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Lobbying, Bribery, and Compliance: An Evolutionary Model of Social Factors

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Abstract

Connecting to rule-makers in order to set favorable rules (lobbying) or paying government executives to bend the current rule (bribing) are the two main strategies for influencing government. This study in an evolutionary game model explain why bribing may become widespread while other states like compliance and cooperative lobbying are Pareto superior. The theoretical model is used to study the effect of social parameters on firm's choice between lobbying and bribing. The results indicate that social disapproval of bribery has a negative impact on corruption. The effect, however, depends on the history of countries. Countries with a long history of corruption have much more difficult task in fight with corruption. Cooperation was the second social factor to be investigated. The effect of cooperation on lobbying is indirect through alleviating the difficulty and costs of linking to the government. Whenever and wherever linking is difficult, firms by cooperation, can make it less impeding.

Keywords: Lobbying, Bribery, Evolutionary Games, Replicator Dynamics, Cooperation.

JEL Classification: D72, D73, C73, O57, Z13.

1. Introduction

All governmental decisions, policies, laws and regulations produce distributional effects. Economic agents have preferences for the outcome of these decisions and, therefore, try to have influence on them. This willingness may be fulfilled by lobbying government or bribing bureaucrats as two primary rent-seeking methods. Bribery includes rent-seeking activities directed at rule enforcers while lobbying is rent-seeking

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activities directed at rule makers[1]. Hardly one can overstate about negative consequences of these corrupt activities. Each year over US$ 1 trillion is paid in bribes worldwide (World Bank, 2002); fifteen per cent of all companies in industrialized countries have to pay bribes to win or retain business, this figure stood at 40% and 60% for Asia and former Soviet Union countries, respectively (World Development Report, 1997: 36). Lobbying is also widespread. Politically active organizations [in United States] in 2009 reported $3.47 billion on direct lobbying expenses, controlling for inflation, almost seven times lobbying expenses in 1983 (Drutman, 2015: 1).

Unfortunately till now "*these two means of influencing the regulatory environment have either been studied separately or viewed as basically being the same thing*" (Harstad and Svensson, 2011: 1). The few studies which have considered both strategies point greatly on firm's size as the main determinant factor of rent-seeking behavior. The main conclusion which is supported by some empirical evidences[2] is that lobbying is observed in rich developed countries while bribing is commonly used in developing economies. These empirical works are restricted to OECD countries. "*If one includes developing countries, though, one might obtain a slightly different picture"* (Beckmann and Gerrits, 2009: 18). Figure 1 shows the lobbying prevalence throughout the world. Vertical axis is the percent of companies which see themselves influential on legislation process[3]. Data are collected from World Business Environment Survey (2000) reported by the World Bank. The dark bars show case studies in contrast with previous literature. As it is shown, lobbying is also common in developing countries like Philippines, Indonesia, Malaysia, Pakistan, Panama, and Uzbekistan. Moreover there are some rich countries like United Kingdom, Germany, and Sweden in which lobbying is very rare. This shortcoming in the literature comes from the attempt to explain countrywide differences in lobbying and bribery prevalence using only

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1. Harstad and Sevenson (2011).
2. Campos and Giovannoni (2007; 2008)
3. Companies which marked their influence on government legislature above 3 in a range from 1=not applicable to 6=very influential.

firms' characteristics and, thus, overlooking effects of social and cultural factors.

To lobby firms first need to build some links with the government. The linkage cost is in fact the cost of being politically active. High linkage cost and the fact that lobbying benefits are non-excludable make firms to pursue it mainly in group. Individual factors like firm's size are not enough to explain cooperative lobbying; in fact many other social and cultural parameters must be noticed. Narayan and Pritchett (1999) states that increased social capital leads to increased community cooperative action and solves local "common property" problems. The same is true for bribery because it is illegal and culturally unacceptable. Aside from individual factors, there are many important social parameters to understand firms' illegal acts. "Social trust – often taken to be a measure of the strength of honesty norms in society – has been identified as a statistically strong and quantitatively important determinant of corruption" (Bjørnskov, 2011: 3). Many of recent empirical studies have confirmed the very close relationship of corruption and social capital.[1]

[1]. For example see Banerjee (2016).

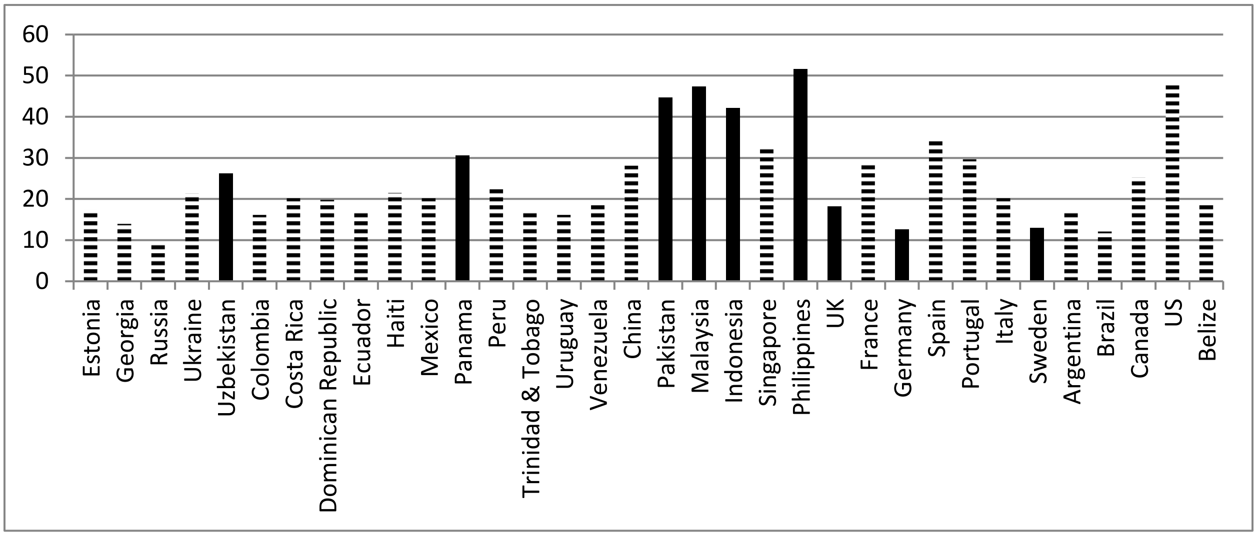

Figure 1: Prevalence of Lobbying in Different Countries

Definition of social capital as "anything" like trust, cooperation or synergy which exist in social networks and relationships lacks precision. Nonetheless, Robinson et al. (2002) argues that there are some capital-like properties in social relations. Schuler (2007) states that social capital needs to be viewed in interaction with other elements like bonding and bridging social capital or between human and social capital. The fact is that social capital has confusing closeness with cultural and human capital. "Social capital and trust are highly systemic, with a strong complementarity between the various sources of reliability, in institutions and individual relationships, and, by consequence, between the lacks of such sources" (Nooteboom, 2007: 16). These social and cultural determinants whatever they are have strong effects on rent-seeking and corrupt behavior of firms. Unfortunately, however, these social factors are mostly neglected.

The main purpose of this study is to theoretically model firm's strategic choice and, at the same time, explain the potential effects of social factors on rent-seeking behavior of firms. To understand firm's choice and the impact of social parameters on it, a population game framework is applied. In population game although there are N players, the game structure is based on two players selected through random matching. Then the traits and payoffs of the basic two-player game is extended to the population using evolutionary dynamic equations. Evolutionary dynamics helps to explain how these strategies spread out and, as result, why countries are different in the prevalence of lobbying and bribing[1]. Strategies with high payoffs become more popular as they spread within the population through learning, copying or inheriting. Since the payoffs themselves depend on the popularity of strategies this mechanism in a loop reinforces successful strategies. In evolutionary dynamics the underlying game, population structure and the way that strategies spread are crucial. Next section discusses the underlying game. Section III reviews different families of evolutionary protocols in order to finds suitable dynamics and then applies the protocol to find the potential evolutionary equilibria. Section IV theoretically studies the importance of social factors on dynamics and final states of population. Section V concludes.

