A Model of Corruption with Complementary Licenses

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and

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Abstract

We consider the case of entry into a business based on complementary licenses, the supply of which is controlled by monopolist bureaucrats who therefore face identical demands. We consider the impact of liberalisation on welfare and corruption when such bureaucrats engage in Nash or sequential interaction in the price space. We also examine how a government with awareness of the results of these interactions in regard to corruption, government revenue and welfare can affect these by choosing official prices of licenses. In the process of our examination we experiment with different objective functions of the government.

1. Introduction

The industrial organisation of corruption, which shows a lot of variation across the globe, is a key determinant of the scope for and profitability of economic activity. In the last couple of decades, starting from the pioneering work by Shleifer and Vishny (1993), this problem has attracted some attention. In this paper, we do an in-depth study of the implications of a specific but common form of industrial organization of corruption – an individual needing licenses from different departments, each manned by a corrupt bureaucrat, to start a business -- for government policy.

As mentioned by Shleifer and Vishny, such industrial organisation of corruption is typical of some African countries, India and other South East Asian Countries and post-communist Russia. For example, in 2001 in Indonesia in order to ship goods from one district to another, a business permit, a commercial driving license and a special pass from the district's revenue office (because of the taxable nature of some goods) were needed (Kuncoro, 2006) where a single license could have replaced these. According to De Soto [2000] legal authorization to build a house on public land in Peru, Egypt and the Philippines requires approval from 52, 31 and 53

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government agencies respectively and more than one administrative procedure within each office. This phenomenon is called overgrazing the commons, in which officials from different parts/levels of the government prey on the same economic activities (Treisman 2000).

In their brief model, Shleifer and Vishny recognize the complementarity among the licenses provided by different departments as all of these are needed to start a business. The starting point of the model presented in this paper is the recognition of this complementarity. Similarly, as assumed in the relevant model by Shleifer and Vishny, we too assume that the marginal cost to the bureaucrat is the official price of the license provided by him, which has to be remitted by him to the government.

However, there are crucial differences between the two models. Shleifer and Vishny’s model assumes that each monopolist bureaucrat determines his output of licenses taking the output of other complementary licenses as given and by setting marginal revenue equal to marginal cost (the official price of the license). On the other hand, we assume that a) each monopolist bureaucrat makes a decision regarding the price of his license taking the prices of other complementary licenses as given and recognizing that the demands for licenses are identical across the different types of complementary licenses or that b) one of the bureaucrats anticipates the price setting behaviour of the others in response to the price set by him, and this response is factored into the first bureaucrat’s price setting behaviour.

Thus, we make the specific assumption that one type of each kind of license would be required to start a business i.e. the inability of a potential entrepreneur to get one or more of complementary licenses would be enough to prevent her from starting a business and knowing this the potential entrepreneur would either buy all licenses or none at all. Moreover, this identical demand is assumed to be a function of the sum of gross prices paid by the entrepreneur to various license providers, the gross price of each license being defined as the sum of the official price to be remitted to the government plus the bribe which is retained by the bureaucrat.

Adding up across individuals in a population characterized by a spread of entrepreneurial ability (this is defined as being equal to their potential income on entering business) we get an identical
industry demand curve facing each monopolist bureaucrat who provides one of the complementary licenses. Our model derives this demand curve on the basis of potential profitability of businesses given the sum of gross prices, the spread of entrepreneurial ability and opportunities presented by employment in the labour market. We go on to model the Nash and Sequential interaction in the price space among monopolist bureaucrats selling complementary licenses, based on the mentioned demand function and the official prices to be remitted to the government, and analyze the implications of these outcomes for the level of corruption and welfare.

A crucial determinant of the Nash outcomes and those of sequential interaction are the official prices set by the government which constitute official/formal barriers to entry into business. The lowering or raising of these barriers obviously has implications for entry in equilibrium into which our analysis provides important insights. At the same time, the gross prices emerging out of the Nash and Sequential interactions are an outcome of the net profitability of businesses after accounting for official prices: if these official barriers to entry are lowered, the bribe providing power of a potential entrepreneur of given entrepreneurial ability is enhanced.

In summary, liberalisation, as defined, provides an increase in the number of those who pay bribes and the bribe providing power of those who would have entered even if liberalisation had not occurred. The additional entry induced by liberalisation also increases the entrepreneurial surplus. This gives rise to the possibility of a non-monotonic relationship between liberalization and welfare. It is these possibilities that the paper investigates and tries to relate the optimality of government regulatory action to the entrepreneurial spread – the productivity of the most productive entrepreneur and the range over which entrepreneurial productivities are spread.

A crucial assumption is that bribe income is not a component of welfare (or disposable income that contributes to affluence within the country) at all and should be excluded from all welfare computations as it represents a leakage from the economic system. On the production side, we can think about two kinds of entrepreneurs – those actually involved in business and the supply of goods and services to people; and entrepreneur bureaucrats who extract rents through their license providing powers. However, we treat producer welfare as the sum of surpluses enjoyed
by the first class of entrepreneurs and neglect the second class. While this might be a simplifying assumption it is true in many cases. For example, in the scandals that have rocked the Indian government recently, it has been alleged that huge amounts of bribe income have been parked outside the country. Such bribe income does not in most cases contribute to producer and consumer welfare within the country but is usually used by those remitting the bribe income for personal gain. In welfare calculations its exclusion might be advisable.

Our paper examines the implications of the nuanced relationship between liberalisation and welfare for government policy regarding liberalisation and shows how these implications vary for different levels and spreads of entrepreneurial ability. Thus, it establishes the need and basis for a case by case determination and fine tuning of the extent of liberalisation.

