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On Institutional Designs and Corruption by Imitation

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Abstract - Imitation is the sincerest form of flattery, and we claim the corruption is driven by imitative behavior for those agents facing an institutional design of corruption. So this paper analyzes an individual level approach and tackles the question of why people engage in corrupt exchange. We show that institutional design determines corruption and that there exists a threshold level in order to imitate the non-corrupt (honest) behavior.

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1 Introduction

Why are some countries poor and others rich? This has been the subject of considerable interest to social scientists for centuries. It is widely accepted that economic growth is a function of human capital, physical capital and technology. There is a growing consensus that it is the quality of institutions that matter in developing these essential recipes of economic growth. Good governance, an inverse function of corruption, is the major catalyst in sprouting such institutions. So the types of institutions determine the more profitable economic activities, and then they determine in some vein the individual behavior. That is, institutions ruled out the rights and incentives of economic agents.

Institutions represent a set of rules that govern social and economic way of life for a small group of individuals or an entire society. Preferences guide the conduct and individual behavior, which in turn determines in aggregate, these same institutions. In short, preferences and institutions are mutually determined, and the circle can be virtuous or vicious.

The word "corruption" comes from the adjective *corruptus*, which in Latin means damaged, broken or destroyed. According to the *Concise Oxford English Dictionary* a meaning for corruption in the social context is bribery, and corruption is equivalent to a moral decay. Corruption is defined as the behavior that deviates from implicit or explicit behavioral norms with or without legal and ethical connotations ruled out by institutions (see Mishra, 2006). Collier (2002), for example, defines corruption as a particular type of individual behavior even if he uses an "institutional choice approach" to explain corruption which suggests a view of corruption as an institution (that may or may not be chosen).

Thinking about corruption as "the rules of the game" as an institution, when almost everyone is corrupt, honesty is the deviant behavior. What needs to be explained under those circumstances is not why any one is corrupt, what needs to be explained is how corruption became the rules of the game, and we show that it is due to an imitative behavior given a fixed institutional design. Acemoglu et al. (2005) pointed out that a primary importance for economic performance are the type of institutions in society, since they influence the structure of economic incentives. For instance, without efficient institutions on property rights, individuals will not have the incentive to invest in physical or human capital or adopt more efficient technologies. Hence institutions are important because they help to allocate resources to their most efficient uses, they determine who gets profits, revenues and residual rights of control. But what if a corrupt behavior controls institutions, what about the economic performance? Hence, the aim of this paper is to analyze why the corrupt behavior and the factors that determine it.

In every country there is corruption, Mexico is certainly not the exception. The scourge of corruption in Mexico is a nice real example of corrupt behavior driven by imitation, i.e. to be corrupt if the others are doing it. The tenacity of corruption in Mexico has no kept politicians from promising to eradicate it, since Mexicans correctly identify corruption either at the root of Mexico's development problems or the cause of a poverty trap through a cultural fact of doing as others do (see Wydick, 2008). Corruption occurs at all levels of the Mexican society, for instance the legendary case of the 114-million-dollar deposited into Swiss bank accounts by Raul Salinas, brother of the former President Carlos Salinas de Gortari, who shortly thereafter fled to exile in Ireland. The money was believed to have came through relationships with Mexican and

Colombian drug cartels during his presidential time administration of the Mexican government. Another case of corruption in Mexico was given in 2004 by Carlos Ahumada, a 40 years old millionaire, who offered million-peso bribes to officials of Mexico's left-of-center Partido de la Revolución Democrática to obtain lucrative sewer-cleaning contracts in Mexico city.[4] In any case, corruption comes at all levels in Mexico as a kind of "cultural behavior", since the word for bribe, *mordida*, literally means the bite, and getting bitten in Mexico is regrettably common. In Mexico the mordida permeates every level of society and institutions where individuals acting because it is a norm and they just do what the others are doing (to corrupt or not). Bribes in Mexico are common and indeed are often deemed necessary for obtaining business licenses and other types of permits, there is a popular Mexican saying: "*el que no transa no avanza*, *who does not corrupt does not move on*".

Of course corruption is not a norm of behavior in every country (e.g. New Zealand, Singapore or Finland, see Transparency International on the Global Corruption Barometer, 2010)[5] but we wonder what accounts for adopting a corruptive behavior or not? We argue that the answer of this question is influenced by individual's expectations driven by imitative behavior about the choices of others around to corrupt or not.

