Corruption Cycles

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1. Introduction

Political corruption has been a persistent phenomenon throughout history and across societies. It is found today in many different forms and degrees in all types of political systems, in developing countries as well as in Western democracies. The phenomenon is not solely or even largely the consequence of a moral fault or cultural backwardness. The root cause of corruption, in Europe as well as in Japan, Latin America and the United States, is found in the mixture of economic and political power.

We take corruption to consist in the illegitimate use of public roles and resources for private benefit, where 'private' often refers to large groups such as political parties. This definition has the advantage of subsuming many different kinds of corrupt behaviour, ranging from public officers' use of their position to maximize personal gain by dispensing public benefits to the implementation of policies that violate the common interest in favour of special interests, such as granting large firms the monopoly of their services within a particular sector. Since this definition of corruption is based upon legal norms, not public opinion or social norms, it has the advantage of directing our attention to the contrast between official and social norms that is present in most societies.[1]

The literature on corruption is a large corpus of descriptive studies, but a full fledged theory of corruption is yet to come. As a result, many dimensions of corruption have been left unexplored.[2] One such problem is the life-cycle of corruption. If corruption is endemic, what are the forces that allow it to prevail? What permits it to continue? An answer to this question cannot be separated from an analysis of the political and economic effects of corruption. There has been widespread disagreement among scholars studying the phenomenon regarding the direction of its effects. The so-called Moralists maintained that corruption is harmful, as it impedes development and erodes the legitimacy of institutions.[3] Revisionists point instead to the possible benefits of corruption: it

[1] The classic statement of this definition of corruption has been given by Nye. According to him, a political act is corrupt when it 'deviates from the formal duties of a public role (elective or appointive) because of private-regarding (personal, close family, private clique) wealth or status gains: or violates rules against the exercise of certain types of private-regarding influence'. Cf. J. Nye, 'Corruption and political development: a cost-benefit analysis', *American Political Science Review*, 61 (1967), p. 416.

[2] An analysis of how a corrupt political system may suddenly collapse is found in C. Bicchieri and C. Rovelli, 'Evolution and revolution: the dynamics of corruption', *Rationality and Society*, 7 (1995).

[3] Cf. G. Myrdal, 'Corruption: its Causes and Effects', in *Asian Drama: an Enquiry into the Poverty of Nations, vol. 2* (New York, Twentieth Century, 1968), and also R. Wraith and E. Simpkins, *Corruption in Developing Nations* (London, Allen and Unwin, 1963).

can speed up cumbersome procedures, bypass inefficient regulations, buy political access for the excluded, thus fostering the integration of immigrant or parochial groups, and even produce policies that are more effective than those emerging from legitimate channels.[4] Revisionists have typically focused their attention upon non-Western nations undergoing political modernization and development. Their belief that corruption is functional to development has fostered the expectation that corruption will disappear once the process of modernization is completed. However, much research in political science indicates that corruption is endemic even in the fully developed Western countries.[5]

Though it is difficult to calculate precisely the impact of corruption on social welfare, the recent corruption scandals in Italy and Japan have brought to light the costs and inefficiencies that accompany corrupt practices. In both cases, governments had many opportunities to grant privileges and exemptions in return for material or political favours. Since huge profits hinge upon such privileges, companies have gone to any lengths, including bribery, to win them. There is evidence that widespread bribery of public officials to obtain public works contracts systematically inflated business costs, while consumers have been injured by monopoly pricing. Corruption has had an influence on public policies, too. Policies have been selected and implemented with a view of generating income and political support. Firms have been 'helped' with price subsidies, regulatory exemptions, protective tariffs and import quotas.[6]

If, as we maintain, systemic corruption has extensive social and economic costs, why is it a recurrent phenomenon? In many countries, we have witnessed long periods of systemic corruption followed by 'clean-ups' that are in turn followed by other periods of corruption.[7] An important task of a theory of corruption is thus to identify what factors are at play in engendering such cycles.

The end of a period of corruption is not necessarily driven by the public getting informed about the existence of corrupt activities. We have learned from history and experience that officials can engage in illegal activities without being reprimanded at the polls. A typical explanation offered for this is that officials can trade material benefits in return for votes. This was certainly true of machine politics in US cities at the turn of the century, as well as of any form of political clientelism, where political parties channel policies and resources towards individuals and groups and, in return, are guaranteed continual electoral support.[8] The American urban political machine, for example, dealt

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[4] Cf. J. Abueva, 'The contribution of nepotism, spoils and graft to political development', *East-West Center Review*, 3 (1966); N. Leff, 'Economic development through bureaucratic corruption', *American Behavioural Scientist*, 8 (1964); H. D. Bayley, 'The effects of corruption in a developing nation', *Western Political Quarterly*, 19 (1966).

[5] Cf. G. Benson, *Political Corruption in America*, (Lexington, 1978); J. Dobel, 'The corruption of a state', *American Political Science Review*, 72 (1978); S. Mamoru and H. Auerbach, 'Political corruption and social structure in Japan', *Asian Survey*, 17 (1977); S. Rose-Ackerman, *Corruption: a Study in Political Economy* (New York, Academic, 1978).

[6] In Italy, for example, by the 1970s the state sector had become a political instrument at the hands of the Christian Democrats. Its economic functions were subordinated to the policies of enabling the survival of that party. Cf. Donald Sassoon, *Contemporary Italy* (London, Longman, 1988).

[7] Cf. K. Gillespie and G. Okrulik, 'The political dimensions of corruption cleanups', *Comparative Politics* (1991).

