The relationship between corruption and public investment at the municipalities' level in Indonesia

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Abstract: This research is conducted to quantitatively measure the relationship between corruption and public investment at municipalities' level in Indonesia. According to Nash Equilibrium derived from mixed strategies, the relationship between corruption and public investment can be both positive and negative depending on the level of the corruption Index. Moreover, the econometric estimations from cross section data and pooled data consistently confirm that the relationship between corruption and public investment is in non linear quadratic form. It was found that the public investment reaches the lowest level when the corruption index ranges from 4.42-4.64.
Key words: Corruption; Public Investment; Game Theory; Regional Development

1. Introduction

In Indonesia, corruption has become one of the major political and economic issues in recent years both pre and post Suharto's era. In the era of Suharto, the nature of corruption in Indonesia was more centralized and thus was more predictable. However, the post-Suharto era has resulted in a different kind of corruption triggered by changes in the political system. The old, highly centralized system has been transformed and replaced by a large decentralized system in which power and authority are more diffused. As a consequence, the corruption is now more fragmented with the local government officials and local legislative members having a dominant role as the actors (Kuncoro, 2004 and 2006). A recent survey by Transparency International Indonesia (henceforth TII) in 2008 showed that corruption in Indonesia is commonly found in activities related to business licenses/permits, bureaucratic process, public contracts/tenders and judicial decisions.

Related to public contracts/tenders, public investment projects have frequently lent to elites or those responsible for acts of high-level corruption or rent seeking. Tanzi and Davoodi (1997,1998), utilizing cross-country data, showed that higher levels of corruption is associated with higher public investment, and leads to a reduction in the project's productivity, a lowering of government revenue and expenditure on operations and maintenances, and a diminishing quality of public infrastructure. However, they also argued that corruption is likely to increase public investment. This may arise because public investment can be easily manipulated by powerful political or bureaucratic personalities, and often gives rise to the payment of higher "commissions" by those who carry out the project. On the other hand, Mauro (1995), also using cross country data, found that corruption reduces total investment and thereby slows down economic growth. A similar result is also shown by Sarkar and Hasan (2001). By using Transparency International's Corruption Perception Index, this study showed that corruption reduces both the volume and efficiency of investment and economic growth.

Given the fragmented nature of corruption in Indonesia and its effect on worsening the economy, it is important to conduct quantitative research measuring the relationship between corruption and public investment at the municipalities' level in Indonesia. This article consists of two main parts. The first section describes the game theory model to explain the relationship between corruption and public investment. The second part discusses the econometrics model and the results. The model is used to verify whether the relationship between corruption and public investment is in line with the solution of game theory.

2. The theoretical model: the corruption-public investment game

This study develops a simple theoretical game in order to analyze the relationship between corruption

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and public investment. The so called corruption public investment game consists of two rational players, an individual public official (called player 1) and a Corruption Eradication Commission (henceforth CEC) as a part of government body (called player 2)[2]. The strategy of player 1 is to decide whether to corrupt or not to corrupt meanwhile the strategy of player 2 is to do strict supervision highly or just low. The payoff function of each player and strategies are represented in Table 1. This payoff draws upon Becker's (1968) analysis of crime in general, Rose-Ackerman's (1975) analysis of the economics of corruption and Macrae's (1982) idea of game theory approach on the economics of corruption.

Table 1 Payoff Matrix of Corruption-Investment Game

		Corruption Eradication Commission (CEC)	
		Strict Supervision	**Low Supervision**
Individual Public Official	**Corrupt**	(w+rK-J(I)), K-rK+M-C(I)	w+rK, K-rK
	Non Corrupt	w+R(I), (K-C(I))	w+R(I), K

Sources: Author

Let *w* be a wage rate. *r* is a fraction/percentage of rent seeking behavior resulting from government projects on public works. *K* is an amount of public investments. *I* is a corruption perception index, ranging from 0 (most corrupt) to 10 (cleanest). *J(I)* is penalties/costs paid by an individual public official when he/she is detected and arrested due to corruption[3]. *R(I)* is a reward to an individual public official for not doing corrupt activities. Thus, the benefits from not being detected as being corrupt received by an official are *(w+rK).* On the other hand, the benefits of being detected are *(w+rK-J(I)).* Moreover, the benefits received by an individual public official from not being corrupt are *w+R(I)*. Since the condition of corruption acceptable to the public official is *rK > R(I)*, the corruptions are economically rational.

