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Abstract

We analyze the provision of infrastructure by a foreign investor when the domestic bureaucracy is corrupt, but puts some weight on domestic welfare. The investor may pay a bribe in return for a higher provisional contract price. After the investment has been sunk, the bureaucracy may hold up the investor, using the threat of expropriation to demand a lower final price or another bribe. Depending on the level of care for domestic welfare, greater bureaucratic centralization may increase or decrease domestic welfare. Because of the threat of hold-up, bribery may result in greater domestic welfare than the honest benchmark does.

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1 Introduction

Bribery of public officials by private agents is estimated to amount to about \$1 trillion per annum across the world (World Bank, 2016). In cross-country studies it is typically found to correlate negatively with per capita national income and growth, and with the quality of government (Rose-Akerman and Palifka, 2016). It is associated with both 'grand corruption', with small numbers of firms or their representatives paying large amounts of money, and with 'petty corruption', for example with many people paying small bribes to avoid fines for traffic offences. In this paper we focus on grand corruption, examining how bribery may affect contract terms in a context that has been of considerable significance to developing economies in the last 30 years or so – investment in infrastructure and public service provision by a foreign firm.[1]

We analyze the relationship between bureaucratic structure and bribery in a framework where bureaucrats bargain sequentially with an investor on behalf of the government.[2] Infrastructure investment commonly involves a large sunk element; but it is hard for governments to make credible commitments, and so investors are particularly vulnerable to hold-up, leading to renegotiation (Guasch et al., 2003). In our model bureaucrat 1 agrees a provisional contract with the investor, specifying the price the investor will be paid, and may negotiate a bribe in return for a higher price. Then, after the investment has been sunk, bureaucrat 2 may hold up the investor, demanding either a lower renegotiated price or a bribe to avert expropriation.[3,4]

We assume that each bureaucrat is willing to take a bribe, but that, perhaps out of a sense of duty or a concern for career prospects, they also place some value on domestic welfare. An offer of a bribe by the investor will be rejected if it is felt by the relevant bureaucrat to have too high a domestic welfare cost. However, the behaviour of each bureaucrat also depends on how far bureaucrats collude, internalizing the externality that each one's decisions may have on the other's payoff. As in Shleifer and Vishny

[1] The World Bank's Private Participation in Infrastructure Database contains information on more than 6,400 projects dating from 1984 to 2015.

[2] Our analysis builds on the framework developed by Bennett and Estrin (2006).

[3] The first bureaucrat may, for example, belong to a government department with an international orientation and have been involved in securing the investment; the second might have a more domestic focus with fiscal responsibilities (any difference between the provisional and final price can be interpreted as a tax).

[4] We analyze equilibria in which investment takes place and expropriation is never carried out. Hajzler and Rosborough (2016) note that over the period 1990–2014 there were 162 expropriations across 44 countries. This suggests that expropriation can be a credible threat.

(1993), we allow for the extreme cases of pure centralization, where bureaucrats 1 and 2 collude fully to maximize their joint payoff, and pure decentralization, where each bureaucrat independently maximizes his or her own payoff; but we take a more general approach, also covering intermediate cases in which there is imperfect collusion between bureaucrats. Bureaucrats may coordinate their behaviour because they are engaged in a long-term relationship, but, as argued by Mookherjee (2013), the enforceability of side contracts between colluding agents may be limited. We develop a simple linear model, excluding any considerations of asymmetric information, to focus on the interaction of the degree of centralization and the potential hold-up of the investor.

Although we assume that each bureaucrat has the same the utility function, in equilibrium the bureaucrats may differ in their choices as to whether to take a bribe. We relate their choices to the level of bureaucratic 'corruptibility', which depends on the weight they place on domestic welfare and on the extent of centralization. In a benchmark case, when corruptibility is negative, neither bureaucrat takes a bribe, and an interior solution may obtain, with bureaucrat 1 agreeing a relatively high provisional price, after which bureaucrat 2 holds up the investor, bargaining down the final price. However, if the government has a sufficiently limited project budget, the promise to pay the provisional price in this interior solution would not be not credible, and we characterize the equilibria.

If corruptibility is non-negative, bureaucrat 2 is willing to take a bribe, but only has the opportunity to do so if bureaucrat 1 and the investor have agreed a provisional price that is high enough for expropriation to be a credible threat. We specify a critical level of a bureaucrat's concern for domestic welfare as a function of the degree of centralization and of a parameter that influences compensation for expropriation. When concern is above this level, in equilibrium the investor bribes bureaucrat 1 to agree a provisional price that is at the maximum level at which expropriation will not be a credible threat, and the final price equals the provisional price. If price were raised further hold-up would occur, with a bribe being paid to bureaucrat 2, but this would negatively impact the surplus available to the investor and bureaucrat 1. Bureaucrat 2 therefore suffers from being second in line to secure a potential bribe.

When, instead, concern for domestic welfare is lower than the critical level, the investor and bureaucrat 1 agree a bribe to set the provisional price at a level that exhausts the budget for the project, in which case there is hold-up. Bureaucrat 2 is bribed and, again, the provisional price is the final price. However, at the maximum no-hold up provisional price there is a discontinuity in the surplus available to bureaucrat 1 and the investor.[5] If the bureaucrat's concern for domestic welfare is sufficiently large, this surplus, which is increasing in the provisional price in this case, cannot reach a level on the higher provisional price range (on which hold-up occurs) than it reaches at the maximum-no hold up provisional price. The solution is then the same as when the concern for domestic welfare is high.

As we would expect intuitively, across these solutions, other things equal, a greater concern for domestic welfare by bureaucrats is associated with a (weakly) lower final price. Also, provided each bureaucrat has some concern for domestic welfare, greater centralization reduces corruptibility, and so may eliminate bribery. Nonetheless, in solutions where there is bribery there is a complicated interaction between the degree of centralization and concern for domestic welfare, so that the effect of greater centralization on domestic welfare may take either sign.

Compared to the benchmark case of negative corruptibility and honest behaviour, we find that although bribery may be associated with a lower level of domestic welfare, the reverse may also be true. Specifically, when price (both provisional and final) is at its lowest level in the bribery solutions described above, it can be less than the interior solution final price in the honest benchmark, so that domestic welfare is greater with bribery.[6] In this case, there is a negative bargaining surplus for the investor and bureaucrat 1 from pushing the provisional price above the maximum no-hold up level. At a higher provisional price the investor would have to pay a bribe to bureaucrat 2, reducing its profit, and if there is limited centralization, bureaucrat 1 would not value this bribe fully. Also, because this bribe would be in return for maintaining the provisional price as final, bureaucrat 1 would suffer through his or her concern for domestic welfare. By holding the provisional price down, bureaucrat 1 and the investor are in effect colluding against the interests of bureaucrat 2.

Hold-up and the threat of hold-up play a critical role in this analysis. With positive corruptibility, when the low-price bribery solution obtains, bureaucrat 1 and the investor cannot make mutual gains by raising the provisional price further, because bureaucrat 2 would then hold up the investor, which in this case has a negative impact on their

[5] We assume that the available finance is greater than the minimum provisional price at which expropriation is a credible threat (otherwise there cannot be hold-up in the model).

[6] Our result is distinct from the 'greasing the wheels' potential positive effect of bribery considered by (Leff, 1964). Some empirical support for this hypothesis is found, for example, by Méon and Weill (2010) and Dreher and Gassebner (2013).

bargaining surplus. If hold-up could somehow be ruled out, say by a binding commitment, this inhibition on raising the provisional price would be removed. Thus, in our analysis the fear of hold-up causes an adjustment of ex ante behaviour that is beneficial to a third party – the domestic population. In the benchmark honesty case, however, if hold-up were ruled out the interior solution for the final price would be unaffected and domestic welfare would be (weakly) greater than when bribery occurs.