[8] Cf. H. Gosnell, *Machine Politics: Chicago Model* (Chicago, University of Chicago Press, 1967).

almost exclusively in particularistic, material rewards (jobs, licenses, welfare payments, selective non-enforcement, etc.) to maintain and extend political control. Indeed, the costs of maintaing a clientist system or a political machine are usually extremely high. In New York City in the 1930s, the total annual pay for posts exempt from civil service regulations (i.e., political jobs) exceeded seven million dollars, and it is reported that boss Tweed, in four years, raised New York City's debt by a multiple of three while leaving both the tax rate and assessments untouched.[9]

One would expect, however, that where there are no large organizations that can provide material inducements through the multitude of explicit exchanges that would be necessary to control elections, informed voters would be less likely to support a corrupt candidate. To explain why corrupt incumbents get re-elected, it has been hypothesized that there occurs an implicit exchange between voter and candidate. According to this hypothesis, one would expect that a corrupt candidate strategy would be to take distinct positions on things many voters care about, and therefore arrange as many implicit trades as possible. Indeed, there is some experimental evidence supporting the implicit trade hypothesis.[10]

In this paper, we demonstrate with a formal model how, under plausible assumptions, corruption can become cyclical. A crucial assumption of our model is that corrupt politicians, in order to be re-elected, have to compensate voters through material incentives. Even in the absence of grassroot clientist organizations handing out individual benefits, corrupt politicians can enact policies that benefit particular industrial and financial groups. If the benefited groups control a large number of votes, a corrupt incumbent will be re-elected. We assume that enacting such policies involves the use of resources on the part of the politician. To sustain systemic corruption politicians thus need resources, and we may expect a political turnover when resources are depleted.[11] Since we assume that a sizeable portion of a politician's resources has been amassed in a

[9] J. Scott, 'Corruption, machine politics and political change', *The American Political Science Review*, 62 (1969).

[10] In a small experiment done with students in 1977, Rundquist, Strom and Peters report that certain kinds of information induce more voting for the corrupt candidate; in that particular experiment, it was information on the candidate's Vietnam position. Subjects who received this information had a probability of 0.44 of voting for the corrupt candidate, whereas subjects who received no information had a zero probability of voting for him. Intensity of preference matters, though, since the experiment shows that the more important the policy issue is to a voter, the higher the probability of voting for the corrupt politician that has a similar view on that issue. This analysis suggests that corrupt incumbents may owe re-election to implicit trading with voters, and predicts that corrupt candidates may have extra incentives to take distinct issue positions than do non-corrupt candidates. Corruption would thus accentuate the tendency to move away from the modal position. Also, this hypothesis may account for the tendency of voters to focus on corruption during periods of economic stagnation, as their expectations of policy satisfaction are low. Cf. B. Rundquist, G. Strom and J. Peters, 'Corrupt politicians and their electoral support: some experimental observations', *The American Political Science Review*, 71 (1977).

[11] This hypothesis is supported by historical evidence from, among other things, the demise of political machines. It is well acknowledged that support generated by machine rewards is based on the continuing distributive capacity of the regime. Since the machine has to buy its popularity, and to the extent it faces competition, the cost of popularity increases and resources may not be sufficient to meet the demands. Machines, both in the US and in new nations such as India, Malaysia, and many West African countries, tend to live beyond their means. When disposable rewards cease or sizably diminish in the absence of economic expansion, support ceases, too.

period of 'honest' administration, an interesting (and testable) consequence of the model presented here is that what drives the cycle's periodicity is not increasing social costs, but the length of the honest administration period. *Ceteris paribus,* the longer the period of honest government has been, the longer corruption will last. Because politicians' resources are limited, in a democratic system discontented electors will eventually vote corrupt politicians out of office.

The new period of honest administration will not last, however. Whereas the penalty for corruption is very high for a newly elected politician, it decreases over time up to the point at which it becomes zero. When the system reaches that critical time, it switches very rapidly to a generalized corruption state. We thus have a threshold, or critical time, at which there will be a cascade of corrupt behaviour. Whereas the periods of corruption or honesty can be very long, the switch from one regime to another is abrupt. As long as governments will wield extensive control over the economy, firms will have an incentive to engage in illegal practices to obtain lucrative public contracts, ensure a monopoly of their services within a particular sector or otherwise obtain some form of preferential treatment. And whenever the penalty for corrupt behaviour is nil, politicians will have an incentive to use their control over public resources to increase their power.

2. The Model

There are two types of players, politicians and contractors. Let $n > 1$ denote the number of politicians, and let $m > 1$ denote the number of contractors. To simplify exposition, we shall assume that $n = m$. Groups of politicians typically have control over a given area, or a given pool of resources. In particular, politicians control public work contracts, and we assume that each of the n politicians has a single contract to award to one of the m contractors in each period.[12]

There are two strategies available to each type of player. Politicians and contractors may either play the honest or the corrupt strategy. Corruption here refers to the illegal activity of giving or taking a bribe in connection with public works contracts. We assume that both the politicians and the contractors interact for many periods, and new contracts are awarded each period. Each interaction can be modeled as a stage game in which politicians and contractors have to decide whether to bribe/be bribed or to behave honestly. The game is repeated indefinitely, with the same or with different parties. What matters is that the parties to the interaction know about the incentives of the players with whom they are interacting.

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[12] This assumption is an extreme simplification. Typically, a political party controls public agencies that extract payments from local companies in exchange for granting public works contracts. In Italy, for example, public agencies such as ANAS (National Roadways Agency), ATM (Milan Transport Agency), AMSA (Municipal Agency for Environmental services) acted as intermediaries between the parties and private firms. In Italy alone there are 60,000 *enti pubblici* (special agencies) that are dominated by parties and function as mechanisms for the distribution of contracts. Cf. David Hine, 'Italy', in F. F. Ridley (ed.), *Government and Administration in Western Europe* (Oxford, Martin Robertson, 1979); cf. also J. LaPalombara, *Interest Groups in Italian Politics* (Princeton NJ, Princeton University Press, 1964).

Note that the payoff for each type of player will depend both on the strategies adopted by the other players of his type and on those adopted by players of the other type. For example, the outcome of a contractor's choice to bribe will depend upon the existence of corrupt politicians, as well as upon the behaviour of other contractors. And the outcome of a politician's willingness to ask for a bribe will depend upon the existence of contractors that are willing to pay, as well as upon the behaviour of other politicians.

2.1 Politicians

To understand how the individual politician's payoffs for a single stage of this repeated game depend on the strategies adopted by the other $n - 1$ politicians, let us consider the following payoff matrix, in which the individual politician is the row player (the game is symmetrical):

	All H	Some or All C
H	b	$b - \dfrac{\delta N}{2n}$
C	$\beta + b - \dfrac{\delta}{2n} - w_t$	$\beta + b - \dfrac{\delta N}{2n} - w_t$

Here H denotes the honest strategy, and C denotes the corrupt strategy. We assume that each politician has one contract to award in each period. The politician gets a payoff of b if he adopts the honest strategy H, and all the other politicians also pay the H strategy. We may think of b as the base salary of the honest politician. Note that if all contractors are honest, a politician will always get a payoff of b, as in this case there will be no possibility of becoming corrupt. Whenever there is at least one corrupt contractor, however, things change. The above matrix represents the case in which some contractors are willing to pay a bribe, and the politician has to decide whether to be honest or corrupt.

