N-1)c_{-jk}. \tag{40}$$

It can be checked that only when $MN < 2\gamma/(2\gamma-1)$ can these two inequalities be satisfied in non-negative (c_{jk}, c_{-jk}) space. In area C, no region but j has type C entrepreneurs, and the wage is responsive to c_j, and thus c_{jk}. It can be checked that the 45-degree line does not pass through C; thus it contains no potential symmetric equilibria.

A final area D contains the rest of non-negative (c_{jk}, c_{-jk}) space. Thus it satisfies inequalities 37, 39, and 40, with the weak inequalities reversed. Areas A, B, and C exhaust the non-negative (c_{jk}, c_{-jk}) space that satisfies the labor market equation 33 at $w \geq \underline{w}$. Thus in region D, some $w \leq \underline{w}$ solves equation 33. Therefore, the wage is at its lower bound in D, $\underline{w}$, and there may be subsistors.

Areas A and D are the only possibilities for symmetric equilibria. Equation 34 shows that in area A, the wage is given by $(y_{med} - \gamma\overline{c})/2$. Payoffs using this wage and the uniform distribution in equation 8 are:

$$\begin{aligned} MN\Pi_{jk}(c_{jk}, c_{-jk}) = {} & \gamma c_{jk}\frac{[\overline{y} - (y_{med} - \gamma\overline{c} + c_j)]}{L} \\ & + \alpha\{\frac{[\overline{y} - (y_{med} - \gamma\overline{c})]}{L}\overline{y}/2 + \frac{y_{med} - \gamma\overline{c} - \underline{y}}{L}(y_{med} - \gamma\overline{c})/2\}. \end{aligned} \tag{41}$$

Differentiation of 41 gives that the A-restricted best response function equals

$$c_A^*(c_{-jk}) = \frac{MNL/2 - c_{-jk}[MN(1-\gamma) - (M-\gamma) - \alpha\gamma\frac{MN-1}{MN}]}{2(M-\gamma) - \alpha\gamma/MN}, \tag{42}$$

whenever $c_A^*(c_{-jk})$ is in A. If $c_A^*(c_{-jk})$ oversteps any boundary of A, then the A-restricted best response $c_A^*(c_{-jk})$ is just equal to the closest c_{jk} to $c_A^*(c_{-jk})$ that puts (c_{jk}, c_{-jk}) in A. This is because the payoff function 41 is quadratic in c_{jk}, and thus is increasing up to the boundary whenever the calculated best response oversteps the boundary. The symmetric equilibrium using 42, call it $c_{im,A}$, is then

$$c_{im,A} = \frac{L}{2[1-\gamma+\frac{1}{N}(1-\frac{\gamma}{M}(1+\alpha))]}. \tag{43}$$

Only the boundary of A corresponding to inequality 37 crosses the 45-degree line, producing a potential symmetric equilibrium of $L/(2\gamma)$.

In area D, $w = \underline{w}$ as argued above. Using this fact in the payoff equation 8 of agency jk, we find that the best response is

$$c_D^*(c_{-jk}) = \frac{NL - c_{-jk}(N-1)}{2}, \tag{44}$$

whenever $c_D^*(c_{-jk})$ is in D. If $c_D^*(c_{-jk})$ oversteps any boundary of D, then the D-restricted best response $c_D^*(c_{-jk})$ is just equal to the closest c_{jk} to $c_D^*(c_{-jk})$ that puts (c_{jk}, c_{-jk}) in D. This is true for the same reason described above for area A. The symmetric equilibrium using 44, call it $c_{im,D}$, is

$$c_{im,D} = \frac{NL}{N+1}. \tag{45}$$

As in A, the only potential symmetric equilibrium on a boundary of D is $L/(2\gamma)$.

It can be checked that if and only if $N < 1/(2\gamma-1)$ and $M \geq [\gamma(1+\alpha)]/[1-N(2\gamma-1)]$ is $c_{im,A}$ no greater than $L/(2\gamma)$, which is necessary for $c_{im,A}$ to be an equilibrium. Similarly, if and only if $N \geq 1/(2\gamma-1)$ is $c_{im,D}$ no less than $L/2\gamma$, which is necessary for $c_{im,D}$ to be an equilibrium. Thus there are three cases to consider.

