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Investigating the Mechanism of Corruption and Bribery Behavior: A Game-theoretical Methodology

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Abstract : *Corruption is now one of the major challenges in many countries around the world, mainly because of its adverse impact on social and economic development. In today's world people are more likely to opt for what is easier and simple even if it is not honest and acceptable. In this paper, we use simple models of game theory in an attempt to understand the motivation and thought processes of bribery behavior. A supposition is made that the briber and bribee make bounded, rational choices under perfect information. The assumption of perfect information is later on relaxed to include expectations in the uncertainty model and the reality of information asymmetry. When gains and losses associated with each player are examined, possible policy instruments and recommendations to curb corruption are distilled therefrom. Focus is mainly on the public sector in Zimbabwe.*

Keywords - *Bribery mechanism, Game theory, Optimal strategy, Nash equilibrium, Payoff matrix*

I. INTRODUCTION

Corruption has since become a major global concern in recent history. The negative impact of corruption on social and economic welfare cannot be disguised. Bribery, embezzlement, extortion and nepotism are some of the common manifestations of this societal evil. The most eminent expression of corruption has been bribery, which Paul Jones (2006) defines as a crime that includes offering, giving or receiving anything of a considerate value in order to influence the actions of an official or any other person in discharge of public duty. To fight corruption, it is important that we get a clear appreciation of the reasons why it happens initially. This paper therefore employs game-theory: an economic tool used to analyze the strategic behavior of players in a setup whereby each player receives a payoff that is determined by the strategies chosen by all participants. One of the most fundamental assumptions of game-theory is the assumption of 'rational players'. This assumption like the central supposition of social sciences, states that people (players in game theory) are self-centered, seek to maximize and expand their individual interests and aim to improve their own personal wellbeing. Analogously bribery takes place when a player decides and selects their ideal strategies after taking into consideration their own actions and that of the other player.

Our analysis initially assumes complete information then relaxes this assumption and employs the concept of expectations. According to the Zimbabwean law, the actions of both the briber and bribee make up a criminal offence. Rational players are therefore likely to carry out due diligence and obtain as much information about the other player as possible. For instance, a player would be interested in knowing the level of confidentiality, amounts of risk taken, payoff for their counterpart and all the other relevant information before choosing their optimal strategy. Thus as Lianju and Luyan (2011), we consider a non-cooperative complete information static game problem first then expand the model to a more realistic setup.

The Zimbabwean public sector has been associated with alarming levels of corruption in almost all of its government departments. This paper therefore manipulates the simple models of game theory to conduct a psychological analysis of the decision making process in bribery behavior motivation based on the rationality assumption and subsequently proposes possible policy recommendations in fighting corruption.

II. BACKGROUND

Karl Marx is remembered as the most eminent advocate of socialism. Societies though, are clearly not places of angelic or robotic order but instead crime lurks even in the most peaceful and lawful communities. Shared resources are sometimes diverted towards private use for own advantage. Logically such immorality is controlled by some kind of policing which requires that a certain number of citizens take public office and work in the best interest of the state. These individuals are then given authority to exercise their mandates by Acts of Parliament within parameters of law. Every society establishes itself around rules and grants powers to law-enforcers to ensure accurate implementation and administration of statutes.

Theoretically, this seems to be a workable solution to lawlessness but in practice its sustainability is questionable. What happens if the law-enforcers themselves become law-breakers and use their special authority for their own private profit? Sadedin (2015) questions, "Who watches the watchers?" Transparency International, a nongovernmental organization which works together with governments, businesses and citizens to stop the abuse of power, bribery and secret deals established the Corruption Perceptions Index which measures the perceived levels of public sector corruption worldwide. According to the 2015 Corruption Perception Index, 114 countries scored below 50 out of 100 indicating serious levels of public sector corruption. According to this report, such statistics translate to more than six billion people living in countries with serious corruption problems. Eduard Mead (2012) alludes to the fact that there are even more complex situations where national administrations appear to be profiteering from the presence of corruption and highlights that a top-down approach would be ideal in that case because the solution would start from authorities then down to everyday workers in public office.