Let us say that the total price of a public work x obtained through a corrupt contract is $a + \alpha + \beta$, where a is the market price of x, α is the mark-up extracted by the contractor, and β is the bribe paid to the politician as a percentage of the whole contract. We are assuming that contract prices are much higher in a corrupt system than in a non-corrupt one. This is not a necessary feature of corrupt systems, though, since corruption may not involve an inefficient allocation of resources. Contracts could be awarded to the highest bribers, and those who can pay the highest bribe must also have the lowest production costs. In our model, however, the bribe (as a percentage of the contract price) is fixed; thus, the higher the contract price, the greater the bribe. In this case, the contractor may also be chosen on the basis of his political 'accountability', capability of sponsoring given party members, etc. To simplify

matters, we assume that contractors, whenever they are corrupt, are all equally accountable.[13]

We also assume that β is an increasing function of the number of corrupt encounters. That is, the greater the number of corrupt dealings, the harder the politicians will compete for funding, raising the price of contracts (hence the fixed percentage β). Each corrupt contract thus has a social cost $\delta = \alpha + \beta$. As we shall discuss presently, once corruption has occurred, the social cost δ increases linearly with time, as the costs of corrupt contracts increase. We talk of a 'social' cost because, when corruption occurs, prices will be higher, which in turn will result in an overall reduction in consumers' income. The social costs do not end here, though. In a corrupt system, consumers may have to pay monopoly prices, and the quality of many goods will usually be inferior.

The politician receives a payoff of $b - (\delta N/2n)$ if he plays the honest strategy, but $N \in [1, n-1]$ if the other politicians are playing the corrupt strategy. Here δ denotes the social cost per corrupt encounter between a politician and a contractor, and N is the number of corrupt encounters (also, the number of corrupt politicians). Note that when all politicians are corrupt, the number of corrupt encounters N, is equal to the number of politicians, n. The total social costs from corruption (δN) are distributed evenly across all $2n$ players, regardless of their involvement.[14] We may think of $\delta/2n$ as a tax people pay for each act of corruption. In a corrupt system, everybody is 'forced' to finance the increasing costs of corruption.

If the politician plays the corrupt strategy C, and all other politicians play the honest strategy H, the politician's net payoff is $\beta + b - (\delta/2n) - w_t$, where $\beta + b > b$ is the *gross* payoff of the corrupt politician, β is the amount of the bribe paid to the politician by a corrupt contractor, and w_t is a penalty each politician faces for being corrupt, where w_t is a decreasing function of time over the period in which the politician is honest.[15] Finally, if the politician plays the C strategy, and $N - 1$ of the other politicians are also playing C, the politician's net payoff is $\beta + b - (\delta N/2n) - w_t$.

We assume that over some period of time t, the parameters in the above payoff matrix satisfy:

$$\beta + b - \frac{\delta}{2n} - w_t \begin{cases} \leqslant b & \text{for } t = 1, 2, \ldots, T-1, \\ > b & \text{for } t \geqslant T. \end{cases}$$

Given these conditions, it follows from the politician's payoff matrix that all n politicians will initially coordinate on the All H outcome. That is, each of the n politicians will choose to play the H strategy up until time T.

At time T, a cascade from All H to All C occurs. It is assumed that time T is the first date at which the corrupt strategy yields a *Pareto superior* outcome

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[13] We are assuming here that there is no exclusion, i.e., that no firm can be excluded from making tender offers for public contracts. What often happens is that larger firms subcontract part of the work to smaller firms.

[14] Recall that, since we have assumed that $n = m$, the total number of players is $2n$.

[15] In section 4 we provide an example of a penalty function that depends upon the evolution of the play of the game.

relative to the honest strategy. The conditions under which the corrupt strategy (All C) yields a *Pareto superior* outcome are:

(i) $\beta + b - (\delta/2n) - w_t > b,$
(ii) $\beta + b - (\delta N/2n) - w_t > b,$
(iii) $\beta + b - (\delta N/2n) - w_t > b - (\delta N/2n).$

The three conditions above just state that corruption is a dominant strategy for each politician, and that generalized corruption (All C) is Pareto superior to generalized honesty (All H). Since each politician will play his dominant strategy, the resulting All C outcome becomes a Nash equilibrium at time T. Taken together, these three conditions lead to the restriction that $\beta > (\delta N/2n) + w_t$. However, since at time T there will be a cascade of corruption and we will have $N = n$, the restriction on β can be rewritten as: $\beta > (\delta/2) + w_t$. Since by definition $\delta = \alpha + \beta$ at the critical time T we must have that $\beta > [(\alpha + \beta)/2] + w_t$, or more simply that:

$$\beta > \alpha + 2w_t.$$

We shall assume that, beginning with time T, the above condition always holds. What the condition states is that the politician's bribe is always greater than the contractor's extra gain from corruption. The inequality may be understood to represent the fact that politicians have greater power than contractors, in that they control resources and future contracts.

After time T, the date of the first corrupt encounters between politicians and contractors, the social costs of corruption are assumed to *grow over time*. We shall assume for simplicity that these social costs grow *linearly* over time.[16] The social costs of corruption grow because the payoff values to both politicians and contractors of corrupt contracts are assumed to increase by a fixed multiple per unit of time. Over time, both contractors and politicians will demand a greater payoff from each corrupt encounter. Since the politician's goal is not just to maximize his wealth, but he also wants to be re-elected, he will need money to consolidate his power.[17] Because a politician is competing against other politicians, he will need increasing amounts of money to maintain his power base. This explains the tendency, noted in many countries, to inflate progressively the prices of public contracts. We shall thus denote the social cost of each corrupt encounter by $\delta_t = \alpha_t + \beta_t$, where α_t is the mark-up received by a contractor who plays the corrupt strategy (we shall describe the contractor's payoff matrix shortly).

We have that for $t \geqslant T$, i.e. for $t = T, T + 1, T + 2, \ldots,$

$$\delta_t = \alpha(t + 1 - T) + \beta(t + 1 - T).$$

Here α and β denote constants, reflecting the amounts that contractors and politicians appropriate from corruption.

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[16] The assumption that the social costs of corruption grow linearly over time is not necessary for our results.

[17] Funds are needed to organize political campaigns, but also to funnel material benefits to a politician's constituency.

