THREE ESSAYS ON INSTITUTION

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The first paper studies how poor quality of institution, such as corruption in public procurement auction, could hurt welfare. We show how competition effect could improve the cost-efficiency but not the quality of a public procurement auction with corruption. In fact, no incentive mechanism can be efficient in this auction if qualities are non-contractible. An empirical study suggests that increasing the number of bidders does increase the percentage cost efficiency albeit at a decreasing rate and decreases the percentage cost efficiency after it reaches a certain number of bidders.

In the second paper, we study how endogeneity between welfare and institutions might make institutional reforms more subtle. We use evidence from an in-depth field study conducted in five districts in Indonesia and build a model that illustrates how initial socioeconomic conditions as well as past institutions generate institutional complexes, including the degree of local capture, local leadership, and participation level. By endogenizing the degree of local capture, we show how cooperation between local leaders and local elites could positively or negatively affect welfare depending on the initial socioeconomic conditions. These institutional complexes that evolve with welfare create self-reinforcing progresses in the long-run. In the context of Indonesia in the post-decentralization period, exogenous shocks, such as an introduction of central government's enforcements on both strengthening local institutions and increasing welfare are needed.

In the third paper, we study how economic institutions intertwine with polit-

ical institutions. A theoretical study of a simple strategic complementary game with private and public information among partially informed agents such as central banks shows that initial fundamentals might give rise to different levels of transparency. An empirical study shows that both economic fundamentals such as the reserve ratio of broad money to foreign exchange reserves and non-economic fundamentals such as an occurrence of crisis and the level of democracy do affect transparency of central banks. We apply this analysis to study the coordination effect of information on the progress towards regional financial integration among East Asian countries. We find that the progress towards regional financial integration might rely more on polity rather than on economic fundamentals.

BIOGRAPHICAL SKETCH

Maria Monica Wihardja was born on April 29, 1977, in Jakarta, Indonesia. From 1983-1989, she attended the Regina Pacis Elementary School, Jakarta, in Indonesia. From 1989-1991, she attended the St. Ursula Secondary School, Jakarta, in Indonesia. From 1991-1994, she entered the United World College of South East Asia, a British International school, in Singapore. From 1994-1995, she went to an all-girls' boarding school, the Dana Hall School, Wellesley, M.A., in U.S.A.. From 1995-1996, she entered her first college, Georgetown University, Washington, D.C., in U.S.A., before she transferred to Brown University. From 1997-1999, she studied at Brown University, Providence, R.I., U.S.A.. In her senior year, she received a full scholarship from Brown University and NAFTA ASEAN. She was awarded a Magna Cum Laude in A.B. in Applied Mathematics - Economics. In the summer of 1999, she joined the Centre of Strategic and International Study, Jakarta, in Indonesia, as an intern. From 1999-2000, she attended the University of Cambridge, Cambridge, in U.K., fully funded by the Association of Cultural Exchange, Corpus Christi College. She was accredited with a Master of Philosophy in Economics. In summer of 2000, she joined the World Bank, Economic Unit, Beijing, in People's Republic of China, as an intern. From 2000-2002, she went back to Brown University, Providence, R.I., in U.S.A., to pursue her graduate study with a six-year teaching assistantship. She was certified with a Master of Arts in Economics. From 2002-2007, she continued with her graduate study at Brown University, Providence, R.I., in U.S.A.. In the Fall 2007, she taught as a Lecturer in Providence College, Providence, R.I., in U.S.A.. In summer 2007, she joined the Centre of Strategic and International Study, Jakarta, in Indonesia as a research fellow. From 2007-2008, she continued her graduate study at Cornell University, Ithaca, N.Y., U.S.A., and received a Master of Science in Regional

Science. In summer 2008, she joined the Komite Pemantauan dan Pelaksanaan Otonomi Daerah, Jakarta, in Indonesia, as a field researcher. From 2008-2009, she continued her graduate study at Cornell University, Ithaca, N.Y., in U.S.A., and expected to receive a Ph.D. in Regional Science in August 2009.

To Papi, Mami, Ciska, Windy, Tanya, and Uter.