We present a novel model to explain why individuals imitate a corrupt behavior thinking of it as a kind of rational behavior. Rational imitation can be explained as follows. An individual, A, can be said to imitate the behavior of another individual, B, when observation of the behavior of B affects A in such a way that A's subsequent behavior becomes more similar to the observed behavior of B. An individual can be said to act rationally when the individual, faced with a choice between different courses of actions, chooses the course which is the best with respect to her interests, her beliefs about possible action opportunities, and the effects of these potential action opportunities (for a survey on the notion of imitation see Sanditov, 2006). Certainly, this election is influenced by the behavior and fillings of the society in the moment when each individual does a choice.

In our model, imitation results in individuals performing a spectrum of tasks "as others do", that is to be corrupt or not. We assume that occasionally each individual in a finite population gets an impulse to revise her (pure) strategy choice either corruption and non-corruption. There are **three** basic elements:

1. First, it is a specification of the time rate at which individuals in the population review their current strategy choice whether they are currently corrupt individuals or not. This rate may depend on the current performance of the agent's pure strategy and of other aspects of the current population state.

2. Second, it is a specification of the choice probabilities of a reviewing individual. The probability i-strategist will switch to some pure strategy j may depend on the current performance of these strategies and other aspects of the current population state, that is how large is currently the share of corrupt individuals and types of institutions in the economy.

3. The last main question is: how the fillings and believes of the society as a whole, act on the choice of each individual.

[4] See Wydick (2008:1) from BBC News, October 20, 1998 and Wall Street Journal, June 23 of 2004, respectively each one.
[5] Available at: http://www.transparency.org/policy_research/surveys_indices/gcb/2010

If these impulses arrive according to i.i.d. Poisson processes, then the probability of simultaneous impulses is zero, and the aggregate process is also a Poison process. Moreover, the intensity of the aggregate process is just the sum of the intensities of the individual processes. If the population is large, then one may approximate the aggregate process by deterministic flows given by the expected payoffs from corruptive and non-corruptive behaviors. Björnerstedt and Weibull (1996) studied a number of such models, where those individuals who revise may imitate other agents in their player-population, and show that a number of payoff-positive selection dynamics, including the replicator dynamics, may be so derived. In particular, if an individual's revision rate is linearly decreasing in the expected payoff to her strategy (or to the individual's latest payoff realization), then the intensity of each pure strategy's Poisson process will be proportional to its population share, and the proportionality factor will be linearly decreasing in its expected payoff. If every revising agent selects her future strategy by imitating a randomly drawn agent in their own player population, then the resulting flow approximation is the replicator dynamics.

The remainder of this paper is organized as follow. Section 2 describes the baseline model and individuals' payoffs of corruption or not. Section 3 starts the dynamics and subsection 3.1 offers the main result of the paper regarding the evolution of corrupt behavior. Section 4 studies a case when imitation is due to dissatisfaction and individuals do not have a complete knowledge on the true value of the expected payoffs. Section 5 sets out some intuitive public policy recommendations. Finally, in Section 6 we conclude.

2 The baseline model

Institutions, according to North (1990), are the rules of the game that comprise formal laws, informal constraints, shared norms, beliefs and self-imposed limits on behavior and their enforcement characteristics; i.e., courts, police, judgemental aunts, etc. This broad definition bundles norms together with institutions and is also favored by Greif (2006): "An institution is a system of rules, beliefs, norms and organizations that together generate a regularity of social behavior."

We reamrk that in this paper we do not consider "institution formation", but we take as given the institutional design from some external (to the individual) form which include the whole structure of rules, means of detecting violation and adjudicating punishments. In order to develop the sequel model, let us state the next definitions:

Definition 1 *We say that "an individual imitates rationally" when faced with a choice between different types of possible future behaviors to adopt it, chooses that type of behavior followed by people, who according to their current beliefs, is representing the higher expected profit.*

Of course this individual choice is influenced by the social perception of these behaviors, when making a decision (see Sanditov, 2006).

Let us consider that there are two types of institutions: the corrupt and non corrupt. A distribution or profiles in these subgroups represented by $I = \{I_c, I_{nc}\}$. Two types of individuals act in such an economy. The type will be represented by an index $i \in \{c, nc\}$.

Definition 2 *We understand as "corrupt institutions" those institutions being caused to regulate individual behavior in terms of social interest by law, deviate from that goal to pursue and they are not punishing but so promoting any individual behavior which is contrary to the goal that gave them birth.*

The efficiency of an institution is defined by its ability to foster growth and economic and social welfare, and to prevent individual behavior contrary to the laws governing coexistence.

Individuals have already formed preferences on social welfare and their own. Based on these preferences will be willing or not, to follow a corrupt conduct. They are grouped by type, into two distinct subpopulations, of those who follow the corrupt behavior and those who do not accept this type of behavior (honest or non-corrupt).