Game theory comes in handy as a method of studying the behavior of economic agents and their motivation for partaking in self-centered malpractices. We look at some important definitions to aid our analysis. Bribery and corruption are manifested in varying ways ranging from tender competitions, police bribery, extortion etc. but this study will narrow its focus to corruption which directly translates to the maladministration of Acts of Parliaments in the Zimbabwean law.

The following are basic definitions to be used in this paper.

- An individual has various **instruments or policy variables** with which it can pursue its goals. For instance, an importer may pay less than the required duties at a port of entry or completely smuggle a consignment while a customs official may collect less than required duties in exchange for a gift. This can all be done in an attempt to maximize personal gains.
- A **strategy** is a specified course of action with clearly defined values for the policy variables. For example, a briber's strategy may consist of paying 50% of a required amount and giving 20% to an official in a bribe which altogether totals to less than 100% of the required amount to yield a positive payoff.
- The **payoff** of a strategy is the net gain that a strategy will bring to an individual for any given counterstrategy of the competitor. From the above example, if the official plays along while the briber maintains his/her chosen strategy, then the briber's payoff is the 30% saved on the total amount due.
- The **payoff matrix** of an individual is a table showing the payoffs accruing to them as a result of each possible combination of their strategies and that of the other player.

III. LITERATURE REVIEW

The first systematic attempt in the field of game theory can be traced back to 1944 in the works of mathematician John von Neumann and economist Oskar Morgenstern. Their book, "Theory of Games and Economic Behavior" is regarded as the classical work upon which modern-day game theory is based. Objective probabilities were used assuming that all agents had the same probability distribution for convenience. This analysis was further extended by Savage (1954) and Pfanzagl (1967) who expanded the axioms of rational preferences to endogenize probability and make it subjective. Savage (1954) also employed Bayes' theorem and restructured the probabilities in light of new information available to economic agents, thus connecting rational choice and inference.

Corruption and bribery were almost off-limits as far as economics was concerned until Rose-Ackerman (1975) published an article that directly focused on the economics of corruption. Mishra (2005) applied economic tools to the analysis of corruption and explored the areas of compensating corruptible law enforcers and the control of bribery and corruption. An even more direct application of game theory to corruption is mentioned in the

writings of Mead (2012). He illustrates on a payoff matrix the courses of action available to each player either to accept a bribe or to alternatively refuse to partake in corruption and instead lobby for higher wages with corresponding payoffs for each strategy. The dominant strategy in his analysis is choosing not to take bribes and he concludes that change needs to be top-down where incentives to take bribes must be reduced in order to bring down corruption levels. Lianju and Luyan (2011) concluded their analysis of bribery behavior by pointing out that bribery is generated once the expected revenue of players is more than their costs. They show that corruption behavior is negatively related to the costs involved and positively related to the psychological expected net revenue. Therefore, part of their policy suggestions included tightening supervision, cutting officials powers and implementing severe punishment for offenders in an attempt to increase the costs of indulging in corruption.

De Graaf (2007) explored the contextual theory of causes of corruption and alludes to the fact that the more we know about corruption, the better we can decide which policy instruments to use to combat corruption. Since social sciences usually deal with concepts rather than processes, it is not surprising that most literature 'freezes' reality and pays more attention to the underlying causes of corruption whilst ignoring the actual processes or mechanisms of corruption behavior. The challenge however, lies in the difficulty inherent in identifying causal links. One can partake in a corrupt activity without knowing and remain convinced that they are 'clean' but if society opines otherwise they are convicted still. In response, Schinkel (2004) poses a philosophical question as to whether reasons for action can or should be seen as causes of action. Causality is examined in this case. De Graaf (2007) highlights the tension in corruption research between actors being regarded as autonomous agents making 'bounded' rational means-end calculations and explaining corrupt behavior by causes beyond individual control. Among the six major classes of causes of corruption stated in his conclusion are the public choice theory and the bad apple theory. With public choice theory the causal chain starts from a free official making a rational decision which leads to a more or less predetermined outcome. Under the 'Bad Apple Theory' his analysis primarily looked at the individual corrupt agent for the causes of corruption in the sense that the bad apples are those people with faulty moral character. The causal link would start from bad character to a corrupt act.