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CHAPTER 1

CORRUPTION IN PUBLIC PROCUREMENT AUCTIONS: POSITIVE EQUILIBRIUM ANALYSIS, INCENTIVE MECHANISM DESIGN, AND EMPIRICAL STUDY

1.1   Introduction

In this paper, we provide a positive equilibrium analysis for a two-dimensional public procurement auction with corruption, when the type space is two-dimensional in cost and quality, independently distributed. First, we show the case without corruption in an N-bidder auction. We discuss the efficiency of this auction, comparative static analysis, and the convergence results as the number of bidders increase. This paper contributes to the literatures on auctions and corruption by introducing incompleteness of information in auctions with two-dimensional-type bidders and extending a two-bidder auction into an N-bidder auction.

With corruption, we analyze the equilibrium bidding and bribing strategies in an incomplete information setting with a finite type space and an infinite strategy space. Burguet and Che (2004) analyze a similar model of a first-price, sealed-bid procurement auction with a corrupt public official in a *complete* information setting. We impose two conditions on the incomplete information auction game with corruption that we analyze. First, to simplify the model, we assume that both the public official and the central planner are non-strategic players. A strategic public official and a strategic central planner have dominant strategies. In the case of a tie, a strategic public official and a strategic central planner are indifferent among a set of actions. A non-strategic public official and a non-strategic central planner play the same strategies as those of the strategic players. In the case

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of tie, however, the bidders have *subjective* beliefs about the actual strategies of these non-strategic players that do not have to coincide with the actual strategies. Second, in an N-bidder auction, we assume the probability of the bidders winning is based on pair-wise instead of group-wise comparison. Other main contribution of this paper to the literatures on auctions and corruption is to show that in this subjective belief model, increasing the number of bidders decreases the equilibrium bids and bribes although at the limit as the number of bidders get very large, there are some types of bidders who offer positive bribes and whose equilibrium bids never converge to the true cost.

The second section of this paper discusses the incentive mechanism design for an unobservable and non-contractible quality. A public procurement auction with multidimensional type in which the quality of each bidder is unobservable and non-contractible falls into the class of games in which the impossibility result theorem applies even though bidders' valuations are private information. We discuss the impossibility result and "constrained efficiency" (Dasgupta and Maskin, 2000; Jehiel and Moldovanu, 2001; Maskin, 1992) on this multidimensional-type-bidder model.

The third section of this paper shows empirical evidence of the effect of number of bidders on the percentage cost efficiency of the auctions. We took 1,404 Semi Electronic public procurement auctions from Indonesia's Department of Public Work in 2006, and we showed a quadratic relationship between the number of bidders and the percentage cost efficiency, which suggests that increasing the number of bidders increases the percentage cost efficiency at a decreasing rate and it starts to decrease the percentage cost efficiency after some number of bidders. The gap between the theoretical predictions and the empirical study may be due to factors,

other than the competition effect, such as inefficiency of selection process with a very large number of bidders, that are not captured in the theoretical model. With too many bidders, the negative factors dominates the competition effect. We formulate policy recommendations based on the theoretical results and the empirical study.

The following section reviews earlier literatures on the topic of public procurement auctions and corruption, multidimensional-type model, existence of an equilibrium in incomplete information game, competition and corruption, and incentive mechanism designs. Section 3 analyzes the equilibrium bidding function without corruption. Section 4 analyzes the equilibrium strategy with corruption. The first sub-section discusses the general property of an equilibrium in this model, including the efficiency of the auction. The second sub-section analyzes the model in an incomplete information setting starting from a model with discrete type and strategy space to a model with discrete type and infinite strategy space. We introduce subjective belief model. We consider bidders with different attitudes towards uncertainties. The last sub-section states the main propositions. Section 5 discusses incentive mechanism designs in the class of multidimensional, common value auctions. Section 6 shows empirical results of the effect of the number of bidders on cost efficiency. Section 7 discusses briefly the policy implication of the results. Section 8 concludes.