Let us assume *J* is a continuous decreasing function in the corruption index *(I)*, $\partial J(I)/\partial I = J'(I) < 0$. This implies that the paid costs or penalties in a corrupt system are larger than that of in non corrupt one[4]. Further, we assume that the second derivative of *J(I)* is negative following the law of diminishing returns, $\partial^2 J(I)/\partial I^2 = J''(I) < 0$, on the contrary, *R(I)* is a continuous increasing function in I, $\partial R(I)/\partial I = R'(I) > 0$. These assumptions imply that a clean government system will create a better reward and punishment system for public officials, thus an increase in *I* will increase the reward *R*. That is the same as *J(I)*, the second derivate of *R(I)* is negative, $\partial^2 R(I)/\partial I^2 = R''(I) < 0$.

Moreover, *M* represents the government's credibility and public trust and *C(I)* is supervision costs as a function of the corruption index. If the government/CEC commits to a strict supervision and is able to catch perpetrators of corruption, they will get benefits, *K-rK+M-C(I)*. We assume that the benefit from government

[2] Corruption Eradication Commission (CEC) known as KPK *(Komisi Pemberantasan Korupsi)* was founded in 2004 in order to combat massive corruption in Indonesia. I assume that the individual public official can not perfectly observe the strategy carried out by the CEC.

[3] The penalties/costs include not only jail terms but also moral and social costs, bribery and extortion costs, etc.

[4] This assumption is made given the facts that in the corrupt system like Indonesia, sometimes, a defendant is like '' a cash cow'' an object of extortion by polices, prosecutors and judges. Extortions and illegal charges not only happen during the legal process but also occur when in prison. Inmates must pay illegal charges in order to obtain better facilities such as a bigger room or tastier meals *(Kompas, 01/14/2010, The Jakarta Post, 01/13/2010 and Majalah Tempo 47/XXXVIII 01/11/2010)*. It should be remembered that in a corrupt system, a defendant can bribe in order to get the minimum penalty or even to avoid prosecutions. However, doing bribery is costly and the probability of success is also low. On the contrary, in the non corrupt system, a defendant will follow the legal process without any extortion and other expenses incurred by the defendant. Therefore, I assume that *J(I)* is continuous decreasing function in *I*.

credibility and public trust *(M)* are larger than the costs of combating corruption *(C)*. Therefore, the activities against corruption by a ruling government are economically rational. *C* is a continuous increasing function in *I*, $\partial C(I)/\partial I = C'(I) > 0$ and the negative second derivative, $\partial^2 C(I)/\partial I^2 = C''(I) < 0$. The high value of *I* represents more budgets or resources allocated in recruiting new employee for supervision, investing online procurement, and creating a fair justice system and reforming a remuneration system which are needed to develop an accountable and clean government.

The Nash Equilibrium is derived under assumptions as *rK-J(I) < R(I)* and *rK < M*. The first assumption means that the net benefits of committing corrupt acts under a strict supervision are smaller than the net benefits of not being corrupt. It follows that every public official will commit corrupt acts if the net benefits of committing corrupt acts are larger that of not being corruption. It contradicts the facts that supervision is aimed to reduce corruption. The second assumption means that the value of the government's credibility and public trust is greater than or equal to the value of corrupted public investments. If this assumption is violated there is no rational reason for the ruling government to eradicate corruptions.

By definition, the strategy-i is a Nash Equilibrium if, for each player-*i*, strategy-*i* is player *i*'s best response to the strategies of the *n-1* other players. In this game, the chosen individual public official is the best response to the strategies of government (CEC). According to the payoff matrix in the table 1, if CEC chooses to commit to implementing strict supervision, a public official's best response is not to be corrupt. However, if CEC does not commit to fight corruption, which means low supervision, an individual public official's best response is corruption. In contrast, if an individual public official chooses to actively corruptly/not corruptly the government's best response is strict supervision/low supervision.