Formalisation of Shleifer and Vishny’s work has also been done by Hanz Zenger (2011). Our model is similar to that by Zenger in the sense that in both non cooperative interactions between profit maximizing bureaucrats in the price space is considered. However, we distinguish between two types of interactions – one of the Nash variety and the other one in which one of the bureaucrats has the first mover advantage. Moreover, the ultimate objective of the two pieces of work is totally different – Zenger’s focus is on the comparison of collusion among bribe taking bureaucrats with non-cooperation while our focus is on the impact of liberalization on corruption and welfare in the context of non-cooperative interactions among bureaucrats; and then the government’s choice of the extent of liberalization, given the results of mentioned interactions and its own objective functions. Our model also allows us to analyse how differences in parametric features such as the level and spread of entrepreneurial productivity within the population, which is assumed be heterogeneous, affect our results.

This paper is structured as follows. In Section 2 we look at the Nash interaction between bureaucrats providing complementary licenses to entrepreneurs in the price space and determine how exogenous variables such as the official prices of the license and the level and spread of entrepreneurial productivity affect outcomes such as bribe per license, businesses licensed etc. In Section 3 we do the same for Sequential interaction among bureaucrats providing licenses – we assume that one of the two bureaucrats has a first mover advantage in regard to the setting of
gross prices (official price plus bribe) and exploits this first mover advantage by anticipating the reaction of the price behaviour of the other bureaucrat to the price set by him. In Section 4 we consider a two stage game where the government maximises an objective function in the first stage by setting official prices based on its anticipation of the effect of these prices on bribe incomes; businesses licensed, and consequent generation of surpluses for business; government revenue etc generated through a Nash/Sequential interaction played out in the second stage. In Section 5 we conclude by looking at implications for policy.

2. Nash Interaction Between Bureaucrats Providing Complementary Licenses

Consider the decision of an individual who is faced with the decision of starting or not starting a business. To start the business he has to get two licenses, each one from a different bureaucrat.

Assume that all individuals have equal labour endowments which they either sell in the labour market or use in business\(^1\). Also assume that labour is the numeraire i.e. the value of individual’s labour endowment is unity. Business is assumed to yield an income \(A_i\) to individual \(i\), which one can interpret as entrepreneurial ability which is assumed to be observable. But in order to start a business he has to pay prices \(p_1\) and \(p_2\) for the licenses are different from the official prices \(c_1\) and \(c_2\) where \(p_1 > c_1\) and \(p_2 > c_2\). Therefore \(p_i - c_i\) will be the bribe received by the \(i^{th}\) bureaucrat per license. We assume that \(A_i\) is uniformly distributed over \([\bar{A}, \tilde{A}]\) for the population of relevant individuals, which is assumed to be a continuous variable. Thus, the probability density function is \(1/\tilde{A} - \bar{A}\) at each level of \(A_i\) in \([\bar{A}, \tilde{A}]\). For simplicity, we assume that \(\tilde{A} \geq 3\). The significance of this assumption will be made clear as we proceed.

Now the \(i^{th}\) individual would start a business if
\[
A_i - (p_1 + p_2) \geq 1 \Rightarrow A_i \geq 1 + (p_1 + p_2) = A^* \text{ let.}
\]
Therefore, only individuals belonging to\([A^*, \tilde{A}]\) will start a business. Given (1) the demand for each type of license is given by
\[
x(p_1 + p_2) = 0 \text{ if } A^* \geq \tilde{A}
\]

\(^1\) One can assume that a person with higher entrepreneurial ability might have higher return to labour endowment. The qualitative aspect of the paper will remain unchanged if we extend our model to this variable returns to labour endowment.
\[ \frac{\tilde{A} - A^*}{\tilde{A} - \bar{A}} \epsilon [0,1] \text{ if } \tilde{A} \geq A^* \geq \bar{A} \\
= 1 \text{ if } A^* \leq \bar{A} \quad (2) \]

Thus, to start with for a very high level of \( p_1 + p_2 \), the demand for each type of license, \( x(p_1 + p_2) \), is 0. As \( p_1 + p_2 \) falls below \( \tilde{A} - 1 \) the demand attains a positive magnitude and increases with a decrease in \( p_1 + p_2 \) till it reaches 1 at \( p_1 + p_2 = \tilde{A} - 1 \). Thereafter, demand remains constant at 1 with a fall in \( p_1 + p_2 \). With this we proceed to analyze the following two stage game:

If we assume that an individual needs to procure both licenses simultaneously a Nash interaction in prices takes place between the two license providing bureaucrats. Here the price charged by each bureaucrat \( i \) is the sum of the official price \( c_i \) for the license being provided by him and a bribe which accrues to him.

Thus given official prices, \( c_1 \) and \( c_2 \), of the two types of complementary licenses needed to start a business, bureaucrat 1 chooses \( p_1 \) to maximise his profits taking \( p_2 \) as given and bureaucrat 2 behaves similarly. The Nash equilibrium of this game is thus a price tuple, the \( i^{th} \) component of which is the price charged by bureaucrat \( i \) (\( i=1,2 \)), with the property that each component price is a best response to the other. In other words it is a price tuple \( (p_1^*, p_2^*) \) where \( p_i^* \) solves

\[
\text{Max}_{p_i} \pi_i(p_i, p_j^*) = (p_i - c_i) \frac{\tilde{A} - 1 - (p_i + p_j)}{\tilde{A} - \bar{A}} \quad \text{for } i=1,2 \text{ and } j \neq i
\]

For partial market coverage to occur it must be true that \( \tilde{A} < A^* = 1 + p_1^* + p_2^* < \tilde{A} \).