In the Shleifer-Vishny model bureaucrats make simultaneous decisions about granting licences to firms for operation in an industry. The internalization of bribe externalities by bureaucrats that occurs with centralized corruption is associated with a lower total value of bribes and higher output and welfare than obtains with decentralized corruption. In a variation of this framework, Waller et al. (2002) consider the potential role for an autocrat, who would specify how much each bureaucrat should take in bribes. The autocrat would keep a proportion of the proceeds and would monitor each bureaucrat imperfectly, penalizing any discovered deviation of a bribe from the mandated level. This form of centralization allows some internalizing of bribe externalities, but adds another bribe-taking player into the model, and so does not necessarily have a positive effect on welfare. The scope for decentralization is also explored in the literature in terms of its potential benefits from devolving responsibility for public service delivery to local elected officials. Bardhan and Mookherjee (2006), for instance, assume that central government officials are less informed than local officials about local needs and are less able to monitor effectively. This benefit of decentralization of decision-making must be set against the disadvantage that local officials may be susceptible to capture by local elites. Additionally, as shown by Albornoz and Cabrales (2013), a sufficiently high level of political competition may result in less corruption.[7]

Bribery and hold-up are modeled in a multi-period framework by Thomas and Worrall (1994). In their formulation the existence of corrupt officials may cause foreign investors to adopt technologies with inefficiently low sunk costs. Also, Dechenaux and Samuel (2012) develop a model in which a regulator hires an inspector to monitor regulatory compliance by a firm. The inspector may hold up the firm, taking a bribe and then reporting corruption anyway, but repeated interaction can support a bribe equilibrium in trigger strategies. The role of hold-up in determining bribe levels is examined empirically

[7] Lessman and Markwardt (2010) find empirically that effective monitoring by a free press is a pre-condition from successful decentralization. In a survey of the literature on fiscal decentralization, Martinez-Vasquez et al. (2015) note that although the majority of empirical papers find that decentralization is associated with more corruption, some, such as Fan et al. (2009), find the reverse.

by Olken and Barron (2009), who study the payments by truck drivers to various officials on trips in Indonesia. Consistent with hold-up theory, they find that drivers who have more to lose, and those who have to pass through more check-points, pay more in bribes.

Our assumption that bureaucrats are concerned about domestic welfare, as well as bribes, accords with the classic contribution by Klitgaard (1988), who suggests that corruption can be limited by raising its 'moral costs'. More recently, Balafoutas (2011) has modeled corruption as a repeated psychological game where bureaucrats suffer from guilt aversion and are less likely to take bribes if this is thought to let the public down. This conclusion is supported empirically by Dong et al. (2012). An alternative approach is taken by Ahlin and Bose (2007), who consider a partially honest bureaucracy, with some bureaucrats completely honest and others completely corrupt, and where applicants for licenses do not know which type they will encounter. Also, Hajzler and Rosborough (2016) formulate a dynamic model where the type of bureaucrat is uncertain and corrupt types encourage investment in return for bribes using the threat of expropriation.[8]

In Section 2 we formulate our model. In Section 3 we consider the renegotiation stage. In Section 4 we examine the negotiation stage and put this together with the results from Section 3 to find the equilibrium in the model. In Section 5 we discuss the results, focusing on the effect of the extent of centralization on domestic welfare and on whether bribery may enhance domestic welfare. Section 6 concludes, and an appendix gives proofs missing from the text.

2 The Model

Consider an infrastructure project that requires a fixed investment to be sunk by a given foreign firm (the 'investor'), and for which payment will be made out of public sector funds. This is consistent with the output of the project having a large public good element (e.g., a port or a road) or being a merit good for which a policy decision has been taken that distribution will be free or at a nominal price (e.g., water).

At time $t = 1$ the investor and the bureaucracy, acting on behalf of the government, agree on a provisional price p. Failure to agree would yield default payoffs of zero. At time $t = 1\frac{1}{2}$, the investor sinks an investment K, leaving it vulnerable to hold-up. At $t = 2$, renegotiation is triggered if the bureaucracy can credibly threaten expropriation, in which

[8]The risks associated with foreign investment in countries with weak governance may be mitigated by public intervention in the market for political-risk insurance. See Koessler and Lambert-Mogilansky (2014) for an analysis that adapts auction theory to model a bureaucrat's behaviour toward firms.

case the government would operate the project. The contract is therefore incomplete, with the government having *de facto* residual control rights over the asset. However, we focus on cases in which, in equilibrium, the investor correctly anticipates renegotiation, after which it operates the project.

Let P denote the price actually paid to the investor (after any renegotiation), W the running costs of the project and $\pi(P)$ gross profit, excluding any bribes paid:

$$\pi(P) = P - K - W. \tag{1}$$

Writing b_t for the bribe paid at time t ($t = 1, 2$), the investor's net profit $\Pi(P)$ if it sinks the capital and operates the project is

$$\Pi(P) = \pi(P) - b_1 - b_2. \tag{2}$$

The government wishes to maximize the net impact of the project on domestic welfare, which is

$$N(P) = U - P, \tag{3}$$

where U denotes the utility of the project output to the domestic population. We assume that

$$U \geq K + W. \tag{4}$$

Price P is constrained to be no more than the budget F that the government has available to finance the project, where[9]

$$F \in [K + W, U]. \tag{5}$$

For all $P \in [K + W, F]$ the participation constraint $N(P) \geq 0$ is satisfied, while $\Pi(P) \geq 0$ if $b_1 = b_2 = 0$ and still holds if $b_1 + b_2 \leq P - K - W$.

We assume that p, P and F are public knowledge. Because there may be hold-up of the investor at $t = 2$, the price P that is paid may be less than the provisional price p. However, we assume that the provisional price is never set above the project budget F, either because the agreement to pay this price is recognized as not credible or because it would be politically unacceptable.[10] Also, since domestic welfare is decreasing in P, if P were to exceed p it could only be the result of bribery by the investor. Given that

[9] We assume the value of F is given exogenously. It might, for example, depend on the government's budgetary procedures or be predetermined before the government can learn what the investor's costs are. It also might come from a separate foreign aid allocation that is not closely related to the project details.

[10] In an earlier version of the paper we made F uncertain, its value being realized after the investment was sunk, if at all. This complicated the analysis without adding significant insight.

this inference is easily made, we assume that because of the threat of sufficiently strong sanctions, or due to political considerations, P would not be raised above p. Thus,

$$P \leq p \leq F.$$

At $t = 1$ negotiation with the investor over its entry and the provisional price p is undertaken by bureaucrat B^1 on behalf of the government. At $t = 2$, bureaucrat B^2 may then renegotiate the contract with investor, using the threat of expropriation.

We assume that, as well as valuing bribe income b^t, bureaucrat B^t places a value $\eta \in (0, \eta_0]$ on each unit of domestic welfare N, so that his or her utility is

$$v^t = \eta N(P) + b_t, \qquad t = 1, 2. \tag{6}$$

We set the upper bound η_0 at a level low enough to exclude solutions to the model in which a bureaucrat would be willing to use his or her own funds to pay a bribe to the investor to undertake the project. This assumption will be specified in detail in Section 4.

The behaviour of each bureaucrat depends on the extent to which they collude. At one extreme, there may be pure centralization, so that they coordinate their behaviour perfectly to maximize the sum of their utilities. At the other extreme, there may be pure decentralization, with the two bureaucrats pursuing their own objectives independently (perhaps belonging to different government agencies). We develop the analysis generally to cover both extremes and intermediate cases. We characterize the extent of collusion between the bureaucrats by the value $\theta \in [0, 1]$ a bureaucrat places on the utility of the other bureaucrat, as given by (6). Thus, B^t maximizes the utility function

$$u^t = v^t + \theta v^s \qquad s, t = 1, 2; s \neq t. \tag{7}$$

The parameter θ represents the enforceable agreement that bureaucrats have developed for mutual benefit from some amount of collusion. If $\theta = 1$, (7) reduces to the case of pure centralization, with each bureaucrat t weighting v^1 and v^2 equally; if $\theta = 0$ we have pure decentralization, with each bureaucrat B^t maximizing v^t ($t = 1, 2$).

We assume that if expropriation were to occur the project would still yield utility U, but that the state would be less efficient than the investor at operating the facility, with running costs $(1+\gamma)W$, where $\gamma > 0$. The cost to the government of expropriation would be $C(p) + (1 + \gamma)W$, where $C(p)$ denotes the compensation paid to the investor, which we specify below.

At $t = 2$ both the investment K and any bribe b_1 are bygones. In making a decision over whether to renegotiate, bureaucrat B^2 takes into account that, if the contract is honoured ($P = p$) then $N(P) = U - p$, while if there were expropriation, $N(P) = U - [C + (1 + \gamma)W]$. Therefore the threat of expropriation is credible if

$$p > C(p) + (1 + \gamma)W. \tag{8}$$

Similarly, the payoffs to the investor when the contract is honoured and if there were expropriation are $p - K - W$ and $C(p) - K$, respectively, so that the investor prefers not to be expropriated if $p - C(p) - W > 0$. Using (8), since $\gamma > 0$, if expropriation is a credible threat then the investor prefers not to be expropriated.