Following the conditions, a Nash Equilibrium does not exist in this game because the solution to such a game necessarily involves uncertainty about what players will do. We introduce the notion of *a mixed strategy*, which we will interpret in terms of one player's uncertainty about what another player will do. Thus a *mixed strategy* for player-i is a probability distribution $p_i = (p_{1i},..., p_{iK})$, where $0 \le p_{iK} \le 1$ for *k=1,...,K* and $p_{i1} + ... + p_{iK} = 1$ (Gibbons, 1992).

In this game, a mixed strategy for CEC is the distribution function *(p,1-p)*, where p is the probability of committing strict supervision and *1-p* is the probability of committing low supervision, and $0 \le p \le 1$. Furthermore, a mixed strategy for an individual public official is the distribution function *(q,1-q)*, where *q* is the probability of committing corrupt acts, *1-q* is the probability of not committing corrupt acts, and $0 \le q \le 1$. Therefore the solution of *p* can be derived by following the expected profit of an individual public official as shown below:

$$E(\pi_{corrupt}) = p(w + rK - J(I)) + (1-p)(w + rK)$$
$$= -pJ(I) + (w + rK) \quad (1)$$
$$E(\pi_{not-corrupt}) = p(w + R(I)) + (1-p)(w + R(I))$$
$$= w + R(I) \quad (2)$$

Substituting eq. 2 into eq. 1, we get:

$$p = \frac{rK - R(I)}{J(I)} \quad (3)$$

or

$$K = \frac{R(I) + pJ(I)}{r} \quad (4)$$

Eq. 3 intuitively shows an increase in rent seeking behavior *(rK)* followed by an increase in the probability of strict supervision. In contrast strict supervision needed to reduce corrupt activities, an increase in penalties/costs

and the reward systems lowers the probability of strict supervision. Further, Eq. 4 intuitively shows a strict supervision in a government system will increase the public investment because the public official will work as efficiently/effectively as possible. An increase in the penalties/costs *J(I)* and the reward system *R(I)* raises public investment since the public official avoids penalties by being involved in corruption. In contrast the rent seeking behavior (r) reduces public investment.

From eq. 4 we can derive the impact of the corruption index (I) on public investment (K). The first order condition of Eq. 4 is shown as below;

$$K_I' = \frac{R'(I) + pJ'(I)}{r} \tag{5}$$

Suppose to $J'(I) < 0$ and $R'(I) > 0$ then K_I' can be both positive and negative depends on the level of *I* itself. If $pJ'(I) > R'(I)$ then K_I' will be negative and if $pJ'(I) < R'(I)$ then K_I' will be positive. Moreover, K_I' will be zero which is called as turning point, when $pJ'(I) = R'(I)$. Therefore, the relationship between public investment and corruption will be positive which means low corruption will increase public investment when the reward system is well developed. On the contrary, the relationship will be negative when the reward system is not well developed yet and the punishment system is dominated.

3. Model specification

I propose an econometric model to quantitatively measure the relationship between corruption and public investment based on the solution of the corruption public investment game. In order to capture the phenomena of Eq. 5, we propose a quadratic function of an econometric model. In addition, the quadratic function permits us to discern the value of the corruption index which can minimize/maximize public investment. The econometric model is shown as:

$$devrev_i = \beta_{11} + \beta_{12} corrupt_i + \beta_{13} corrupt_i^2 + \beta_{14} \log(gdrbcap_i) + \varepsilon_i \tag{6}$$

$$devgrdp_i = \beta_{21} + \beta_{22} corrupt_i + \beta_{23} corrupt_i^2 + \beta_{24} \log(pop_i) + v_i \tag{7}$$

Where, *devrev* is a public investment represented by the ratio between expenditure of development to total revenue and *devgrdp* is the public investment represented by a ratio between development expenditure to gross regional domestic product[5]; *corrupt* is the corruption perception index; *grdpcap* is income per capita; *pop* is number of the population; ε_i and v_i are error term; and lastly, *i* represents region. The data of development expenditure are calculated from the regional budget of each municipality published by the Ministry of Finance while regional income per capita and population refers to the publication of Central Bureau of Statistic (BPS)[6].

