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Bounded Rational Corruption Model

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ABSTRACT

This study modifies the model of Galor and Zeira (1993) to reveal that the corruption is natural to human. Corruption is bounded rational because an individual is half conscious when he or she commits corruption. The individual does not aware of being monitored and the punishment. The incentive to corrupt is always greater than the incentive not to corrupt unless the society develops good monitoring system and enforces the punishment.

Keywords: Corruption, bounded rationality, microeconomic behavior, mechanism design, monitoring and punishment

JEL Classification: D73, D01, D82

1. Introduction

We believe that corruption is the root of all evil. However, instead of blaming an individual who commits corruption, we think that it is better to understand and accept that corruption is natural to human. Microeconomics says human responds to incentives and this is also why people commit corruption; people will always choose to commit corruption when the incentive from the corruption is greater than the incentive from not to commit corruption. To prevent the corruption, a society needs to design a mechanism to stop the incentive to commit corruption or to make it less than the incentive from not to commit corruption. The question is what should be that mechanism.

This paper tries to develop a mathematical model by modifying the model of Galor and Zeira (1993) to explain the corruption. It also tries to find a good mechanism to prevent corruption. It aims at truly understanding the reasons behind the corruption and finds a good way to eradicate corruption from society.

2. Assumptions of the model

The underlying assumptions of this model are as follows:

A1. An individual who commits corruption earns more than another one who does not commit corruption.
A2. The cost to commit corruption is h.
A3. An individual has a level of asset, X.
A4. An individual whose asset, *X*, is greater than *h* will be able to choose whether to commit corruption.
A5. An individual whose asset, *X*, is less than *h* can borrow money to commit corruption.
A6. The earning from corruption, W_K, is greater than the earning from no corruption, W_N. The earning from corruption will be given in the second year while the earning from no corruption will be given in both the first and second years.
A7. There are two periods. The first period is for the making decision to commit corruption. The second period is for the earning from the corruption or from the honesty.
A8. Utility of an individual is given by $U = C^{\alpha} S^{1-\alpha}$ where C is consumption and S is savings with the parameter alpha which lays between zero and one, $0 < \alpha < 1$. The summation of consumption and savings is the total income, $C + S = Y$.
A9. The long-run equilibrium, the steady state, is defined as the sustainability of assets, $X_t = X_{t+1}$.
A10. The savings in this period turns into the assets in the next period, $S_t = X_{t+1}$.
A11. The loan interest rate is i while the deposit interest rate is r, where $i > r$.

3. The short-run equilibrium of the model

Following mathematical settings and solutions in Garlor and Zeira (1993), the model begins with the setting of Lagrangian function to maximize utility under budget constraint. Then it finds the first derivative of the Lagaragian function by C, S and λ. After that, it sets those first derivatives to zero. It arranges the terms and finds the optimal utility as follows:

$$U^* = \alpha^\alpha (1-\alpha)^{1-\alpha} \cdot Y$$

To make the terms easier, we set $\alpha^\alpha (1-\alpha)^{1-\alpha}$ to be e. Therefore, $U^* = eY$.

Moreover, the model gets $S^* = (1-\alpha)Y$.

Case 1: An individual whose assets, X, is greater than the cost to commit corruption, h, but chooses not to commit corruption.

The total income at the end of the second year is the combination of the asset in the first year with its deposit interest plus the earning in the second year.

$$Y = (X + W_N)(1+r) + W_N$$

The utility of this person can be derived as follows:

$$U_N = eY = e[(X + W_N)(1+r) + W_N]$$

$$U_N = e(1+r)X + eW_N(2+r)$$

It should be reminded that $e = \alpha^\alpha (1-\alpha)^{1-\alpha}$.

The savings of this person can be shown as follows:

$$S_t^N = (1-\alpha)[(X + W_N)(1+r) + W_N]$$

$$S_t^N = (1-\alpha)(1+r)X + (1-\alpha)(1+r)W_N + (1-\alpha)W_N$$

$$S_t^N = (1-\alpha)(1+r)X + (1-\alpha)W_N(1+r+1)$$

$$S_t^N = (1-\alpha)(1+r)X + (1-\alpha)(2+r)W_N$$

Case 2: An individual whose assets, X, is greater than the cost to commit corruption, h, and chooses to commit corruption.