The solution to the above profit maximization problem and therefore the best response function in case the price charged by individual \( j \) is \( p_j \) is given by

\[
p_i = \frac{(\tilde{A} - 1) - (p_j - c_i)}{2} \quad \forall i = \{1,2\}, \ j = \{1,2\}, \ i \neq j \quad (3)
\]

The Nash equilibrium prices as a function of official prices in this simultaneous move game will be

\[
p_1^* = \frac{\tilde{A} - 1 + (2c_1 - c_2)}{3} \quad (4)
\]

\[
p_2^* = \frac{\tilde{A} - 1 + (2c_2 - c_1)}{3} \quad (5)
\]

In this case the total price paid for the licenses is given by
\[ p_1^* + p_2^* = \frac{2(\bar{A} - 1) + (c_1 + c_2)}{3} \] (6)

Given (6), the condition for partial market coverage \( \bar{A} < \bar{A}^* = 1 + p_1^* + p_2^* < \bar{A} \) will occur iff \( (\bar{A} - 1) - 2(\bar{A} - \bar{A}) < c = c_1 + c_2 < \bar{A} - 1 \). We can assume a lower bound on \( c \), \( \bar{c} \) which is determined by transactions, material and other operating costs. Assuming \( (\bar{A} - 1) - 2(\bar{A} - \bar{A}) < 0 \) to be small enough we get a condition: \( \bar{c} < c = c_1 + c_2 < \bar{A} - 1 \) for viable levels of \( c \).

From (6) the total price paid by the entrant to the two bureaucrats for the licenses (cost to the potential entrant of entry) is increasing in \( \bar{A} \) as well as the sum of official prices. However, it rises by only one-third of the increase in the sum of official prices of the licenses. Total businesses licensed are \( \frac{[(\bar{A} - 1) - c]}{3(\bar{A} - \bar{A})} \) which is decreasing in the total official price of the licenses. The bribe paid per entrant is \( B = \frac{2[(\bar{A} - 1) - c]}{3} \) which is increasing in \( \bar{A} \) but decreasing in the sum of official prices. However, the bribe only decreases by \( 2/3^{rd} \) of the increase in the official prices of licenses. The total income from corruption is \( \frac{2[\bar{A} - 1 - c]^2}{9(\bar{A} - \bar{A})} \) which is decreasing in the sum of official prices of the licenses. However, the decrease tapers off with an increase in \( c \) while the number of entrants into the industry declines with an increase in \( c \) at a constant rate.

Therefore, we can now state our first proposition:

**Proposition 1:** An increase in official prices will lead to increase in gross license prices, and decrease in bribe per entrant, total income from corruption and also businesses licensed.

**Proof:** Follows from the above discussion and examination of the derived expressions. QED

As official prices rise, the market for bribes and entry into business contracts by leaving out those with lower productivity. Thus, gross prices increase in equilibrium but as mentioned above only by \( \frac{1}{3} \) of \( c \). The increase by less than \( c \) can be explained by the fact that those entering the market in the absence of an increase in \( c \) and still able to enter now face a decrease in their ability to pay bribes because of the very increase in \( c \). Therefore, the income from corruption per
Proposition 2: The level of bribe will also be increasing in $\bar{A}$ but will be independent of the lowest level of potential productivity, $\bar{A}$. The effect of a higher $\bar{A}$ on total income from corruption will be ambiguous. For given $\bar{A}$, the total income from corruption will be decreasing in the total entrepreneurial spread, $\bar{A} - \bar{A}$.

**Proof:** Follows from the above discussion and examination of the derived expressions. QED

This proposition follows from the fact that the average productivity levels of those entering business increases with $\bar{A}$ but is unaffected by $\bar{A}$ in the case of partial entry which we have assumed. The effect on income from corruption from an increase in $\bar{A}$ is ambiguous as the density of entrepreneurs at each level of productivity also decreases to compensate for the increase in bribe. Therefore, the effect on the number of businesses licensed is ambiguous. Again for given $\bar{A}$, a higher entrepreneurial spread would imply that the same level of bribe income would be multiplied by a lower number of licenses to yield a lower total income from corruption.

Computation of the first derivative of the total income from corruption with respect to $\bar{A}$ reveals that it is $\frac{2}{9} \left[ \frac{\bar{A} - (1 + c)}{\bar{A} - \bar{A}} \right] \left[ 2 - \frac{\bar{A} - (1 + c)}{\bar{A} - \bar{A}} \right]$. Assuming that $\bar{A} > (1 + c)$ (otherwise there would be no licensing) the derivative is positive only iff $2(\bar{A} - \bar{A}) > \bar{A} - (1 + c))$. This condition is satisfied if $\bar{A} - 2\bar{A} + 1 > c \iff (\bar{A} - \bar{A}) > (\bar{A} - 1) > c$. Further note that any decrease in $c$ exercises a direct positive effect on income from corruption. Thus, as long as $(\bar{A} - \bar{A}) > (\bar{A} - 1) > c$ (the range of productivities is large and the difference between the lowest level of potential entrepreneurial productivity and labour productivity is small) a lower level of $c$ (liberalisation) would imply that an increase in peak productivity will increase total income from corruption.

Now consider the case where this inequality holds initially but is reversed by an increase in $c$. In that case, further increase in peak productivity may bring back the inequality to its original status and increase total income from corruption. In summary, as the government increases the official price of licenses keeping in mind that its most productive entrepreneurs are becoming even more
productive, the income from corruption falls. But in a growing economy such as India or China the peak productivity can often plays catch up so that the ebb and flow of income from corruption might be a natural outcome of development.