Since the corruption cascade will occur at T, we must have that

$$\delta_t = \begin{cases} 0 & \text{for } t < T, \\ \alpha(t + 1 - T) + \beta(t + 1 - T) & \text{for } t \geqslant T. \end{cases}$$

The timing of the cascade from All H to All C is completely determined by the w_t function. The w_t penalty affects the payoff of any politician who chooses to play C, regardless of the strategy chosen by the other politicians. From the definition above, we can find the value of δ_t at $t = T$, the time of the cascade, i.e. $\delta_T = \alpha + \beta$. We can then use this value for δ_t to find a critical value for w_t at which the individual politician will be just indifferent between corrupt and honest behaviour, i.e. when $b = \beta + b - (\delta_t/2n) - w_t$. This critical value is given by:

$$w_{\text{crit}} = \frac{1}{2n}[(2n - 1)\beta - \alpha].$$

The sequence of values for w_t is assumed to diminish over time during the period in which the politician is honest. In particular, we shall assume that the sequence, $\{w_t\}$, satisfies:

$$w_1, \ w_2, \ \ldots, \ w_{T-1} > \frac{1}{2n}[(2n - 1)\beta - \alpha] > 0, \ \text{and}$$
$$w_t = 0 \text{ for all } t \geqslant T.$$

This diminishing w_t function is a crucial feature of our model. We may assume that this function captures receding memories about past corruption. Another possible interpretation of the diminishing w_t function is that, as time passes, politicians consolidate their power. Over time, politicians are able to award more contracts and gain greater influence. The greater the influence the politician has, the less likely it is that the politician will be revealed as corrupt. Greater influence might mean, among other things, that political parties may come to control the media as well as the judiciary system, so that the probability of being denounced and punished for corruption becomes effectively nil.[18] In section 4 we provide yet another interpretation of the w_t function, where we assume that w_t is simply a past average of the contractors' payoff performance. Contractors are assumed to have finite memories of past payoff performance. If they have received good payoffs over the recent past, then the penalty for corruption is diminishing, while if they have received poor payoffs in the past, the penalty for corruption is rising.

At time T, the individual politician will always choose to be corrupt. Since it is common knowledge that the critical time has been reached, the other politicians (who are identical in all respects) will also choose to become corrupt precisely at the same time, i.e. we will never observe any intermediate state at which only some of the politicians are corrupt. That the corruption cascade will be a sudden phenomenon is a testable implication of our model, provided that certain *ceteris paribus* conditions are satisfied. They will include, among other things, rational behaviour on the part of the politicians, and the absence of behavioural norms that may constrain the choice-set of agents.

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[18] This has been the case in Japan, as reported by W. Holstein, *The Japanese Power Game* (New York, Macmillan, 1990).

2.2 Contractors

The individual contractor's payoffs for a single stage of this repeated game depend on the strategies adopted by the other $m - 1$ contractors, as well as on the presence of corrupt politicians. The individual contractor is the row player in the following payoff matrix (the game is symmetrical):

	All h	Some or All c
h	a	$a\left(\dfrac{n - N}{m}\right) - \dfrac{\delta N}{2n}$
c	$a\left(\dfrac{n - N}{m}\right) + N(\alpha + a) - \dfrac{\delta N}{2n}$	$a\left(\dfrac{n - N}{m}\right) + \dfrac{N}{M}(\alpha + a) - \dfrac{\delta N}{2n}$

Note that, when all politicians are honest, every contractor will behave honestly, regardless of his propensity. While there is no penalty for a contractor who attempts to bribe a politician, such attempts are useless before time T. The above matrix thus depicts a situation in which there is at least one corrupt politician, i.e. $N \in [1, n]$. The number of corrupt contractors in the above matrix is denoted by $M \in [1, m]$.

Here, h denotes the honest strategy, and c denotes the corrupt strategy. The individual contractor's expected payoff (in terms of contracts awarded) is a if the contractor plays the h strategy and all other contractors also play the h strategy. The contractor receives a payoff of $a[(n - N)/m] - (\delta N/2n)$ if he plays the h strategy, but some or all of the other contractors choose the c strategy. Here again, N denotes the number of corrupt encounters (equivalently, the number of corrupt politicians, or corruptly negotiated contracts).

If the individual contractor chooses to play the c strategy, he receives a payoff of $a[(n - N)/m] + N(\alpha + a) - (\delta N/2n)$ if all other contractors play h, and there are N corrupt politicians. However, if the individual contractor plays c and $M - 1$ of the other contractors play c, the payoff to the individual contractor is reduced to $a[(n - N)/m] + (N/M)(\alpha + a) - (\delta N/2n)$, where M is the total number of corrupt contractors (including the row player).

Note that, since at time T there will be a cascade of corrupt behaviour on the part of the politicians, a state of corruption is always generalized, that is, it is a Nash equilibrium for all politicians and all contractors to play the corrupt strategy so that $N = n$ and $M = m$. In this generalized state of corruption, the All c payoff to contractors can be rewritten more simply as $(\alpha + a) - (\delta n/2n)$. Under the assumption that $n = m$, the conditions under which the above game is a prisoner's dilemma for contractors are:

(i) $a[(n - N)/m] + N(\alpha + a) - (\delta N/2n) > a$,
(ii) $a > \alpha + a - (\delta n/2n)$,
(iii) $\alpha + a - (\delta n/2n) > a[(n - N)/m] - (\delta N/2n)$.

As was the case for the politicians, the three conditions above just state that corruption is a dominant strategy for each contractor, but for contractors, unlike politicians, the outcome of overall honesty is better than that resulting

from corruption. The difference between contractors and politicians is that contractors *always* face a prisoner's dilemma situation, whereas politicians' choice to become corrupt results in a Pareto superior outcome.

Using the defintion of δ_t at $t = T$ i.e. $\delta_T = \alpha + \beta$, and the fact that $n = m$, we find that the above conditions reduces to the simple restriction that

$$\beta > \alpha.$$

Thus we find that a restriction for a prisoner's dilemma among contractors is that the additional payoff that each contractor receives from a corrupt encounter, α, is less than the additional payoff a politician receives from each corrupt encounter, β. Note that the above inequality is implied by the condition $\beta > \alpha + 2w_t$ that guarantees that corruption is a Pareto superior Nash equilibrium for the politicians at $t \geqslant T$.