Take $N < 1/(2\gamma-1)$ and $M \geq [\gamma(1+\alpha)]/[1-N(2\gamma-1)]$ first. In this case, the two candidates for a symmetric equilibrium are $c_{im,A}$ and $L/(2\gamma)$; $c_{im,D}$ is ruled out because N is too small. To check that $c_{im,A}$ is an equilibrium, we must check that a deviation to any other region is not a strict improvement; by construction, a deviation within A is not optimal. Consider B first. All B-restricted best responses are on the common boundary of A and B, as argued in the description of B. Since the boundary is already accounted for in the A-restricted best response, no deviation to B is an improvement. Next consider C. One can check that if $M \geq 2$ as we are assuming, then no value of c_{jk} puts $(c_{jk}, c_{im,A})$ in area C. Thus there is no possible deviation to C. Finally consider D. We argue that the D-restricted best response to $c_{im,A}$ must be on the common boundary. If it were above, then it would also be above the 45-degree line, since the A-restricted best response is at the 45-degree line and not above the boundary. Notice from equation 44 that the slope of the D-restricted best response function is greater than that of the boundary, and both slopes are negative. Thus the D-restricted best response would be above the boundary at $c_{im,A}$ and when it crosses the 45-degree line, since its slope is negative but no less than that of the boundary. But this is impossible because $N < 1/(2\gamma - 1)$ implies that the B-restricted best response does not cross the 45-degree line in the interior of B. Thus $c_{im,A}$ is an equilibrium.

The second candidate $L/(2\gamma)$ is clearly an equilibrium if it equals $c_{im,A}$, which happens when $M = [\gamma(1+\alpha)]/[1 - N(2\gamma - 1)]$. But we argue that if $c_{im,A} < L/(2\gamma)$, then $L/(2\gamma)$ cannot be an equilibrium. This is because the A-restricted best response to $c_{im,A}$, which is $c_{im,A}$, is strictly below $L/(2\gamma)$; and since it is decreasing, the A-restricted best response to $L/(2\gamma)$ is also strictly below $L/(2\gamma)$. Now A includes the possibility of responding $L/(2\gamma)$ to $L/(2\gamma)$; this is exactly on the boundary. But as we have argued, the A-restricted best response is below $L/(2\gamma)$, proving that a deviation would make the agency better off. Thus for $N < 1/(2\gamma - 1)$ and $M \geq [\gamma(1+\alpha)]/[1 - N(2\gamma - 1)]$, the unique symmetric equilibrium is $c_{im,A}$.

Next consider $N \geq 1/(2\gamma - 1)$. The two candidates for symmetric equilibrium are $c_{im,D}$ and $L/(2\gamma)$; $c_{im,A}$ is ruled out because N is too large. To check that $c_{im,D}$ is an equilibrium, we must check that a deviation to any other region is not a strict improvement; by construction, a deviation within D is not optimal. Now it is impossible to deviate into B from D, since all of B involves $c_{-jk} < L/(2\gamma)$, while $c_{im,D}$ is not less than $L/(2\gamma)$ for $N \geq 1/(2\gamma - 1)$. Also, for $N \geq 1/(2\gamma - 1)$ and $M \geq 2$, as we are assuming, area C does not exist in non-negative (c_{jk}, c_{-jk}) space. This leaves only A. We argue that the A-restricted best response to $c_{im,D}$ must be on the common boundary. If it were below, then it would also be below the boundary when it crossed the 45-degree line, for analogous reasons to those used above. But this is impossible because $N \geq 1/(2\gamma - 1)$ implies that the B-restricted best response does not cross the 45-degree line in the interior of B. Thus $c_{im,D}$ is an equilibrium.

The second candidate $L/(2\gamma)$ is clearly an equilibrium if it equals $c_{im,D}$, which happens when $N = 1/(2\gamma - 1)$. But if $c_{im,D} > L/(2\gamma)$, then for exactly analogous reasons to those above, $L/(2\gamma)$ cannot be an equilibrium. Thus for $N \geq 1/(2\gamma - 1)$, the unique symmetric equilibrium is $c_{im,D}$.