Definition 3 *We say that "an individual is corrupt" or follow a corrupt behavior, when guided by self-interest, she is acting aside from the laws that govern the society in which is embedded.*

Then, institutional quality will refer to the extent to which such external elements are effective in detecting and punishing corrupt activities. Corrupt institutions of course consist of people performing corrupt acts. Consider an economy populated by types of institutions, g, from individuals, i, where individuals must behave as a corrupt or not, i.e. individuals' decision type $i \in \{c, nc\}$ is corrupt c or not nc.[6] Let the share of institutional design type be denoted by the vector $g = (g_c,\ g_{nc})$ normalized to one, $g_c + g_{nc} = 1$. Efficient or good institutions use mechanisms to punish the corrupt individual behavior, or non-legal activities of its employees, while these mechanisms do not exist in corrupt institutions. Corrupt individuals may obtain an extra-income from non-legal activities.

Assume that the social welfare is measured by a common good and all individuals in the society has the opportunity to use it in an equalitarian form this good. So if the total welfare in the society is defined by a real positive number, $S \in R_+$, each individual receive the same quantity of welfare from the society $s = S/N$ where N is the finite size of the population. However not all individual has the same taste for this good.

Suppose also that all individual in the society is engaged in an institution, and assume in addition that all individual receive the same salary given by m. The pair (s, m) defines a social state. Hence individuals' utility is defined by the function $U_i : R \times R \to R$, $i \in \{c, nc\}$, i.e.

$$U_i\,(s,\ m) = s^{\alpha_i} \cdot m^{\beta_i} \tag{1}$$

where $\alpha_i > 0$ measures the marginal impact of welfare distribution and $\beta_i > 0$ measures the marginal utility from monetary payoffs for all behavior $i \in \{c, nc\}$.

However, the individual utility is affected either by matching with a good institution or a bad one. Hence when a corrupt individual matches a bad institution g_c, then:

$$U_{cg_c}\,(s,\ m) = s^{\alpha_c}(m + b_c)^{\beta_c}, \tag{2}$$

[6]It is assumed here that individuals who would actively benefit from the continued functionality —good or bad— of institutions have no capacity to influence the institution designer type.

where $b_c > 0$ is earning of corruption activities. While matching a good institution g_{nc}, then:

$$U_{cg_{nc}}(s,\ m) = s^{\alpha_c}(m + b_c)^{\beta_c} - MP_{nc}(e), \tag{3}$$

where $M > 0$ is the cost or punishment for the corrupt behavior and $P_{nc}(e) \in (0, 1)$ measures a probability of monitoring corrupt activities or institutional effectiveness on eliminating corruption.

On the other side, the individual utility of non-corrupt behavior is:

$$U_{ncg_{nc}}(s,\ m) = s^{\alpha_{nc}} \cdot m^{\beta_{nc}} \tag{4}$$

with $\alpha_{nc} > \alpha_c$ meaning that non-corrupt individuals enjoy more the social state because such an individual matches a good g_{nc} institutional type.

Moreover, let us continue considering that if a non-corrupt individual is matched with a bad institution, then her utility function linearly decreases by facing such an institution g_c**,** i.e.:

$$U_{ncg_c}(s,\ m) = s^{\alpha_{nc}} \cdot m^{\beta_{nc}} - A_{nc} \tag{5}$$

where $A_{nc} > 0$ measured a disagreement for facing a bad institution. As we see, this parameter indirectly measured the degree of social disapproval towards a corrupt behavior.

Then the expected payoff of a corrupt individual is given by:

$$E(c/g) = [s^{\alpha_c}(m + b_c)^{\beta_c}]g_c + [s^{\alpha_c}(m + b_c)^{\beta_c} - MP_{nc}(e)]g_{nc}. \tag{6}$$

And the expected payoff of a non-corrupt individual is:

$$E(nc/g) = [s^{\alpha_{nc}}m^{\beta_{nc}} - A_{nc}]g_c + [s^{\alpha_{nc}}m^{\beta_{nc}}]g_{nc}. \tag{7}$$

So rational individuals prefer to be non-corrupt when $E(c/g) < E(nc/g)$, and this inequality follows if:

$$g_c < \frac{s^{\alpha_{nc}} \cdot m^{\beta_{nc}} - s^{\alpha_c}(m + b_c)^{\beta_c} + MP_{nc}(e)}{A_{nc} + MP_{nc}(e)} = g_h, \tag{8}$$

or equivalently:

$$g_c < \frac{U_{ncg_{nc}}(s,\ m) - U_{cg_c}(s,\ m) + MP_{nc}}{Anc + MP_{nc}(e)} = g_h. \tag{9}$$

Hence individuals prefer to be non-corrupt if the share of bad institutions is lower than this threshold value, $g_c < g_h$.