Instead of an absolute value, we use a ratio to lessen the effect of large variation in the development expenditure among regions due to populations and the area size. A region with high income per capita may need more public investments both in quantity and quality but the size if the population may reduce the quantity of public investment. The populous regions commonly also have many public officials so a larger budget must be allocated on routine expenditures such as salary which might reduce a portion of public investment. Therefore, we use regional income per capita in Eq. 5 and population in Eq. 6 as control variables. In addition, to check the consistency of the relationship between corruption and public investment, the magnitude of corruption's coefficients in both equations must be the same.

We estimate these models by utilizing both 2004 cross-section data and pooled data of 2004/2006. However, we have difficulties employing a large data set because the data of regional corruption index is very limited. TII in 2004 surveyed only 21 cities/municipalities which were conducted among 1,305 business people

[5] Public investment (development expenditure) is all expenditure such as education, health, infrastructure, etc. in the regional budget except wages/salaries for public officials.

[6] The regional budget of municipalities in Indonesia can be accessed at the Ministry of Finance homepage: http://www.djpk.depkeu.go.id/datadjpk/71/.

from the cities/regions[7]. In addition, in 2006, TII conducted surveys in 32 districts / cities, with a total of 1,760 respondents. The corruption index is on a 10-point scale where 0 means corrupt/bad and 10 means clean/good. Furthermore, the aim of estimating the models both using cross-section data and pooled data is to obtain robust estimation and consistent results. This has the advantage of enabling us to control the unobservable region-specific-characteristics that may be correlated with corruption and public investment. In addition, the method enables us to control regions and time invariant variables where a time series or cross section study cannot do (Baltagi, 1995).

4. The non linear relationship between corruption and public investment

Estimation using least squares and pooled least squares provide statistically strong evidence of a non-linear relationship between corruption and public investment. Table 2 shows that the magnitude of all corruption coefficients is at the same direction indicating consistent results. The second model with DEVGRDP as dependent variable provides lower standard errors of regression both in the cross section and the pooled estimation.

The coefficients of corruption perception index in each model are -110.07, -14.59, -92.43 and -16.62 respectively. However, the coefficients of corruption squared index are 12.27, 1.61, 9.97 and 1.88 respectively. This means that the corruption index negatively influences public investment while its square moves in the opposite direction. Since the higher the corruption index the cleaner the system, the eradication of corruption represented by a higher corruption index will reduce the share of development expenditure while the marginal effect of eradicating corruption will increase the share of public investment. This confirms the U-shaped form of the relationship between corruption and public investment. These findings are in line with the solution of corruption public investment game that the relationship could be both positive and negative depending on the level of the corruption index.

Table 2 Regression Result

Variables	Least Squares		Pooled Least Squares	
	DEVREV	**DEVGRDP**	**DEVREV**	**DEVGRDP**
Constant	131.72	39.10	82.84	44.49
	1.14	*1.92**	*1.09*	*118.35****
Corruption Perception Index	-110.07**	-14.59	-92.43	-16.62
	-2.55	*-1.79**	*-2.04***	*-23.45****
Corruption Perception Squared Index	12.27	1.61	9.97	1.88
	*2.70***	*1.81**	*1.93**	*20.38****
Log(GRDPCAP)	8.78		10.18	
	*4.84****		*10.08****	
Log(Population)		-0.35		-0.47
		-0.94		*-5.67****
R-Squared	0.53	0.29	0.28	0.47
F-Statistic	6.49	2.36	4.36	9.98
S.E of Regression	8.234	1.011	11.155	1.184
Observation	21	21	38	38

Source: Author's estimation
Notes: Figures in italic are t-statistic. The standard errors are corrected due to heterocedasticity.
****,**,* are significant at 10 per cent, 5 per cent and 1 per cent respectively.*

[7] This index was calculated as the average scores of perception by the bribe payers on public contract and service performance index. The cities/municipalities included in this survey are Medan, Solok Regency, Padang, Tanah Datar Regency, Pekanbaru, Palembang, Batam, Jakarta, Bekasi, Wonosobo Regency, Semarang, Yogjakarta, Surabaya, Tangerang, Cilegon, Denpasar, Banjarmasin, Kota Baru, Balikpapan, Manado, and Makassar. However, Jakarta and Kota Baru are not included in the pooled data.