3. Sequential Application for Licenses from Bureaucrats and the Resulting Price Game

Here we assume that out of bureaucrats 2 and 1, bureaucrat 2 is the leader and bureaucrat 1 is the follower i.e. the purchase of license from bureaucrat 2 has to precede that from bureaucrat 1. Thus, bureaucrat 2 being the first mover will internalize the behaviour of bureaucrat 1 i.e. price charged by the second mover (Bureaucrat 1), in response to any given price set by Bureaucrat 2, in charging a price to maximise profits. We solve for Bureaucrat 1’s optimization problem first. The optimization problem of Bureaucrat 1 will be

$$\text{Max}_{\pi_1} \pi_1 = (p_1 - c_1) \frac{(\bar{A} - 1 - p_1 - p_2)}{\bar{A}}$$ (7)

From the first order condition we get that $\frac{1}{(\bar{A} - \bar{A})} [\bar{A} - 1 - 2p_1 - p_2 + c_1] = 0$. Since $\bar{A} - \bar{A} \neq 0$ we get $p_1 = \frac{\bar{A} - 1 + c_1 - p_2}{2}$. Bureaucrat 2 will maximize his payoff internalizing this price behaviour of Bureaucrat 1 by solving the following optimization problem:

$$\text{Max}_{\pi_2} \pi_2 = \frac{(p_2 - c_2)}{(\bar{A} - \bar{A})} \left[ \bar{A} - 1 - \frac{\bar{A} - 1 + c_1 - p_2}{2} - p_2 \right]$$ (8)

Therefore the subgame perfect price choices for the interaction turn out to be

$$p_1^* = \frac{(\bar{A} - 1) + (3c_1 - c_2)}{4}$$ (9)

$$p_2^* = \frac{(\bar{A} - 1) + (c_2 - c_1)}{2}$$ (10)

Of course this solution has to obey the usual constraints

$$\frac{(\bar{A} - 1) + (c_2 - c_1)}{2} \geq c_2 \Rightarrow \bar{A} - 1 \geq c$$ (11)

$$\frac{(\bar{A} - 1) + (3c_1 - c_2)}{4} \geq c_1 \Rightarrow \bar{A} - 1 \geq c$$ (12)

Again for interior solution we need $\bar{A} < 1 + p_1^* + p_2^* \leq \bar{A}$. By adding (10) and (1) we get the total price paid by an individual for licenses

$$p_1^* + p_2^* = \frac{3(\bar{A} - 1) + c}{4}$$ (13)
Using that in the mentioned condition for interior solution as well as (11) or (12) we get the refinement of the condition for partial market coverage:

$$3(\bar{A} - \bar{A}) + (\bar{A} - 1) < c \leq \bar{A} - 1$$

But assuming a large enough spread of productivity and a small enough difference between $\bar{A}$ and unity, the binding condition for partial market coverage becomes

$$\bar{c} < c \leq \bar{A} - 1.$$ 

Using (14) the bribe paid by the any individual is given by

$$B' = \frac{3[(\bar{A}-1)-c]}{4}$$

The net income from bribery of Bureaucrat 2 (the leader) is $\pi_2 = \frac{(\bar{A}-1-c)^2}{8(\bar{A}-\bar{A})}$ and Bureaucrat 1 (the follower) is $\pi_1 = \frac{(\bar{A}-1-c)^2}{16(\bar{A}-\bar{A})}$. Therefore the total income from corruption is $\frac{3(\bar{A}-1-c)^2}{16(\bar{A}-\bar{A})}$. Here we get propositions 1’ and 2’ which are exactly on the same lines as Propositions 1 and 2. But we also get propositions based on comparisons between sequential and simultaneous purchase. Therefore we can state the following proposition:

**Proposition 3:** With partial market coverage and sequential purchase of licenses

(a) The bribe paid by each individual is higher vis-à-vis simultaneous purchase and the difference in bribe paid is increasing in $\bar{A}$.

(b) The total income from corruption is lower vis-à-vis simultaneous purchase and the magnitude of the difference is increasing in $\bar{A}$.

**Proof:** This follows from direct comparison of bribe per individual and total income from corruption under Nash and sequential interaction.

Part a) of the proposition follows from the fact that in Nash interaction the profit maximising bureaucrats set prices where their best response functions cross each other (i.e. the price set by each bureaucrat is the best response to the other.), given that they are aware of the simultaneity of procurement of their licenses, whereas under sequential purchase the leader (second bureaucrat) maximises profits by incorporating the best response of the follower (first bureaucrat). Profit maximisation by her therefore incorporates three effects of price increase: the direct effect which is positive; an indirect effect for given price of the follower through effect on marketed quantity which is negative; and a third effect which takes into the fact that any price
increase by her would trigger a price decrease by the other bureaucrat and would tend to dilute the second of the mentioned effects, the reduction of equilibrium quantity. Thus, in comparison to Nash interaction the second bureaucrat ends up charging a higher price and the first bureaucrat a lower price. But the sum of the prices would increase because bureaucrat 1 would not exactly compensate for the entire price increase of bureaucrat 2 given that a price decrease has two effects: a direct negative effect which is offset by the positive effect on marketed quantity.

Part b) of the proposition follows from the fact that $p_1^* + p_2^*$ is higher under sequential interaction as compared to simultaneous purchase/Nash interaction which is yet higher than the price charged by a joint monopolist i.e. one who has sole control over the sale of the two licenses (in this case $p_1^* + p_2^* = \frac{A-1-c}{2}$). This is the total price at which the joint market profits are maximized. Note that Nash equilibrium and the equilibrium emerging in the case of sequential interaction are at increasing distances in regard to $p_1^* + p_2^*$ from the level which maximises total joint market profits. Given a smoothly behaved profit function with a unique maxima, the total profit income or income from corruption for the corrupt bureaucrats will be higher under Nash than under sequential interaction.