Finally, consider $N < 1/(2\gamma - 1)$ and $M \leq [\gamma(1+\alpha)]/[1 - N(2\gamma - 1)]$. The only candidate equilibrium here is $L/(2\gamma)$. Arguments used above show that for N in this range, at $L/(2\gamma)$ both A-restricted and D-restricted best responses are on the common boundary to A and D; thus they equal $L/(2\gamma)$. As argued above, area B involves $c_{-jk} < L/(2\gamma)$, so there is no possible deviation into B. Finally, there is no possible deviation into C either, since it only involves $c_{-jk} > L/(2\gamma)$ for M and N in this range, as can be checked. This confirms that $L/(2\gamma)$ is indeed the unique symmetric equilibrium here.

Thus we have shown that for $M \geq 2$ and $\gamma > 1/2$, the unique symmetric equilibria under imperfect mobility are:

$$c_{im} = \begin{cases} \frac{L}{2[1-\gamma+\frac{1}{N}(1-\frac{\gamma(1+\alpha)}{M})]} & , \quad N < \frac{1}{2\gamma-1} \ \ \& \ \ M \geq \frac{\gamma(1+\alpha)}{1-N(2\gamma-1)} \\ \frac{L}{2\gamma} & , \quad N < \frac{1}{2\gamma-1} \ \ \& \ \ M \leq \frac{\gamma(1+\alpha)}{1-N(2\gamma-1)} \\ \frac{NL}{N+1} & , \quad N \geq \frac{1}{2\gamma-1} \end{cases}$$

The case where $M = 1$ is included in the proof of proposition 3. One can check that the equilibria derived there correspond to the ones here when $M = 1$ is substituted in. Thus these are the unique symmetric equilibria for any positive integers M and N and $\gamma > 1/2$. It is clear that c_{im} is increasing in N and decreasing in M.

Next we take the case where $\gamma \leq 1/2$. First assume $M \geq 2$. Again we partition non-negative (c_{jk}, c_{-jk}) space into four areas over which the wage is differentiable in c_{jk}. When $\gamma \leq 1/2$, equations 33 and 34 will always hold with equality. This can be checked by checking that the values $y_{med}/2$ and $\underline{w}$ make labor demand less than and greater than labor supply, respectively; thus some intermediate value equates the two.

The discontinuity of the uniform distribution leads to several cases, depending on which regions satisfy the inequality 35. Fix region j and agency jk. Now it may be that both c_j and c_{-j} satisfy 35, or that one does and not the other, or that neither do. These four cases give rise to four areas of non-negative (c_{jk}, c_{-jk}) space.

A, where both c_j and c_{-j} satisfy 35, is described by the inequalities 36 and 38. In A, the wage equals $(y_{med} - \gamma\overline{c})/2$, where $\overline{c} \equiv c_{jk}/MN + c_{-jk}(MN-1)/MN$ is just the average of agencies' choices.

Area B is where c_j does not satisfy 35 while c_{-j} does. This area is defined by the inequality identical to 36, except with the weak inequality reversed, and by

$$c_{-jk} \leq \frac{L}{2(1-\gamma)}. \tag{46}$$

In B, there are no type C entrepreneurs in region j, and the wage is unresponsive to changes in c_j and thus c_{jk}. Therefore, profit to agency jk is the same for any (c_{jk}, c_{-jk}) combination within B. Assumption 1 puts the best response in B at the lower boundary, which is where 36 holds with equality. This boundary is shared with area A. It can be checked that the 45-degree line passes through B only at $c = L/[2(1-\gamma)]$. This is the only potential symmetric equilibrium in B.

Area C is where c_j satisfies 35 while c_{-j} does not. It is defined by the inequality identical to 38, except with the weak inequality reversed, and by

$$c_{jk} \leq \frac{NL}{2(1-\gamma)} - (N-1)c_{-jk}. \tag{47}$$

In area C, no region but j has type C entrepreneurs, and the wage is responsive to c_j, and thus c_{jk}. It can be checked that the 45-degree line passes through C only at $c = L/[2(1-\gamma)]$; this is C's only potential symmetric equilibrium.