2. The Underlying Two-Players Random Matching Game

In our model, there is only one industry with N firms. To concentrate on the impacts of social parameters which is the main objective of this study, it is assumed that all firms are similar. Firms face an environmental rule which imposes some additional costs on them. There is only one

[1]. Myopic decision making and anonymity are tacit assumptions of evolutionary dynamics. For decision to lobby or to bribe beside the corresponding payoffs, the state of population also matters. Since bribery is illegal or lobbying needs cooperation, the population's state and the prevalence of these strategies are important. This justifies the objective of this study to understand the impact of social factors on firm's behavior. Anonymity also helps to overlook firm-level characteristics and differences and instead focus on social factors common among firms.

alternative rule which is, therefore, in the interest of all firms.[1] One main strategy is cooperation with others to produce permanent rent through changing the current rule (lobbying). Supply of lobbying attempt like other collective acts is limited with free-riding problem. Free-riders have two alternative strategies. They can passively obey the rule (compliance) or bypass the rule by bribing rule-enforcers (bribing). The role of government can be reduced to and be modeled as a probability function over the possible set of rules. Since there are only two rules, the current green rule and the alternative one, assigned probability may be perceived as winning chance. This means that assuming a given winning chance function, I will concentrate on firms' strategic choice in relation with each other instead of analyzing the bargaining process between government and interest groups.

Rent obtained through bribing is assumed to be rival and prone to congestion. This means that as more firms bribe the rent diminishes. Therefore, in case of bribery firms have conflicting benefits and compete. In order to understand this competition consider, as an example, people who are waiting in queue. If they cooperate to lobby and set a new rule by which there is no need to stay in the queue anymore, all firms will commonly benefit from a non-excludable non-rival ease. If firm, instead, by proposing bribe try to get better position in queue, the rent soon would be vanished as number of bribers increase. Firms have to decide whether to follow their common interest through cooperation for lobbying or to seek their individualistic benefit through competing with other firms in proposing bribes.

Lobbying, bribing and compliance are the three strategies available to firms for influencing government. Lobbying is the direct contact of firms with rule makers to persuade them for a change in the current rule. If the

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[1]. In real world, there are many rival industries. But, here assume a group of firms with common interests (like firms which are faced with a costly green law) whose conflict is only about cooperation or acting individually. The competition with other rival industries is embedded in the winning probability function. Competition in the literature usually is modeled as lobbying contest. The probability of winning depends on the power, the effort and the contributions of different competing industries.

alternative rule is enforced all the firms benefit from a non-excludable non-rival durable rent. It doesn't matter which firms were participated in the negotiation. The rent of lobbying, however, will not be obtained with certainty; there is the possibility of failure in the negotiation. The lobbying rent firms might expect to get is:

$$\mathcal{R}_L = (p^w \times 1) + \delta(p^w \times 1) + \delta^2(p^w \times 1) + \cdots + \delta^n(p^w \times 1) = \frac{p^w}{1-\delta}$$

The probability of winning p^w is fixed. The benefits corresponding to the current and the new rule are valued as 0 and one respectively. Parameter δ is the weight of future benefits. To lobby firms need to contact with the government. The cost of setting links C is fixed. The cost of being politically active usually is high so that lobbying individually would not be profitable.

> ***Assumption (1):*** *The participation cost is fixed and high such that prevents firms from individual lobbying;* $\mathcal{R}_L < C$.

Sharing the fixed cost of lobbying is not the only incentive for cooperation. United lobbyists are more powerful in negotiations with government. The probability of winning in case of cooperation is multiplied by a parameter ψ indicating synergy or necessity of cooperation. Marginal contribution[1] of the second cooperator is equal to $\mathcal{H} = \frac{(\psi-1)p^w}{1-\delta} + \frac{C}{2}$. Firms have more incentive to cooperate for lobbying when either linkage cost or synergy is high. Table 1 represents the payoff structure of the game for the row player.

[1]. This is only the marginal contribution of the second cooperator in the two-player game. In random matching there is no externality from other players.

Table 1: Payoff Structure of the Game

	Lobby	Comply	Bribe
Lobby	$\mathcal{R}_L - C + \mathcal{H} = \frac{\psi\, p^w}{1-\delta} - \frac{C}{2}$	$\mathcal{R}_L - C = \frac{p^w}{1-\delta} - C$	$\mathcal{R}_L - C - \mathfrak{D}_b = \frac{p^w - 1}{1-\delta} - C$
Comply	$\mathcal{R}_L - \mathfrak{D}_l = \frac{p^w - d}{1-\delta}$	0	$-\mathfrak{D}_b = \frac{-1}{1-\delta}$
Bribe	$\mathcal{R}_L + \mathcal{R}_B - \mathfrak{D}_l = \frac{1}{1-\delta}(1 - [B + d + f])$	$\mathcal{R}_L + \mathcal{R}_B = \frac{1}{1-\delta}(1 - [B + f])$	$\mathcal{R}_L + \mathcal{R}_B - \mathcal{L} = \frac{1}{1-\delta}(\gamma - [B + \tau f])$

Although there is much to get from cooperation, there are always some firms which decide to free-ride because the benefits of lobbying are non-excludable. Non-cooperators evade from sharing the fixed lobbying cost but they will benefit from lobbyists' attempts for changing the current rule. Free-riders may passively comply with the current rule or bypass it through bribing.

Bribers are more harmful to lobbyists than compliers because while lobbyists are trying to change the rule bribers may steal their projects. The damage received from bribers is $\mathfrak{D}_b = \frac{1}{1-\delta}$. To clarify the discussion suppose according to the current rule firms need to stay in queue. Thus, the cost imposed on firms by this rule is the time of waiting. A group of firms try to lobby with rule-makers to replace the current situation with an alternative rule which according to there is no need to wait in the queue. This alternative rule is in common interest of all firms. On the other hand, firms by proposing bribe to rule-enforcers may get a better position in the queue. But bribers get the better position at cost of worse position for non-bribers. This rent is rival and shows that firms have conflicting interests in case of bribery.

Passive compliers while evading from lobbying costs, benefit from a change in the rule. This means that in case of being matched with a cooperating lobbyist, compliers can increase their payoff by refusing to contribute to the linkage cost. This free-riding behavior also decreases winning chance of lobbying. The only cost a complier which is faced with a lobbyist must incur is the possibility of being punished due to its free-riding. The punishment $\mathfrak{D}_l = \frac{d}{1-\delta}$ is either direct or indirect punishment known in the literature as selective incentive mechanism. For example, a trade union is able to create selective incentive by providing some excludable goods like insurance exclusively to its members. Withholding these goods from non-members is a form of punishment of non-cooperators. The punishment by decreasing free-riders payoff acts as stabilization mechanism for the lobbying coalition.

> ***Assumption (2):*** *Although free-riders have to carry a punishment imposed by lobbyists, evading the fixed linkage cost is still appealing. Free-riding incentive is the payoff compliers get by deviation i.e.* $\pi^{CL} - \pi^{LL} = \frac{C}{2} - \frac{(\psi-1)\, p^W + d}{1-\delta} > 0.$

These two assumptions indicate that, in table (1), compliance dominates lobbying strategy. Although playing compliance against lobbyists might be profitable, it is not advantageous against bribers. Compliers by sitting passively aside and obeying the rules are in danger of losing projects to bribers. Like the example of queue bribers receive better position which compliers has lost. When firms encounter bribers, the compliance strategy gives negative payoff equal to the value of lost rent or position, $\mathfrak{D}_b$.

Rent of bribery is temporary and should be renewed for the next periods by bribing again the same or different inspectors. The exemption which bribers get is valuable only if the lobbyists fail to change the rule. Bribers with probability p^w benefit from success in lobbying and with probability $(1 - p^w)$, lobbying failure, they enjoy the rent of bribing. In other words, firms by bribing insure themselves against lobbying failure, $\frac{(1-p^w)}{1-\delta} + \frac{p^w}{1-\delta} = \frac{1}{1-\delta}$. The positive rent of bribery incite firms to compete with each other in proposing bribes. This rent equals $\mathcal{R}_b = \frac{(1-p^W)-[B+f]}{1-\delta}$, where B is the bribe payment and f is the expected punishment (the punishment times the likelihood of detection) bribery.

Table (1) the payoff of bribery is shown for long period instead of one period in order to make it possible to compare with lobbying.

> ***Assumption (3):*** *The exemption obtained from bribery is valuable i.e.* $(1 - p^w) > B + f$.