The earning from corruption will be received by the second year. Therefore, the total income at the end of the second year combines the rest of the asset after committing corruption with the deposit interest plus the earning from corruption.

$$Y = (X - h)(1 + r) + W_K$$

The relevant utility can be derived as follows:

$$U_{E1} = eY = e[(X - h)(1 + r) + W_K]$$

$$U_{E1} = e(X - h)(1 + r) + eW_K$$

$$U_{E1} = e(1 + r)X - e(1 + r)h + eW_K$$

$$U_{E1} = e(1 + r)X + e(W_K - (1 + r)h)$$

The savings function can be obtained as follows:

$$S_t^{E1} = (1 - \alpha)[(X - h)(1 + r) + W_K]$$

$$S_t^{E1} = (1 - \alpha)(1 + r)X - (1 - \alpha)(1 + r)h + (1 - \alpha)W_K$$

$$S_t^{E1} = (1 - \alpha)(1 + r)X + (1 - \alpha)[W_K - (1 + r)h]$$

Case 3: An individual whose assets, X, is less than the cost to commit corruption, h, and chooses to borrow money to commit corruption.

The income at the end of the second year includes the cost of investment in the first year with its loan interest plus the earning from the corruption.

$$Y = (X - h)(1 + i) + W_K$$

It should be noted that the first term is negative because $X < h$. By defining $X - h = -g$ then the income can be rearranged as follows:

$$Y = (X - h) + (X - h)i + W_K$$

$$\text{and} \quad Y = W_K - g - gi$$

That is the income at the end of the second year is the earning from corruption less the loan and the loan interest.

The relevant utility can be shown as follows:

$$U_{E2} = eY = e[(X-h)(1+i)+W_K]$$

$$U_{E2} = e(1+i)X - e(1+i)h + eW_K$$

$$U_{E2} = e(1+i)X + e(W_K - (1+i)h)$$

The savings function of this individual can be presented as follows:

$$S_t^{E2} = (1-\alpha)[(X-h)(1+i)+W_K]$$

$$S_t^{E2} = (1-\alpha)(1+i)X - (1-\alpha)(1+i)h + (1-\alpha)W_K$$

$$S_t^{E2} = (1-\alpha)(1+i)X + (1-\alpha)[W_K - (1+i)h]$$

Plotting U_N , U_{E1} and U_{E2} onto the space where the horizontal axis is the initial asset (X) and the vertical axis is the utility (U) yields the diagram in Figure 1.