We write compensation as a convex combination of $p - W$, the marginal profit (after capital is sunk), calculated at the contract price, and of capital cost K:[11]

$$C(p) = \alpha(p - W) + (1 - \alpha)K, \qquad \alpha \in (0, 1). \tag{9}$$

This allows, for example, for the 'fair market value' of the asset to be determined largely in terms of forgone future profit (α large) or largely in terms covering sunk costs (α small).[12] Together with (8), (9) defines the critical contract price p^R above which renegotiation will take place:

$$p^R = K + W + \frac{1}{1 - \alpha}\gamma W. \tag{10}$$

Thus, assuming that the participation constraints are satisfied, and given that $p \geq P$, either $p \in [K + W, p^R]$ and there is no renegotiation, or $p \in (p^R, F]$ and renegotiation follows. To focus on cases in which F is large enough for renegotiation to be feasible, we assume that

$$F > p^R. \tag{11}$$

Hence, given (5), $F \in (p^R, U]$.[13]

[11] International investment is protected by customary international law and by numerous International Investment Agreements. Most agreements follow the Hull standard, typically specifying compensation according to 'fair market value' for the asset, including forgone future profits, but there is no agreed precise definition (UNCTAD, 2012).

[12] We exclude the possibility that $\alpha = 1$ because, from (8) and (9), the threat of expropriation would not then be credible. We also exclude $\alpha = 0$ because the price p agreed at $t = 1$ would then be irrelevant for behaviour at $t = 2$, and the solution would be a simple bargain at $t = 2$ over price P.

[13] Note that $F > p^R$ also implies that F is large enough for the government to pay compensation and run the project for any $p \in (K + W, F]$. To see this, observe that $C(p) + (1 + \gamma)W$ is maximised for $p = F$. At this point, using (8)-(10), $C(F) + (1 + \gamma)W = p^R + \alpha\left(F - p^R\right)$. The condition $F > p^R + \alpha\left(F - p^R\right)$ is then equivalent to $F > p^R$.

3 Renegotiation $(t = 2)$

Solving by backward induction, we first take the provisional price p as given and examine how at $t = 2$, if there is renegotiation, the price P is related to p. Renegotiation takes place if $p \in (p^R, F]$. The investor is assumed to be indifferent between forgoing \$1 in the form of a lower price or in the form of a bribe. If bureaucrat B^2 behaves honestly, that is, if $b_2 = 0$, he or she will aim to maximize $N(P)$, that is, to get the investor to agree to a price P as far below p as possible. The difference in these prices can be regarded as an (implicit) tax,

$$T = p - P. \tag{12}$$

If, however, B^2 is willing to take at least \$1 of bribe then, given the linearity of u^2, B^2 will wish to drive up the bribe b_2 as far as possible, rather than negotiating a reduction in price. In this case $P = p$.

In choosing how to take the 'payment' from hold-up of the investor – as a bribe or as an implicit tax – bureaucrat B^2 will make a cost-benefit comparison. From (7), each \$1 of bribe yields B^2 a benefit of 1, while, also using (3), each \$1 of tax yields yields one unit of domestic welfare, with a value to B^2 of $(1+ \theta)\eta$. Thus, B^2's decision depends on the sign of

$$\Omega(\theta, \eta) = 1 - (1 + \theta)\eta. \tag{13}$$

We call $\Omega(\theta, \eta)$ the level of corruptibility. If $\Omega(\theta, \eta) > 0$, B^2 prefers to take a bribe and leave $P = p$; but, if $\Omega(\theta, \eta) \leq 0$, B^2 behaves honestly, renegotiating price down, i.e., $p - P = T > 0$.[14]

Given the contract price p agreed at $t = 1$, a Nash bargain between bureaucrat B^2 and the investor gives the following solution for renegotiation at $t = 2$.[15]

Lemma 1 *(a) If $\Omega(\theta, \eta) \leq 0$, there is no bribery at $t = 2$ and*

$$\begin{aligned} P &= C(p) + \left(1 + \frac{\gamma}{2}\right) W \equiv P^*(p) \text{ if } p \in (p^R, F]; \qquad (14) \\ P &= p \text{ if } p \in [K + W, p^R]. \end{aligned}$$

[14] Although bureaucrat B^1 has the same utility function as B^2, the sign of $\Omega(\theta, \eta)$ does not indicate whether bureaucrat B^1 will take a bribe, because B^1 faces a different decision problem to B^2.

[15] The assumption that bargaining determines the level of bribe is supported by Svensson (2003), who tests the bargaining hypothesis on Ugandan data. He finds that firms' ability to pay, proxied by their current and expected future profitability, and 'refusal power,' measured by the estimated alternative return on capital, can explain a large part of the variation in bribes across firms.

(b) If $\Omega(\theta,\eta) > 0$, then $P = p$ and the investor pays the bribe

$$\begin{aligned} b_2(p) &= \frac{1-\alpha}{2}\left[p - K - W + (1+\theta)\eta\left(p - p^R\right)\right] \text{ if } p \in (p^R, F]; \\ b_2(p) &= 0 \text{ if } p \in [K+W, p^R]. \end{aligned} \tag{15}$$

If $p \in (p^R, F]$ and bureaucrat B^2 negotiates honestly, then, using (14) the tax

$$T(p) = p - P^*(p) = p - C(p) - \left(1 + \frac{\gamma}{2}\right) W$$

is agreed with the investor. Given (8) and (9), $T(p) > 0$, that is, the price paid is $P^*(p)$ as given by (14), which is less than the contract price p. Also, given (9) and (10), for $p \in (p^R, F]$, $b_2(p)$ in (15) is positive.

If compensation $C(p)$ is greater the investor's payoff from expropriation would be greater and B^2's payoff smaller, and so any payment ($T(p)$ or $b_2(p)$) to avoid expropriation would be smaller.

4 Negotiation ($t = 1$)

In negotiations at $t = 1$ bureaucrat B^1 and the investor will anticipate how renegotiation at $t = 2$ will depend on the provisional price p. Solutions therefore depend on whether bribery will occur at $t = 2$. We first show that if corruptibility $\Omega(\theta,\eta) \leq 0$, so that it is anticipated that B^2 will behave honestly, B^1 will also behave honestly. This enables us to obtain the solution for the benchmark case in which there is no bribery at all. We then analyze the case in which $\Omega(\theta,\eta) > 0$, so that B^1 anticipates that B^2 will take a bribe.

4.1 Negative Corruptibility

Suppose first that $\Omega(\theta,\eta) \leq 0$, so that bureaucrat B^2 would not be willing to take a bribe at $t = 2$; i.e., $b_2 = 0$ and, if $p > p^R$, $T(p) > 0$. If at $t = 1$ the investor pays bureaucrat B^1 a bribe b_1 to raise price p, then, substituting from (3), we have from (2) and (7) that

$$\begin{aligned} \frac{\partial \Pi}{\partial b_1} &= \frac{\partial p}{\partial b_1}\frac{\partial P}{\partial p} - 1; \\ \frac{\partial u^1}{\partial b_1} &= -(1+\theta)\eta\frac{\partial p}{\partial b_1}\frac{\partial P}{\partial p} + 1. \end{aligned} \tag{16}$$

Therefore, both $\partial \Pi / \partial b_1 \geq 0$ and $\partial u^1 / \partial b_1 \geq 0$ if

$$\frac{1}{(1+\theta)\eta} \geq \frac{\partial p}{\partial b_1}\frac{\partial P}{\partial p} \geq 1. \tag{17}$$

With $\Omega(\theta,\eta) = 1-(1+\theta)\eta \leq 0$, the outside inequality here cannot be satisfied. Therefore there is no bribery at $t=1$ irrespective of whether $p \in [K+W, p^R]$ or $p \in (p^R, F]$.

Lemma 2 *If $\Omega(\theta,\eta) \leq 0$, so that bureaucrat 2 behaves honestly, then bureaucrat 1 also behaves honestly.*

Let $\hat{p}$ and $\hat{P}$ denote the equilibrium values of p and P, respectively. Our first proposition describes $\hat{P}$ when there is honest behaviour by both bureaucrats. To characterize the equilibrium fully we need to consider the value of the objective function in the Nash bargain at $t=1$ between bureaucrat B^1 and the investor, where the two players take into account how behaviour at $t=2$ will be affected. We denote this value by

$$x^1(p) = \Pi(p)u^1(p),$$

where $\Pi(p)$ and $u^1(p)$ are given by (2) and (7), and after appropriate substitutions each can be written in reduced form as functions of the provisional price p.