According to the U-shaped form, both corrupt and non-corrupt regions tend to have a larger share of development expenditure. Along with Tanzi (1997) and Tanzi and Davoodi (1998), in a region where the corruption is higher, the public investment is also higher. In high-level corruption or rent seeking, high level officials are the decision makers of public investment regarding in terms of its scale and composition. This may distort such public projects been carried out specifically to provide some individuals or political groups with opportunities to receive "commissions" from the project implementers. Government officials, in collusion with local legislative members, sometimes decide budget allocation in accordance with orders from private companies. Hence, the decision of budget allocation for public investment projects is based on the commission offered and received from the third parties instead of on the basis of the cost benefit analysis.

However, the public investment will decrease along with the campaign against corruption and the combating activities represented by an improvement of the corruption index. At this stage, the number of private companies which were previously privileged to order public projects, and which colluded with government officials and local legislative members to allocate budget based on "commission received", sharply decrease due to high supervision from the Corruption Eradication Commission and media's focus on corrupt activities. In addition, the budget is allocated based on the cost benefit analysis and the local needs, thus public investment is not as much as before.

A further consequence of the campaign against corruption is that many government officials refuse to be appointed as a project leader. The rejection of this position is because of anxiety over being arrested as a corruption defendant after the project finished. Another corollary is in the business side where many companies fail to fulfill the requirements of public projects bidding such as tax clearance, tax registering, submitting financial statements, etc. In some cases, many projects are offered without bidders interested in participating in the tender causes the project to fail to be completed on time and the process to be repeated and take a longer time. Moreover, the law enforcement which has not implemented perfectly yet forces the interested private companies to wait and see. Therefore, an under developed either prudential system of project tenders or law enforcement might delay implementation of some projects and the public investment will decrease along with an improvement in the corruption index.

According to the U-shaped form, the ratio of development expenditure to total revenue will reach the lowest/minimum value when the corruption index equals 4.49 in 2004 and 4.64 in pooled data. Moreover, the ratio of development expenditure to gross regional domestic product will attain the lowest value when the corruption index equals 4.53 in 2004 and 4.42 in pooled data. Generally, the public investment reaches the lowest value when the corruption index ranges from 4.42-4.64. In those regions having a corruption index below the turning point, the public investment decreases along with the improvement in the corruption index. In contrast, in those regions having a corruption index larger than the turning point, the public investment and corruption index move in the same direction which means the public investment will increase in conjunction with an increase in the corruption index. TII's survey showed the average of regional corruption index was 4.69 in 2004 and 4.72 in 2006, thus most of regions were just past the turning point.

One of reasons why the public investment and the corruption index moved in the same direction when the corruption index is greater than 4.42-4.64 is that both law enforcement and reward/remuneration systems are well developed so there is little incentive for corruption by public officials. Consequently, either the total revenue share of development expenditure or the GRDP share of development expenditure tends to be higher because some of development expenditure/public investment is not diverted to the pockets of public officials. Moreover, the budget allocations are decided along with the schedule, in a transparent and well targeted way, based on the cost benefit analysis and the needs of the local people. In general, a low level of corruption represented by a high corruption index has been demonstrated to be positively correlated with the achievement of better investment rates, particularly through the building of institutions in support markets. This enhances efficiency in market and bureaucracy, fairness in business, trust in society, and reduces transaction costs and uncertainty in the economy. This finding supports Mauro (1995) which institutional efficiency encourages a high investment.

5. Concluding remarks

The Nash Equilibrium derived from mixed strategies proves that the relationship between corruption

and public investment can be both positive and negative depending on the level of the corruption Index. The estimation results from both the cross section data and the pooled data show that the relationship between corruption and public investment is a non-linear quadratic, U-shaped form. Both corrupt and non corrupt regions tend to have a larger share of development expenditure. However, a larger share in the corrupt regions is caused by rent seeking behavior in which government officials try to allocate a larger budget on public projects in order to acquire commission from private companies. In contrast, a larger share in the non corrupt regions is a result of institutional efficiency. Even though most regions in Indonesia are at the lowest level of public investment, great efforts to eradicate corruption would likely have an immediate effect of increasing public investment. However, the empirical investigation using a longer longitudinal data as well as more regional samples needs to be done in order to check the consistency result.

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