Although the All c outcome is a prisoner's dilemma for the contractors, they do not immediately coordinate upon the All c outcome – in fact, they spend the first T periods at the All h outcome. As we already mentioned, while the incentives are such that contractors will always try to bribe politicians (i.e. play the corrupt strategy), the contractors will not be immediately successful in their efforts because of the w_t function. Once we reach time T, however, the contractors will bribe, the politicians will take the bribes, and the cascade, from the contractors' perspective, from All h to All c will be immediate.

2.3 Elections

We assume throughout that the political system is a democratic one. Elections are held at some date $t = (1 + \phi)T$, where $\phi > 0$. That is, we assume that elections are held only *after* politicians have 'chosen' to become corrupt. There are n elected positions, and to win, each candidate has to get a majority of the $2n$ votes. We assume, for simplicity, that for every corrupt incumbent politician, there is an honest politician who will run against him. A state of generalized corruption is a prisoner's dilemma for the contractors who, though always ready to bribe, know that they would be better off in a state in which everyone is honest.

Politicians are not long-lived players in the game, whereas contractors endure forever. This is a key assumption. Although politicians are inevitably driven to the All C outcome, they are content to stay at All C, because it is a Pareto superior outcome. As we shall presently explain, politicians may choose to forgo the Pareto superior payoff in order to be re-elected. Provided the politician cares enough about power, even a negative payoff will be acceptable.

The same is not true for contractors. We can think of contractors as being infinitely lived agents. Alternatively, we may think of family dynasties, where contracting businesses are handed down from one generation to the next. Once the contractors are at All c, they will seek to vote the politicians out of office at the earliest possible opportunity. Each contractor, being rational, will vote for the incumbent only if at the time of the election the contractor is *no worse off in terms of payoffs than he is in the All* h *state*. If the contractor is worse off, as he is in a prisoner's dilemma, he votes for the alternative honest candidates, who can credibly guarantee him the All h payoff for T more periods. The contractors' first opportunity to vote the politicians out of office will be at the next election, which occurs at date $t = (1 + \phi)T$. Thus, the contractor will

have to endure the lower payoff at All c for some period of time, e.g. for ϕT periods.

The corrupt incumbents, however, can seek to win (buy) votes by compensating contractors for their loss in the All c state. Politicians are always assumed to vote for themselves. So if all contractors are compensated for being in the prisoner's dilemma, each politician receives at least $m + 1$ votes. If we assume that $m \geqslant n$, corrupt politicians who compensate contractors always win re-election. Yet compensation, as we shall see, cannot continue indefinitely.

In fact, politicians do more than simply compensate contractors for their losses from corruption. Politicians provide contractors with the difference between the contractors' All h payoffs and the contractors' All c payoffs, plus a little bit more, say $\varepsilon > 0$.

The politicians begin to compensate contractors at time T (when $w_t = 0$) by drawing upon their accumulated payoff earnings. Prior to time T, each politician has accumulated a payoff of $b(T - 1)$. In every period $t \geqslant T$, each politician receives:

$$\beta_t + b - \frac{\delta_t n}{2n},$$

where we have set $N = n$ since in the unique Nash equilibrium all politicians are corrupt. Using our definition for δ_t, and the fact that $n = m$, we can rewrite the politician's per-period payoff for $t \geqslant T$ as:

$$\frac{1}{2}[\beta(t + 1 - T) - \alpha(t + 1 - T)] + b.$$

Using the politician's per-period payoff beginning at time T, and the accumulated earnings prior to time T of $b(T - 1)$, we can now find the politician's *accumulated* payoff at each date $t \geqslant T$. Since it is assumed that $w_t = 0, \forall t \geqslant T$, we can ignore the w_t term starting at time T.[19] Each politician's accumulated payoff for $t \geqslant T$ is simply the sum of the payoffs the politician has received up through time $T + k - 1$, where $k = 1, 2, \ldots$ denotes the number of periods of generalized corruption. We can write this accumulated payoff as:

$$P_{T+k-1} = \frac{k(k + 1)}{4}(\beta - \alpha) + b(T + k - 1).$$

Election is according to majority rule. Each politician is only assured of receiving his own vote, but needs at least $(2n)/2 = m$ additional votes to win re-election. Therefore, each of the n politicians has to compensate all of the m contractors for being at the All c outcome rather than at the All h outcome to ensure re-election.[20] The compensation amount contributed by all n politicians to each of the m contractors must be such that each contractor is no worse off, and is in fact slightly better off, at the All c outcome of the game, as compared with the All h outcome.[21]

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[19] This assumption regarding w_t at $t \geqslant T$ is made for simplicity, and we relax this assumption later on in section 4.

[20] Note that, were $m > n$, politicians would only need to compensate a subset of contractors in order to win re-election.

[21] This compensation amount is *not* guaranteed to contractors. In fact, as we shall see, compensation of contractors by politicians will not continue indefinitely. For this reason, the compensation amount does not appear in the contractors' payoff matrix.

Beginning at time $t = T$, the *minimum* amount that must be paid by each politician to each contractor with whom he is interacting is an increasing function of time and is given by:

$$a - \left(a + \alpha_t - \frac{n\delta_t}{2n}\right) > 0.$$

This amount is simply the difference between the All h and All c outcomes. However, we assume that politicians provide contractors with $\varepsilon > 0$ more than this minimum amount so that contractors are not just indifferent between voting for the corrupt incumbent politicians or voting for the honest new politcians. Note that ε is paid as part of the corrupt contract, and it must compensate the contractor also for all the social costs incurred in periods when he does not get a contract.

So the compensation amount paid to each corrupt contractor in every period of corruption can be written as:

$$\frac{n\delta_t}{2n} - \alpha(t + 1 - T) + \varepsilon.$$

Using the definition of δ_t and the fact that $n = m$, we find that this compensation amount at date $t + 1 - T > 0$ is:

$$\frac{1}{2}[\beta(t + 1 - T) - \alpha(t + 1 - T)] + \varepsilon.$$

The accumulated compensation amount at date $T + k$ is found by summing the compensation amounts received at every date $T \leqslant t \leqslant T + k - 1$, for $k = 1, 2, \ldots$ This accumulated compensation can be written as:

$$C_{T+k-1} = \frac{k(k + 1)}{4}(\beta - \alpha) + k\varepsilon,$$

where k again denotes the number of periods in which the economy has been in the generalized state of corruption.