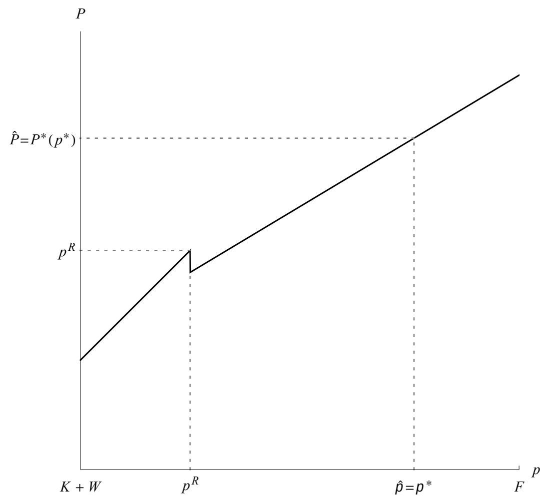
Proposition 1 *Suppose $\Omega(\theta,\eta) \leq 0$, so that both bureaucrats behave honestly. (i) If $F \geq p^*$ then $\hat{P} = P^*(p^*)$. (ii) If $F < p^*$ then (a) if $P^*(p^*) \leq p^R$, then $\hat{p} = P^*(p^*) = \hat{P}$; and (b) if $P^*(p^*) > p^R$, then $\hat{P} = p^R$ if $x^1(p^R) > x^1(F)$, but $\hat{P} = P^*(F)$ otherwise, where*

$$p^* = \frac{1}{2\alpha}\left[U + \alpha(K+W) - (1-\alpha)p^R\right]; \tag{18}$$

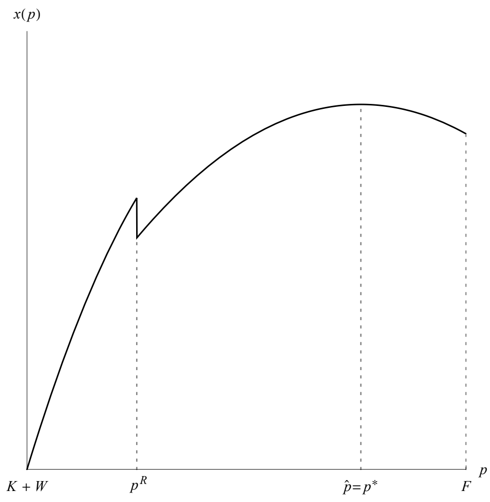
$$P^*(p^*) = \frac{1}{2}(U+K+W). \tag{19}$$

Before commenting on the different parts of the proposition it is helpful to consider the case of an interior solution with hold-up as illustrated in Figure 1.[16] Panel a shows the relationship between the provisional price p and the final price P when $\Omega(\theta,\eta) \leq 0$. If $p \in [K+W, p^R]$ there is no hold-up and so $P = p^R$. But if $p \in (p^R, F]$ there is hold-up so that $P < p$ (and $dP/dp < 1$). For $\lim_{p\downarrow p^R} P$, the reduction of price with hold-up results in a discontinuity in the function $P(p)$ at p^R. Panel b shows the value of the Nash objective function $x^1(p)$. Each segment is concave, and $x^{1\prime}(p) > 0$ for $p \in [K+W, p^R]$. Corresponding to the discontinuity shown in panel a, there is a discontinuity in $x^1(p)$ in panel b. When, as drawn, F is not a binding constraint, the $x^1(p)$-maximum is at $\hat{p} = p^*$, so that, from panel a, $\hat{P} = P^*(p^*)$. Proposition 1 describes this interior solution together with the other cases that obtain when there is a binding constraint.

[16] Figure 1 is drawn for the parameter values $\{\alpha,\gamma,\eta,\theta,F,K,W,U\} = \{.6,.8,.6,.1,1,.1,.1,1.01\}$.



(a) The $t = 2$ Nash bargaining solution.



(b) The $t = 1$ Nash product.

Figure 1: Negative corruptibility.

Part (i) of the proposition, for $F \geq p^*$, combines two cases. The first is the interior solution illustrated in the figure, with $\hat{p} = p^*$and renegotiation to $\hat{P} = P^*(p^*)$. Secondly, however, for some parameter values the solution is $\hat{p} = \hat{P} = P^*(p^*)$ (i.e., without renegotiation).[17] Part (ii) describes the solution when there is a binding constraint $F < p^*$. If also $P^*(p^*) \leq p^R$, as specified in Proposition (ii)(a), then (given (11)), we have $\hat{p} = P^*(p^*)$, without renegotiation ($P = p$). However it is possible that, instead, $P^*(p^*) > p^R$, as in part (ii)(b). In terms of in Figure 1b F would lie between p^R and p^* and so the interior solution $p = p^*$ could not be reached. Then the solution is either $\hat{p} = p^R$ or $\hat{p} = F$, depending on which yields the higher Nash product $x^1(p)$. Either solution may obtain because of the discontinuity in $x^1(p)$. In the figure, $x^1(p)$ is maximized on $p \in [K+W, p^R]$ at $p = p^R$. On $p \in (p^R, F]$, with the constraint $F < p^*$, $x^1(p)$ is maximized at $p = F$. If $F > \frac{1}{\alpha}(U - (1-\alpha)(K+W) - \gamma W)$ then $x^1(F) > x^1(p^R)$ and the solution is $\hat{p} = F$; otherwise $\hat{p} = p^R$.

4.2 Positive Corruptibility

Now suppose that $\Omega(\theta, \eta) > 0$, so that bureaucrat B^2 is willing to take a bribe. In this case we need to consider separately the possibility of a solution in the range $p \in [K+W, p^R]$ or in the range $p \in (p^R, F]$. If $p \in [K+W, p^R]$ there is no scope for renegotiation at $t = 2$ and so $b_2 = 0$; but if $p \in (p^R, F]$ bribe $b_2 > 0$ at $t = 2$, as given by (15). However, in each case $P = p$. We shall see that the willingness of B^2 to take a bribe does not necessarily result in a bribe b^2 being paid.

Proceeding as we did above for $\Omega(\theta, \eta) \leq 0$, we obtain

$$\frac{\partial \Pi}{\partial b_1} = \left(1 - \frac{\partial b_2(p)}{\partial p}\right)\frac{\partial p}{\partial b_1} - 1; \tag{20}$$

$$\frac{\partial u^1}{\partial b_1} = \left[\theta \frac{\partial b_2(p)}{\partial p} - (1+\theta)\,\eta\right]\frac{\partial p}{\partial b_1} + 1. \tag{21}$$

Therefore, both $\partial u^1/\partial b_1 \geq 0$ and $\partial \Pi/\partial b_1 \geq 0$ if

$$\left(1 - \frac{\partial b_2(p)}{\partial p}\right)\frac{\partial p}{\partial b_1} \geq 1 \geq \left[(1+\theta)\,\eta - \theta \frac{\partial b_2(p)}{\partial p}\right]\frac{\partial p}{\partial b_1}, \tag{22}$$

[17] If $p^* > p^R$, as in Figure 1, but also $p^R \geq P^*(p^*)$, then $\hat{p} = P^*(p^*)$ is an equilibrium (as well as $\hat{p} = p^*$, $\hat{P} = P^*(p^*)$) as it is not renegotiated. If instead $p^* \leq p^R$, then, since $P^*(p^*) < p^*$, $\hat{p} = P^*(p^*)$ is not renegotiated, and is an equilibrium.

where, using (15),

$$\frac{\partial b_2(p)}{\partial p} = 0 \text{ if } p \leq p^R \tag{23}$$

$$\frac{\partial b_2(p)}{\partial p} = \frac{(1-\alpha)\left[1+(1+\theta)\,\eta\right]}{2} \text{ if } p \in (p^R, F]. \tag{24}$$

If $p \in [K+W, p^R]$ then, since $b_2 = 0$, (22) reduces to $\partial p/\partial b_1 \geq 1 \geq (1+\theta)\eta\partial p/\partial b_1$. With $\Omega(\theta,\eta) = 1-(1+\theta)\eta > 0$, there exist values of $\partial p/\partial b_1$ (> 1) such that (22) is satisfied. There is a Pareto gain – to the investor and bureaucrat B^1 – for any marginal increase in b_1, and thus in p. If, therefore, $p \in [K+W, p^R]$ in the solution, this will involve the payment of a bribe to B^1, with b_1 raised to make p is as high as is feasible within the given range; i.e., $p = p^R$.

However, if $p \in (p^R, F]$, it is found from (24), using $\Omega(\theta,\eta) > 0$, that $0 < \partial b_2(p)/\partial p < 1-\alpha$. From the left-hand inequality in (22) it then follows that $\partial p/\partial b_1 > 1$. The outer inequality in (22) therefore holds if

$$1-(1+\theta)\,\eta-(1-\theta)\frac{\partial b_2(p)}{\partial p} \geq 0. \tag{25}$$

Substituting from (24), (25) holds if and only if $\eta \leq \bar{\eta}(\theta,\alpha)$, where

$$\bar{\eta}(\theta) = \frac{2-(1-\theta)\,(1-\alpha)}{(1+\theta)(2+(1-\theta)\,(1-\alpha))}. \tag{26}$$

Throughout the range $p \in (p^R, F]$, if the value η a bureaucrat places on domestic welfare is sufficiently low, the investor and bureaucrat B^1 can achieve a mutually beneficial gain by agreeing a bribe to raise price p. Thus, on this range, $p = F$ is preferred. If instead η takes a greater value ($\eta > \bar{\eta}(\theta)$) there is no scope for such a bribe.[18]

The role of θ in the solution will be discussed at the end of this section and in the next. Here we note that $d\bar{\eta}(\theta;\alpha)/d\alpha > 0$ for $\theta < 1$, but zero for $\theta = 1$. The dependence of $\bar{\eta}(\theta,\alpha)$ on α occurs through the value of bribe b_2. From (24), when α takes a greater value so does $\partial b_2(p)/\partial p$, and from (20) and (21), a unit increase in b_2 increases u^1 by θ and Π by 1, so that the surplus available in the bargain between B^1 and the investor changes by $1-\theta$. Therefore, if $\theta < 1$ there is greater scope for mutual gain by raising (b_1, p), and so, when α is larger, η must take a higher value for the mutual gain to be non-positive. But if $\theta = 1$ $\bar{\eta}(1) = 1/2$, independent of α.