4. Optimal Choice of Official License Prices by the Government

By government we mean a higher administrative authority which sets the official prices of the licenses and is aware of the demand functions facing the bureaucrats. It is the government which decides whether purchase of licenses is going to be sequential or simultaneous and anticipates fully the results of the Nash/sequential interaction in terms of bribes, incomes from corruption etc.

Why in reality does the government not try to check such corruption by setting up monitors? First, monitoring can be costly. Second, it might not be feasible, given the number of bureaucrats in different departments providing licenses. Third, there might be problems of collusion between the monitors and the bureaucrats. Fourth, income from bribes itself acts as an incentive payment for bureaucrats to dispense licenses and therefore doing away with these incentive payments
would call for replacement by another incentive that is legal. In fact it is possible to ‘legalise’ these bribes by calling these facilitation payments.

To summarise, ‘bribery’ is in many cases not a desirable phenomenon even though in other cases it is the grease which keeps the wheels of the government machinery moving, at least for those who avail of its services. On the other hand, bribe income is a leakage from society and such income cannot be used for other productive purposes such as poverty alleviation.

Therefore, ideally it is not the amount of anticipated bribe income that should determine the official prices set by the government but the welfare levels generated by these official prices. Official prices affect welfare in myriad ways – through bribery which is a leakage from society, through generation of business entry and therefore entrepreneurial surpluses, and generation of government revenues.

The government can incorporate the results of the Nash/Sequential interaction, as mentioned above (the effect of official prices on bribes and incomes from corruption), in maximising an objective function. The kind of objective function it pursues reflects its policy bent/intent.

Below we look at some of the building blocks of these objective functions:

1) Net Entrepreneurial Surplus (NES): This is the amount that entering businessmen earn over and above the money they have to pay to monopolist bureaucrats for their entry and income they would have earned had they continued to be employed in the labour market.

2) Gross Entrepreneurial Surplus (GES): This is the income earned by entering businessmen over and above the amount they have to pay to monopolist bureaucrats for entry into business.

3) Government Revenue (GR): This is defined simply as the product of the number of licensed businesses and c.

4) Labour Income of those not entering the business sector (L)

We can derive mathematical measures for these building blocks as follows:

\[ NES = \int_{A_*}^{\hat{A}} (A_t - A^*) \, dA_t = \frac{(\hat{A}-A^*)^2}{2(\hat{A}-A)} \]  

(16)
Here it must be noted that $A^*$ is a function of $c$ but we express these building blocks in terms of $A^*$ mostly for the sake of elegance. The various objective functions that the government may pursue are listed as follows

(a) NES
(b) GES
(c) NES + GR
(d) GES + GR
(e) NES + GR + L
(f) GES + GR + L

Objective functions a) and b) correspond to some sort of crony capitalism where the government is bothered only about business. In regard to c) and d) the government is bothered above raising resources i.e. this can be regarded as some sort of concern for development programmes. Note that the value of $c$ which optimizes GES+GR+L also optimizes NES+GR. To see that note that optimizing NES+GR is the same as optimizing NES + GR +1 = NES + GR + L + (1 - L). But 1-L is the labour income sacrificed by those entering business. Therefore, NES +(1-L)=GES. Therefore optimizing NES+GR is the same as optimizing NES + GR +1 as also GES + GR + L. In other words, we can think of leaving out f) from our list of potential objective functions.

Having a maximand such as NES + GR + L implies that the government is in fact bothered about the quantity of labour supply. For example, consider qualified white collar workers
who are potential entrants into a particular industry not necessarily linked to their line of work. The government might want to discourage the entry of many of these, other than the most productive ones, into business. By doing so it would have a highly skilled labour force in place in the economy and related skills would remain in fairly abundant and cheap supply.

Note that government revenue is maximized at \( c = \frac{\bar{A} - 1}{2} \). Increases in \( c \) which result in \( c \) not overshooting \( \frac{\bar{A} - 1}{2} \) would increase government revenue but decrease entrepreneurial surplus. At the same time \( L \) is also increasing in \( c \). Thus, incorporation of \( L \) in the objective function would increase the optimal level of \( c \). Thus, incorporation of \( L \) in the objective function implies less entry into business and a larger proportion of the labour force not entering business.

Note, as mentioned, that while income from corruption is always declining in \( c \), government revenue follows a) an inverted U shaped trajectory with respect to \( c \) with maximum at \( c = \frac{\bar{A} - 1}{2} > 0 \) if \( \bar{c} < \frac{A - 1}{2} \) (Figure 1a) or b) a negative trajectory with respect to \( c \) with maximum at \( \bar{c} \) if \( \bar{c} > \frac{A - 1}{2} \) (Figure 1b).

In case b), there will be a positive correlation between government revenue and income from corruption for all admissible values of \( c \) (\( \bar{c} \leq c \leq \bar{A} - 1 \)). Liberalisation will have adverse consequences by increasing income from corruption but at the same time will increase government revenue. Changes which reduce \( \bar{c} \) and enhance \( \bar{A} \) will increase the length of this range. Interestingly for this case, adverse impacts of liberalisation on both government revenue and income from corruption are ruled out. In other words, countries where peak productivity is low but the lower bound on official prices of licenses is still lower, can at least hope to reap the rewards from liberalisation in the form of higher government revenues even though income from corruption will always be increasing with liberalisation.
If $\bar{c} < \frac{\bar{A} - 1}{2}$ then government revenue will be increasing in $c$ for the range $\frac{\bar{A} - 1}{2} \geq c \geq \bar{c}$ over which income from corruption will be decreasing in $c$. Thus, there will be a negative correlation between income from corruption and government revenue over this range and a positive correlation over the range $\frac{\bar{A} - 1}{2} \leq c \leq \bar{A} - 1$ where again income from corruption will be declining in $c$. An increase in peak productivity and a decline in the lower bound on $c$ will increase the length of the former range; the mentioned increase in peak productivity will also increase the length of the latter range.