There remains the question of how long the politicians can sustain the corrupt state of All C for themselves and All c for contractors by compensating the contractors for being in the prisoner's dilemma. To answer this question, we can set

$$nP_{T+k-1} = mC_{T+k-1},$$

and solve for the date k at which the politicians' resources will be completely depleted by the compensation paid to contractors. Using the definitions of P_{T+k-1} and C_{T+k-1}, and the fact that $n = m$ we have:

$$\frac{nk(k + 1)}{4}(\beta - \alpha) + nb(T + k - 1) = \frac{nk(k + 1)}{4}(\beta - \alpha) + nk\varepsilon.$$

We can solve this equation for k, the number of periods of generalized corruption:

$$k = \frac{b(T - 1)}{\varepsilon - b}.$$

Note that for $k > 0$, it must be the case that $(\varepsilon - b) > 0$ (or that $\varepsilon > b$). Provided this condition is satisfied, the All C and All c states can be sustained for k periods

beginning with period T. The politicians are voted out of office in the first election that is held after time $T + k - 1$. Note that $\partial k/\partial b > 0$, and $\partial k/\partial T > 0$, while $\partial k/\partial \varepsilon < 0$. We have assumed b, the politician's salary, to be fixed. T depends on how fast the penalty for corruption w_t declines. Therefore, the slower is the decline in w_t, the longer corruption can last. By making $(\varepsilon - b)$ very small but positive, the politicians can sustain corruption for a very long period of time as well. We always assume, however, that there is a limit to how close ε can be to b. Since agents have a perceptual threshold, and will not perceive a value of ε below it, ε must always be bounded away from b.

It may be interesting to ask what would happen if elections were held before $T + k - 1$ (but after T). In this case, a rational contractor that is able to calculate when compensation will end would vote for the corrupt incumbent only if the total payoff he can expect between this election and the next exceeds the All h payoff he is sure of getting for $T - 1$ periods by electing an honest politician. Contractors, however, may lack this crucial piece of information or, alternatively, they may be myopic decision makers that get their clues from the immediate past. If they received compensation in the past, they will expect it to continue in the future and thus re-elect the corrupt incumbent. Re-election of corrupt incumbents might also be due to contractors discounting future payoffs, thus overlooking the fact that incumbents might run out of money much before the next election and make them lose compensation quite soon. The fact that contractors may be myopic, as opposed to fully rational and informed, will only lengthen the term of corrupt politicians. Eventually, however, they will be voted out of office.

Another possibility is that elections take place before the critical time T, i.e. before politicians have had a chance of becoming corrupt. In this case, it is in the interest of a rational contractor to re-elect the incumbents, as w_t keeps declining and he knows that at time T he will get a compensation. A myopic contractor, on the other hand, will be indifferent as between candidates.

We have assumed thus far that politicians will compensate contractors until they run out of money. Politicians, however, *choose* to compensate. But in so doing, they may get negative payoffs, depending on the value they choose for ε. To see that the politician's payoff after compensating the contractor may be negative, recall that in the corrupt state, the politician receives a per period payoff of $\beta_t + b - (\delta_t n/2n)$ *prior* to compensating the contractor. The compensation amount at time $t \geqslant T$ is $a - (a + \alpha_t - (n\delta_t/2n)) + \varepsilon$, or simply $(n\delta_t/2n) - \alpha_t + \varepsilon$. Therefore, the net payoff to the politician at time T when $\alpha_t = \alpha$, $\beta_t = \beta$, and $\delta_t = \delta = \alpha + \beta$ is:

$$\beta + b - \frac{n\delta}{2n} - \left(\frac{n\delta}{2n} - \alpha + \varepsilon\right)$$

or

$$\beta + \alpha - \delta - (\varepsilon - b)$$

which reduces to simply $-(\varepsilon - b)$. If $\varepsilon > b$ then $-(\varepsilon - b) < 0$. In this case, the politicians' net payoff after compensation is negative, and since $b > 0$, the All H payoff is now better than the All C payoff, hence the politicians are now facing a prisoner's dilemma.[22]

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[22] For politicians to face a prisoner's dilemma after choosing to compensate, we also require that $b - (N\delta_t/2n) < -(\varepsilon - b)$.

If we vary the value of ε, we may get very different results. For example, if $\varepsilon = 0$, the net payoff to the corrupt politician who compensates is b and the net payoff to the corrupt contractor is a. Since these payoffs are identical to those obtained in a state of generalized honesty, one might suppose that the incumbent, in order to be re-elected, will want to offer to the contractor $\varepsilon > 0$. If $b > \varepsilon > 0$, the politician will always get a positive payoff of $b - \varepsilon > 0$, the contractor will always get a payoff of $a + \varepsilon$, and corruption will continue indefinitely. We know, however, that corruption cycles depend on $\varepsilon > b$. What justifies this inequality?

Clearly, it is the contractors who will request the amount of extra compensation ε. But under which condition would contractors choose a value for $\varepsilon > b$? It must be the case that, on average, contractors gain more from an alternation of periods of honesty (where they get a for $T - 1$ periods) and periods of corruption (where they get $a + \varepsilon$ for the duration of the corrupt period and $\varepsilon > b$) than from an indefinite corrupt payoff of $a + \varepsilon$, where $\varepsilon < b$.

In case $\varepsilon > b$, we may additionally suppose that there exist two different types of politicians: those who care about pecuniary benefits, and those who care about power, or being in office. The second type will keep compensating contractors until he runs out of funds, whereas the first type may stop compensating immediately after re-election. Indeed, when this type of politician stops compensating will depend upon the length of the mandate. For example, if elections are held before T, this type of politician will eventually become corrupt and compensate up to the next election. Afterwards, he will stop compensating and 'retire' after another election, when he will be voted out of office. Such a politician may even organize a clean-up as a last resort, in order to regain credibility and having thus a chance of being re-elected one more time.[23] If, on the other hand, elections occur after T, but before $T + k - 1$, such politicians will compensate contractors up to the next election (in order not to reveal their type), and then stop. If elections take place after $T + k - 1$, this type of politician will never compensate, as he will be voted out of office anyway.

The politician's type, however, is his private information. The rational contractor will have a probability distribution over politician types, and choose so as to maximize his expected utility with respect to those probabilities. We have not taken up all these different cases in the paper since the only effect they may have on corruption cycles is to extend or shorten the duration of the cycle. In what follows, therefore, we shall assume that politicians always compensate contractors.