Bribery also dominates compliance strategy. Therefore, firms compete with each other in proposing bribes to get this positive rent. The incentive for competition when other players comply is $\pi^{BC} - \pi^{CC} = \frac{1-[B+f]}{1-\delta} = \mathcal{R}_b + \mathcal{R}_L > 0$. Here there is no lobbyist, the briber is faced with a complier and, thus, the probability of winning is zero. This rent is what bribers get from exemption. As the population of bribers increases their payoffs change. First because the social punishment like feeling shame would be less severe as number of bribers increase or as corruption becomes more prevalent. The parameter τ indicates this effect. Second because the rent bribers get is rival like a position in queue. One firm might be able to get better position by bribing rule-enforcers but if all firms do the same no one can be thoroughly successful. The parameter γ indicates degree of congestion. The bribery rent decreases as more firms compete in proposing bribe; the amount of loss is $\mathcal{L} = \frac{1}{1-\delta}\big((1 - \gamma) - (1 - \tau)f\big)$.

> ***Assumption (4):*** *Congestion is so high such that a big part of the rent would be lost as firms compete with each other in proposing bribe i.e.* $\gamma < B + \tau f$.

The game in table (1) is a form of prisoner dilemma with three strategies. While everyone was benefited from cooperation for lobbying, free-riding incentive urges the population toward another state with lower payoff. Lobbying is strictly dominated by free-riding strategies, compliance and bribing. A worse situation happens when firms continue with com[p]eting for the rival rent of bribery. This mercenary attitude leads to bribery equilibrium with lowest payoff for all players. Bribing is the only Nash equilibrium of the game although cooperation for lobbying and compliance are Pareto superior. This game reflects cooperation failure as firms fall in endless competition for rival rent of bribery which soon would be vanished by an increase in number of bribers or the bribe payments.

To extend this two-player game to a population game some standard assumptions are made. A random matching symmetric game is considered. Individuals within population interchangeably play this basic game. Strictly speaking, firms are assumed to be similar with exactly the same strategy set. Stability is also a bit different concept here. Evolutionary Stable Strategy (ESS) is a Nash equilibrium which is immune to invasion of new traits or strategies. Invasion refers to the spread of new strategies through innovation, copying etc. among the population. Every ESS is Nash equilibrium but the converse is not true. The ESS is best response to itself (Nash equilibrium); however, if it is a weak best response then the other strategies should not be a best response to themselves.

Normalizing the whole population to one, $x^C+x^B+x^L=1$, where X is the share of subgroups like lobbyists, bribers and compliers. Payoffs can be written as functions of two of the subgroups because using the normalization above the rest subsumes the population of the third strategy. The payoffs of different strategies are listed in formula (1). Fixing the population complier to $\overline{x}^C$, the payoff structure of the game is drawn in two-dimensional Figure 2. Compliance was selected because the primary aim is to see how the society lose as bribery grows. Notice that $\boldsymbol{\pi^{LL}} > \boldsymbol{\pi^{BB}}$ although bribery is dominant and the unique Nash equilibrium.

$$\Pi = \begin{Bmatrix} \pi^L = x^L\pi^{LL} + x^C\pi^{LC} + x^B\pi^{LB} = (\mathcal{R}_L - C) + \mathcal{H}x^L - \mathfrak{D}_b x^B \\ \pi^C = x^L\pi^{CL} + x^C\pi^{CC} + x^B\pi^{CB} = (\mathcal{R}_L - \mathfrak{D}_l)x^L - \mathfrak{D}_b x^B \\ \pi^B = x^L\pi^{BL} + x^C\pi^{BC} + x^B\pi^{BB} = (\mathcal{R}_b + \mathcal{R}_L) - \mathcal{L}x^B - \mathfrak{D}_l x^L \end{Bmatrix} \qquad (1)$$

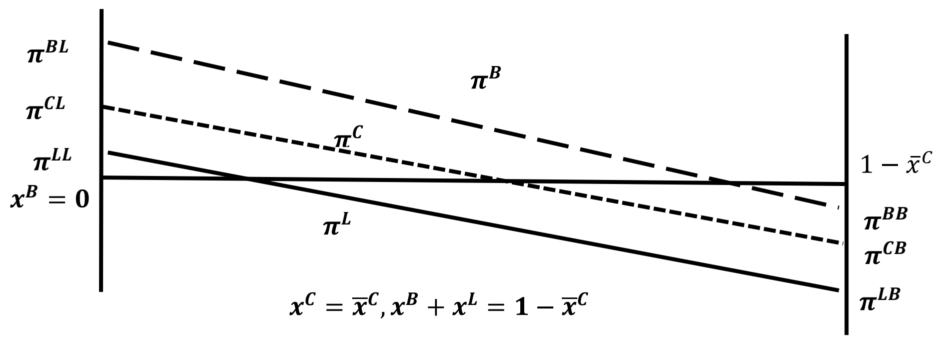

Figure 2: Payoffs of Different Strategies for a Given Population of Compliers

Lobbying is strictly dominated by compliance strategy because of the assumption (2) which according to free-riding is profitable even if there is risk of receiving punishment. Bribing also dominates compliance because of assumption (3) saying that the rent of bribery is always positive. Assumption (4) is crucial for determining the slope of the bribing payoff function. If the congestion were high the final rent is lower as numbers of bribers increase (number of lobbyists decrease). Bribery is the unique Nash equilibrium and thus unique evolutionary stable strategy. It is not only the best response to itself but also to other strategies for every state of population. Starting from every point inside the population simplex it is expected that bribery spreads throughout the population. Bribing equilibrium is stable and immune to any invasion by other strategies. However, the figure above contains another important point regarding the problem of cooperation failure. As bribery spreads in the population, all players will be worse off. The negative slopes of payoff functions show that bribery although evolutionary stable, it is Pareto inferior to lobbying and compliance states.

3. Evolutionary Dynamics of the Game

Suppose there are N firms randomly drawn to play an evolutionary game with pure strategy set $h \in \{Lobbying. Compliance. Bribing\}$. The state of population is described by vector $x = (x^L, x^C, x^B)$ where x^h is the proportion of the population adopting strategy h. Suppose that every player is preprogrammed to adopt a pure strategy, but when a player is drawn to play, she gets an opportunity to 'review' her strategy and switch to another type. A revision protocol ρ takes the current payoffs and the aggregate behavior as inputs; its outputs are some conditional switch rates $\rho_{ij}(\pi.x)$. These rates describe how frequently agents playing strategy $i \in h$, who consider switching after getting a revision opportunity, switch to the strategy $j \in h$. The game and the revision protocol together define a stochastic evolutionary process.

The deterministic dynamics is $\dot{x}_i = \sum x_j \rho_{ji}(\pi.x) - x_i \sum \rho_{ij}(\pi.x)$ where the first term shows the inflow and the second term is the outflow of *i*-strategists. Inflow includes agents who currently play a different strategy but are ready and willing to switch to strategy i. On the other hand, outflow consists of i strategy players who are going to apply other strategies. There are many different protocols. In some protocols agents are very rational and their decision depends only on the payoff structure of the game. In some others agents copy and follow each other such that their decision depends on the state of population. One criterion for choosing a protocol is that how information-demanding it is because assuming an agent with high information about the payoffs of all strategies or state of population in each period of time is very unrealistic.

The other important criteria about protocols are positive correlation (incentive consistency) and Nash stationarity. Positive correlation requires that whenever a population is not at rest, system grows according to payoffs; $V_\pi(x) \neq 0 \Rightarrow V_\pi(x)\Pi(x) > 0$ where $V_\pi(x)$ is the growth rate and $\Pi(x)$ is the payoff matrix. Nash stationarity bridging between dynamic and traditional game theory says that every rest point is Nash, if there were not a player who benefits from switching; $V_\pi(x) = 0 \iff x \in NE(\Pi)$. The other important point is that the final result should not depend heavily on the formulation of protocols; in other words the results should be robust. It can be shown that the final conclusions hold under any number of protocols sharing certain family resemblance. Below a short review of various families of evolutionary dynamics is presented[1].

Best response dynamics is the closest protocol to Nash equilibrium. The players in this protocol are rational without myopic decision-making. They need only information about payoff matrix. The main weakness of best response dynamics is that it is not differentiable. Another family of dynamics is excess payoff protocols. Agents compare payoff of each strategy with the average payoff of society and, hence, switch to strategy with the highest excess payoff. This protocol is the most information demanding protocol in that agents not only should know the payoff of each strategy but also need to know the exact state of population to calculate the average. This problem can be solved if the average payoff in protocol is replaced with a less information-demanding reference payoff. For example, in the pairwise comparison protocol agents compare the payoffs of strategies together. These two protocols satisfy both Nash stationarity and positive correlation properties. Projection dynamics is another class of protocols with a nice geometrical interpretation. Positive correlation requires that the growth vector form an acute angle with the payoff vector at every state where the population is not at rest. To minimize distortion one can always take growth vector to be the closest point in vector plane to payoff vector, the orthogonal projection. This type of dynamics has close relationship with replicator dynamic which is very famous and common in evolutionary games.