Thus, irrespective of which case a) or b) we are considering, changes which make it easier to apply for a license by reducing pecuniary and transaction costs and increase productivity at the upper end of the spectrum etc. will be reflected in greater association of liberalization with enhanced government revenue even though liberalisation according to our model will always be associated with corruption. Exactly the opposite types of changes will have exactly opposite consequences.
Let $O(c)$ be the objective function of the government which is obtained by expressing the government’s objective function in terms of certain proximate variables (entrepreneurial surplus, government revenue and labour income of those not becoming entrepreneurs) and substituting into it the expressions for equilibrium values of these in terms of $c$ and other parameters (such as the level and spread of entrepreneurial productivity) emerging out of mentioned Nash and sequential interactions. Thus, a variant of $O(c)$ can be found for any of the candidates (a) to (e) above. The government then solves the problem.
\[ \text{Max}_c 0(c) \text{ s.t } c \geq \bar{c} \quad (20) \]

The above is equal to the sub-game perfect equilibrium of the following two stage game:

Stage 1: The government chooses \( c_1 \) and \( c_2 \) and therefore \( c = c_1 + c_2 \), the payoff function of the government being given by \( 0(c) \)

Stage 2: Given \( c_1 \) and \( c_2 \) and, therefore, \( c = c_1 + c_2 \), the Nash or Sequential interaction game is played out between bureaucrats.

The government can then choose \( c \) to maximise \( O(c) \) given the results of Stage 1. The tables below (1 and 2) list out the optimal values of \( c (c^*) \) emerging from the solution of the problem (20) (these then are the solutions to the mentioned sub-game) corresponding to each of the candidates (a)-(e) under Nash as well as Sequential interaction and the associated values of \( A^* \), bribe per license, income from corruption, government revenue, and labour income by those not entering business etc.

**Table 1: Optimal values of \( c \) and other variables under simultaneous purchase of licenses (Nash interaction)**

<table>
<thead>
<tr>
<th>Objective Function</th>
<th>Optimal values of ( c )</th>
<th>( A^* )</th>
<th>Bribe per license</th>
<th>Businesses Licensed</th>
<th>Total income from Corruption</th>
<th>Government Revenues</th>
</tr>
</thead>
<tbody>
<tr>
<td>NES</td>
<td>( \bar{c} )</td>
<td>( \frac{2 \bar{A} + (1 + \bar{c})}{3} )</td>
<td>( \frac{2[\bar{A} - (1 + \bar{c})]}{3} )</td>
<td>( \frac{\bar{A} - (1 + \bar{c})}{3(\bar{A} - \bar{A})} )</td>
<td>( \frac{2 \left[(\bar{A} - (1 + \bar{c})\right]^{2}}{9(\bar{A} - \bar{A})} ) ( \frac{\bar{A} - 1 - \bar{c} - \bar{c}^2}{3(\bar{A} - \bar{A})} )</td>
<td></td>
</tr>
<tr>
<td>GES</td>
<td>( \bar{c} )</td>
<td>( \frac{2 \bar{A} + (1 + \bar{c})}{3} )</td>
<td>( \frac{2(\bar{A} - (1 + \bar{c})]}{3} )</td>
<td>( \frac{\bar{A} - (1 + \bar{c})}{3(\bar{A} - \bar{A})} )</td>
<td>( \frac{2 \left[(\bar{A} - (1 + \bar{c})\right]^{2}}{9(\bar{A} - \bar{A})} ) ( \frac{\bar{A} - 1 - \bar{c} - \bar{c}^2}{3(\bar{A} - \bar{A})} )</td>
<td></td>
</tr>
<tr>
<td>NES + GR</td>
<td>( \frac{2}{5}(\bar{A} - 1) )</td>
<td>( \frac{4}{5} \bar{A} + \frac{1}{5} )</td>
<td>( \frac{2}{5}(\bar{A} - 1) )</td>
<td>( \frac{1}{5} \bar{A} - \frac{1}{5} )</td>
<td>( \frac{2 \left((\bar{A} - 1)\right]^2}{25 \bar{A} - \bar{A}} )</td>
<td>( \frac{2 \left((\bar{A} - 1)\right]^2}{25 \bar{A} - \bar{A}} )</td>
</tr>
<tr>
<td>GES + GR</td>
<td>( \frac{2}{5} \bar{A} - 1 )</td>
<td>( \frac{4}{5} \bar{A} )</td>
<td>( \frac{2}{5} \bar{A} )</td>
<td>( \frac{1}{5} \bar{A} - \frac{1}{5} )</td>
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<td>( \frac{2 \left((\bar{A} - 1)\right]^2}{25 \bar{A} - \bar{A}} )</td>
</tr>
</tbody>
</table>
Note that the government will optimize by setting \( c = \bar{c} \) even for the last three mentioned objective functions even if values mentioned under the column labeled ‘optimal choice of c’ is less than \( \bar{c} \). This of course depends upon the magnitude of \( \bar{A} \). This leads to Proposition 4.