Also note that, in case different constituencies vote differently (one may vote for new, honest politicians, whereas another may re-elect corrupt incumbents), this will not be a problem as long as there is no political interaction among them. In case there is interaction, the honest politicians will be at a disadvantage. We assume throughout the paper that there is political separation among constituencies.

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[23] A surprising phenomenon noticed by political scientists who have studied corruption clean-ups is that the vast majority of corruption clean-ups are initiated by incumbents. See Gillespie and Okruhlik, 'The political dimensions of corruption cleanups'.

3. An Example

We now illustrate our conclusions in this paper with a numerical example. Let us consider the simplest possible case where $n = m = 2$. Suppose further that $a = b = 1/6$ and $\alpha = 1/3 < \beta = 2/3$, so that $\delta_t = \alpha_t + \beta_t = t + 1 - T$ for all $t \geqslant T$. Thus, at time $t = T, \delta = 1$, at time $t = T + 1, \delta = 2, \ldots$ etc. Since there are only two politicians, we have that the number of corrupt politicians N, excluding the row player, is equal to 1, so that in the first period in which there is corruption, at time $t = T$, $(\delta N/2n) = 1/4$ and, in the generalized corrupt state at $t = T$ where $n = N = 2$, $(\delta n/2n) = 1/2$. Thereafter, the per capita social costs of corruption, $(\delta_t n/2n)$, grow linearly by the amount:

$$\frac{n\delta_t}{2n} = \frac{(t + 1 - 10)}{2} \text{ for } t \geqslant T = 10.$$

Finally, we must specify a sequence for w_t. We shall assume that

$$w_t = \begin{cases} \dfrac{T - t}{2} & \text{for } t \leqslant T, \\ 0 & \text{for } t > T. \end{cases}$$

Recall that we have chosen $T = 10$. It is easily verified that the cascade in the two politicians' strategy choices from All H to All C occurs at time $T = 10$, when the politicians' payoff matrix changes over, for the first time, to a situation where generalized corruption is the Pareto superior outcome.

With the above parameterization, it is easily verified that the two contractors *always* face a prisoner's dilemma (since $\beta > \alpha$), but these two contractors must nevertheless coordinate on the All h strategy until the cascade at time T occurs. We can think of the two contractors as consistently offering to bribe the two politicians in periods $t = 1, 2, \ldots, T - 1$, and having their offers refused up until time $T = 10$. However, beginning with period $T = 10$, both politicians begin accepting bribes from both contractors, and the economy achieves the generalized state of corruption characterized by All C and All c.[24]

The *minimum* amount of compensation that must be paid to each contractor in each period of corruption $t \geqslant T = 10$, is given by:

$$\frac{n\delta_t}{2n} - \alpha(t + 1 - T) = \frac{(t + 1 - 10)}{2} - \frac{(t + 1 - 10)}{3} = \frac{(t + 1 - 10)}{6}.$$

Note that this compensation amount grows over time, in response to the growing social costs of corruption. In fact, the politicians collectively pay each contractor slightly more – ε more – than this minimum amount in each period $t \geqslant T = 10$, as a way of insuring that each contractor casts his vote for the two corrupt politicians rather than the two honest political challengers. Therefore, the actual compensation amount in period $t \geqslant T = 10$, is $[(t + 1 - 10)/6] + \varepsilon$. Let us assume that $\varepsilon = 5/24$. The politician's net payoff, after compensation, is given by $\beta_t + b - (n\delta_t/2n) - [(t + 1 - 10)/6] - \varepsilon$, which is equal to

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[24] Note that at $t = T - 1$, the period just prior to the cascade, $w_{T-1} = 1/2$ and, given our parameterization, we find that $\beta < \alpha + 2w_{T-1}$, so that honesty remains the Pareto superior outcome for all politicians. However, at $t = T$, $w_T = 0$, and we find that the inequality $\beta > \alpha$ holds at this point, thus triggering the cascade from All H to All C.

$[2(t + 1 - 10)/3] + b - [(t + 1 - 10)/2] - [(t + 1 - 10)/6] - \varepsilon$, and reduces to $-(\varepsilon - b) = -1/24$. Note that since $-1/24 > b - (\delta N/2n) = -1/12$, there is *no* incentive for the compensating, corrupt politician to attempt to revert to the honest (H) strategy. That is, in this parameterization, the politician who chooses to become corrupt, and who compensates, finds himself in a prisoner's dilemma. Since the per period net payoff to the corrupt politician who compensates is negative, eventually this politician's resources will be exhausted and the politician will be unable to continue compensating.

In order to have a finite number of periods of corruption, $\infty > k > 0$, we must impose the constraint that $\varepsilon > b$. Since we have assumed that $\varepsilon = 5/24 > b = 1/6$, we have that $(\varepsilon - b) = 1/24$. We now have all the information to calculate k, the number of corrupt periods. We find that

$$k = \frac{b(T - 1)}{\varepsilon - b} = \frac{3/2}{1/24} = 36.$$

In this example, the honest regime lasts for $T - 1 = 9$ periods, while the corrupt regime lasts for 36 periods. Here, periods can be measured as weeks, months or even years. The main point is that a sustained period of corruption is possible. If elections are held every $(1 + \phi)T$ periods, and $(1 + \phi)T < k$, then there will be $k/(1 + \phi)T$ elections in which the corrupt incumbents are re-elected in democratic elections, provided contractors are myopic. If contractors are fully rational and informed, however, there will only be $[k/(1 + \phi)T] - 1$ re-elections of corrupt incumbents. That is, there will be one less election in which corrupt incumbents get re-elected because the fully rational and informed contractors know k. Hence they can foresee that compensation will end before the politician's final term in office is completed. Eventually, however, the corrupt regime will give way to a new, honest regime. This change will occur when the politicians run out of funds needed to compensate the contractors, and the contractors respond to this situation by (rationally) voting for the honest political challengers (and throwing the corrupt politicians out of office). Following the election of new, 'honest' politicians, the w_t penalty function returns to its highest value, and then begins diminishing once again. Note also that the social cost of corruption, δ_t, returns to zero for the duration of the honest regime. The cycle beings anew.