Note that $[\alpha_{nc} + MP_{nc}(e)] > [U_{ncg_{nc}}(s,\ m) - U_{cg_{nc}}(s,\ m)]$ indicates that as far as the punishment cost for corruption, $MP_{nc}(e)$ plus the disagreement of facing a bad institution, A_{nc} is large enough, then individuals prefer to behave honestly and do not to inquire in corrupt activities. So here we have an incentive for bad individuals to turn over non-corrupt activities when the number of bad institutions declines and they will be better under better institutions. Note also, that the intensity of the displeasure that the

corrupt behavior creates in an honest worker, (measured here by A_{nc}) plays a positive social role in the imitation game, doing that the threshold value, from that the honest behavior has an higher expected value, decreases. It is natural to think that in a society where the imitative behavior plays a central role, the degree of social disapproval toward a behavior influence the choice of individual behavior. The intensity with which society disapproves of social behavior is partially represented in our model by A_{nc}.

It can be shown that when the distaste for corrupt behavior, as measured by A_{nc} is high, then more efficient is the punishment for corrupt behavior. It is natural to think that in a society where imitation plays a central role, the degree of social rejection toward a behavior can influence the behavior of individual choice. The above can be summarized in the following proposition.

Proposition 1 *The following statements are verified:*

1. *If* $A_{nc} > [U_{ncg_{nc}}(s,\ m) - U_{cg_c}(s,\ m)]$ *then the threshold value* g_h *increases with the expected payoff of punishment for corrupt behavior.*

2. *If* $A_{nc} < [U_{ncg_{nc}}(s,\ m) - U_{cg_c}(s,\ m)]$ *then the threshold value* $g_h > 1$ *such that* $E(nc/g) > E(c/g); \forall\ g$.

Proof. Let $g_h : \{\mathbb{R} - A_{nc}\} \to \mathbb{R}$ be defined by:

$$g_h(MP_{nc}) = \frac{U_{ncg_{nc}}(s,\ m) - U_{cg_c}(s,\ m) + MP_{nc}}{Anc + MP_{nc}(e)}, \tag{10}$$

see (9). It follows that:

$$\frac{dg_h(MP_{nc})}{dMP_{nc}} > 0 \Leftrightarrow A_{nc} > [U_{ncg_{nc}}(s,\ m) - U_{cg_c}(s,\ m)].$$

■

Therefore, we state the following corollary.

Corollary 1 *If*

$$[U_{cg_c}(s,\ m) - U_{nc}g_{nc}(s,\ m)] < 0,$$

to get an efficient punishment of the corrupt individual, will be ensured that:

$$MP_{nc} > -[U_c g_c(s,\ m) - U_{nc}g_{nc}(s,\ m)]$$

Proof. Note that the function $g_h(MP_{nc})$ (equation (10)) is increasing $\forall\ MP_{nc} > 0$, but positive if and only if $MP_{nc} > -[U_c g_c(s,\ m) - U_{nc}g_{nc}(s,\ m)]$. Otherwise the threshold value is zero or negative and verified for any distribution $g_c > g_h$. ■

Under the conditions of Proposition1 and Corollary 1: As the threshold increases, measures of punishment for corrupt behavior are more efficient. Fulfilling the conditions of the corollary that only high punishment will have social impact. However if the probability of facing a corrupt institution is greater than this threshold, either because the penalties are low and large the number of inefficient institutions or

because society does not have a strong rejection towards corrupt institutions, then corrupt behavior tends to become a model worthy of imitation. Under this situation we can state the following remark:

Remark 1 *If corruption is high, then it is contagious and does not respect borders sector. Corruption reduces levels of morality and trust behavior. Once it takes root, it tempts others and reduces the incentive to attack it. When levels of A_{nc} diminish, it becomes harder to resist corrupt practices.*

In short, as bad institutions become less, and as individuals have an increased odds for using or dealing with such institutions (measured by A_{nc}), then imitation will be to conduct legal and non-corrupt activities.

3 On the dynamics of corrupt behavior

Consider that individuals' population $i \in \{c, nc\}$ compromises a profile distribution $x = (x_c, x_{nc})$ normalized to one, $x_c + x_{nc} = 1$. Individuals are absolutely rational, so they change their behavior according to the expected payoffs associated with such an adopted behavior i. Assume that in time $t = t_0$ the profile distribution is $x(t_0) = (x_c(t_0), x_{nc}(t_0))$, and the profile distribution of institutions is fixed at $q = (g_c, g_{nc})$.