**Proposition 4:** The government will set \( c = \bar{c} \) as the optimal value of \( c \) for sequential (simultaneous) purchase for the objective function

a) **NES + GR** if \( \bar{A} < \frac{7}{3} \bar{c} + 1 \) ( \( \bar{A} < \frac{5}{2} \bar{c} + 1 \))

b) **GES + GR** if \( \bar{A} < \frac{7}{3} (\bar{c} + 1) \) ( \( \bar{A} < \frac{5}{2} (\bar{c} + 1) \))

<table>
<thead>
<tr>
<th>Objective Function</th>
<th>Optimal values of ( c )</th>
<th>( \bar{c} )</th>
<th>Bribe per license</th>
<th>Businesses Licensed</th>
<th>Total income from Corruption</th>
<th>Government Revenues</th>
</tr>
</thead>
<tbody>
<tr>
<td>NES</td>
<td>( \bar{c} )</td>
<td>( 3\bar{A} + (1 + \bar{c}) ) ( \frac{4}{3} )</td>
<td>( \bar{A} - (1 + \bar{c}) ) ( \frac{4}{3} )</td>
<td>( \frac{3}{16}(\bar{A} - 1)^2 ) ( \frac{4}{49} \bar{A} - \bar{A} )</td>
<td>( \frac{3}{16}(\bar{A} - 1)^2 ) ( \frac{4}{49} \bar{A} - \bar{A} )</td>
<td></td>
</tr>
<tr>
<td>GES</td>
<td>( \bar{c} )</td>
<td>( 3\bar{A} + (1 + \bar{c}) ) ( \frac{4}{3} )</td>
<td>( \bar{A} - (1 + \bar{c}) ) ( \frac{4}{3} )</td>
<td>( \frac{3}{16}(\bar{A} - 1)^2 ) ( \frac{4}{49} \bar{A} - \bar{A} )</td>
<td>( \frac{3}{16}(\bar{A} - 1)^2 ) ( \frac{4}{49} \bar{A} - \bar{A} )</td>
<td></td>
</tr>
<tr>
<td>NES + GR</td>
<td>( \frac{3}{7}(\bar{A} - 1) ) ( \frac{6}{7} \bar{A} + \frac{1}{7} )</td>
<td>( \frac{3}{7}(\bar{A} - 1) ) ( \frac{4}{7} \bar{A} - \bar{A} )</td>
<td>( \frac{1}{7}(\bar{A} - 1) ) ( \frac{4}{7} \bar{A} - \bar{A} )</td>
<td>( \frac{3}{16}(\bar{A} - 1)^2 ) ( \frac{4}{49} \bar{A} - \bar{A} )</td>
<td>( \frac{3}{16}(\bar{A} - 1)^2 ) ( \frac{4}{49} \bar{A} - \bar{A} )</td>
<td></td>
</tr>
<tr>
<td>GES + GR</td>
<td>( \frac{3}{7} \bar{A} - 1 ) ( \frac{6}{7} \bar{A} )</td>
<td>( \frac{3}{7} \bar{A} ) ( \frac{4}{7} \bar{A} - \bar{A} )</td>
<td>( \bar{A} ) ( \frac{4}{7} \bar{A} - \bar{A} )</td>
<td>( \frac{3}{16}(\bar{A} - 1)^2 ) ( \frac{4}{49} \bar{A} - \bar{A} )</td>
<td>( \frac{3}{16}(\bar{A} - 1)^2 ) ( \frac{4}{49} \bar{A} - \bar{A} )</td>
<td></td>
</tr>
<tr>
<td>NES + GR + L</td>
<td>( \frac{3}{7} \bar{A} + \frac{1}{7} ) ( \frac{6}{7} \bar{A} + \frac{2}{7} )</td>
<td>( \frac{3}{7} \bar{A} - \frac{6}{7} ) ( \frac{4}{7} \bar{A} - \bar{A} )</td>
<td>( \bar{A} - 2 ) ( \frac{4}{7} \bar{A} - \bar{A} )</td>
<td>( \frac{3}{16}(\bar{A} - 2)^2 ) ( \frac{4}{49} \bar{A} - \bar{A} )</td>
<td>( \frac{3}{16}(\bar{A} - 2)^2 ) ( \frac{4}{49} \bar{A} - \bar{A} )</td>
<td></td>
</tr>
</tbody>
</table>
c) NES + GR + L if $\bar{A} < \frac{7}{3} \bar{c} - \frac{1}{3} (\bar{A} < \frac{5}{2} \bar{c} - \frac{1}{2})$

In other words, when peak productivity is below a threshold level relative to the lower bound on official prices of licenses, we find the optimal choice of c and associated levels of bribery, income from corruption and government revenue to be independent of the type of objective function adopted by the government. It is only when peak productivities relative to the mentioned lower bound cross this threshold that we expect different regimes to throw up different choices in regard to the sum of official prices of licenses and associated income from corruption, bribery and government revenue to therefore vary.

Consider the case where the objective function is NES + GR. If $\frac{\bar{A} - 1}{2} < \bar{c}$ then government revenue will be declining for all admissible values of $\bar{c}$. Thus, NES + GR would be declining in c for all admissible values of c. If $\frac{\bar{A} - 1}{2} > \bar{c}$ then GR would be increasing in c initially till $c = \frac{\bar{A} - 1}{2}$ is reached. With NES declining in c, the twin possibilities of the optimal value of c exceeding or equalling $\bar{c}$ still exist.