In fact, replicator dynamics itself belong to a family of protocols known as imitative dynamics. The name indicates that in this family of protocols the probability of a change depends on the population of target strategy, $\rho_{ij}(\pi.x) = x_j\, r_{ij}(\pi.x)$. However depending on $r_{ij}(\pi.x)$ this protocol also may demand information about payoffs of particular strategies or the average payoff of the population. Bounded-rationality of agents is the base of evolutionary games. The diffusion speed depends not only on the payoffs but also on the popularity of strategies because the more popular

[1]. To know better the deterministic dynamics and their properties read chapter 5 of Sandholm’s (2010) book.

a strategy is the more probable it is to be copied or to be imitated. Imitation of Success is one of the imitative family protocols. According to this protocol probability of a change depends on popularity and the payoff of the target strategy $\rho_{ij}(\pi.x) = x_j \pi_j$. This dynamics result in famous replicator dynamics.

$$\dot{x}_i = \sum x_j \rho_{ji}(\pi.x) - x_i \sum \rho_{ij}(\pi.x) => \dot{x}_i = \sum x_j x_i \pi_i - x_i \sum x_j \pi_j$$
$$\dot{x}_i = x_i \left(\pi_i \sum x_j - \sum x_j \pi_j\right) = x_i \left(\pi_i - \frac{\sum x_j \pi_j}{\sum x_j}\right) => \dot{x}_i = x_i (\pi_i - \bar{\pi}) \quad (1)$$

The population's average payoff is presented below in formula (2). The rent of lobbying $\mathcal{R}\_L$ increases the average payoff because a change in the rule benefits all population regardless of their cooperative or free-riding behavior. The population also benefits from cooperation $\mathcal{H}$ and loses as firms fight for the rival bribery rent.

$$\bar{\pi} = \left((1 + x^C)\mathcal{R}_L - C\right)x^L + \mathcal{M}_b x^B + \mathcal{H}{x^L}^2 - \mathcal{L}{x^B}^2 - \mathfrak{D}_l(1 - x^L)x^L - \mathfrak{D}_b(1 - x^B)x^B \quad (2)$$

In the formula above $x^L(\mathcal{R}_L - C), x^C x^L \mathcal{R}_L$, and $\mathcal{M}_b x^B$ are the rent received by lobbyists, compliers and bribers respectively. An increase in probability of winning add to the average payoff through increasing the benefits of lobbyists and compliers while it has no effect on bribers payoff because bribers by paying bribe have insured the whole rent against lobbying failure. Lobbyists with a population equal to x^L benefit from cooperation of other firms by $\mathcal{H}x^L$but on the other hand, bribers with a population x^B lose from the presence of other bribers by $\mathcal{L}x^B$. The punishment $\mathfrak{D}_l$ imposed by lobbyists x^L to free riders $(1 - x^L)$, and the damage $\mathfrak{D}_b$ which non-bribers $(1 - x^B)$ incur because of venal act of x^B bribers decrease the average payoff. Now having the average payoff and the payoff of different strategies at hand, presented in formula (1) and (2) respectively, we can obtain and discuss more about the dynamics of the strategies.

First it comes the analysis of lobbyists' population dynamics. Higher marginal contribution of cooperators and the selective incentive mechanism created to punish free-rides work to the advantage of lobbyists' population growth. Higher lobbying rent resulted from either from higher probability of winning or lower participation costs is also in favor of lobbying. On the other hand, higher rent of bribery, lower costs of bribery, and the damage which bribers impose on others change the population dynamics against lobbyists. However, as number of bribers increases moving away from lobbying toward bribing slows down due to congestion.

$$\dot{x}^L = x^L(\pi^L - \bar{\pi}) = -(\mathcal{H} + \mathfrak{D}_l - \mathcal{R}_L){x^L}^3 + (\mathcal{H} + C - (2 - x^B)\mathcal{R}_L + \mathfrak{D}_l){x^L}^2 + \Big((\mathcal{R}_L - C) - (\mathcal{R}_L + \mathcal{R}_b)x^B + (\mathcal{L} - \mathfrak{D}_b){x^B}^2\Big)x^L \quad (3)$$

$$\frac{\partial \dot{x}^L}{\partial \mathcal{H}} = \frac{\partial \dot{x}^L}{\partial \mathfrak{D}_l} = {x^L}^2(1 - x^L) \geq 0.\ \frac{\partial \dot{x}^L}{\partial \mathcal{R}_L} = x^L x^C(1 - x^L) \geq 0.\ \frac{\partial \dot{x}^L}{\partial C} = -x^L(1 - x^L) \leq 0$$

$$\frac{\partial \dot{x}^L}{\partial \mathcal{R}_b} = -x^L x^B \leq 0.\ \frac{\partial \dot{x}^L}{\partial \mathcal{L}} = -\frac{\partial \dot{x}^L}{\partial \mathfrak{D}_b} = x^L {x^B}^2 \geq 0$$

Dynamics of bribers' population is shown in formula (4). Obviously rent of bribery has positive effect on bribers reproduction. Weakening non-bribers by taking their positions and imposing damage on them, $\mathfrak{D}_b$, also increases bribers offspring. As corruption becomes popular, however, the bribers' loss due to congestion decelerates dynamics of their population. On the other hand, all parameters in favor of other strategies like marginal contribution of cooperation, serious punishment of free-riders, and lower linkage cost make bribery less absorbing. The impact of lobbying rent is positive because it benefits all players regardless of their behavior.

(4)

$$\begin{aligned}\dot{x}^B &= x^B(\pi^B - \bar{\pi}) \\ &= (\mathcal{L} - \mathfrak{D}_b){x^B}^3 \\ &- \left(\mathcal{L} - \mathfrak{D}_b + \mathcal{R}_b + \mathcal{R}_L(1 - x^L)\right){x^B}^2 \\ &+ \Big((\mathcal{R}_L + \mathcal{R}_b) - (2\mathcal{R}_L - C)x^L \\ &- (\mathcal{H} + \mathfrak{D}_l - \mathcal{R}_L)\, {x^L}^2\Big) x^B\end{aligned}$$

$$\frac{\partial \dot{x}^B}{\partial \mathcal{R}_b} = x^B(1 - x^B) \geq 0.\ \frac{\partial \dot{x}^B}{\partial \mathcal{L}} = -\frac{\partial \dot{x}^B}{\partial \mathfrak{D}_b} = -{x^B}^2(1 - x^B) \leq 0$$

$$\frac{\partial \dot{x}^B}{\partial \mathcal{H}} = \frac{\partial \dot{x}^B}{\partial \mathfrak{D}_l} = -{x^L}^2 x^B \leq 0.\ \frac{\partial \dot{x}^B}{\partial \mathcal{R}_L} = x^C(1 - x^L)x^B \geq 0.\ \frac{\partial \dot{x}^L}{\partial C} = x^L x^B \geq 0$$

The population dynamics of compliers is represented by formula (5). It is clear that all parameters in favor of lobbying and bribing make the passive strategy of compliance less appealing. Higher marginal contribution of cooperators, severe punishment of free riders, higher rent of lobbying, and lower linkage cost encourage compliers to cooperate with other lobbyists. Moreover, the dynamics becomes against compliers when the bribery rent is high, the damage imposed by bribers $\mathfrak{D}_b$ is more harmful, or the congestion in bribery rent is low.