So the evolution of individuals' type $i \in \{c, nc\}$ depends on differences in expected payoffs and the dynamic flow of individuals must follow the next evolution:

$$\begin{aligned} \dot{x}_{nc} &= [E(nc/g) - E(c/g)]\, \dot{x}_c \\ \dot{x}_{nc} &= -\dot{x}_c \end{aligned} \tag{11}$$

Hence the share of non-corrupt individuals may increase, decreases or is stationary and this is according to the sign of $E(nc/g) - E(c/g)$. In fact the share of the most successful behavior may increase.

Proposition 2 *In a given period of time $t = t_0$ is verified $x(t_0) = (x_{nc}(t_0),\, x_c(t_0))$, hence:*

1. *If $g_c(t) < g_h \;\forall\, t > t_0$ implies that $(x_{nc}, x_c) \to (1, 0)$ with $t \to \infty$, $\forall\, (x_{nc}(t_0), x_c(t_0)) \neq (1, 0)$.*
2. *If $U_{nc} g_n c - U_c g_c > A_{nc}$ implies that $(x_{nc}(t), x_c(t)) \to (1, 0)$ with $t \to \infty, \forall (x_{nc}(t_0), x_c(t_0)) \neq (1, 0)$ regardless of the distribution g.*
3. *If $[U_c g_c\,(s,\, m) - U_{nc} g_{nc}\,(s,\, m)] < 0$ then for values $MP_{cn} > -[U_{nc} g_{nc}\,(s,\, m) - U_c g_c\,(s,\, m)]$ takes place at time t, an increase in the percentage of corrupt individuals if and only if $g_c(t) < g_h(MP_{nc})$.*

Proof. If $g_c(t) < g_h \;\forall\, t > t_0$, then $[E(nc/g) - E(c/g)] < 0$ and it follows the first statement of the theorem. From point (2) of theorem (1) it follows that $g_h > 1$ then the percentage of bad or corrupt institutions never exceeds the threshold value. Note that in this case for all values of g_c is verified that $g_c > g_h$ so that the evolution of the system goes to $((x_{nc}, x_c) = (0, 1)$. In this case, only from an expected value of punishment for corrupt behavior more than $-[U_{nc} g_{nc}\,(s,\, m) - U_c g_c\,(s,\, m)]$ will $g_h(MP_{nc}) > 0$ when $g_c(t) < g_h$, then in such a time t the percentage of corrupt individuals decreases. ■

To simplify the future analysis of this evolution, and to obtain some conclusion, let assume that:

$$\alpha_c = \alpha_{nc} = \beta_c = \beta_{nc} = 1.$$

In this case it follows that $E(nc/g) - E(c/g) = MP_{nc}(e) - g_c(1 + MP_{nc}(e)) - b_c s$, and the threshold value for this case is given by:

$$\hat{g}_h = \frac{MP_{nc}(e) - b_c s}{MP_{nc}(e) + A_{nc}}.$$

Then, the share of the non-corrupt individuals increases as far as the share of bad institutions is lower and verifies the inequality $g_c < \hat{g}_h$. To get an economy of non-corrupt individuals the share of good institutions should be large enough and this happen as large is the welfare distribution s and earning of corruption activities decreases, b_c.

3.1 Corrupt behavior by imitation

Assume that individuals do not have complete information for the exact values of $E(c/g)$, $E(nc/g)$ and g.

Our exercise of imitative behavior works out in the following way (see Accinelli et al 2010). A reviewer individual i under the probability $r_i(x) \in [0, 1]$ raises the question about if she must or not change her current type $i \in \{c, nc\}$. So $r_i(x)$ is the time rate at which at which individuals review their strategy choice. This probability depends on the actual distribution of the population x and in the benefits associated with her current behavior.[7] It is natural to assume that the likelihood that an individual make to herself this question, depends inversely with the performance of her current behavior.

