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A Bribery Game: Corruptionin Healthcare System

Gabriela Tuchilus, Mihai Daniel Roman
Corresponding Author:PhD. Student Gabriela Tuchilus, The Bucharest University of Economic Studies, Bucharest, Romania
Corresponding Author:Prof. Dr. Mihai Daniel Roman, The Bucharest University of Economic Studies, Bucharest, Romania
Corresponding Author: Gabriela Tuchilus

ABSTRACT: *Corruption is an international issue and mostly no service sector is free from it. Healthcare systemsare seriously affected, from government level to hospital and healthcare provider level. In this paper we model the interactions between patients and doctors using game theory to analyse the bribing behaviour. Hence, we developed a simultaneous game for the situations when the strategies of the patient and doctor do not align considering two cases: (1) when the patient has advantageous bargaining power and (2) when the doctor has advantageous bargaining power. Based on the models we suggest the following anti-corruption measures: increase remuneration for medical staff, improve medical system so that the patients be treated equally, improve the detection of corruption by introducing audits and inspections, punish the corruption acts.*
KEY WORD*: anti-corruption measures; bribe; healthcare; simultaneous game*

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I. INTRODUCTION

The problem of corruption is still unsolvable, creating severe issues for all service sectors and the health system is not spared. Forms of corruption in healthcare and medicine may include, but not be limited to, the following: bribes paid by individuals and firms to obtain different benefits, theft and embezzlement, damage to public assets and instruments for private gain, absenteeism (not attending work but claiming salary), informal payments, use of human subjects for financial gain, nepotism, favouritism, political influence in selection of healthcare professionals. No matter the form is, corruption leaves a deep mark on patient care, clinical research and medical education, being one of the biggest sores of the health system.

European Commission together with TNS opinion & social network developed a survey and carried it out in October 2017 in the 28 European countries. The survey covered public attitudes on the existence of corruption in their country, how this is widespread in different sectors of society and the acceptability of bribing to obtain something from public administration or services. 31% from the interviewed people think corruption exists in the healthcare system.

Figure 1:Percentage of respondents who would gave an extra payment or a gift to medical stuff, or make donations to the hospital

Source: Special Eurobarometer 470 Report 2017. available online at: http://ec.europa.eu/commfrontoffice/publicopinion/index.cfm/ResultDoc/download/DocumentKy/81007

From figure 2 we can observe that in Romania (19%) and Hungary (17%) just under a fifth said they had to make an extra payment on top of the standard fees, or give a valuable gift, or make donations to the hospital, as do over one in ten of those polled in Lithuania (12%) and Greece (13%).

Being asked why they had to make a payment or valuable gift to the medical stuff, or had made a hospital donation 20% say that they were asked to go for a private consultation to be treated in a public hospital, 16% felt that they had to give an extra payment or valuable gift and did so after the care was given, 13% say that the doctor or nurse expected an additional payment or valuable gift was expected in advance, 12% say that they were asked to pay for a privileged treatment, 11% of respondents spontaneously mentioned a different reason for having to give a payment or gift.

Unfortunately, the bribe practices, whether it's money, gift or favour, became usual and expected nowadays and in some countries, they can make the difference between life and death.

In this paper our focus is on corruption in the public health system, considering the interactions between patients and doctors, which are modelled using game theory. Hence, we developed a simultaneous game for the situations when the strategies of the patient and doctor do not align considering two cases: (1) when the patient has advantageous bargaining power and (2) when the doctor has advantageous bargaining power. Based on the conditions for a no-corruption equilibrium resulted from the game we can suggest the following anti-corruption measures: raise salaries for medical stuff; increase the probability of bribery detection and the penalty imposed to the doctor in case bribery is discovered, increase the penalty imposed to the patients which are trying to bribe the medical stuff, decrease the time patients spend waiting in the queue and decrease the possibility of doctors 'practices to make patients offering bribe to receive better services.