(5)

$$\begin{aligned}\dot{x}^C = -\dot{x}^B - \dot{x}^L &= (\mathcal{H} + \mathfrak{D}_l - \mathcal{R}_L){x^L}^3 - (\mathcal{L} - \mathfrak{D}_b){x^B}^3 \\ &- (\mathcal{H} + C - 2\mathcal{R}_L + \mathfrak{D}_l){x^L}^2 + (\mathcal{L} - \mathfrak{D}_b + \mathcal{R}_b + \mathcal{R}_L){x^B}^2 \\ &+ (\mathcal{H} + \mathfrak{D}_l - 2\mathcal{R}_L)\, {x^L}^2 x^B - (\mathcal{L} - \mathfrak{D}_b + \mathcal{R}_L){x^B}^2 x^L \\ &+ (3\mathcal{R}_L + \mathcal{R}_b - C)x^B x^L - (\mathcal{R}_L - C)x^L - (\mathcal{R}_L + \mathcal{R}_b)x^B\end{aligned}$$

$$\frac{\partial \dot{x}^C}{\partial \mathcal{H}} = \frac{\partial \dot{x}^C}{\partial \mathfrak{D}_l} = -{x^L}^2 x^C \leq 0.\ \frac{\partial \dot{x}^C}{\partial \mathcal{R}_L} = -(x^L x^C + x^B)x^C \leq 0.\ \frac{\partial \dot{x}^L}{\partial C} = x^L x^C \geq 0$$

$$\frac{\partial \dot{x}^B}{\partial \mathcal{R}_b} = -x^B x^C \leq 0.\ \frac{\partial \dot{x}^B}{\partial \mathcal{L}} = -\frac{\partial \dot{x}^B}{\partial \mathfrak{D}_b} = {x^B}^2 x^C \geq 0$$

Table 2: Payoff Structure of the Exemplar Game

	Lobby	**Comply**	**Bribe**
Lobby	1.5	-1	-5
Comply	1.6	0	-4
Bribe	2	2.4	-0.2

$\boldsymbol{p^w =.5.\psi = 1.5.\delta = 0.75.C = 3.d = 0.1}$
$\boldsymbol{p^d f = 0.2.B = 0.2.\tau = 0.75.\gamma =.3}$

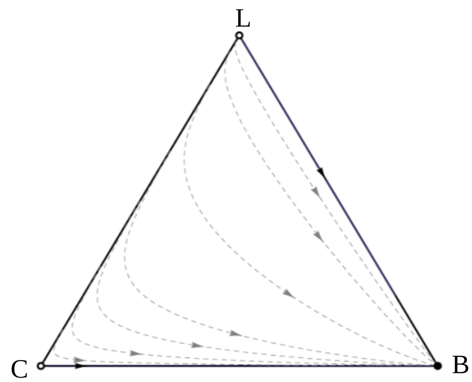

Figure 3: Evolutionary Dynamics of the Exemplar Game with Selected Trajectories

Lobbying and compliance are strictly dominated and bribery is the only evolutionary stable strategy. This means that regardless of the applied protocol, dynamics of the game started from every point in the strategies simplex ends in bribery equilibrium. A simple simulation using some exemplar amounts for the parameters is shown above in Table 2, **Error! Reference source not found.** and

Figure ***3***.[1]

[1]. Figures have been produced using Dynamo code in Mathematica. Dynamo code is provided by Sandholm et al. (2012).

All trajectories started from every point inside the simplex end in bribery equilibrium. However, the trajectories near the lobbying-compliance boundary are a bit inclined toward compliance strategy because in this region the initial number of bribers is very low and, thus, their reproduction level is also low. But as time goes on more and more firms will be absorbed by bribing strategy and finally the population rests at this evolutionary stable equilibrium.
Figure ***3*** represents a traditional cooperation failure game. At the end, all players lose as they selfishly follow the bribing strategy which is individually profitable but gets them a congestible rival rent.

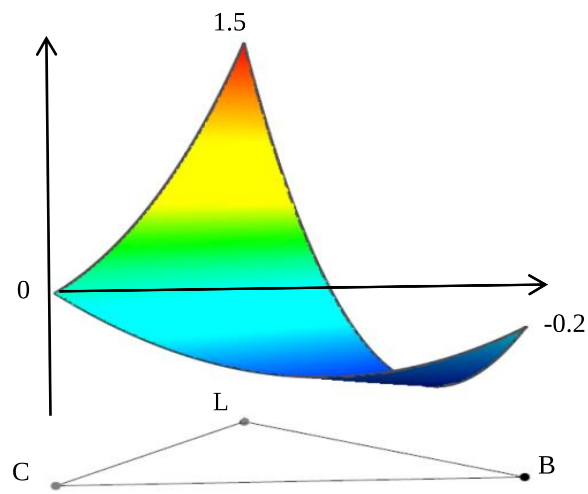

Figure 3: Potential Function of Exemplar Game Representing the Payoff of Population

4. Impact of Social Parameters

What we observe in real world is different from the main conclusion of presented assuming model by which bribery as the unique dominant strategy spreads throughout the population. A quick look at Corruption Perception Index shows that some countries like Georgia, Lithuania, Croatia, and Uruguay have overcome corruption; in the last decade an

increase about twenty scores has happened in these countries. Moreover, as
Figure ***4*** shows, lobbying and compliance are commonly used as much as bribery in most of the countries. Vertical axis is the percentage of companies which are influential on legislation reported by World Business Environment Survey (2002). This index serves as a proxy for lobbying. Horizontal axis, on the other hand, represents Corruption Perception Index (2012) for different countries. Assuming fifteen percent influence rate and the score of fifty in CPI as imaginary boundaries between free riders-lobbyists and corrupted-clean countries, the space is divided into four regions.

Regions I and III are in line with previous studies by which countries are specialized in one of the rent-seeking strategies; developed countries use lobbying and developing countries use bribing to influence government. United States as an example of countries located in region III is specialized in lobbying while, on the other hand, Azerbaijan in region I is corrupted. But the regions II and IV in contrast represent countries in which both or none of lobbying or bribing are used. In region II both lobbying and bribing strategies are common in countries like Philippine, Pakistan and Indonesia. Region IV represents countries like Sweden and Germania in which firms prefer to comply with the rules.

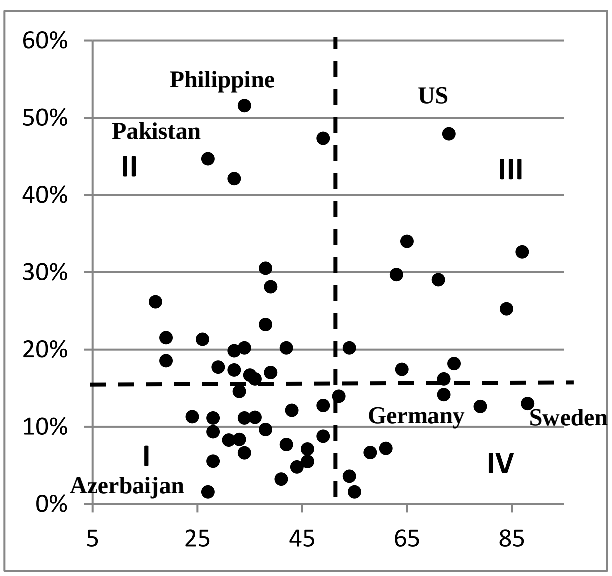

Figure 4: Lobbying Versus Corruption in Different Countries

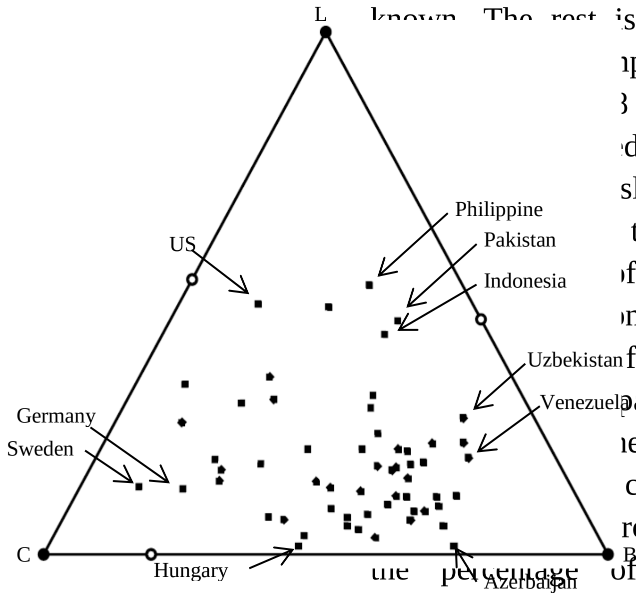

Figure 5: Prevalence of Lobbying, Bribing and Compliance in the World

Data are presented in the same simplex, shown in

Figure 5, in order to make the comparison easier between facts and assumptions. In this standard 2-simplex the coordinates is based on the fact that the three strategies are substitute and cannot be used simultaneously.

Using data of influence rate, the percentage of lobbyists is known. The rest is devoted to ...pliers. For ...3 percent of ...d States have ...slatures, this ...that the rest ...f bribers and ...nsidering the ...frequency of ...panies, 73 for ...e compliers ...computed by ...robability by the percentage of remaining companies i.e. 52%, which brings 38 percent compliance. Since these numbers must sum up to one, the coordinates of Unites states is (0.48, 0.38, 0.14) showing the prevalence of lobbying, compliance and bribing respectively.