This paper builds from this previous literature and expands the concepts from analyzing not only the causes but also the mechanisms and thought processes involved in corruption and bribery behavior using the game theory approach then distils possible policy recommendations for combating corruption in the Zimbabwean public sector.

IV. ANALYSIS OF GAINS AND LOSSES FOR BRIBER AND BRIBEE

In the bribery mechanism, the two parties exchange their interest. The briber wants to get gains which far outweigh the losses and the bribee is willing to exchange for the briber's gift with their power by offering the briber things and gains which the briber should not get in normal conditions. As in game analysis, the bribe-giver fully contemplates the possible decisions of the bribee for the reason that this greatly impacts their income whilst the bribee also considers the possible strategies of the briber. This can be represented in a static game scenario. There are two players each with two pure strategies of either bribery or no bribery and the different strategy combinations at their disposal yield different payoffs. In an attempt to obtain an equilibrium of this game there is need to ascertain the gains of the players by analyzing their costs and benefits.

Symbolize the players as A (bribee) and B (briber) and manipulate the assumption of complete information where players have perfect knowledge of each other. Suppose A has certain power and influence which B hopes to get from A. If obtained through bribery, B will get additional revenue x than in normal circumstances. This will however be accompanied by bribery cost y which comprises of material cost, risk cost or moral cost arising from the mental torture for his behavior. If the briber B does everything above board without corruption these costs will be zero, i.e. $y = 0$ while his extra income is zero too, i.e. $x = 0$. In the event that B chooses to bribe while A chooses not to bribe, player B will also need to pay a certain cost we shall denote z.

When B bribes A, A weighs the interest and seriously ponders on it before deciding whether to accept bribery. A remains with 2 choices either to accept the bribe or to refuse to accept the bribe. If A opts for the later and remains honest he gets moral satisfaction of a reputation of integrity and a sense of job security and his payoff under this situation is denoted b. Otherwise, if the bribe is accepted he will alter public power for a certain amount of bribery and denote his payoff as w. This will however be accompanied with mental torture and behavioral risk from such corruption. We assume that the risk cost and moral prices he pays is equal to the interest for refusing the bribe.

We assume both players pursue profit maximization therefore $w, b, x, y > 0$ and $w > 2b, x > y$ for the revenue and costs of players. We can represent this game using the following payoff matrix in Table 1.

Table 1: Payoff Matrix of the Game between Briber and Bribee

B \ A	Bribery	No Bribery
Bribery	$(w-b)$ / $(x-y)$	b / $-z$
No Bribery	0 / 0	0 / 0

Players choose the optimal strategy which maximizes their own profit with regard to other player's strategies. In search of the Nash equilibrium for the game represented in Table 1 we employ the eliminated dominated strategy.

For A (bribee), no matter what strategy B (briber) chooses, his payoff from bribe is always higher than the payoff from 'no bribe'. That is, $w - b > b$, $0 = 0$. 'Bribe' is superior to 'no bribery'. Likewise, because $x - y > 0$, $0 = 0$, bribe is the dominant strategy for the briber B. The fact that the Nash equilibrium point 'bribery, bribery' is also Pareto optimal shows that we can curb corruption by making alterations to the costs and benefits associated with each player's strategy. The hypothesis $w > 2b$, $x > y$ shows that both players' gains are much higher than their cost in a successful bribery case.