The paper is organized as follows: the next section gives a brief background on corruption in healthcare systems by going through the existent literature on this topic; in section three is presented the model including the game set-up; section four provides a summary of our findings and the last one concludes the findings.

II. LITERATURE REVIEW

Corruption is "the most serious ethical crisis in medicine today" (Chattopadhyay; 2013). It can take many forms, it can activate in different areas as patient care, research and medical education and its implications in health and medicine can be devastating. Corruption seems to be a difficult problem as it is a complex phenomenon, being not only a legal issue, but an economic, social, cultural, political and ethical one. Many researches have approached this topic and analysed it closely using different methods.

Starting from a set of hypotheses, Andrei et. all. (2009) defined simultaneous equations with regards to the performance of services in the public health and compared the least squares method and the two stages least squares method by applying the Hausman test. Their results show that the level of corruption at the national level in the opinion of medical staff with higher education is highly dependent on: (1) the changes of management personnel onpolitical criteria, (2) the satisfaction level of the medical personnel, (3) the age of the person who was interviewed and (4) the category of medical staff. Other econometric methods, namely unifactorial and multifactorial regression model, were also used to analyse corruption's effects on health system performance in the European area. The findings show that the increased number of active population, the increased level of life expectancy, the increased public expenditure, determines a low level of corruption (Besciu; 2016).

Habibov (2016) investigated the effect of corruption on healthcare satisfaction in a set of 12 Post-Socialist countries using instrumental variable regression on the sample of 2010 Life in Transition survey. The results indicate that experiencing corruption significantly reduces healthcare satisfaction. To arrive to the bottom of the issue, Vian and Crable (2016) examined the drivers and motivations behind corruption in the health system. Based on these, he discussed anticorruption strategies to prevent and keep corruption under control by giving real-world examples of policies, systems, and activities. Chattopadhyay (2013) reviewed the forms of corruption in healthcare and medicine and underlined several anti-corruption measures: zero tolerance for unethical and corrupt practices in health, protection of whistle-blowers, solid legislation and last but not the least, education in ethics.

When hearing the term of corruption, many people think to bribery. The behaviour which lead to the choice to bribe/not to bribe or accept/reject bribe can be also explained using Game Theory. Xie (2005) set up a non-cooperative static game to analyse the bribery behaviour and described the interaction between the participants considering them both "rational players". Starting from the same assumption, Lianju and Luyan (2011) designed two bimatrix game models to investigate how the briber choose to bribe or not and the bribed to accept or reject. Based on the strategies the cost-benefit of the players was analysed and the following anticorruption measures were suggested: severe punishment of those taking bribes, strengthening surveillance and control, establish a good incentive mechanism, improve market regulation and create a crediting environment. Havlicek and Valenčík (2011) went further with the research in this direction by adding to the payoff matrixes new elements related to blackmail action. Hence, they consider two types, blackmailed persons

and persons who blackmail and created a game to determine the consequences of each player'decions, where moves are made subsequently.

Parallel investigations on corruption topic approach the survey-based method to understand people 'perceptions on the existence of corruption in healthcare sector.

Stepurko et. All. (2013) conducted a survey in six CEE countries (Bulgaria, Hungary, Lithuania, Poland, Romania and Ukraine). 35–60% of the respondents in each country responded they have made informal payments. The general opinion is that cash payments are considered corruption acts, while gifts not – they are rather considered a way to thank for great services.

Aiken, L. et. All (2012) used cross sectional survey to determine whether hospitals with a better nurse staffing and proper work environments, therefore with a good level of care, can affect the stability between the nurse workforce and the patient care in European countries and United States. The results show that the level of satisfaction increases for both nurses and patients according to the level of care and the quality of work environment. Hence one method of retaining qualified nurses and obtaining better outcomes for the patients could be improving the working environments in hospitals.