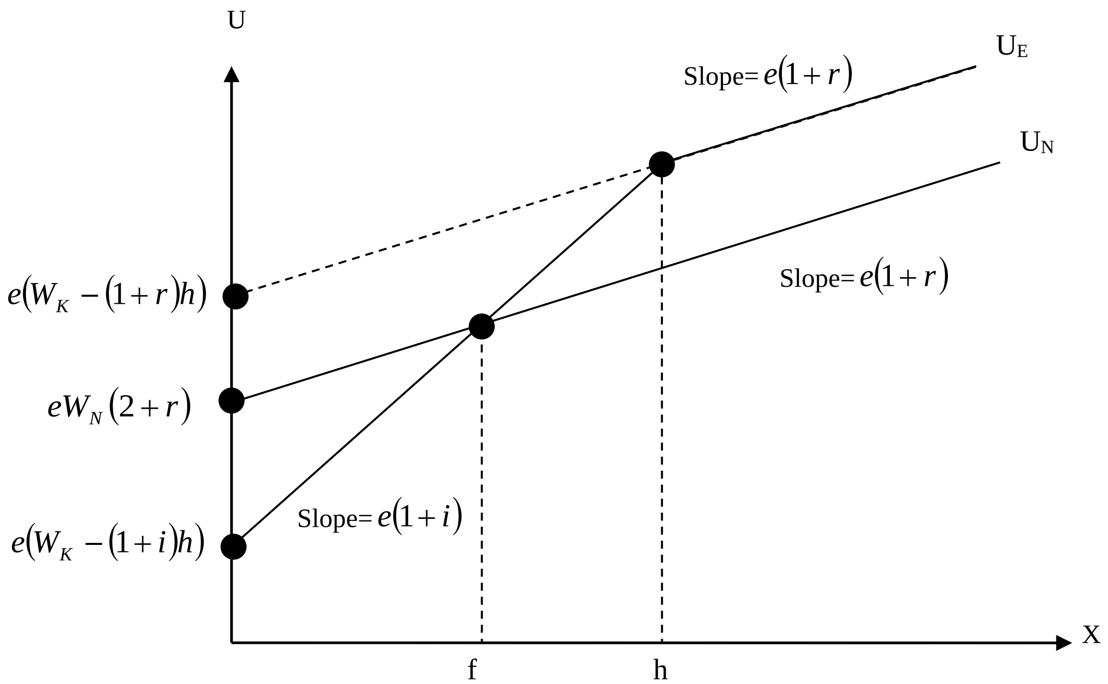

Figure 1: Utilities from committing corruption and not committing corruption

It is natural for human that an individual with initial asset, *X*, that is greater than the cost of committing corruption, *h*, will certainly choose to commit corruption. This is because the earning from corruption, W_K is greater than the earning from no corruption, W_N. Therefore, when an individual can invest to commit corruption and earn the higher income, he or she will choose to do it for sure. This behavior can be illustrated by Figure 1 that the utility of committing corruption, U_E, is greater than the utility of not committing corruption, U_N, for a person whose asset is greater than *h*. Following that human responds to incentives, therefore this individual will prefer to commit the corruption.

For the individual whose asset is less than *h* but greater than *f*, his or her utility from committing corruption is also greater than from no corruption. Thus, the solution is that this individual will choose to borrow money to commit corruption. The reason is simple; it is worth to do so.

The only case that the incentive of corruption is less than that of no corruption is for the individual whose asset is less than *f*. The reason is because the individual cannot bear the loan interest if he or she borrows to commit corruption. This is not because he or she has better morale than the one in other cases at all. It is all because it is not economically worth to commit corruption when an individual has to borrow too much money to invest for the corruption.

3. The long-run steady state of the model

For the steady state in the long-run, an individual would prefer to have a stable level of asset in the future. Therefore, the steady state can be defined as the equivalence between the assets in this year and next year, $X_t = X_{t+1}$. This equivalence can be illustrated by the *45* degree line in the space of X_t and X_{t+1}.

Next, asset in the next year is determined by the savings in this year, $S_t = X_{t+1}$. Consequently, the steady state can be found where the savings function intersects with the *45* degree line.

The savings function is fragmented due to the level of initial assets. Figure 2 displays the three fractions of the savings function. The first part to the left-hand-side belongs to the individual whose asset is below the threshold *f*. The middle part belongs to the one whose asset is below the cost to commit corruption, *h*, but above the threshold *f*. The third part to the right-hand-side belongs to the individual with the richness of initial asset above the cost, *h*. The combination of the three fractions constructs the savings function that determines the asset in the next year.

The intersections between the fragmented savings function and the *45* degree line indicates the steady states which presents the long-run equilibrium of the model. Figure 3 illustrates three steady states. They are B, G and A.

The asset at point B which accounted as X_1 is obviously lower than the asset at point A which accounted as X_3. It is noticeable that the steady state B happens to the individual whose initial asset is below the threshold *f* while the steady state A presents to the one whose initial asset is above the cost of committing corruption, *h*. Therefore, this diagram ensures that an individual who commits corruption will be naturally richer than the one who do not commit corruption.