1.2   Literature Review

Literature on corruption in first-price, sealed-bid public procurement auctions that is closest to our model is by Burguet and Che (2004). In our model, we study the

N-bidder case while in their model there are only two bidders. Also, we study the incompleteness of information model, while in their model information is complete. Burguet and Perry (2007) study corruption and favoritism in a first-price sealed bid procurement auction between the auctioneer and the bidder, where *right of first refusal* is offered by the auctioneer to the dishonest or favored bidder. Unlike the multidimensional type of the bidders in cost and quality in this paper, the type of the bidders is one-dimensional in cost. Lengwiler and Wolfstetter (2005) study corruption in a first-price and second-price sealed-bid auction, where the auctioneer is corrupt by either inviting the highest-bidding bidder to lower the bid to the second highest bid and sharing the difference between the two bids or by proposing the second-highest bidder to increase the bid to the first-highest bid and sharing the difference between the valuation and the bid. The bidders' type is one-dimensional in valuation. Arozamena and Weinschelbaum (2005) study corruption in a first-price auction where an agent, who does not care about the outcome of the auction, runs the auction and makes an agreement with one of the bidders who have one-dimensional valuations prior to the auction that he/she is allowed to change his/her bid after the rivals' bids are revealed to him/her. Meneza and Monteiro (2006) study corruption in an auction where the auctioneer approaches the winner to lower his/her bid to the second highest bid and share the profit. Bidders have one-dimensional private valuations. Auctioneer in this paper also minimizes the probability of a punishment if getting caught by approaching only one bidder. Esõ and Schummer (2004) study signalling in a second-price sealed bid auction. Most of these literatures on auctions and corruption only study auctions in the presence of corruption with one-dimensional-type bidders.

Asker and Cantillon (2008b) analyze the equilibrium of a scoring auction without corruption when the type space is multidimensional. They show that the set

of equilibria when bidders' strategies depend only on their "pseudotype" is the same as the set of equilibria when bidders' strategies depend on the multidimensional type space. This study gives a result in the case of a multidimensional type space that parallels the equilibrium result in Che (1993). They also show that the other properties of equilibria of the standard IPV(Independent Private Value) auction apply, including the efficiency of the auction and the revenue equivalence result in the case of multidimensional type bidders. In this paper, we also use the concept of "pseudotype" for auctions without the presence of corruption. Athey (2001) shows the existence of a Pure Strategy Nash Equilibrium (PSNE) in a non-decreasing strategy in both finite and infinite games satisfying the Single Crossing Condition. The two literatures, Athey (1997) and Athey (2001), are important for the purpose of this paper by giving general existence result for an incomplete information game, in particular, the existence of an equilibrium strategy in step functions in a game with discrete strategy space and continuum type space. In section 4 of this paper, we will give an example of an equilibrium strategy in step functions in an auction game with corruption with discrete strategy space and continuum type space. In the sections that follow, we will use the definition of efficiency by Maskin and Dasgupta (2000). In particular, they define an auction to be efficient in the case of common-value valuations with unidimensional signal, if for all n-tuple signals for all n bidders, at the equilibrium, the bidder with the highest valuation that is a function of the n-tuple signals wins. In this paper, private signals are multidimensional but valuations are private, and an auction is efficient if the bidder with the highest valuation that is a function of his/her multidimensional private signals wins. Celentani and Ganuza (2002) show that increasing competition may in fact increase corruption. Bliss and Di Tella (1997) shows that an increase in competition does not necessarily decrease corruption.

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In this paper, we show that increasing the number of bidders in an auction with corruption decreases corruption.

Dasgupta and Maskin (2000) show that when signals are multidimensional and valuations are common values where signals are independently distributed, then there may be no efficient auction. They introduce what is called "constrained efficiency" (the second-best). We show in this paper that with non-contractible quality an auction is constrained efficient in which cost is minimized but quality is chosen randomly. There are at least two other literatures that analyze multidimensional signal model with common values and all these literatures confirm the disappointing results of inefficiency in the case of multidimensional - common values problem. These are the literatures by Jehiel and Moldovanu (2001) and Maskin(1992).

1.3 The Model Without Corruption

Each bidder i has a type that is private information: $(q_i, c_i^0) \in \Re_+^2$, where q_i is the quality and c_i^0 is the initial cost. We first assume that $F(q_i) = F(c_i^0) = $Uniform $[0,1]$ and later, generalize. In this model, we will specifically focus on what is called the scoring auction. In this auction, each bidder is evaluated by a score that is a combination of the quality and the bid. An example of the score in a procurement auction is a linear combination of the quality and the bid. In this model, the central planner uses a scoring rule we denote by $s_i = q_i - c_i$, where c_i is the bid. Let $u_i = (c_i - c_i^0) p(s_i \geq s_{-i})$. The strategy of each bidder is a mapping from his or her type in a two-dimensional real number to his or her bid in a one-dimensional real number: $\Re_+^2 \to \Re_+$. We denote $F(v_i)$ as the cumulative distribution function

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of v_i, where v_i is the quality minus the cost, and $\tilde{s}_i$ as a deviation from the scoring rule at the equilibrium, s_i.