Ensor (2004) closely evaluated the informal payments for care in transition economies and sustains that applying penalties may help to reduce some of them. The disadvantage of this measure is that if the public hospitals cannot provide the expected services, patients will choose the private health system. Another option would be to formalize the unofficial payments, but this needs to be first addressed across all sectors and closely monitored to evaluate its effectiveness.

Bribery is nowadays one of the main challenges for the healthcare system, as many patients are in the position to offer money to receive (better) medical service. Hence for this study we are interested to analyse the behaviour of corrupt people who pay or receive bribes form Game Theory's perspective, detailed in the next section.

III. GAME-THEORETIC MODELLING

In our previous work, we established the modified B-G and C-L-Y Model[1]describing the interaction between a patient (P) and a doctor (D) to explain the corruption behaviour in public health system. The weakness of the designed game is that it only shows the payoffs for "Bribe" - "Bribe" and "Not Bribe" – "Not Bribe" strategies of the patient and doctor, but not the payoffs for the players in two "Not Bribe – "Bribe" scenarios.

Here our aim is to find the unknown payoff hence we modified the above-mentioned model to represent a simultaneous game for the situations when the strategies of the patient and doctor do not align (see Table1) where:N is doctor's monthly salary;R is the bribe;S is the penalty imposed for corruption act;$t_1$is the time waiting in the queue (number of hours);$t_2$is the time the corrupt interaction takes (number of hours); and ϵZ are the psychological costs which are composed as follows: ϵ represents the doctor's subjective personal taste regarding bribery, while Z is the social sanction from being caught as corrupt. In other words, Z is the degree to which corruption is accepted in the society, and Z= the proportion of noncorrupt doctors in the total population as in the Chang-Lai-Yang model.

Table 1: Simultaneous Game

	P		
D		**Bribe**	**Not Bribe**
	Bribe	Doctor: $\frac{R-S-\epsilon Z}{N}$ Patient: $-R-T-t_2$	Doctor: Unknown Patient: Unknown
	Not Bribe	Doctor: Unknown Patient: Unknown	Doctor: N Patient: $-t_1$

The basic set-up is modified to represent a simultaneous game and present two situations: (1) when the patient has advantageous bargaining power; (2) when the doctor has advantageous bargaining power.

3.1 "Patient has advantageous bargaining power" Model

An example where the patient has advantageous bargaining power is when patient is an important person. If the bargaining power of the patient is greater than the bargaining power of the doctor ($\beta > \beta$-1), then in the case where the patient chooses "Not Bribe" he/she has an advantage and the outcome will be the formal process, even if the doctor chose the "Bribe" option (in other words, the patient is immune to extortive bribery). Similarly, in the case where patient chooses "Bribe" and the doctor chooses "Not Bribe", the outcome will be either a "Bribe"- "Bribe" or the formal process, "Not Bribe-Not Bribe" since the higher bargaining power of the

[1]Game-theoretical model describing designed based on Bowles-Garoupa (1997) and Chang-Lai-Yang (2000) models (Tuchilus, 2018)

patient might allow him/her to convince the doctor. Given that the patient's bargaining power is β, this is also the probability that the patient will be able to influence the doctor towards an outcome in his favour[2]. Hence the set-up of a simultaneous game-theoretic matrix will look like this:

Table 2: Simultaneous game set-up if the patient has advantageous bargaining power

	P*		
D		**Bribe**	**Not Bribe**
	Bribe	Doctor: $\frac{R-S-\epsilon Z}{N}$ Patient: $-R-T-t_2$	Doctor: $\beta(0)+(1-\beta)N$ Patient: $\beta(0)+(1-\beta)(-t_1)$
	Not Bribe	Doctor: $\beta\left(\frac{R-S-\epsilon Z}{N}\right)+(1-\beta)N$ Patient: $\beta(-R-t_2-qT)+(1-\beta)(-t_1)$	Doctor: N Patient: $-t_1$

*bargaining power advantage, 0 <β< 1 and β> 0.5

Patient's reasoning is as follows:

a. if the doctor chooses "Not Bribe" he/she will prefer the strategy with a greater payoff, comparing the payoffs $\beta(-R-t_2-qT)+(1-\beta)(-t_1)$ and $-t_1$.
b. if the doctor chooses "Bribe", then his/her payoff can either be $-R-T-t_2$ or $\beta(0)+(1-\beta)(-t_1)$.