A final area D contains the rest of non-negative (c_{jk}, c_{-jk}) space. Thus it satisfies inequalities 46 and 47, with the weak inequalities reversed. In region D, the wage is constant at $w = (y_{med} - \gamma\overline{y})/[2(1-\gamma)]$ and there are no type C entrepreneurs in any region. Therefore, profit to agency jk is the same for any (c_{jk}, c_{-jk}) combination within D. Assumption 1 puts the best response in D at the lower boundary, which is where 47 holds with equality. This boundary is shared with area C. It can be checked that the 45-degree line coincides with the lower boundary of D only at $c = L/[2(1-\gamma)]$. Therefore, this is the only potential symmetric equilibrium in D as well.

Since $L/[2(1-\gamma)]$ is in area A as well, area A holds the only possibilities for symmetric equilibria. Equation 34 shows that in area A, the wage is given by $(y_{med} - \gamma\overline{c})/2$. Thus A is analyzable exactly as it was in the case where $\gamma > 1/2$. The unique potential non-boundary symmetric equilibrium is $c_{im,A}$, given in equation 43. It can be checked that no matter what values M and N take, $c_{im,A} < L/[2(1-\gamma)]$, which is necessary for $c_{im,A}$ to be an equilibrium since it ensures $c_{im,A}$ is in A. A deviation to region B from $c_{im,A}$ is possible. As argued above, the B-restricted best response is always on the common boundary with A, which is accounted for in the A-restricted best response to $c_{im,A}$, $c_{im,A}$. Thus no deviation to B will improve jk's payoff. It can be checked that it is impossible to deviate to C or D from $c_{im,A}$, since they both involve $c_{-jk} > c_{im,A}$. Thus $c_{im,A}$ is indeed an equilibrium for any value of M and N.

It remains to check the possible boundary equilibrium, $c = L/[2(1-\gamma)]$. It can be checked that this equilibrium is in area C, as is any deviation downward. We will show that the C-restricted payoff has a negative partial derivative in c_{jk} at $(L/[2(1-\gamma)], L/[2(1-\gamma)])$. Thus some deviation downward would strictly improve agency jk's payoff.

Equation 34 shows that the wage in C is equal to

$$\frac{y_{med} - \frac{M-1}{M}\gamma\overline{y} + \frac{c_j\gamma}{M}}{1-\gamma\frac{M-1}{M}}.$$

Using this in 8 and differentiating with respect to c_{jk} gives that

$$\begin{aligned}\frac{MNL[M-\gamma(M-1)]}{\gamma}\frac{\partial\Pi_{jk}(c_{jk},c_{-jk})}{\partial c_{jk}} &= \frac{ML}{2} - M(1-\gamma)(c_j + c_{jk}/N) \\ &+ \frac{\alpha}{2N}[\overline{y} - 2w - \frac{ML/2 - \gamma c_j - \gamma L(M-1)}{M-\gamma(M-1)}].\end{aligned} \tag{48}$$

Substituting $c_{jk} = c_j = L/[2(1-\gamma)]$ and simplifying gives that

$$\frac{MNL[M-\gamma(M-1)]}{\gamma}\frac{\partial\Pi_{jk}(c_{jk},c_{-jk})}{\partial c_{jk}} = \frac{L}{2N}(-M + \frac{\alpha\gamma}{1-\gamma}),$$

which is negative because $\alpha\gamma/(1-\gamma)$ is less than one. This proves that a deviation downward in area C would improve agency jk's payoff. Thus $L/[2(1-\gamma)]$ cannot be an equilibrium.

Thus we have shown that for $M \geq 2$ and $\gamma \leq 1/2$, the unique symmetric equilibrium under imperfect mobility is

$$c_{im} = \frac{L}{2[1-\gamma+\frac{1}{N}(1-\frac{\gamma(1+\alpha)}{M})]}.$$

The case where $M = 1$ is included in the proof of proposition 3. One can check that the equilibrium derived there for $\gamma \leq 1/2$ corresponds to the one here when $M = 1$ is substituted in. Thus this is the unique symmetric equilibria for any M and N and $\gamma \leq 1/2$. Clearly this expression is decreasing in M and increasing in N. This completes the proof. ◯

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