A possible solution to corruption lies in two major courses of action. Firstly, increasing the risk of incurring cost and moral briber cost would work to counter bribery efforts. Secondly, increasing the rewarding strength to no bribery and statutory penalties of bribery would work likewise. The cost associated with bribery will be changed and punishment will be felt once there is bribery intent.

V. GAME THEORY'S CURE FOR CORRUPTION (UNCERTAINTY MODEL)

What would be effect of relaxing the assumption of complete information? The hypothesis that each player knows with certainty the exact value of the payoff of each strategy is unrealistic. The most probable situation in the real world is that the player, by adopting a certain strategy, may expect a range of results for each counter-strategy of the rival with each result having an associated probability. The payoff matrix is thus constructed so as to include the expected values of each payoff. In this instance, the expected value is the sum of the products of possible outcomes of a pair of strategies adopted by the two players each multiplied by its probability. If payoff or gain is denoted by g such that g_{si} represents the s^{th} of the n possible outcomes of strategy i of player A and P_s is the probability of the S^{th} outcome of strategy i then the expected value would be:

$$E(G_{ij}) = g_{1i}P_1 + g_{2i}P_2 + \ldots\ldots\ldots\ldots + g_{ni}P_n \qquad (1)$$

$$= \sum_{s=1}^{n} g_{si}P_s$$

Therefore, under a policy of increasing costs of bribers and increasing the gains associated with 'no bribery' accompanied by high legal penalties, the payoff matrix of the new game will be as shown in table 2.

Table 2: Payoff Matrix of the new game between briber and bribee

B \ A	Bribery	No Bribery
Bribery	$(w-b)$ / $(x-y)$	b / $-z$
No Bribery	$-b$ / 0	0 / 0

At Nash equilibrium let us assume that player A's optimal strategy is $(p, 1-p)$ and the optimal strategy of player B is $(q, 1-q)$ meaning that A chooses bribery with the probability p and chooses not to accept a bribe

with $(1-p)$ whilst B chooses to bribe with q and not to bribe with probability $(1-q)$. Maintaining the axiom of profit maximisation implies that A will choose an appropriate probability to optimize the unconstrained optimization function:

$$(P_A): \max\ pq(w-b)+(1-p)qp-bp(1-q) \quad (2)$$

With the solution of optimal probability $q^* = \frac{b}{b-w}$ (3)

Note that A's probability of choosing not to accept a bribe increases as his costs increase.

B also aims at maximising the function:

$$(P_B): \max\ pq(x-y)-zq(1-p) \quad (4)$$

The optimal solution is $p^* = \frac{z}{x-y+z}$ (5)

The Nash equilibrium for this new game will be a combined strategy situation

$$((p^*,1-p),(q^*,1-q^*))$$

The (no bribery, no bribery) solution has no costs and gains as no corrupt act would have taken place.

VI. ANALYSIS OF VARIABLES AND POLICY RECOMMENDATIONS

The optimal probability for A (bribee), who in our analysis is an official in public office, is q^* as represented in equation (3). A closer look reveals that if b increases while w remains constant or at least does not decrease then the probability of an official choosing a bribe strategy would be reduced. Therefore, a policy strategy in curbing corruption might possibly lie in rewarding an official's choice of remaining honest, and making a clear acknowledgement of integrous reputation accompanied with psychological relief of job security. The central idea behind the variable b simply shows that bribery and corruption can be reduced by giving an official more reasons to remain honest and integrous than to choose otherwise. When work incentives and fringe benefits are closer to the levels desired by public office holders, they will have more to lose by engaging in corruption because what would be at stake would be incomparable to what would be on offer. This is a typical top-down solution in which the answer lies with the administration in authority. In this instance, society would fight corruption by bidding up the price for the briber such that the magnitude of the bribe that would alter an official's decision strategy would be higher than the legally required amount to be paid to the state.