Having opted for a change, the individual will adopt a strategy followed by the first person from the population to be encountered (her neighbor), i.e. there is a probability $p_{i/j}(x) \in [0, 1]$, that a reviewing $i-$strategist really switch to some pure strategy $j \in \{c, nc\}$. In a finite population one may imagine that review times of an agent are the arrival time of a Poisson process with arrival time $r_i(x)$, and that at each time the agents selects a pure strategy according to the probability distribution $p_{i/j}(x)$. Consider independence of switches across agents, and the process of switches from strategy i to strategy j as a Poisson Process with arrival rate $x_i r_i p_{i/j}$. Assuming a continuum of agents and by the law of large numbers, we model these aggregate stochastic process as a deterministic flow. So the evolution of the population will be given by the following dynamic system:

$$\begin{aligned} \dot{x}_{nc} &= r_c(x) p_{c/nc} x_c - r_{nc}(x) p_{nc/c} x_{nc} \\ \dot{x}_c &= -\dot{x}_{nc} \\ x(t_0) &= (x_c(t_0), x_{nc}(t_0)), \end{aligned} \tag{12}$$

System (12) represents the interaction between two groups (corruptive and not) of individuals that

[7] This is the "behavioural rule with inertia" (see Bjornerstedt and Weibull, 1996; Weibull, 1995 and Schlag, 1998; 1999) that allows an agent to reconsider her action with probability $r \in (0, 1)$ each round.

imitate their neighbors. The RHS of $\dot{x}_{nc}$ is an inflow-outflow model: all those corrupt strategists becoming non-corruptive minus all those non-corrupt becoming corrupt agents. The differential equation (12) can be written as:

$$\dot{x}_{nc} = r_c p_{c/nc} - x_{nc}\left(r_c p_{c/nc} + r_{nc} p_{nc/c}\right), \tag{13}$$

let us label $A = r_c p_{c/nc} + r_{nc} p_{nc/c}$ and $B = r_c p_{c/nc}$. Hence the next proposition is straightforward.

Proposition 3 *If we assume an imitative behavior as the basis for the choice of individual behavior, the distribution of individuals about the possible behaviors, corrupt or non-corrupt, converges to* $x^* = (x^*_{nc}, x^*_c) = (\frac{B}{A}, 1 - \frac{B}{A}) >> 0$. *There is only one situation in which corrupt behavior disappears in the long term, i.e. in which equilibrium is reached at* $(x_c, x_{nc}) = (0, 1)$, *and this is when no agent honest (or non-corrupt) is revising* $r_{nc} = 0$, *and all corrupt is revising,* $r_c = 1$.

Proof. The solution of (13) is

$$x_{nc}(t) = x_{nc}(t_0)\exp\left(-At\right) + \frac{B}{A},$$

where $x_{nc}(t_0)$ is the share of non-corrupt individuals at time $t = t_0$. It follows then, that such rate converges to

$$\frac{B}{A} = \frac{r_c p_{nc/c}}{r_c p_{nc/c} + r_{nc} p_{c/nc}}$$

Note that $x_{nc}(t) \to 1$ when $r_{nc} p_{c/nc} = 0$ happens when all the non-corrupt individuals remain with their current behavior. ■

Corollary 2 *The share of non-corrupt individuals, in the long term, increases with the likelihood that corrupt individuals are reviewers, while decreasing with the likelihood that non-corrupt individuals are doing the revision.*

Proof. Just consider the quotient B/A as a function of r_c and r_{nc}, it will then: $\frac{\partial B/A}{\partial dr_c} > 0$ while $\frac{\partial B/A}{\partial dr_{nc}} < 0$. ■

As in the case of imitation by dissatisfaction these probabilities or frequencies depend on the results obtained by the behavior followed by individuals of either type. The frequency will be higher in corrupt than in non-corrupt whenever $E(nc/g) > E(c/g)$ so $g_c < g_h$. This is summarized in the following corollary:

Corollary 3 *An increase in the threshold value* g_h *brings an increase, in the long term, of the share of individuals who follow an honest behavior.*

The proposition 3 and its two corollaries (2 and 3) state that almost all possible evolutionary trajectories for the population distribution, in the long term, lead to a mixed state in which coexist the two types of behavior. But institutional efficiency should determine the predominance of one or another type of behavior. The efficiency of existing institutions in a society can be measured by the likelihood that an individual reviewer is corrupt. The more efficient, or lower the number of corrupt institutions, the greater the likelihood that corrupt individuals make question to their behavior.

Note that $\frac{B}{A} = \frac{P(c \to nc)}{P(c \to nc)+P(nc \to c)}$ representing relative weight of likelihood for an individual corrupt changing type regarding probability of reviewing type.