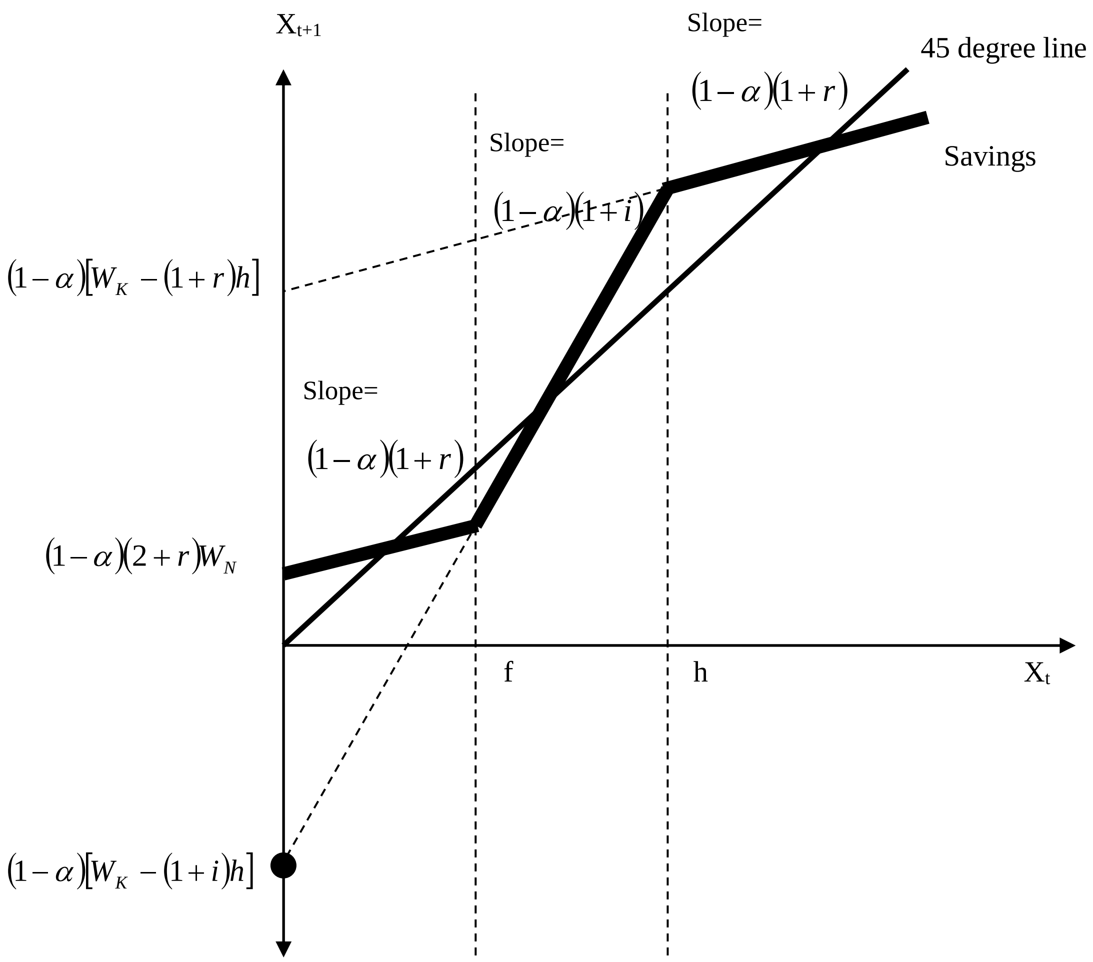

Figure 2: Fragmented savings function and the long-run equilibrium

The most interesting point is at the steady state in the middle which is at point G. In this case, Galor and Zeira (1993) shows that this steady state is unstable. Even though it looks pretty stable and reasonable for an individual whose initial asset lies between the threshold *f* and the cost of committing corruption *h* that he or she will choose to commit corruption and enjoy the asset of X_2, this steady state is sensitive to the shocks.

For the negative shock, i.e. an individual loses an amount of money, b, which pulls the total asset down to be *g* minus *b*. This point is presented by the level of g_2 in Figure 4. At this level, the asset in the next period, measured on the savings function, is less than the asset in this period measured on the *45* degree line, $X_{t+1} < X_t$. When the income in the next period is determined by $Y_{t+1} = (X_{t+1} - h)(1+i) + W_K$ and the income in this period is calculated by $Y_t = (X_t - h)(1+i) + W_K$, it is remarkable that the only difference is at X_{t+1} and X_t . It is obvious that the income in the next period will be less than the income in this period when X_{t+1} is less than X_t . Moreover, when the savings function in the next period is determined by $S_{t+1}^{E2} = (1-\alpha)[(X_{t+1} - h)(1+i) + W_K]$ while the savings function in this period can be derived from $S_t^{E2} = (1-\alpha)[(X_t - h)(1+i) + W_K]$, it is also obvious that the savings in the next period will be less than that of this period. When this situation persists, then the savings will move down along the savings function from point G until the asset in the next period equals to the asset in this period again at point B (Figure 4). This mechanism will shift the steady state from G to B.