Proposition 1 gives an explicit equilibrium bidding function in the case of a two-dimensional auction with two symmetric bidders and two-dimensional type of cost and quality. We use a substitution method in our proof. We could also use the method of a change variable used by Che (1993) that produces the same result.

Proposition 1.1 Without corruption, the equilibrium bidding strategy is given by:

$$c(v_i, c_i^0) = c_i^0 + \frac{\int_{v_i}^{v_i} F(\delta)d\delta}{F(v_i)} \tag{1.1}$$

where $v_i = q_i - c_i^0$.

Proof. (See Appendix I) ∎

Proposition 1 generalizes to any Probability Distribution Functions of q_i and c_i^0: $F(q_i)$, $F(c_i^0)$.

Corollary 1.1 The auction is efficient:

$$\frac{ds_i}{dv_i} = 1 - \frac{F(v_i)^2 - p(v_i)\int_{-1}^{(v_i)} F(\delta_i)d\delta_i}{F(v_i)^2} > 0 \tag{1.2}$$

Proof. (See Appendix II) ∎

Corollary 1 generalizes to any Probability Distribution Functions of q_i and c_i^0, $F(q_i)$, $F(c_i^0)$.

Example 1.1 $F(c_i^0) = F(q_i) = Uniform\ [0,1]$

For $F(q_i)=F(c_i^0)=Uniform\ [0,1]$, $F(v_i)$ is given by:

$$F(v_i)=\left[\begin{array}{l} \frac{(v_i+1)^2}{2}, \ -1 \leq v_i \leq 0 \\ \\ 1-\frac{(1-v_i)^2}{2}, \ 0< v_i \leq 1 \end{array}\right].$$

The bidding function $c(v_i,c_i^0)$ without corruption is given by:

$$c(v_i,c_i^0) = c_i^0 + \frac{\int_{-1}^{v_i} \frac{(\delta+1)^2}{2} d\delta}{(\frac{(v_i+1)}{2})}, \ for\ -1 \leq v_i \leq 0$$

$$c(v_i,c_i^0) = c_i^0 + \frac{\int_{-1}^{0} \frac{(\delta+1)^2}{2} d\delta + \int_0^{v_i} (1-\frac{(1-\delta)^2}{2})d\delta}{(1-\frac{(1-v_i)^2}{2})}, \ for\ 0<v \leq 1 \qquad (1.3)$$

$$c(v_i,c_i^0) = c_i^0 + \frac{\frac{1}{6}v_i^3+\frac{1}{2}v_i^2+\frac{1}{2}v_i+\frac{1}{6}}{(\frac{(v_i+1)^2}{2})}, \ for\ -1 \leq v_i \leq 0 \qquad (1.4)$$

$$c(v_i,c_i^0) = c_i^0 + \frac{\frac{1}{6}+(\frac{1}{2}v_i+\frac{1}{2}v_i^2-\frac{1}{6}v_i^3)}{(1-\frac{(1-v_i)^2}{2})}, \ for\ 0<v_i \leq 1 \qquad (1.5)$$

Note: for $v_i=-1$, the second term of $c(v_i,c_i^0)$ requires an application of the L'Hôpital's rule twice:

$$Lim._{v_i->-1} \frac{\frac{d}{dv_i}(\frac{1}{6}v_i^3+\frac{1}{2}v_i^2+\frac{1}{2}v_i+\frac{1}{6})}{\frac{d}{dv_i}(\frac{(v_i+1)^2}{2})} = \frac{\frac{1}{2}v_i^2+v_i+\frac{1}{2}}{(v_i+1)}=\frac{0}{0}.$$

$$Lim._{v_i->-1} \frac{\frac{d}{dv_i}(\frac{1}{2}v_i^2+v_i+\frac{1}{2})}{\frac{d}{dv_i}(v_i+1)} = \frac{v_i+1}{1}=0.$$

Proposition 1.2 Without corruption, the equilibrium bid increases in quality in the game with $F(q_i)=F(c_i^0)=Uniform\ [0,1]$.

Proof. (See Appendix III) ∎

Proposition 2 states that without corruption, in the game with uniform $[0,1]$ distributions the equilibrium bid increases with the quality.