On the doctor's side, his/her reasoning is as follows:

a. if the dominant patient chooses "Not Bribe", then his/her payoff can be $\beta(0)+(1-\beta)N$ or N.
b. if the dominant patient chooses "Bribe", then his/her payoff can be: $\frac{R-S-\epsilon Z}{N}$ or $\beta\left(\frac{R-S-\epsilon Z}{N}\right)+(1-\beta)N$.

For anti-corruption purposes, the goal is to align incentives so that both the patient and the doctor "Not Bribe" as their dominant strategy. The driver's dominant strategy will be "Not Bribe" if:

$$\begin{cases} -t_1 > \beta(-R-t_2-qT)+(1-\beta)(-t_1) \\ (1-\beta)(-t_1) > -R-T-t_2 \end{cases}$$

$$\begin{cases} R > t_1-t_2-qT \\ R > t_1-t_2-\beta t_1-T \end{cases}$$

Thus, the equation when patient's dominant strategy is 'Not Bribe' will take the following form:

$$R > t_1-t_2-qT$$

The doctor will have "Not Bribe" as a dominant strategy if:

$$\begin{cases} N > (1-\beta)N \\ \beta\left(\frac{R-S-\epsilon Z}{N}\right)+(1-\beta)N > \frac{R-S-\epsilon Z}{N} \end{cases}$$

Since N is always is also greater than $(1-\beta)N$ because $0<\beta<1$, we need to consider the second equation in order to find the equation correspondent to doctor's dominant strategy as 'Not Bribe':

$$\beta\left(\frac{R-S-\epsilon Z}{N}\right)+(1-\beta)N > \frac{R-S-\epsilon Z}{N}$$

$$N > \frac{R-S-\epsilon Z}{N}$$

$$R < N^2-S-\epsilon Z$$

Therefore, in a situation when the patient has advantageous bargaining power, both the patient and the doctor will have "Not Bribe" as their dominant strategy, (1) and (2) need to hold simultaneously:

$$\begin{cases} R > t_1-t_2-qT \\ R < N^2-S-\epsilon Z \end{cases} \Rightarrow t_1-t_2-qT < R < N^2-S-\epsilon Z$$

The above equationrepresents the interval of R for a no-corruption equilibrium. This is the condition when the maximum bribe that a patient can offer is lower than the minimum bribe that the doctor can accept.

In order to increase the set R that would fall in that interval, the anti-corruption measures should be targeted to reduce t_1-t_2-qT and increase $N^2-S-\epsilon Z$. This includes:

Table 3: Anti-corruption tools of the model where patient has advantage bargaining power

Code	**Variable**	**Affecting**	**Change with an anti-corruption impact**
N	Doctor's monthly salary	Doctor	Increase
S	Penalty imposed to the doctor for getting bribery	Doctor	Increase

[2]In Nash bargaining, β is used to determine what share of the rent the actor gets; in paper we also useβ in a comparable manner - to determine with what likelihood a player will be able to convince or influence another player.

T	Penalty imposed on the patient for bribing	Patient	Increase
q	Probability of bribery detection	Both doctor and patient	Increase
t_1	Time spent in the queue	Patient	Decrease

The outcomes and respective anti-corruption tools for this case, when the patient has advantageous bargaining power and agreement is endogenous, are identical to the modified Bowles-Garoupa and Chang-Lai-Yang model. This indicates that the Bowles-Garoupa and Chang-Lai- Yang set-up is for the situations where bribery is passive, but not for situations where bribery is extortive, as represented in the next set-up when doctor has advantageous bargaining power.