Figure (6) shows that while in some countries like Germany and Sweden complying with the rules is the best strategy in some others both rent-seeking strategies, lobbying and bribing, are common. These points together with the fact that in developed countries lobbying is commonly used are in contrast with the conclusion of our default game in which bribery was the unique dominant strategy. In such prisoners' dilemma games "the undesirable outcome is the only Nash equilibrium, so the only way that any of the other outcomes can be supported is by a permanent intervention to change the payoffs or the rules of the game" (Bowles, 2004). At the following of this section the role of some social factors as permanent interventions changing the games and their significance on firm's behavior will be investigated. This will be done theoretically using the previously presented assuming model as underlying game. We will see that how changes in social parameters improve the model and explain compliance and lobbying usage.

- **Social Disapproval of Bribery**

One of the permanent interventions is to enhance the risk and the costs of illegal acts. It is expected that as social and legal punishments f increases, proposing bribes becomes less attractive and, as result, firms prefer to passively abide from the rules rather than to commit a crime. To incorporate this effect, I have to modify the assuming model. Suppose that the legal and social punishments are high such that the assumption (3) does not hold; $\mathcal{R}_b \leq 0 => (1 - p^w) \leq B + f$. In this new game bribery is not always profitable especially when number of bribers are very low and firm's action is visible to the public. Lobbying is dominated by free-riding strategies but now there are two Nash equilibria. The first one is the compliance equilibrium and the second is the bribery. The compliance equilibrium is Pareto superior than bribery equilibrium. In fact, permanent intervention in form of increasing costs of bribery has changed the game from a cooperation failure game with one unique Nash equilibrium to a coordination failure game with two Pareto ranked Nash equilibria. The two equilibria are evolutionary stable and the point x^{B*} is the boundary of their basins of attraction.

Figure 6 shows this new payoff structure of the game.

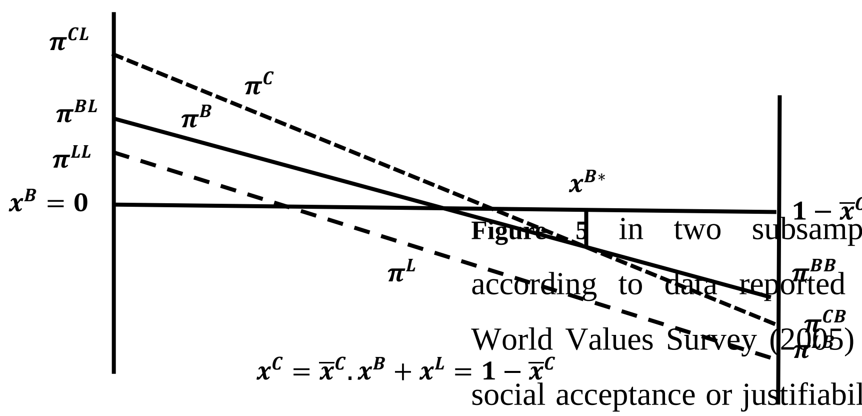

Figure 6: They Payoffs of Different Strategies for a Given Compliers Population

From dynamic equations (3), (4), (5), it is easy to conclude that a decline in rent of bribery decreases the number of bribers while it has positive effects on lobbyists' and compliers' populations. Dynamics of the new exemplar game in which f is increased from 0.2 to 0.9 is depicted in

Figure *7*. Stable states are represented with black. To understand the effect of social punishment I divide countries of

Figure 5 in two subsamples according to data reported by World Values Survey (2005) on social acceptance or justifiability of bribing[11].

[11].This index is the percentage of people who think bribing is justifiable;

ranked greater than 8 in a range of 10. High ranks are used because lower ranks although show social disapproval of bribing might not be answered trustfully.

represents these actual data. As it was expected countries with high social disapproval of bribing, shown as the gray points, are located mostly close to compliance strategy and countries in which social punishment is low and corruption is partially acceptable, black points, are inclined toward bribing strategy. The quick result is that simulated model prediction of two equilibria is correct and social parameters are important in explaining the prevalence of compliance among countries.

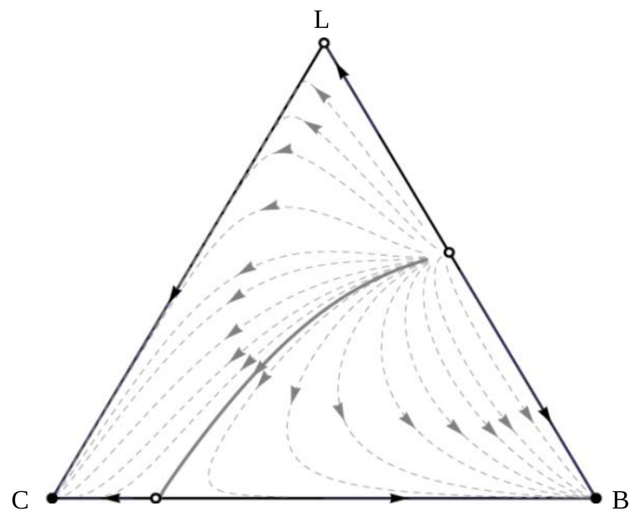

Figure 7: Evolutionary Dynamics of the Exemplar Game

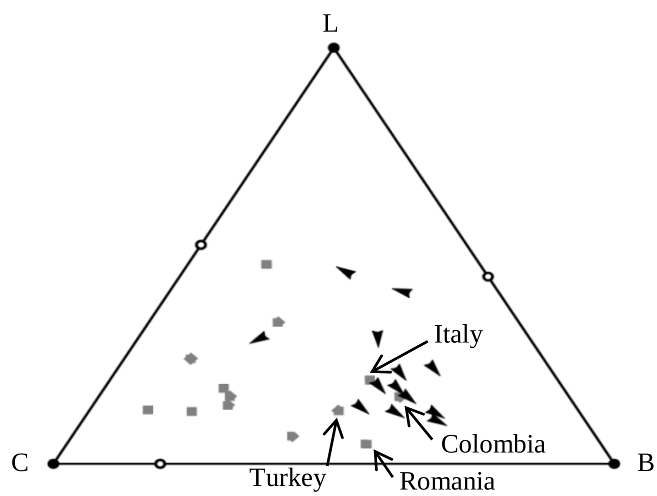

Figure 8: Evolutionary Dynamics of the Exemplar Game

One Important point is hidden in the above figures. In

there are some countries like Italy, Romania, Colombia and Turkey in which bribing is unjustifiable but still popular. This shows that the mitigating effect of social disapproval on corruption is not certain. The final conclusion in the simulated model, the point which the dynamics rests on, depends on the initial point. Countries with a long history of corruption cannot escape from bribery equilibrium. These countries are the ones with low scores in Corruption Perception index of (1999). This point implicitly indicates that why anti-corruption programs through setting severe punishments have failed in Fight with corruption. Another hypothesis is about the interaction of social and legal punishment. Social disapproval of bribery and severity of judiciary may reinforce each other. The results is presented in propositions (1), and (2).

Proposition (1): *Social disapproval of bribery has a negative effect on corruption.*

Proposition (2): *The effect of social punishment on corruption prevalence depends on history of countries.*

Proposition (3): *Social and legal punishments of corruption may reinforce each other.*

- **Cooperation**

Another social parameter which helps countries to escape from bribery equilibrium is cooperation. Cooperation among firms helps them to fulfill their common benefit through lobbying. Some of these countries are placed in regions II and III of

Figure ***4***. In order to incorporate the effect of cooperation in theoretical model, some of the previous assumptions need to be modified. Previously

I had assumed that lobbying is dominated by compliance due to free-riding behavior of some players. Although free-riding is of great concern, many studies[1] have shown that either if the final production of team work is non-excludable or if the marginal production is increasing with number of group members, large coalitions will be formed. Khandan (2015) in another paper showed the process of coalition formation of firms and factors determining its size. In countries with high cooperation firms have no incentive to free-ride. This means that the assumption (2), positive rent for free-riders, does not hold in these countries; $(\pi^{CL} - \pi^{LL}) \leq 0 => \frac{(\psi-1)\, p^w + d}{1-\delta} \geq \frac{C}{2}$. These countries are correspond with high degree of synergy which increases the benefits of cooperation. This modification in assumption makes cooperation a stable equilibrium.