Proposition 1.3 Without corruption, the bid increases with the bidder's cost.

Proof. (See Appendix IV) ■

Proposition 3 generalizes to any Probability Distribution Functions of q_i and c_i^0: $F(q_i)$ and $F(c_i^0)$.

Proposition 1.4 Without corruption, the probability of the bidder winning depends positively on the bidder's quality.

Proof. (See Appendix V) ■

This generalizes to any Probability Distribution Functions of q_i and c_i^0: $F(q_i)$ and $F(c_i^0)$.

Proposition 1.5 Without corruption, the probability of the bidder winning depends negatively on the bidder's cost.

Proof. (See Appendix VI) ■

This generalizes to any Probability Distribution Functions of q_i and c_i^0: $F(q_i)$ and $F(c_i^0)$.

Corollary 1.2 *(N-Symmetric Player Game)* Without corruption, the equilibrium bidding strategy in the N-symmetric player game is given by:

$$c(v_i, c_i^0) = c_i^0 + \frac{\int_{v_i}^{v_i} F(\delta)^{N-1} d\delta}{F(v_i)^{N-1}} \tag{1.6}$$

where $v_i = q_i - c_i^0$.

Proof. (See Appendix VII) ∎

Corollary 1.3 Without corruption, the equilibrium bidding strategy in the N-symmetric player game decreases in N and converges to the true cost.

Proof. (See Appendix VIII) ∎

Example 1.2 *For $F(q_i)=F(c_i^0)=Uniform$ $[0,1]$, the bid in an N-player game is given by:*

$$c(v_i, c_i^0) \;=\; c_i^0 + \frac{\int_{-1}^{v_i} [\frac{(\delta+1)^2}{2}]^{N-1} d\delta}{(\frac{(v_i+1)}{2})^{N-1}}, \; \text{for } -1 \le v_i \le 0 \qquad (1.7)$$

$$c(v_i, c_i^0) \;=\; c_i^0 + \frac{\int_{-1}^{0} [\frac{(\delta+1)^2}{2}]^{N-1} d\delta + \int_{0}^{v_i} [(1-\frac{(1-\delta)^2}{2})]^{N-1} d\delta}{(1-\frac{(1-v_i)^2}{2})^{N-1}}, \; \text{for } 0<v_i \le 1 \quad (1.8)$$

The following table shows that bids weakly decrease in N.

Table 1.1: Example 1.2

N\(c_i^0,q$_i$)	(0,0)	(0,1)	(1,0)	(1,1)
2	.333	1.167	1	1.333
4	.143	.65	1	1.143
5	.111	.576	1	1.111
10	.053	.401	1	1.053
20	.026	.282	1	1.025
50	.010	.177	1	1.010

Note that at v_i=-1 (c_i^0=0,q_i=1), the bid remains at 1. At v_i=-1, the second term of the c_i function is zero after we apply L'Hopital's rule. Moreover, we notice that as N increases the bids converge downwards to the true cost.

1.4 The Model With Corruption

There are N+2 players in this game: the central planner, the public official, and the N bidders. The central planner is a non-strategic, virtual, dummy, or passive player and chooses the winning bidder based on reported quality bids and cost bids. The central planner may represent a government whose utility reflects the social welfare that is the quality minus the cost of the project. We also assume that the public official is a non-strategic player whose moves are determined by nature and whose decision-making process is based on pair-wise comparison as explained below. The strategies of the non-strategic central planner and the non-strategic public official are consistent with the dominant strategies of a strategic central planner and a strategic public official.

The main purpose of treating the central planner and the public officials as non-strategic players is because it simplifies the N+2-player game into an N-player game enabling us to focus on the strategic behaviors of the bidder. Treating the central planner and the public official as non-strategic players does not change how the central planner and the public official move because a strategic central planner and a strategic public official have dominant strategies, and we assume that non-strategic central planner and the non-strategic public official will play these dominant strategies. The only difference between this model and the model with a strategic public official and a strategic central planner is that in the case of a tie in which a strategic central planner and a strategic public official are indifferent among a set of actions, bidders may have subjective beliefs about what actions are chosen by the central planner and the public official that do not have to coincide with the actual moves[1]. This is called the subjective belief model.

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[1]We may think a horse race as an example of the subjective belief model in which bettors have subjective beliefs about which horse is going to win.