3.2 "Doctor has advantageous bargaining power" Model

A situation when doctor has advantageous bargaining power is when patient is in a hurry. If the bargaining power of the doctor is greater than the bargaining power of the patient, then if the doctor chooses "Bribe" and the patient chooses "Not Bribe" two things can happen: doctor will either be able to extort the bribe from the patient, or the doctor will spend a significant amount of time on the interaction with the patient, hoping to extract a bribe after all. Similarly, if the doctor chooses "Not Bribe" and the patient chooses "Bribe" then the outcome will be the same as the "Not Bribe"- "Not Bribe" outcome and the patient wont' be able to convince the doctor for a bribe no matter how hard he tries, because in this case the doctor has advantageous bargaining power. Given that the probability with which the doctor can achieve an outcome in his/her favour is 1-β, $0 < \beta < 1$ and $\beta < 0.5$, where β is driver's bargaining power and consequently 1-β is doctor's bargaining power. Hence, the set-up of game-theoretic matrix looks like this:

Table 4: Simultaneous game set-up if the doctor has advantageous bargaining power

		P	
		Bribe	Not Bribe
D*	**Bribe**	Doctor: $\frac{R-S-\epsilon Z}{N}$ Patient: $-R-T-t_2$	Doctor: $(1-\beta)\frac{R-S-\epsilon Z}{N}+\beta N$ Patient: $(1-\beta)(-R-T-t_2)\ +\beta(-\widehat{t_1})$
	Not Bribe	Doctor: N Patient: $-t_1$	Doctor: N Patient: $-t_1$

* bargaining power advantage, $0 <\beta< 1$ and $\beta> 0.5$

ˆ inflated value by doctor

When patient's logic follows: "If the doctor chooses "Not Bribe", the patient is indifferent between two strategies available because payoffs would be both $-t_1$ – he needs to wait in the queue until his turn comes. If the doctor chooses "Bribe", the patient will choose the greater payoff between: $-R-T-t_2$ and $(1-\beta)-R-T-t_2+\beta(-\widehat{t_1})$.

Doctor's logic is similar: "If the drives chooses "Not Bribe", then he/she compares payoffs:$(1-\beta)\frac{R-S-\epsilon Z}{N}+\beta N$ and N.

Similarly, if the patient chooses "Bribe", the doctor compares: $\frac{R-S-\epsilon Z}{N}$ to N.

For both the patient and doctor to end up in the no-corruption equilibrium, both need to have "Not Bribe" as the dominant strategy. That will be patient's dominant strategy if:

$$(1-\beta)(-R-T-t_2)\ +\beta(-\widehat{t_1})>\ -R-T-t_2$$
$$\beta(R+T+t_2)>\beta\widehat{t_1}$$
$$R+T+t_2>\widehat{t_1}$$

Doctor's dominant strategy will be "Not Bribe" if and only if:

$$\begin{cases} N>(1-\beta)\dfrac{R-S-\epsilon Z}{N}+\beta N \\ N>\dfrac{R-S-\epsilon Z}{N} \end{cases} <=> \begin{cases} (1-\beta)N>(1-\beta)\dfrac{R-S-\epsilon Z}{N} \\ N>\dfrac{R-S-\epsilon Z}{N} \end{cases} <=> \begin{cases} N>\dfrac{R-S-\epsilon Z}{N} \\ N>\dfrac{R-S-\epsilon Z}{N} \end{cases}$$

Hence, doctor's dominant strategy will be 'Not Bribe' regardless of what the opponent does when:

$R < N^2 + S + \epsilon Z$.

In the situation where doctor has advantageous bargaining power, both players will end-up in a no-corruption equilibrium, by having "Not Bribe" as the dominant strategy, if:

$$\begin{cases} R>\widehat{t_1}-T-t_2 \\ R<N^2+S+\epsilon Z \end{cases}$$

Hence the equation when both parties have 'Not Bribe' as their dominant strategy will look like:

$\widehat{t_1}-T-t_2<R<N^2+S+\epsilon Z$.