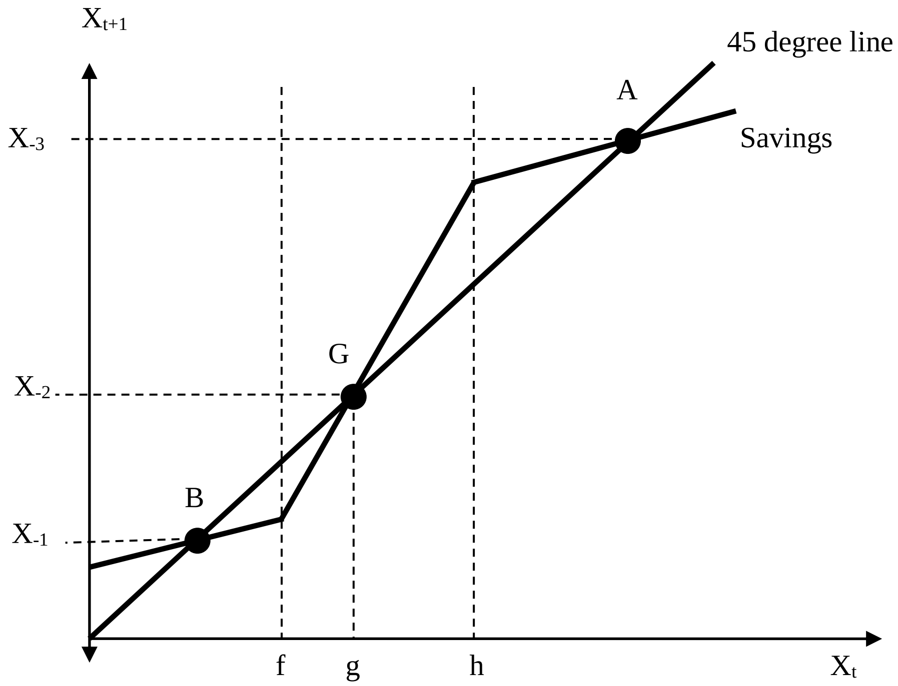

Figure 3: Steady state of the bounded rational corruption model

The unstable steady state, G, can be shifted to the higher steady state, A, by the positive shock too. In Figure 5, when an individual gets an additional income, *a*, then his or her total asset will be increased to be *g* plus *a*, which equals to the level of g_3. At this level, the asset in the next period measured on the savings function is greater than the asset in this period measured on the *45* degree line. Following the line of thinking described earlier, the income in the next period will be greater than that of this period. Moreover, the savings in the next period will be also larger than the savings in this period. The persistence of the situation will lead the savings to grow more and more until the assets of both periods meet the equalizer again at point A. This is the mechanism to shift the unstable steady state G into A.

It is also noticeable that on the left-hand-side of the steady state B, the asset in the next period measured on the savings function is also greater than that of this period measured on the *45* degree line. Therefore, the individual whose asset is below the steady state B will follow the streamline to B naturally. In contrast, on the right-hand-side of the steady state A, the asset in the next period will be less than that of this period. Therefore, there is a force to push an individual whose asset is above A to end up with the steady state A.