Figure 9 represents the payoff structure of this new game. Higher synergy or necessity of cooperation makes cooperation and, therefore, lobbying profitable. In this new game none of the strategies are strictly dominated. In

Figure ***9*** compliers population is fixed to $\bar{x}^C$ and the payoffs are drawn as function of lobbyists' population. There are three Nash equilibria which all are evolutionary stable. The equilibria can be Pareto ranked from lobbying equilibrium with the highest payoff to compliance and then bribing equilibrium with the lowest payoff.

[1]. Esteban and Ray (2001); Marwell and Pamela (1988; 1993)

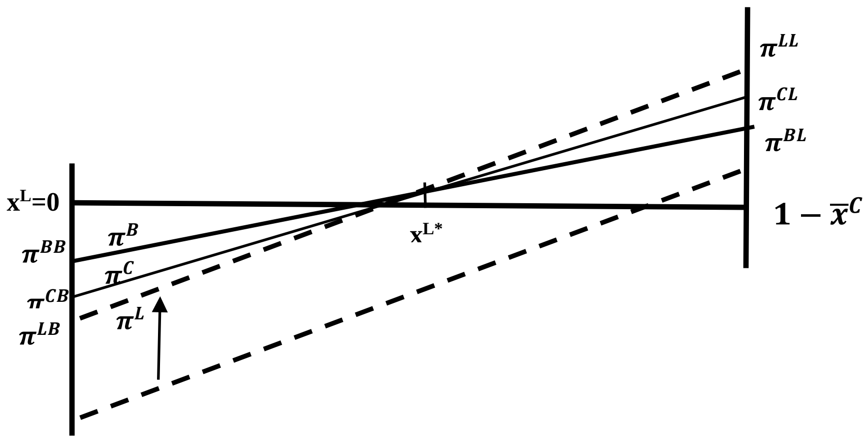

Figure 9: Payoffs of Different Strategies for a Given Compliers Population

According to dynamic equations (3), (4), (5), an increase in synergy ψ or the marginal benefit of cooperation $\mathcal{H}$ influence positively on lobbyists' population but decreases the number of bribers and compliers. To show this in simulated model, synergy has been increased from 1.5 to 2. The new dynamics of population is drawn and presented in Figure 10. Synergy and high benefits of cooperation make lobbying stable, however the other strategies are still stable and absorbent.

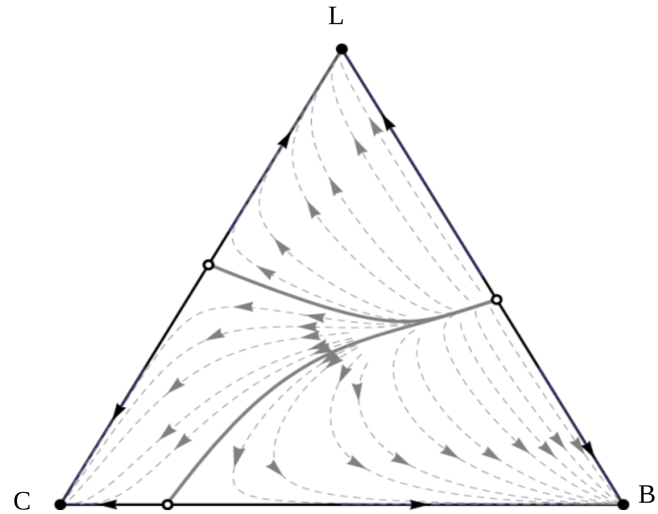

Figure 10: Evolutionary Dynamics of the Exemplar Game

Another incentive for cooperation is to share the linkage cost. The expected linkage cost is $EX(C) = \frac{C}{2}(x^L) + C(1 - x^L)$. The expected linkage cost depends on the likelihood of being matched with cooperators or non-cooperators. The expected linkage cost is lower when there are many cooperators; $EX(C) = C\left(1 - \frac{x^L}{2}\right)$. This means that the positive effect of cooperation is greater and more significant when linking to the government is more difficult and costly. Propositions (3) and (4) summarize the results.

Proposition (4): *Cooperation among firms has positive effect on lobbying but decreases corruption.*

Proposition (5): *The positive effect of cooperation on lobbying depends on difficulty of linking to government.*

6. Conclusion

Economic agents have the incentive to influence government. Two rent-seeking strategies available are lobbying, linking to the government in order to set favorable rules, or bribing, bending the current rule by paying rule-enforcers. Unfortunately, few studies have considered both strategies at the same time to analyze firms' choice between lobbying and bribing. Moreover, the literature to explain firms' behavior is focused mainly on individual characteristics like the size, the capital endowment, or the firms' ownership. The main objective of this study is to instead focus on the effects of social parameters which unfortunately are totally neglected in the literature. This is crucial because both lobbying and bribery have some important social and cultural aspects.

In this regard the first contribution is building up a theoretical model to explain firms' choice and dispersion of lobbying and bribery inside the society. A population game with evolutionary dynamics is used for this purpose. At First, I started with a basic model with some assumptions. It was shown that lobbying and compliance strategies are dominated by bribing. Bribers by free-riding on the effort of lobbyists and stealing their projects obtain a positive rent. Because of this rent, bribery spreads throughout the population, however, as bribers' population increases their corresponding rent recedes. The congestion effect makes bribing equilibrium to be Pareto ranked lower than lobbying and compliance states. This theoretical model explains why corruption spreads and why the society falls into a bribery trap with the lowest payoff.

Then the theoretical model is used to understand how social parameters change the game so that other strategies, lobbying and compliance, are also used. Social disapproval of bribery raises the risk of corrupt activities and, thus, encourages firm to comply with the rules. However, as it is shown, the final effect depends on the history of countries. Social punishment is less impactful on corruption in countries with long history of corruption. The second social factor investigated was cooperation among firms. Since cost of linking to government is usually high and, in addition, the benefits of lobbying are non-exclusive, firms prefer to lobby in group.

References

Banerjee, R. (2016). Corruption, Norm Violation and Decay in Social Capital. *Journal of Public Economics, 137,* 14-27.

Beckmann, K., & Gerrits, C. (2009). Lobbying and Corruption as Substitute Forms of Rent-seeking. In W. Schäfer, A. Schneider & T. Tobias (Eds.), *Markets and Politics - Insights from a Political Economy Perspective*. Marburg: Metropolis-Verl.

Bjørnskov, C. (2011). Combating Corruption: On the Interplay between Institutional Quality and Social Trust. *Journal of Law and Economics, 54*, 135-159.

Campos, N., & Giovannoni, F. (2008). Lobbying, Corruption and Other Banes. *William Davidson Institute WP, 930*, Retrieved from https://deepblue.lib.umich.edu/handle/2027.42/64386.

---------- (2007). Lobbying, Corruption and Political Influence. *Public Choice*, *131*(1), 1-21.

Drutman, L. (2015). *The Business of America is Lobbying: How Corporations Became Politicized and Politics Became More Corporate*. New York: Oxford University Press.

Esteban, J., & Ray, D. (2001). Collective Action and the Group Size Paradox. *American Political Science Review*, *95*(3), 663-672.

Harstad, B., & Svensson, J. (2011). Bribes, Lobbying, and Development. *American Political Science Review*, *105*(1), 46-63.

Marwell, G., & Pamela, O. (1993). *The Critical Mass in Collective Action: A Micro-social Theory*. Cambridge: Cambridge University Press.

Narayan, D., & Pritchett, L. (1999). Cents and Sociability: Household Income and Social Capital in Rural Tanzania. *Economic Development and Cultural Change*, *47*(4), 871-897.

Nooteboom, B. (2007). Social Capital, Institutions and Trust. *Review of Social Economy*, *65*(1), 29-53.

Pamela, O., & Marwell, G. (1988). The Paradox of Group Size in Collective Action. A Theory of Critical Mass, II. *American Sociological Review*, *53*(1), 1-8.

Robinson, L. J., Allan Schmid, A., & Siles, M. E. (2002). Is Social Capital Really Capital? *Review of Social Economy*, *60*(1), 1-21.

Sandholm, W. H. (2010). *Population Games and Evolutionary Dynamics*. Cambridge: MIT Press.

Sandholm, W. H., Dokumaci, E., & Franchetti, F. (2012). Dynamo: Diagrams for Evolutionary Game Dynamics. Retrieved from http://www.ssc.wisc.edu/~whs/dynamo.

Schuler, T. (2007). Reflections on the Use of Social Capital. *Review of Social Economy*, *65*(1), 11-28.

World Business Environment Survey. (2012). *The World Bank*. Retrieved from http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:20699364~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html.