[18] The condition for (25) to hold could instead be written $\Omega(\theta,\eta) \geq 2\,(1-\alpha)\,(1-\theta)\,/[3-\theta-\alpha(1-\theta)]$.

If $\eta > \bar{\eta}(\theta)$ p will be raised as far as p^R, but no further, with bribery at $t = 1$, but no bribery at $t = 2$. If instead $\eta \leq \bar{\eta}(\theta)$ then on the range $p \in [K + W, p^R]$ p would be raised to p^R, while on the range $p \in (p^R, F]$ p would be raised to F. However, although the surplus is increasing in p in both these ranges, there is a discontinuity above p^R if $\theta < 1$ (parallel to the discontinuity in the bargaining surplus $x^1(p)$ shown in Figure 1).[19] Thus, if $\eta \leq \bar{\eta}(\theta)$ and $\theta < 1$, p will either be raised to p^R, with bribery only at $t = 1$, or it will be raised to F, with bribery in both periods. We show in the proof of Proposition 2 how the sign of $x^1(p^R) - x^1(F)$, and therefore which of the two prices is optimal, depends on the level of care η for domestic welfare. If η is at least as great as a critical value $\eta'(\theta)$, then $p = p^R$, but otherwise $p = F$. For $\theta < 1$, $\eta'(\theta) < \bar{\eta}(\theta)$, and so the range of η for which $p = p^R$ is wider than $[\bar{\eta}(\theta), 1)$. But for $\theta = 1$ the discontinuity in the surplus disappears and so $\eta'(\theta) = \bar{\eta}(\theta)$.

As noted in Section 2, we shall restrict attention to solutions in which bribes are non-negative. Bribe $b_2 \geq 0$ endogenously, but to ensure that $b_1 \geq 0$ we shall assume that η is sufficiently small ($\eta \leq \eta_0$). Consider the solution $p = \hat{p}$, with $\hat{p} = p^R$ or $\hat{p} = F$ as appropriate, to the Nash bargain between B^1 and the investor. If, disregarding the bribe b_1 associated with this solution, the payoff for bureaucrat B^1 would be no greater than that for the investor, then the value that b_1 takes will be non-negative. This is achieved if η is sufficiently small. In the more interesting of our two cases, where $\eta \geq \eta'(\theta)$ and so $\hat{p} = p^R$, since there is no scope for bribery at $t = 2$, the assumption $\eta \leq \eta_0$ reduces to the condition that the total value B^1 puts on domestic welfare, i.e., $\eta(1 + \theta)N(p^R)$ is no greater than the investor's profit $\pi(p^R)$, which seems a relatively mild assumption. Using (1) and (3), this condition writes as

$$\eta \leq \frac{1}{1+\theta} \frac{p^R - K - W}{U - p^R} \equiv \eta_0^R(\theta). \tag{27}$$

When $\eta < \eta'(\theta)$, so that $\hat{p} = F$, the assumption is stronger: the payoff for B^1 then also includes the value θb_2 he or she places on bribe b_2, while the investor's profit is reduced by b_2. Thus, we assume that $\eta \leq \eta_0^F(\theta)$, where $\eta_0^F(\theta)$ solves[20]

$$\eta_0^F(\theta)(1 + \theta)N(F) + (1 + \theta)b_2(F, \eta_0^F(\theta)) - \pi(F) = 0. \tag{28}$$

[19] If $p = p^R$, $u^1 = (1 + \theta)\eta(U - p^R)$ and $\Pi = p^R - K - W$. As $p \downarrow p^R$, $u^1 \downarrow (1 + \theta)\eta(U - p^R) + \theta b_2(p^R)$ and $\Pi \downarrow p^R - K - W - b_2(p^R)$. Thus, in the limit, the difference in surplus $u^1 + \Pi$ between these cases is $(1+\theta)\eta(U-p^R)+p^R-K-W-\left[\left((1 + \theta)\eta(U - p^R) + \theta b_2(p^R) + p^R - K - W - b_2(p^R)\right)\right] = (1-\theta)b_2(p^R)$. If $\theta < 1$ the surplus is greater at $p = p^R$.

[20] Specifically, using (1), (3) and (15), $\eta_0^F(\theta) = \frac{(\alpha(1+\theta)+1-\theta)(F-K-W)}{(1+\theta)[2(U-F)+(1-\alpha)(1+\theta)(F-p^R)]}$.

Proposition 2 *Assume $\Omega(\theta, \eta) > 0$, that (28) holds, and let*

$$\eta'(\theta) \equiv \frac{(1+\theta+\alpha(1-\theta))\,F - 2p^R + (1-\theta)\,(1-\alpha)(K+W)}{(1+\theta)\,(3-\theta-\alpha(1-\theta))\,(F-p^R)} \leq \bar{\eta}(\theta). \tag{29}$$

If $\eta \in (\eta'(\theta), \eta_0^R(\theta))$, then $\hat{p} = \hat{P} = p^R$, $b_1 = b_1^R$ and $b_2(\hat{p}) = 0$, where

$$b_1^R = \frac{1}{2}\left[\pi(p^R) - (1+\theta)\eta N(p^R)\right]; \tag{30}$$

but if $\eta < \eta'(\theta)$ and $\eta \leq \eta_0^F(\theta)$, then $\hat{p} = \hat{P} = F$, $b_1 = b_1^F$ and $b_2(\hat{p}) > 0$, where

$$b_1^F = \frac{1}{2}\left\{\pi(F) - (1+\theta)\eta[N(F) + b_2(F)]\right\}. \tag{31}$$

The sign of $\eta - \eta'(\theta)$ therefore plays a critical role. If a bureaucrat's concern η for domestic welfare is greater than or equal to $\eta'(\theta, \alpha)$ the price for the project is at the low level p^R, but otherwise it is at the high level F. The interaction between the care η for domestic welfare and the centralization parameter θ plays an important role here.

From (30) and (31) , using (5), (11) and (15), b_1^R and b_1^F are both strictly decreasing in η and θ. As we would expect intuitively, with greater bureaucratic concern η for domestic welfare the bribe to induce bureaucrat B^1 to raise price (in either price range $p \in [K+W, p^R]$ or $p \in (p^R, F])$ is larger. Also, bribe b_1 is larger when centralization θ is greater. When B^1 places a greater weight θ on B^2's utility $v^2 = \eta N(P) + b_2$, he or she needs a greater inducement b_1 to raise $p(= P)$ because of the first term, $\eta N(P)$. For $\eta \geq \eta'(\theta)$, since $p = p^R$, $b_2 = 0$, and so $db_1^R/d\theta > 0$. For $\eta < \eta'(\theta)$, $b_2 > 0$, and from (15), $db_2/dp > 0$, and so less inducement is needed for B^1 to agree a higher price. However, this effect is dominated by the first effect (through $\eta N(P)$) for positive corruptibility $\Omega(\theta, \eta)$.

Corollary 1 *A sufficient condition for equilibria to exist with $b_1 = b_1^R > 0$ and $\hat{p} = p^R$ is that $\eta_0^R(0) > \eta'(0)$.*

Consider $\theta = 0$. Since $\eta'(0) < 1$, if $\eta \in [\eta'(0), 1]$ a bribe $b_1 = b_1^R$ (of unspecified sign if permitted) would secure provisional price $\hat{p} = p^R$. For this bribe to be positive, however, it is also required that $\eta < \eta_0^R(0)$. Thus, η in the range $[\eta'(0), \min(\eta_0^R(0), 1)]$ results in $b_1 = b_1^R > 0$ and $\hat{p} = p^R$, so that the final price $\hat{P}$ is p^R. This is not to argue that $\theta = 0$ is required for price p^R to obtain. In the next section we shall explore further the (η, θ)-pairs that yield this solution.