4. The Penalty for Corruption

Up to now, we have not said too much about the penalty, w_t, that politicians face for choosing to play the corrupt strategy. We simply assumed that this penalty was monotonically decreasing over the period in which all politicians played the honest strategy. Furthermore, at $t = T$, it was assumed that the value of this penalty fell *below* a critical value, w_{crit}, and was in fact equal to 0 for the duration of the period in which all politicians played the corrupt strategy. Following an election in which new, honest politicians replaced the corrupt incumbents, we assumed that w_t reverted to its high initial value, and then began declining once again for the remainder of the honest regime. This assumption regarding the behaviour of w_t was made so as to avoid needlessly complicating our analysis. Nevertheless, it is possible to provide an interpretation of the penalty function that makes it depend on the behaviour of the

players. Even with this new interpretation of the w_t function we still have corruption cycles.

Let us suppose that contractors have a finite memory. In particular, they can only remember their payoff histories over the past τ periods. The penalty the n politicians face for corruption is determined by the number of periods over the past τ periods in which all m contractors fail to receive a payoff greater than or equal to a, their payoff in the honest state. In particular, each one of the n politicians faces a corruption penalty equal to:

$$w_t = \frac{1}{n} \sum_{s=0}^{s=\tau-1} I_{t-s},$$

where I_{t-s} denotes the value of an indicator function at time $t - s$. We have that $I_{t-s} = 1$ if at time $t - s$ the m contractors all received payoffs below a, i.e. if the n politicians all played the C strategy but failed to compensate the m contractors for their suboptimal payoffs. We have that $I_{t-s} = 0$ if at time $t - s$ the m contractors all received payoffs greater than or equal to a. This specification of the penalty function reflects the notion that the (non-politician) electorate has finite memory, and seeks to penalize politicians only when their payoff falls below the honest regime payoff. Note that, by construction, the value of w_t is bounded, and must lie between 0 and τ/n. Indeed, let us assume that initially w_0 is equal to τ/n. This would be the case if, in the previous τ periods (prior to the initial time 0), all n politicians played the corrupt strategy and chose not to compensate any of the m contractors. In this case, the m contractors would have been in a prisoner's dilemma for τ periods with an expected payoff that was less than a, their payoff in the honest regime. Let us assume that an election occurs at time 0, and the contractors vote the corrupt incumbents out of office, replacing them with new, honest politicians. Thus, as in the numerical example of section 3, where $\tau = 10 = T$ and $n = 2$, the new honest regime begins with the maximum penalty, $w_0 = 5 = \tau/n$. In each period of the honest regime, the indicator function takes the value 0, so that over the course of the honest regime the value of the penalty for corruption is falling, as the contractors' memories of the suboptimal payoffs from the previous corrupt regime gradually fade. Eventually, at time T, we find that $w_T = 0$, as we had assumed in the numerical example, and the politicians switch to playing the C strategy.

Beginning with period $T + 1$, the corruption penalty does not necessarily start to rise again. Rather, the value of w_t in periods $t > T$ depends on the actions of the politicians in the corrupt regime. If the politicians compensate the contractors for their losses from being in the corrupt regime, then w_t remains equal to 0 for as long as this compensation continues. It is only following a period of corruption in which the n politicians decide not to compensate contractors that the value of w_t, as we have defined it, begins to rise again. Our previous analysis did not consider the effect of this rise in the value of w_t following a period in which there was no compensation. We simply assumed that the corrupt politicians would be voted out of office in the first election following the no-compensation period. That outcome, however, turns out to be only one of two possibilities. A second possibility is that as w_t starts to rise following a corrupt period without compensation, the value of this penalty may reach a level at which the payoff to the individual politician from playing the corrupt strategy, C, is worse than the payoff the individual politician receives

from playing the honest strategy, H. That is, with w_t rising there may occur a time at which

$$b - \frac{\delta_t N}{2n} > \beta_t + b - \frac{\delta_t}{2}.$$

How soon this inequality will occur will depend on the parameters of the model.

For example, let us suppose that $\tau = 6$, and that at time 0 new, honest politicians have just been elected following six periods of a corrupt regime without compensation. Thus, $w_0 = 3$. The new corruption cascade will occur at $T = \tau = 6$. Let us suppose that after time T, the corrupt politicians refuse to compensate contractors. The penalty w_t starts rising immediately, and it can be shown (using the same parameters as in our numerical example of section 3) that at time $T + 6$ ($t = 12$), where $w_{12} = 3$, the above inequality holds for the first time. Thus, at $t = 12$, we find that corrupt politicians who do not compensate decide at this point to change over from playing the C strategy to playing the H strategy once again.

If the date at which the above inequality first holds is prior to the date of the next election, the corrupt politician who is not compensating switches to the honest strategy, and a period of honesty follows. We can interpret this outcome as representing a 'clean-up' initiated by corrupt incumbents. If elections occur while the reformed incumbents remain in this new honest phase, then the contractors will be indifferent between electing them and electing new, honest politicians. Of course if the date at which the above inequality first holds occurs *after* the next election, the corrupt incumbents who did not compensate are voted out of office. The latter possibility is the one that we had assumed in our previous analysis.

5. Conclusions

We have analysed corruption as a cyclical phenomenon. The kind of corruption we have modeled is the exchange of bribes for public contracts, but our analysis can easily be extended to other types of corrupt exchanges. One type of agents, the contractors, always face a prisoner's dilemma. Since corrupting public officers is their dominant strategy, contractors always try to bribe until they succeed. Yet since all of them eventually succeed, contractors find themselves locked for a while in a suboptimal state. To ensure re-election, corrupt, incumbent politicians will compensate contractors for being in a prisoner's dilemma until they run out of funds. Then they are voted out of office. We have also considered the case in which politicians succeed in paying so low a compensation that corruption can be sustained indefinitely. We conclude that corruption cycles appear for two different reasons: one is a failure on the part of corrupt politicians to compensate contractors for their Pareto inferior outcome. The other reason is that politicians offer too much excess compensation to corrupt contractors, and thus exhaust their cumulated resources.

One could enrich the basic model by varying such parameters as the length of the period between elections, as well as by assuming different types of agents, (e.g., myopic vs. fully rational; power-seekers vs. money-seekers) or, as we did, by offering different interpretations of the penalty function. Given the

assumptions of the model, the length of the corruption cycle would be affected, not the cyclical nature of corruption. Eventually, corrupt politicians will be replaced.

In our model, it is contractors that both create and resolve crises. Elections are the means to escape the prisoner's dilemma, but the dilemma will be confronted again as soon as politicians feel secure enough to accept bribes. Hence a democratic system, far from being a permanent curb to corruption, is rather one of the main drives of corruption cycles.