Thus, for $\frac{\bar{A} - 1}{2} > \bar{c}$, government revenue is maximised at a value of $c > \bar{c}$ but NES + GR is maximised at $c = \bar{c}$ iff $2 < \frac{\bar{A}}{(c+1)} < \frac{5}{2}$ for Nash interaction and $2 < \frac{\bar{A}}{(c+1)} < \frac{7}{3}$ for sequential interaction. Again, for $\frac{\bar{A} - 1}{2} > \bar{c}$, NES + GR + L is also maximised at $c = \bar{c}$ iff $2 < \frac{\bar{A}}{(c+1)} - \frac{3}{(c+1)} < \frac{5}{2}$ for Nash interaction and $2 < \frac{\bar{A}}{(c+1)} < \frac{7}{3} - \frac{8}{3(c+1)}$ for sequential interaction. Thus, if NES + GR + L was the government’s objective function, ex-ante (without knowledge of $\bar{A}, \bar{A}$ and $\bar{c}$) the likelihood that $\bar{c}$ would be the optimal choice of c would be lower than if the objective function was NES + GR. This is to be expected as the objective functions in increasing order of their pro- business stance are NES+GR+L, NES + GR and NES.

Let $0_i(c)$ be the i$^\text{th}$ type of objective function and $X_i$ be the ith type of variable (one out of (1)-(4) above). Let $I_i$ be the i$^\text{th}$ type of bureaucratic interaction – Nash (i=1) and sequential (i=2). Let $X_i(0_i(c), I_i)$ be the level of $X_i$ as a function of $0_i(c)$ and $I_i$ at the optimal level of c.
Proposition 5: Subject to all conditions mentioned in Proposition 4 not being fulfilled the following results are true:

(a) \( c(NES, I_i) = c(GES, I_i) < c(GES + GR, I_i) < c(NES + GR, I_i) < c(NES + GR + L, I_i) \) for \( i = 1, 2 \) where \( c(. ) \) denotes optimal official price as a function of relevant arguments

(b) \( B(NES, I_i) = B(GES, I_i) > B(GES + GR, I_i) > B(NES + GR, I_i) > B(NES + GR + L, I_i) \) for \( i = 1, 2 \) where \( B(.) \) refers to bribe income as a function of relevant arguments

(c) The same trend as above is followed for income from corruption

(d) \( GR(NES, I_i) = GR(GES, I_i) < GR(GES + GR, I_i) < GR(NES + GR, I_i) \) for \( i = 1, 2 \)

(e) For \( 3 < \tilde{A} (5 < \tilde{A}) \), \( GR(NES + GR, I_i) < GR(NES + GR + L, I_i) \) for \( i = 1 \) (2)

Proposition 6: Comparing the results of Nash and sequential interactions and subject to the conditions of Proposition 4 not being fulfilled, the optimized official price per license is lower under sequential interaction as compared to Nash interaction for each type of objective function. For each type of objective function, bribe per business entry at the optimal level of \( c \) is higher and income for corruption, business entry, as well as government revenue lower at the optimized value of \( c \) for sequential interaction than under Nash interaction.

Conclusion

This paper considers the case of entry into a business based on complementary licenses, the supply of which is controlled by monopolist bureaucrats who therefore face identical demands. These identical demands are a function of the sum of prices charged by the monopolist bureaucrats. Prices charged by these monopolist bureaucrats, when determined by Nash or sequential interaction, are found to be increasing in official prices. We find that liberalisation (reduction in official prices) increases bribes (the differences between prices charged and official prices) as well as income from corruption. The former is declining in the magnitude of the range of entrepreneurial abilities but is ambiguously affected by peak productivity (the income from
business of the most productive potential business entrants) while the latter is increasing in peak productivity but independent of the mentioned range.

Government revenue, being a key input into developmental activity, the impact of liberalisation on the level of government revenue is crucial even though liberalisation itself always increases corruption in our model. Given that material and transaction costs of providing licenses determine the lower bound on the official prices of licenses, a low peak potential entrepreneurial productivity among the total population would imply that liberalisation would always increase government revenue. However, if that peak level itself is high, liberalisation at high levels of the official price would stimulate government revenue generation but at low levels of the official price would have exactly the opposite result.

Comparing across sequential and Nash interactions, while it is true that the former results in lower corruption for all objective functions, this ‘benefit’ is at the expense of government revenue and entry into business.

A government which is aware of the mentioned interactions determining corruption, bribery and government revenue can affect these outcomes by setting the official price of licenses. We experiment with different objective functions of the government to reflect their varying interests/ideologies. We find that it is only when peak productivities cross a certain level that different objective functions result in different optimal levels of the sum of official prices of the licenses and associated values of other variables such as government revenue, income from corruption and bribe per unit license. In such cases, inclusion of government revenue into the objective function over and above entrepreneurial surplus increases the official prices of licenses and reduces incomes from corruption.

Several policy lessons emerge from our discussion – liberalisation will often spur corruption but should at the same time spur economic activity. Therefore, in a regime where official prices are high it might still make sense to liberalise. Second, and especially when productivities at the upper end of the spectrum of potential entrants are low, liberalisation by stimulating entry might be a good means of enhancing government revenue for development activity. Third, while
sequential licensing might seem a more orderly process than a process which involves simultaneous applications for various kinds of licenses the latter process results in greater government revenue and more business activity. The lower observed income from corruption observed for the first type of licensing is a natural consequence of lower entry into business and despite the incidence of higher level of bribe per unit license.

Comparing across Nash and sequential purchase of licenses, the latter results in lower government revenue but at the same time results in lower income from corruption, albeit a higher level of bribe. The lower income from corruption is at the expense of lower entry and lower entrepreneurial surplus. Thus, we end up with lower entrepreneurial surplus and lower government revenue for financing development if the government sets up a system of sequential purchase of licenses rather than simultaneous purchase of licenses.

To summarise, while liberalisation does enhance corruption it also stimulates business activity. Moreover, the extent of warranted liberalisation would vary on a case to case basis and would depend on the level and range of productivities. The extent of liberalisation that governments opt for in general depend on their objective functions – however, the optimal official price of licenses and associated levels of bribery, corruption and government revenue is often identical to start with and then attains different levels with growth in peak productivity.

**References**