5 Implications for Domestic Welfare

When θ or η takes a greater value, corruptibility $\Omega(\theta, \eta)$ is smaller. If $\Omega(\theta, \eta)$ changes from positive to non-positive, the solution changes from one involving bribery as in Proposition 2 to honest behaviour as in Proposition 1. In this respect, the degree of centralization θ and care η for domestic welfare can be regarded as substitutes. However, if $\Omega(\theta, \eta) > 0$, so that bribery occurs, θ and η interact in a complicated way in the determination of the solution – whether $\hat{P} = p^R$ or $\hat{P} = F$.

Figure 2 illustrates the Nash product $x^1(p)$ for a numerical example in which the solution is $b_1 = b_1^R$ and $\hat{P} = p^R$.[21] $x^1(p)$ is increasing on both $p \in [K + W, p^R]$ and $p \in (p^R, F]$ with a discontinuity at $p = p^R$ corresponding to that in Figure 1a. The maximum value of $x^1(p)$ must occur at either $p = p^R$ or $P = F$, and in this example $\eta > \eta'(\theta)$ and so the maximum is at $p = p^R$. From (29), the condition $\eta > \eta'(\theta)$ could alternatively be written as an upper bound on F, and it can be seen from the figure that if the value of F were raised enough, the solution would instead be $\hat{p} = F$.

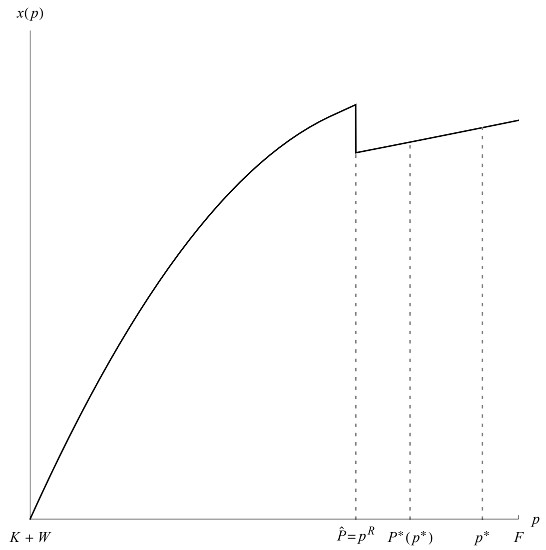


Figure 2: The first period Nash objective function with positive corruptibility.

Comparing Propositions 1 and 2, it is straightforward to see that, depending on parameter values, domestic welfare may be lower or higher when bribery occurs than when bureaucrats behave honestly. In particular, honesty is associated with the higher level of

[21] Figure 2 is drawn for the parameter values $\{\alpha, \gamma, \eta, \theta, F, K, W, U\} = \{.75, .3, .6, .1, .4, .12, .1, .5\}$.

domestic welfare when bribery results in price $\hat{P} = F$. However, as the result that bribery can be beneficial may be counter-intuitive, we consider this finding further, focusing on the case that gives the cleanest result.

Proposition 3 *Assume that* $F \geq p^*$ *and* $\frac{1}{2}(U - K - W) - \frac{1}{1-\alpha}\gamma W > 0$. *Then if* $\Omega(\theta, \eta) > 0$, *(28) holds and* $\eta \in (\eta'(\theta), \eta_0^R(\theta))$, *so that bribe* $b_1 = b_1^R$ *is paid, domestic welfare is greater than if* $\Omega(\theta, \eta) \leq 0$ *and there is no bribery.*

For corruptibility $\Omega(\theta, \eta) \leq 0$ this proposition focuses on part (i) of Proposition 1, where it is assumed that $F \geq p^*$, but no further conditions are involved. In this case neither bureaucrat is willing to take a bribe and price $\hat{P} = P^*(p^*)$. Now, suppose that corruptibility $\Omega(\theta, \eta) > 0$. From Proposition 2, if (28) holds and $\eta \geq \eta \in (\eta'(\theta), \eta_0^R(\theta))$, then $\hat{P} = p^R$. Therefore, if $P^*(p^*) > p^R$, price $\hat{P}$ is lower in the bribery case than when there is no willingness to take a bribe. From (10) and (19), $\frac{1}{2}(U - K - W) - \frac{1}{1-\alpha}\gamma W > 0$ is the condition for $P^*(p^*) > p^R$.

Less centralization θ or care η for domestic welfare can cause corruptibility to switch from being positive to being negative, so that bribery then occurs. Under the conditions in Proposition 3, price switches from $\hat{P} = P^*(p^*)$ to $\hat{P} = p^R$, and domestic welfare increases. If instead $\eta \leq \eta'(\theta)$, then with bribery $\hat{p} = F$, so that the bribery solution involves lower domestic welfare than obtains in the honest solution. We illustrate these cases at the end of this section.

Intuitively, when corruptibility $\Omega(\theta, \eta) > 0$ there is a mutual gain for B^1 and the investor from agreeing a bribe b_1 to push up price p to at least p^R. However, raising p above p^R can be bad for the investor as there is then hold-up, with bribe b_2 being paid, and the negative effect on profit of paying b_2 outweighs the positive effect of the higher price. It can also be bad for bureaucrat B^1, for although he or she benefits indirectly from the bribe b_2, bribe b_1 then falls (from (31), the two bribes are substitutes). Provided B^1 does not care care too much about b_2, he or she would rather not push price above p^R. Then both the investor and B^1 prefer to hold price at p^R.

When corruptibility $\Omega(\theta, \eta) \leq 0$, the investor benefits from increasing p above p^R, and pressures for this outcome in the bargain at $t = 1$. The ability of B^1 to resist calls to push up p is weakened by the fact that, if p is raised, the final price P will go up by only $\alpha < 1$. (In contrast, in the bribery case, P goes up one-for-one with the provisional price p.) Although B^2 then secures a final price below p, the overall effect is that P is higher than in the bribery case.

Ranges of (θ, η)-values for which Proposition 3 holds are illustrated in Figure 3.[22] With the values chosen for the figure $F \geq p^*$ and $\frac{1}{2}(U - K - W) - \frac{1}{1-\alpha}\gamma W > 0$. The curve $\Omega(\theta, \eta) = 0$ is the rectangular hyperbola $\eta = 1/(1 + \theta)$ on or above which the honest solution of Proposition 1 obtains. The locus $\eta = \eta_0^R(\theta)$, as given by (27), is also a rectangular hyperbola, and is the upper bound of values for which bribe b_1^R is non-negative. From (10), (19) and (27), the condition $\frac{1}{2}(U - K - W) - \frac{1}{1-\alpha}\gamma W > 0$ is sufficient for $\eta_0(\theta) < 1/(1+\theta)$. The curve $\eta = \eta'(\theta)$ divides the (θ, η)-space into those values for which, if other constraints are satisfied, $b_1 = b_1^R$ and $\hat{P} = p^R$ (on or above $\eta = \eta'(\theta)$), while $b_1 = b_1^F$ and $\hat{P} = F$ (below $\eta = \eta'(\theta, \alpha)$). From (29), $\eta'(\theta) = 1/2$, while, with the values assumed for the figure, $\eta_0^R(0) > \eta'(0, \alpha)$ as specified in Corollary 1. For the assumed values, $\eta_0^F(\theta)$ everywhere lies above $\eta = \eta'(\theta)$ and so non-negativity is guaranteed for any (θ, η)-values for which $b_1 = b_1^F$ and $\hat{P} = F$ is a potential solution.

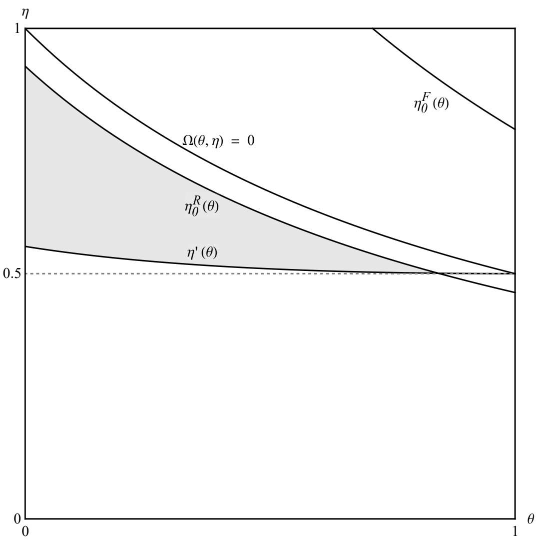


Figure 3: (θ,η)-configurations with advantageous bribery.