World Development Report. (1997). *The World Bank.* Retrieved from http://www.worldbank.org/en/publication/wdr/wdr-archive.

World Values Survey. (2005). Official Data File, 20090901; 2009. World Values Survey Association, Retrieved from http://www.worldvaluessurvey.org/wvs.jsp.

Corruption Perception Index. (2012). *Transparency International*. Retrieved from http://www.transparency.org/cpi2012 .

Corruption Perception Index. (1999). *Transparency International*. Retrieved from http://www.transparency.org/cpi2012.

Attachment (Computational Details):

$$\Pi = \begin{Bmatrix} \pi^L = x^L\pi^{LL} + x^C\pi^{LC} + x^B\pi^{LB} = (\mathcal{R}_L - C) + \mathcal{H}x^L - \mathfrak{D}_b x^B \\ \pi^C = x^L\pi^{CL} + x^C\pi^{CC} + x^B\pi^{CB} = (\mathcal{R}_L - \mathfrak{D}_l)x^L - \mathfrak{D}_b x^B \\ \pi^B = x^L\pi^{BL} + x^C\pi^{BC} + x^B\pi^{BB} = (\mathcal{R}_L + \mathcal{R}_b) - \mathcal{L}x^B - \mathfrak{D}_l x^L \end{Bmatrix}$$

- Average Payoff

$$\bar{\pi} = x^L\big((\mathcal{R}_L - C) + \mathcal{H}x^L - \mathfrak{D}_b x^B\big) + (1 - x^L - x^B)\big((\mathcal{R}_L - \mathfrak{D}_l)x^L - \mathfrak{D}_b x^B\big) + x^B\big((\mathcal{R}_L + \mathcal{R}_b) - \mathcal{L}x^B - \mathfrak{D}_l x^L\big)$$

$$\bar{\pi} = \big((1 + x^C)\mathcal{R}_L - C - \mathfrak{D}_l(1 - x^L)\big)x^L + \big((\mathcal{R}_L + \mathcal{R}_b) - \mathfrak{D}_b(1 - x^B)\big)x^B + \mathcal{H}{x^L}^2 - \mathcal{L}{x^B}^2$$

- Dynamics of lobbying population

$$\dot{x}^L = x^L(\pi^L - \bar{\pi}) = x^L\Big((\mathcal{R}_L - C) + \mathcal{H}x^L - \mathfrak{D}_b x^B - \big((1 + x^C)\mathcal{R}_L - C - \mathfrak{D}_l(1 - x^L)\big)x^L - \big((\mathcal{R}_L + \mathcal{R}_b) - \mathfrak{D}_b(1 - x^B)\big)x^B - \mathcal{H}{x^L}^2 + \mathcal{L}{x^B}^2\Big)$$

$$\dot{x}^L = x^L(\pi^L - \bar{\pi}) = -(\mathcal{H} + \mathfrak{D}_l - \mathcal{R}_L){x^L}^3 + (\mathcal{H} + C - (2 - x^B)\mathcal{R}_L + \mathfrak{D}_l){x^L}^2 + \Big((\mathcal{R}_L - C) - (\mathcal{R}_L + \mathcal{R}_b)x^B + +(\mathcal{L} - \mathfrak{D}_b){x^B}^2\Big)x^L$$

$$\dot{x}^L = x^L(\pi^L - \bar{\pi}) = -\left(\frac{(\psi - 2)p^w + d}{1 - \delta} + \frac{C}{2}\right){x^L}^3 + \left(\frac{(\psi - 3 + x^B)p^w + d}{1 - \delta} + \frac{3C}{2}\right){x^L}^2 + \left(\left(\frac{p^w}{1 - \delta} - C\right) - \left[\frac{\gamma + (1 - \tau)p^d f}{1 - \delta}\right]{x^B}^2 - \left(\frac{1 - [B + p^d f]}{1 - \delta}\right)x^B\right)x^L$$

- Dynamics of bribers population

$$\dot{x}^B = x^B(\pi^B - \bar{\pi}) = x^B\Big((\mathcal{R}_L + \mathcal{R}_b) - \mathcal{L}x^B - \mathfrak{D}_l x^L - \big((1 + x^C)\mathcal{R}_L - C - \mathfrak{D}_l(1 - x^L)\big)x^L - \big((\mathcal{R}_L + \mathcal{R}_b) - \mathfrak{D}_b(1 - x^B)\big)x^B - \mathcal{H}{x^L}^2 + \mathcal{L}{x^B}^2\Big)$$

$$\dot{x}^B = x^B(\pi^B - \bar{\pi}) = (\mathcal{L} - \mathfrak{D}_b){x^B}^3 - \big(\mathcal{L} - \mathfrak{D}_b + \mathcal{R}_b + \mathcal{R}_L(1 - x^L)\big){x^B}^2 + \Big((\mathcal{R}_L + \mathcal{R}_b) - (2\mathcal{R}_L - C)x^L - (\mathcal{H} + \mathfrak{D}_l - \mathcal{R}_L)\,{x^L}^2\Big)x^B$$

$$\dot{x}^B = -\left[\frac{\gamma + (1-\tau)p^d f}{1-\delta}\right]{x^B}^3 + \left[\frac{(B+\gamma-1) + (2-\tau)p^d f + p^w(1-x^L)}{1-\delta}\right]{x^B}^2 + \left(\left(\frac{1-B-p^d f}{1-\delta}\right) - \left(\frac{(\psi-2)p^w + d}{1-\delta} + \frac{C}{2}\right){x^L}^2 - \left(\frac{2p^w}{1-\delta} - C\right)x^L\right)x^B$$

-Dynamics of compliers population

$$\dot{x}^C = -\dot{x}^B - \dot{x}^L = (\mathcal{H} + \mathfrak{D}_l - \mathcal{R}_L){x^L}^3 - (\mathcal{H} + C - (2 - x^B)\mathcal{R}_L + \mathfrak{D}_l){x^L}^2 - \left((\mathcal{R}_L - C) - (\mathcal{R}_L + \mathcal{R}_b)x^B + +(\mathcal{L} - \mathfrak{D}_b){x^B}^2\right)x^L - (\mathcal{L} - \mathfrak{D}_b){x^B}^3 + \left(\mathcal{L} - \mathfrak{D}_b + \mathcal{R}_b + \mathcal{R}_L(1 - x^L)\right){x^B}^2 - \left((\mathcal{R}_L + \mathcal{R}_b) - (2\mathcal{R}_L - C)x^L - (\mathcal{H} + \mathfrak{D}_l - \mathcal{R}_L)\,{x^L}^2\right)x^B$$

$$\dot{x}^C = -\dot{x}^B - \dot{x}^L = (\mathcal{H} + \mathfrak{D}_l - \mathcal{R}_L){x^L}^3 - (\mathcal{L} - \mathfrak{D}_b){x^B}^3 - (\mathcal{H} + C - 2\mathcal{R}_L + \mathfrak{D}_l){x^L}^2 + (\mathcal{L} - \mathfrak{D}_b + \mathcal{R}_b + \mathcal{R}_L){x^B}^2 + (\mathcal{H} + \mathfrak{D}_l - 2\mathcal{R}_L)\,{x^L}^2x^B - (\mathcal{L} - \mathfrak{D}_b + \mathcal{R}_L){x^B}^2x^L + (3\mathcal{R}_L + \mathcal{R}_b - C)x^Bx^L - (\mathcal{R}_L - C)x^L - (\mathcal{R}_L + \mathcal{R}_b)x^B$$

$$\dot{x}^C = -\dot{x}^B - \dot{x}^L = \left(\frac{(\psi-2)p^w + d}{1-\delta} + \frac{C}{2}\right){x^L}^3 + \left[\frac{\gamma + (1-\tau)p^d f}{1-\delta}\right]{x^B}^3 - \left(\frac{(\psi-3)p^w + d}{1-\delta} + \frac{3C}{2}\right){x^L}^2 - \left[\frac{(B+\gamma-1) + (2-\tau)p^d f}{1-\delta}\right]{x^B}^2 + \left[\frac{\gamma + (1-\tau)p^d f - p^w}{1-\delta}\right]{x^B}^2x^L + \left(\frac{(\psi-3)p^w + d}{1-\delta} + \frac{C}{2}\right){x^L}^2x^B - \left(\frac{p^w}{1-\delta} - C\right)x^L - \left(\frac{1-B-p^d f}{1-\delta}\right)x^B - \left(\frac{-2p^w - 1 + B + p^d f}{1-\delta} + C\right)x^Bx^L$$