Therefore, an anti-corruption initiative aimed at curbing traffic police bribery should (separately or simultaneously) increase $N^2 + S + \epsilon Z$ and decrease $\widehat{t_1} - T - t_2$. Table 5 illustrates how this could be achieved by impacting individual variables.

Table 5: Anti-corruption tools of the model where the doctor has advantage bargaining power

Code	Variable	Affecting	Change with an anti-corruption impact
N	Doctor's monthly salary	Doctor	Increase
S	Penalty imposed to the doctor for getting bribery	Doctor	Increase
T	Penalty imposed on the patient for bribing	Patient	Increase
$\widehat{t_1}$	Duration of the interaction between doctor and patient inflated by the doctor	Both doctor and patient	Decrease
t_2	Duration of the corrupt interaction	Both doctor and patient	Increase

IV. SUMMARY OF FINDINGS

In this paper, different modelling set-ups of patient-doctor interactions were used to generate a mathematical condition (a double inequality) for a no-corruption equilibrium. Specifically, the double inequality indicated a bribe interval, where the maximum bribe a rational and utility-maximizing patient is willing to offer is lower than the minimum bribe a rational and utility-maximizing doctor is willing to accept. Utilizing this condition, measures were derived to increase this bribe interval that leads to a no-corruption equilibrium of the game - the anti-corruption measures of the models. In sum, the modified Bowles-Garoupa and Chang-Lai Yang models generated measures similar to the simultaneous models where either the patient or the doctor has a bargaining advantage, but not identical, as seen from Table 6 below.

Table 6: Summary of anti-corruption measures

			Modified B-G and C-L-Y Model (Tuchilus, 2018)	**"Patient has advantageous bargaining power" Model**	**"Doctor has advantageous bargaining power" Model**
Code	**Variable**	**Affecting**	**Change with an anti-corruption impact**		
N	Doctor's monthly salary	Doctor	Increase	Increase	Increse
S	Penalty imposed to the doctor for getting bribery	Doctor	Increase	Increse	Increase
T	Penalty imposed on the patient for bribing	Patient	Increase	Increase	Increase
q	Probability of bribery detection	Both doctor and patient	Increase	Increase	N/A
t_1	Time spent in the queue	Patient	Decrease	Decrease	N/A
$\widehat{t_1}$	Duration of the interaction between doctor and patient inflated by the doctor	Both doctor and patient	N/A	N/A	Decrease
t_2	Duration of the corrupt interaction	Both doctor and patient	N/A	N/A	Increase

Using all three models makes the anti-corruption measures more robust, regardless of whether the assumption of agreement is exogenissed or not. The third model where doctor has advantageous bargaining power provides an additional policy tool, linked to potential inflation of the doctor-patient interaction inflated by the doctor.

Based on this modelling, effective policy tools to decrease the level of corruption/bribery in health system are: (1) increasing the doctors' salary, (2) increasing the probability of detection of corruption, (3) increasing the penalty imposed to the doctor for getting bribery, (4) increasing the penalty imposed on the patient for bribing medical stuff, (5) decreasing the time patients spend in the queue, (4) decreasing the possibility of the doctor to inflate the duration of the interaction between him and the patient.

V. CONCLUSIONS

To effectively address corruption in healthcare system and design appropriate anti-corruption measures, first we need to identify and understand the problem and its roots. Hence, in this paper we have set-up

a simultaneous game to model the patient-doctor interactions in order toanalyse the bribing behaviour. Furthermore, our objective was to find the no-corruption equilibrium condition that will lead both the doctor and the patient to go for "Not Bribe" option.

Based on our models we suggest anti-corruption measures: raise salaries for medical stuff; increase the probability of bribery detection and the penalty imposed to the doctor in case bribery is discovered, increase the penalty imposed to the patients which are trying to bribe the medical stuff, decrease the time patients spend waiting in the queue and decrease the possibility of doctors' practices to make patients offering bribe to receive better services.

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