The solution to the model is $b_1 = b_1^R$ and $\hat{P} = p^R$ for all (θ, η)-values in, or on the boundaries of, the shaded area. On or above the $\Omega(\theta, \eta) = 0$ curve, an honest solution obtains with $\hat{P} = P^*(p^*)$. Since the condition $\frac{1}{2}(U - K - W) - \frac{1}{1-\alpha}\gamma W > 0$ is equivalent to $P^*(p^*) > p^R$, the bribery solutions in this area give greater domestic welfare than in the honest solution. Below the $\eta = \eta'(\theta)$ curve, however, $b_1 = b_1^F$ and $\hat{P} = F > P^*(p^*)$.[23]

[22] Figure 3 is drawn for the parameter values $\{\alpha, \gamma, F, K, W, U\} = \{.75, .3, .43, .15, .1, .5\}$.
[23] The remaining region is that between $\Omega(\theta, \eta) = 0$ and the upper envelope of the other two curves.

Starting at any point interior to the shaded region in the figure, if there is a reduction in θ to marginally outside the region, so that $\hat{P}$ becomes F instead of p^R, then $\hat{P} = p^R$ can be restored by an appropriate increase in η. In this sense, the figure illustrates that in bribery solutions the degree of decentralization θ and care η for domeqstic welfare are substitutes, the reverse of their interaction in determining the value of $\Omega(\theta, \eta)$ and so whether there is honesty or bribery. Although this comment only relates to a numerical example, it is an indication of the complexity of the interaction between θ and η.

Finally, we note that the possibility of hold-up plays a critical role in this analysis.

Corollary 2 *If hold-up is ruled out by assumption, domestic welfare cannot be greater with bribery than with honesty.*

If hold-up could be ruled out by a binding commitment, then the low price p^R would not be a solution with bribery. In Section 4.2 we saw that if $\eta > \eta'(\theta)$ the opportunity for mutual gain for B^1 and the investor through a bribe b_1 caused p to be raised to the highest level at which hold-up would not occur, i.e., $\hat{p} = p^R$. p is not raised further because of the repercussions that would then ensue from B^2 demanding bribe b_2. However, if hold-up could not occur, the mutual gain to B^1 and the investor from an incremental increase in p would no longer disappear above p^R. p would then be raised to F.

6 Conclusion

In this paper we have analyzed corruption and bureaucratic structure in the context of an infrastructural investment by a foreign firm, focusing on equilibria in which the threat of hold-up is insufficient to prevent the investment from occurring. In the model, a critical role is played by the potential for hold-up and by the timing of the opportunities for bribery – before and after the investment is sunk. We parameterize the degree of collusion between bureaucrats (i.e., how far the bureaucracy is centralized), which, together with the concern bureaucrats have for domestic welfare, determines the extent of bureaucratic 'corruptibility'. Lower concern and greater decentralization are each associated with greater corruptibility.

In this region, for any $\theta \in [0, 1)$, the non-negativity constraint for bribe b_1^R comes actively into play and the comparison of values of $x^1(p)$ becomes more complicated. If we assume that $b_1 = \max(0, b_1^R)$ then, when the non-negativity constraint binds, a solution $\hat{p} = \hat{P}$ interior to $(p^R, F]$ may hold, or there may be a corner solution at p^R or F. Comparison of the conditions under which each of these solutions obtains depends on the interaction of the various constraints, and does not add to the message of the paper, so we have omitted it.

With non-positive corruptibility there is no bribery and, in equilibrium, depending on parameter values, hold-up may occur. With positive corruptibility there is bribery when the provisional price is agreed, but whether there is bribery after the investment is sunk depends on whether the agreed provisional price is high enough for hold-up to be credible. We characterize a critical level of bureaucrats' concern for domestic welfare, which is a complicated function of the extent of centralization. Below the critical level, a high provisional price is agreed and there is hold-up, with bribery at both stages, and domestic welfare is relatively low. If instead bureaucrats have greater concern for domestic welfare (but there is still positive corruptibility) a low provisional price is agreed, there is no hold up, and domestic welfare is higher than in the benchmark case where bureaucrats eschew bribes. However, it is the anticipation that hold-up would occur if the provisional price were higher that underlies this potential solution.

For simplicity, we have assumed linear utility and imposed a given project budget to bound solutions. If the model were generalized with more general functional forms, by allowing the bureaucrats to have differing preferences, or with uncertainty but symmetric information, the analysis would become more complicated, but we would not expect the general thrust of the results to change. It would be interesting, however, to reformulate the model with asymmetric information, in particular with regard to costs and the government's budget.

Appendix

Proof of Lemma 1. (a) $\Omega(\theta,\eta) \leq 0$, so $b_2 = 0$. Suppose $p \in (p^R, F]$. Then, substituting from (3) and (12) into (6)-(7), with provision by the investor, $u^2 = (1+\theta)\eta\,[U - (p - T)]$. With expropriation, the cost to the government would be $[C + (1+\gamma)W]$ so, using (9), $u^2 = (1+\theta)\eta\,\{U - [\alpha p + (1-\alpha)K + (1+\gamma-\alpha)W]\}$. Therefore B^2's net payoff from agreeing provision by the investor is $(1+\theta)\eta\,[\alpha p + (1-\alpha)K + (1+\gamma-\alpha)W - p + T]$. Also using (2), provision by the investor gives a profit $\Pi = p - T - K - W$, while with expropriation $\Pi = C - K = \alpha(p - K - W)$. The net payoff to the investor is therefore $(1-\alpha)(p - K - W) - T$. The Nash bargain then gives

$$T = (1-\alpha)(p-K) - \left(1 + \frac{\gamma}{2} - \alpha\right) W.$$

Using $P = p - T$, $P = P^*(p)$. If instead $p \in \left[K + W, p^R\right]$ expropriation is not a threat, so there is no renegotiation: $P = p$.

(b) $\Omega(\theta,\eta) > 0$, so $T = 0$. Suppose $p \in (p^R, F]$. Net payoffs are therefore $(1+\theta)\eta\,(C + (1+\gamma)W - p) + b_2$ and $p - b_2 - W - C$. Substituting from (9), the Nash bargain over b_2 gives (15), and, using (9) and (10), it is found that $b_2 > 0$.

The profit from the bargain at $t = 2$ for the investor is $p - b_2 - W - C$, which, using (15) and (9), is found to be positive. The payoff for the bureaucrat is $(1+\theta)\eta\,(\alpha(p-W)+C-p)+b_2$ from the bargain at $t = 2$. Using (9) and (15), this reduces to $((1-(1+\theta)\eta)\,(1-\alpha)\,(p-K-W) +\gamma W\,(1+\theta)\,\eta)/2 > 0$. Therefore both players receive positive payoffs from the bargain over b_2.

If instead $p \in \left[K+W, p^R\right]$ expropriation is not a threat, so there is no renegotiation: $P = p$. ■

Proof of Proposition 1. Assume $\Omega(\theta,\eta) \leq 0$. Then from Lemma 2 the bureaucracy behaves honestly. If we disregard the constraint F, the Nash bargain between B^2 and the investor gives $\hat{P} = \arg\max_P\left((U-P)\,(P-K-W)\right)$. From (14), if $p \in (p^R, F]$ then $P = C(p) + \left(1+\frac{\gamma}{2}\right)W$. Substituting this into the Nash maximand and using (9) gives $\hat{p} = p^*$ (eq. (18)), and then, using (14), $\hat{P} = (U+K+W)/2 = P^*(p^*)$ (eq. (19)). If instead $p \in \left[K+W, p^R\right]$, so that $P = p$, the Nash bargain also gives $\hat{P} = P^*(p^*)$. We now use these results to classify equilibria for the different configurations of parameter values.

(i) Assume $F \geq p^*$. There are two cases, depending on whether $p^* > p^R$ or $p^* \leq p^R$.

Suppose $p^* > p^R$. If also $p^R \geq P^*(p^*)$, then $p = P^*(p^*)$ is not renegotiated and so is an equilibrium; but $p = p^*$ results in renegotiation, and then $p = P^*(p^*)$ is an equilibrium. Thus, either by renegotiation or by going straight to the solution, the equilibrium is $p = P^*(p^*)$. If instead $p^R \leq P^*(p^*)$, $p = P^*(p^*)$ does not yield an equilibrium because it would be renegotiated; but $p = p^*$ gives $p = P^*(p^*)$ after renegotiation, an equilibrium.

Suppose $p^* \leq p^R$. Then, since $P^*(p^*) < p^*$, $p = P^*(p^*)$ is not renegotiated $(P = p)$ and is an equilibrium.

(ii) Assume $p^* > F$. Consider the two ranges for p: $\left[K+W, p^R\right]$ and $p \in (p^R, F]$.

If $p \in \left[K+W, p^R\right]$ there is no renegotiation: $P = p$. If also $P^*(p^*) \leq p^R$, $p = P^*(p^*)$ is an equilibrium; but if $P^*(p^*) > p^R$, concavity of $x^1(p) = \Pi(p)u^1(p)$ implies that $p = p^R$ is an equilibrium.