4 Imitation by dissatisfaction

Because dissatisfaction on current behavior an individual reviewer must copy the behavior of the first person she meets on the street, so $p_{i/j} = x_j$, $\forall i \neq j \in \{c, nc\}$. Then, by rearranging terms the dynamic system (12) takes the form:

$$\begin{aligned} \dot{x}_{nc} &= (r_{nc} - r_c)\, x_{nc}^2 + (r_c - r_{nc}) x_{nc} \\ \dot{x}_c &= -\dot{x}_{nc} \end{aligned} \tag{14}$$

and after some little of algebra, we get the following chain of equalities:

$$\dot{x}_{nc} = (r_{nc} - r_c)\, x_{nc}^2 + (-r_{nc} + r_c) x_{nc} = (r_{nc} - r_c)\, x_{nc}(x_{nc} - 1)$$

Note that $\dot{x}_n \geq 0$ if and only if $(r_{nc}(x) - r_c(x)) \leq 0$ and $x_c(t_0) > 0$, which means that the share of non-corrupt individuals increases when, $r_c > r_{nc}$, more corrupt individuals review their behavior considering a change on it.

Thinking that as far as the payoff level of the $i-$strategist, $E_i(\cdot)$, increases her average reviewing rate, $r_i(x)$, will decrease. So assume r_i is linear in payoff levels, thus the propensity to switch behavior is decreasing in the level of the expected payoff, that is:

$$r_i\,(x) = \alpha_i - \beta_i E\,(i/g) \quad \forall i \in \{c, nc\}\,, \tag{15}$$

where α_i, $\boldsymbol{\beta}_i \geq 0$ and $\frac{\alpha_i}{\boldsymbol{\beta}_i} \geq E\,(i/g)$ assures that $r_i \in [0, 1]$. We interpreted α_i as a marginal degree of dissatisfaction and β_i as the marginal performance of the own expected payoff when reviewing the current strategy i. Then the corrupt individual makes to herself this reviewing rate more often than a non-corrupt individual if an only if $E(nc/g) > E(c/g)$.

We may assume that individuals do not know the exact value for the expected payoffs, however they are able to take an approximation of such true values in order to estimate it. Let us denote by $\bar{E}(i/g)$ the estimators of the true values $E\,(i/g)$. The process of imitating successful behaviors exhibits *payoff monotonic updating*, since each $i-$strategist changes her strategy if and only if $\bar{E}(i/g) < \bar{E}(j/g)$, $\forall\ i \neq j \in \{c, nc\}$.

To simplify consider the case of: $\alpha_c = \alpha_{nc} = \alpha$ and $\beta_c = \beta_{nc} = \beta$. Then equation (14) becomes:

$$\begin{aligned} \dot{x}_{nc} &= -\beta \left(\bar{E}(nc/g) - \bar{E}(c/g)\right) x_{nc}^2 + \beta(\bar{E}(nc/g) - \bar{E}(c/g))x_{nc} \\ \dot{x}_c &= -\dot{x}_{nc} \\ x(t_0) &= (x_c(t_0), x_{nc}(t_0)), \end{aligned} \tag{16}$$

So the share of non-corrupt individuals increases if $\bar{E}(nc/g) - \bar{E}(c/g) > 0$, and this happen with a positive probability, namely $P\left[\bar{E}(nc/g) - \bar{E}(c/g) > 0\right] > 0$, i.e. if the event $\bar{E}(nc/g) - \bar{E}(c/g) > 0$ has a positive measure. Makes sense to assume that the probability $P(\bar{E}(c/g) - \bar{E}(nc/g)) > 0)$ increases with the difference between the true expected payoffs $E(nc/g) - E(c/g)$, i.e. individuals prefer to behave as non-corrupt when $E(c/g) < E(nc/g)$ and this inequality follows if the share of bad institutions is lower than the threshold value, $g_c < g_h$, given by equation (8).

Theorem 1 *The level x_c prevailing in society depends on the institutional design $g = (g_c,\, g_{nc})$.*

Proof. The first equation of system (16) can be written as:

$$\dot{x}_{nc} = \beta \left(\bar{E}(nc/g) - \bar{E}(c/g)\right) x_{nc}(1 - x_{nc}),$$

then $\dot{x}_{nc} > 0$ if and only if $0 < x_{nc} < 1$ (which implies that the likelihood of corrupt and non-corrupt individuals is zero) and $\bar{E}(nc/g) - \bar{E}(c/g) > 0$ which in turn increased likelihood is verified if and only if the difference between the true expected values $E(nc/g) - E(c/g)$ increases. Such difference is positive and increasing with $g_{nc} > 1 - g_h$, hence $P(\bar{E}(nc/g) - \bar{E}(c/g) > 0)$ grows with the institutional type $g_{nc} > 1 - g_h$. We know that people prefer to behave as a non-corrupt when $E(c/g) < E(nc/g)$ and this inequality holds if the percentage of corrupt institutions is lower than the threshold value, $g_c < g_h$, given by equation (8). ■

Established social rules have a normative character. By definition, corruption means the breakdown and moral violation of such rules. As good institutions ensure discourage corrupt behavior, such as trying to increase the degree of social disutility, A_{nc}. Such institutions, $g = (g_c,\, g_{nc})$, are a key to attacking corruption.