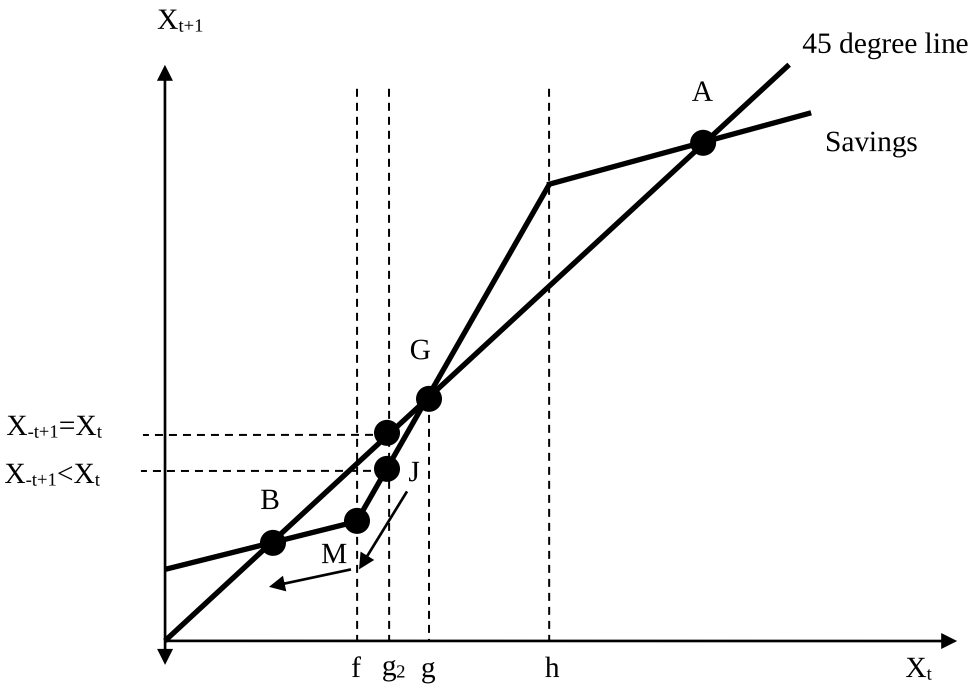

Figure 4: Mechanism to shift the steady state from g to B

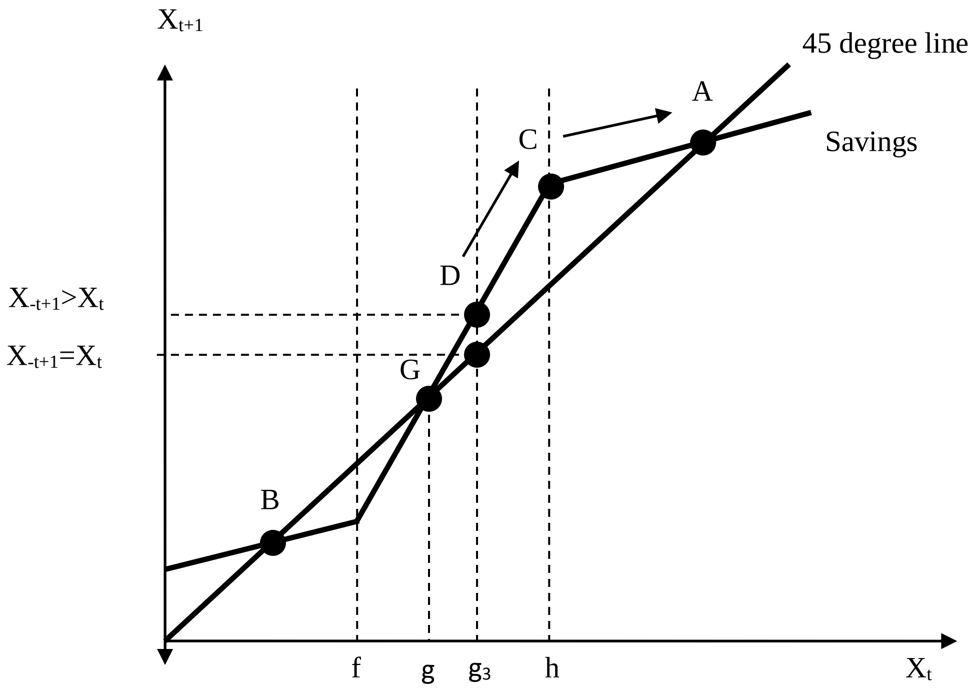

Figure 5: Mechanism to shift the steady state from g to A

4. Mechanism design to prevent corruption

So far, this study has shown that corruption is natural to human. An individual who can invest to commit corruption will end up with higher proserity than another one who cannot invest into it. This will curtainly lead all the individuals whose assets are greater than the cost to commit corruption choose to do it.

However, this solution misses a thing. That is the punishment to the corrupt person. An individual commits corruption without the awareness of the punishment. This is the bounded rationality of committing the corruption. Many persons belief that they will not be punished at all for their corruptions because of some protections from the higher agents or by money that they can bribe officials to exempt the punishment. These believes seem to be unrealistic. The corrupt person seems to be half-conscious in beliving of these protections as if they are illusions that lure them to commit crime.

By the analysis of the steady states, it can be seen that when an individual who gains the asset at the middle, point G, loses an amount of money, he or she will be pulled down to the poorer status, piont B. This shift of the steady state allows the society to design a credible threat of punishment to corrupt person. Strong law enforcement will signal the punishment to every one in the society. By this punishment and enforcement, the incentive to commit corruption fades out.

Another way to prevent corruption is to avoid an individual to recieve the subsidy for corruption. The subsidy is the additional amount of money that a person may recieve and pull his or her total asset up. In the analysis of the steady state, it causes the shift from point G to A. In the real world, this subsidy usually comes in the kind of “candy box” which is filled with cash. A person receiving the candy box will enjoy his or her higher and higher financial status until it reaches the steady state at point A. Therefore, the way to prevent corruption is to ensure that the individual cannot recieve the candy box. By this idea, the society needs to develop a good monitoring system. The society will be alerted when the giving and receiving of candy box is witnessed or monitored. This system will reduce the incentive to receive the candy box as well as the incentive to commit corruption.

5. Conclusions and further studies

This paper has mathematically proven that corruption is a nature of human. The world without monitoring and punishment for corrupt persons will end up with corruption for sure. This is because the corrupt person will enjoy more utility and prosperity than another one who does not commit corruption both in the short-run and long-run. The only way to prevent corruption is to reduce these incentives by the development of good monitoring system that avoid an individual to receive the subsidy for corruption, and the strong enforcement of punishment for the corrupt person. The keys to the uncorrpt society are therefore the monitoring and punishment. The theory awaits the empirical studies both in econometric modeling and experimental economics to shed light on its correctness and validity.

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