If $p \in (p^R, F]$, renegotiation occurs and $P = P^*(p)$. But $p \leq F < p^*$ is infeasible, and so as $x^1(p)$ on the interval $(p^R, F]$, $x^1(p)$ is maximized at $p = F$.

Comparing $p \in \left[K+W, p^R\right]$ and $p \in (p^R, F]$, $p = P^*(p^*) = P$ yields the higher equilibrium when it is feasible, i.e., unless $P^*(p^*) > p^R$, in which case either $p = F$, so that $P = P^*(F)$, or $p = p^R$, depending on which yields the higher value of $x^1(p)$. Using (2), (3), (10) and (14), $x^1(P^*(F)) \gtreqless x^1(p^R)$ as $F \lesseqgtr (U-(1-\alpha)(K+W)-\gamma W)/\alpha$. ■

Proof of Proposition 2. First suppose $\eta > \bar{\eta}(\theta)$. Then, on the interval $p \in \left(K+W, p^R\right]$, there exists a way to simultaneously raise p and b such that both Π and u^1 are increased. Hence $\hat{p} \geq p^R$. To see that p will not be raised above $\hat{p}$ we now show that the Nash product $x^1 = u^1\Pi$ is decreasing on the interval $p \in \left(p^R, F\right]$. To do this, it suffices to show that both Π and u^1 are decreasing in p on this interval. Substituting (30) and $P = p$ into Π and u^1 we obtain

$$u^1 = \Pi = \frac{1}{2}\left[\Omega(\theta,\eta)p + (1+\theta)\,\eta U - (K+W) - (1-\theta)b_2\,(p)\right].$$

Hence,

$$\frac{\partial u^1}{\partial p} = \frac{\partial \Pi}{\partial p} = \frac{1}{2}\left(\Omega(\theta,\eta) - (1-\theta)\frac{\partial b_2\,(p)}{\partial p}\right).$$

It follows that $\frac{\partial \Pi}{\partial p} < 0 \Leftrightarrow \frac{\partial u^1}{\partial p} < 0 \Leftrightarrow \Omega(\theta, \eta) - (1-\theta)\frac{\partial b_2(p)}{\partial p} < 0$. Noting that $\frac{\partial b_2(p)}{\partial p} = \frac{(1-\alpha)(2-\Omega(\theta,\eta))}{2}$ we obtain

$$\begin{aligned}\Omega(\theta, \eta) - (1-\theta)\frac{\partial b_2(p)}{\partial p} &= \Omega(\theta, \eta) - \frac{1}{2}(1-\alpha)(1-\theta)(2-\Omega(\theta, \eta)) \\ &= \frac{(\bar{\eta}(\theta, \eta) - \eta)(1+\theta)}{1+(1+\theta)\bar{\eta}(\theta, \eta)}.\end{aligned}$$

As $\eta > \bar{\eta}(\theta)$ it follows that $\Omega(\theta, \eta) - (1-\theta)\frac{\partial b_2(p)}{\partial p} < 0$. Hence $\eta > \bar{\eta}(\theta, \eta) \Rightarrow \hat{p} = p^R$. Now suppose $\eta \in [\eta'(\theta), \bar{\eta}(\theta)]$. Again, on the interval $p \in \left(K+W, p^R\right]$, there exists a way to raise simultaneously p and b_1 such that both Π and u^1 are increased. Hence $\hat{p} \geq p^R$. But now it is also possible to raise simultaneously p and b_1 such that both Π and u^1 are increased on the interval $p \in \left(p^R, F\right]$. Hence $\hat{p} \in \left\{p^R, F\right\}$. Then $\hat{p} = p^R \Leftrightarrow x^1\left(p^R\right) \geq x^1(F)$. As a Pareto gain exists, the Nash bargaining solution that maximises Πu^1 will also maximise the surplus $\Pi + u^1$. Utilising this observation, from (2) and (7), we obtain $x^1\left(p^R\right) \geq x^1(F) \Leftrightarrow \eta \geq \eta'(\theta)$. Hence $\hat{p} = p^R$. Hence $\eta \geq \eta'(\theta) \Rightarrow \hat{p} = p^R$. Conversely, if $\eta < \eta'(\theta)$ then again $\hat{p} \in \left\{p^R, F\right\}$, but now $x^1\left(p^R\right) < x^1(F)$, so $\hat{p} = F$. ■

References

Ahlin, Christian, and Pinaki Bose (2007), 'Bribery, inefficiency, and bureaucratic delay,' Journal of Development Economics, 84, 465–486.

Albornoz, Facundo, and Antonio Cabrales (2013), 'Decentralization, political competition and corruption,' Journal of Development Economics, 105, 103–111.

Balafoutas, Loukas (2011), 'Public beliefs and corruption in a repeated psychological game,' Journal of Economic Behavior and Organization, 78, 51–59.

Bardhan, Pranab, and Dilip Mookherjee (2006), 'Corruption and decentralisation of infrastructure delivery in developing countries,' Economic Journal, 116, 101–127.

Bennett, John, and Saul Estrin (2006), 'Corruption and bureaucratic structure in a developing economy,' IZA Discussion paper No. 2156.

Choi, Jay P., and Marcel Thum (2004), 'The economics of repeated extortion,' RAND Journal of Economics, 35, 203–223.

Dechenaux, Emmanuel, and Andrew Samuel (2012), 'Pre-emptive corruption, hold-up and repeated interactions,' Economica, 79, 258–283.

Dong, Bin, Uwe Dulleck and Benno Torgler (2012), 'Conditional corruption,' Journal of Economic Psychology, 33, 609-627.

Dreher, Axel, and Martin Gassebner (2013), 'Greasing the wheels? The impact of regulations and corruption on firm entry,' Public Choice, 155, 413–432.

Fan, C. Simon, Chen Lin and Daniel Treisman (2009), 'Political decentralization and corruption: Evidence from around the world,' Journal of Public Economics, 93, 14–34.

Guasch, J. Luis, Jean-Jacques Laffont, and Stephane Straub (2008), 'Renegotiation of concession contracts in Latin America,' International Journal of Industrial Organization, 26, 421–442.

Hajzler, Christopher, and Jonathan Rosborough (2016), 'Government corruption and foreign direct investment under the threat of expropriation,' Staff Working Paper 2016-13, Bank of Canada.

Klitgaard, Robert (1988), Controlling Corruption, Berkeley: University of California Press.

Koessler, Frédéric, and Ariane Lambert-Mogilansky (2014), 'Extortion and political-risk insurance,' Journal of Public Economics, 120(C), 144–156.

Leff, Nathaniel (1964), 'Economic development through bureaucratic corruption,' The American Behavioral Scientist, 8, 8–14.

Lessman, Christian, and Gunther Markwardt (2010), 'One size fits all? Decentralization, corruption, and the monitoring of bureaucrats,' World Development, 38, 631–646.

Lui, Francis T. (1985), 'An equilibrium queuing model of bribery,' Journal of Political Economy, 93, 760–781.

Martinez-Vasquez, Jorge, Santiago Lago-Peñas and Agnese Sacchi (2015), 'The impact of fiscal decentralization: a survey,' International Center for Public Policy Working Paper 15-02, Georgia State University.

Méon, Pierre-Guillaume, and Laurent Weill (2010), 'Is corruption an efficient grease?' World Development, 38, 244–259.

Mookherjee, Dilip (2013), Incentives in hierarchies, in Robert Gibbons and John Roberts, ed., The Handbook of Organizational Economics, Princeton and Oxford: Princeton University Press.

Olken, Benjamin J., and Patrick Barron (2009), 'The simple economics of extortion: Evidence from trucking in Aceh,' Journal of Political Economy, 117, 417–452.

Rose-Ackerman, Susan, and Bonnie J. Palifka (2016), Corruption and Government: Causes, Consequences, and Reform, 2nd edition, Cambidge UK: Cambridge University Press.

Shleifer, Andrei, and Robert W. Vishny (1993), 'Corruption,' Quarterly Journal of Economics, 108, 599–618.

Svensson, Jakob (2003), 'Who must pay bribes and how much? Evidence from a cross section of firms,' Quarterly Journal of Economics, 207–230.

Thomas, Jonathan, and Tim Worrall (1994), 'Foreign direct investment and the risk of expropriation,' Review of Economics Studies, 61, 81–108.

UNCTAD (2012), Expropriation, United Nations Conference on Trade and Development, Series on Issues in International Investment Agreements II, New York and Geneva: United Nations.

Waller, Christopher J., Thierry Verdier and Roy Gardner (2002), 'Corruption: top down or bottom up?' Economic Inquiry, 40, 688–703.

World Bank (2016), Anti-corruption, Governance Brief, November 28, http://www.worldbank.org/en/topic/governance/brief/anti-corruption.