5 Anti-corruption policy

This section will discuss briefly some elements of anti-corruption policies. These are primarily public policy. As such, they are evaluative and prescriptive guidelines of behavior in a social context, and aimed to clarify and define solutions to public problems as in the case at hand: corruption.

We understand the evolution of corrupt behavior as the result of a rational process of imitation, it is

possible to consider the threshold introduced in (9)

$$\frac{U_{ncg_{nc}}(s,\ m) - U_{cg_c}(s,\ m) + MP_{nc}}{Anc + MP_{nc}(e)} = g_h,$$

as a starting point for this discussion.

A high threshold value g_h ensures that, even in the presence of a relatively high number of corrupt institutions, as punishment for corrupt behavior or the probability of detecting it increases, the evolution process of corruption can be affected by a negative sign making the decline over time on the proportion of corrupt agents, and that non-corrupt increases according to the solution of the dynamic system (13).

Assuming that individual preferences are given and that in the short term they are not influenced the institutions that govern it, the discussion of public policy measures aimed at avoiding or increasing the positive evolution of corrupt behavior in the short term should focus on considering the denominator of the fraction that determines the threshold above. This leads us to consider as fundamental elements the value of the fines and the likelihood of punishment for corrupt behavior, which to be effective, it must be accompanied by a high degree of disutility in the honest created by corrupt behavior. The public policies should be aimed at:

- Generate a new social culture to combat corruption. We have shown that corruption is driven by imitation, and developing a cultural change to mimic the good citizenship can succeed in combating corruption.
- Raising the level of disutility caused by corrupt behavior.
- Doing research and integrate basic information on the activities of the institutions to support their actions for improving their performance.
- The value A_{nc} represents the social disgust towards corruption, and it may be increased. For example:
  - Provide quality and transparency of governance.
  - Provide agreements involving the society.

Moreover it is also true that the preferences are formed in childhood, so the new members of the institutions may differ with time of their predecessors, to be influenced by their environment.

Finally, Theorem 1 points out the importance of institutions. An economy with an efficient institutional design will have low levels of corruption. Remember as Douglass North (from the new institutional economics) tells how Justice, culture and politics disrupt the economy. For example, if it is too expensive to make a personal or collective contract to develop an economic activity, how expensive is because institutions do not function well. If the law allows us to fulfill contracts or anyone with money can go outside without protection by law, then the transaction costs are very expensive in any country. In this line of thought, we can conclude that when institutions are inefficient and generate high transaction costs in the most efficient way to trade is through corruption or fraud. This is because corruption is often more efficient than the

established institutional rules, because they get to avoid a system of inefficient institutions. Not always, but often the corruption lowers the transaction cost. So if you want to eliminate corruption, you have to do an improvement of the system of rules and institutions (for example, to find ways to legally lower transaction costs).

6 Concluding remarks

We have considered throughout this work the involvement of individuals in corrupt activities responding to an imitation process, regulated by a society in which the percentage of corrupt (or bad) institutions exceeds a certain threshold value. However, corruption is ultimately the direct result of the decisions and behavior of individuals determined by their preferences and realized in a society, which influences the formation of such preferences and therefore the further decisions.

Society influences the evolution of individual behavior through institutions that establish rules of behavior. It is particularly important to define the future evolution of individuals behavior considering the percentage of corrupt and non-corrupt institutions in the society. The non-corrupt behavior punished honest deviation, while the corrupt encourage corrupt behavior facing an institutional design.

The above model is novel in the literature, indicating that corruption evolves from a process of imitation followed by rational agents with incomplete information on the expected value of their strategic decisions. Based on these considerations we construct a dynamic system that represents the evolution of corruption from an initial distribution of types (good and bad) of institutions.

More generally, we have illustrated the importance of thinking about corruption based on "the rules of the game", i.e. from institutions. When almost everyone is corrupt, honesty is a deviant behavior, and corruption is imitated. We conclude that institutional design matters to avoid corrupt behavior, when the number of bad institutions is lower that a certain threshold thew the economy evolves to non-corrupt behavior. But what about the quality of institutions. Future research should go on the direction about how can we measure the quality of institutions? That is a difficult problem for future work. It is very difficult to measure and why it is so complicated theorizing about institutions compared with other fields of economy, because theory is something not seen or felt or heard.

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