The variable w is the payoff associated with an official changing public power for a certain amount of bribe accompanied by psychological torture and behavioural risk of corruption. Equation (3) reveals that a reduction of that payoff will lead to a decrease in the optimal probability of an official choosing a bribe strategy. Alternatively, this will increase the probability $(1-q^*)$ of choosing a 'no bribe' strategy. In this instance, the idea is to eradicate the ignorance of the public officer and reveal to them the far reaching impacts of their actions. A possible policy strategy would then be to create as much awareness on the effects of corruption as possible. When parties involved in corrupt activities are cognisant of how corruption erodes economic stability of a country, how it damages business and consumer confidence, how it increases bureaucracy and reduce both foreign and direct investment not mentioning the negative impact on the fiscus and economic development, their psychological torture component of w would be higher and subsequently reduce their optimal probability q^* of choosing a bribe strategy. The effects of including the corruption agenda in all corporate fora within government department meetings should not be underestimated as a policy strategy.

The z variable represents the cost to the briber who chooses to offer a bribe whilst the official in public office chooses not to accept the bribe. Whilst x is the additional revenue from getting the official's powers through bribery. The difference $x-z$ would be the net payoff for the briber. In the optimal solution in equation (5) an increase in this variable *ceteris paribas,* will result in a lower optimal probability p^* of the briber choosing a bribe strategy, or a higher optimal probability $(1-p^*)$ of choosing a 'no bribery' strategy.

Naturally, x and z tend to fluctuate in unison as they are closely related. The higher the possible payoff for the briber, the higher the cost to him if the officer chooses not to accept the bribe. How then can this cost be increased? In a case where one unsuccessfully offers a bribe to an official, the worst case scenario in monetary

terms would be a situation where evidence of the bribe is preserved and the act is taken to constitute a criminal offence. Although the bribe would not have been accepted, the probability of choosing bribery for a person contemplating such an act would be greatly reduced. Possible policy strategies would include increasing the accessibility of toll-free lines for reporting corruption, engaging tip off anonymous experts with rapid response, in-house surveillance technology and involving the public officials themselves in the strategies of fighting corruption. If 'walls have eyes and ears', then $x - z$ would be higher and p^* lower meaning a high optimal probability $(1 - p^{*)}$ of choosing a 'no bribe' strategy.

As we saw that the assumption of complete information was unrealistic, a situation of perfect information asymmetry would by far wither the motives of bribery behaviour. An important policy instrument which can be distilled from this would be creating a strategically developed rotational plan for public officials which is religiously adhered to. Its main effect will be the avoidance of the development of long standing relationships between public officials and clients. This will alter the probabilities associated with payoffs for both players in the strategic game. Job rotations will mean that each player will make a move with less or no information about the possible strategies of the other. This will not only increase the probability of an unsuccessful corrupt activity but also reduce p^* by increasing the z cost of the briber whilst ensuring that the official does not become too comfortable in a work area to contemplate the diversion of public resources.

VII. CONCLUSION

Of striking importance is that, this paper does not only examine causes of corruption but goes further to analyze the psychological processes of motives behind corruption and bribery behavior. Being corrupt is a choice as much as not being corrupt is. As when addressing the fundamentals of consumer choice, economic agents do have preferences but when incentives are introduced, choices can be altered. Conclusively, bribery behavior is inversely related to the cost, and positively related to the expected revenue.

Further research in this area should have more enlightening outcomes if it extends the analysis to embezzlement, extortion, discrimination, favoritism and other forms of corruption which are not dealt with in this paper. This should be as a result of the wide range of motivating factors behind corruption which naturally are expected to have corresponding policy solutions for the problem. Likewise, although this paper uses evidence only from the Zimbabwean public sector, corruption is also influenced by other non-quantitative factors such as culture which differ with every nation hence the above recommendations may not be universal in addressing corruption.

Possible applications of the paper may range from policy formulation by anti-corruption organizations in the public sector to corporate planning by personnel departments of private sector companies. Although the social ill of corruption cannot be completely eradicated, understanding the psychology behind it places policy makers in a better light as far as implementing the correct incentives and disincentives is concerned in reducing its prevalence.

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