We start this section by stating an example with a strategic public official and a strategic central planner as a benchmark to the model with a non-strategic public official and a non-strategic central planner. In both models, the equilibrium bids and bribes do show similar strategic behaviors of the bidders with respect to their types.

Bidder

Each bidder i has a type denoted by t_i that is two-dimensional in q_i and c_i^0, where q_i is the quality and c_i^0 is the initial cost. The strategy of bidder i is denoted by s_i that is a two-tuple strategy in c_i and f_i, where c_i is the bid and f_i is the bribe. There are N player that is I={1, ...N}, and i denotes an individual player. Denote q_i^m as the post-manipulated quality that is the quality that the public official reports to the central planner, and s_i^m as the post-manipulated scoring rule that is equal to the post-manipulated quality minus the bid. The two-bidder model can be represented in the following game as follows:

$$\Gamma(N = 2) = \{I = \{1,2\}, \{s_i = (c_i, f_i)\}_{\forall i \in \{1,2\}}, \{u_i(c, f, q^m | (c_i^0, q_i))\}_{\forall i \in \{1,2\}},$$
$$\{t_i = (c_i^0, q_i)\}_{\forall i \in \{1,2\}}, \{(F(c_i^0), F(q_i))\}_{\forall i \in \{1,2\}}\}$$

where:

bidders are symmetric;

$t_i \in T_i$, where T_i is the type space of bidder i ;

s_i: $T_i \rightarrow \Re^2$, where T is the type space of bidder i;

u(c,f,q^m|(c_i^0,q_i)):

$$u(c, f, q^m | c_i^0, q_i) = (c_i - c_i^0 - f_i)(p(s_i^m \geq s_{-i}^m)), \tag{1.9}$$

$$p(s_i^m \geq s_{-i}^m) = p(q_i^m - c_i \geq q_{-i}^m - c_{-i} | f_i \geq f_{-i})p(f_i \geq f_{-i}) + \tag{1.10}$$

$$p(q_i^m - c_i \geq q_{-i}^m - c_{-i} | f_{-i} > f_i)p(f_{-i} > f_i), \forall i = 1, 2 \tag{1.11}$$

Note that bribes are contingent on the bidders winning and the quality report q^m is the strategy of the public official that is a function of bribes.

Public Official

The utility function of the public official, A, is given by: $u_A = f_1 p_1 + f_2 p_2$, where p_i is the probability of bidder i winning. The strategy of the public official is a mapping from bribes offered to quality reports, that can be written by: q^m: $\Re^2 \to \Re^2$

Central Planner

The utility function of the central planner, P, is given by: $u_P = (q_1 - c_1)p_1 + (q_2 - c_2)p_2$, $p_2 = 1 - p_1$. The strategy of the central planner is to choose a winning bidder given the quality report and the cost bids by choosing a bidder with the highest score, s_i^m. The strategy of the central planner can be written as: $p_1 : \Re^4 \to \Re$. Note, that eventhough the central planner only gets the manipulated quality reports, the central planner cares about the true quality. Suppose in this model that the central planner is unaware of the bribery that takes place.

Time Line

The sequence of the game is as follows. At time 0, nature chooses the types of bidders, {c^0,q}, and the types of bidders are privately observed by all bidders. The

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central planner does not observe the cost nor quality of the bidders. The central planner only observes the quality but not the cost. At time 1, the bid, c_i, is submitted to the central planner and (contingent) bribe, f_i, is offered to the public official simultaneously and privately by each bidder. At time 2, the public official observes $q=\{q_1,q_2\}$ and reports $q^m=\{q_1^m(f_1,f_2), q_2^m(f_1,f_2)\}$ that is not necessarily equal to q to the central planner without any information about c. At time 3, the central planner evaluates each bidder by a scoring rule: $s_i^m=q_i^m\text{-}c_i$, and chooses the winning bidder i, i| $s_i^m=$Max. $\{s_1^m,s_2^m\}$.

The immediate properties that can be derived from the utility functions of the bidders, public official, and central planner are the following.

Lemma 1.1 (Type-Relevant Strategy) *Since the utility of the bidders is non-trivially dependent on c_i^0 and is trivially dependent on q_i, then the only incompleteness of the payoff-relevant information is c_i^0 and the equilibrium strategy will be only non-trivially dependent on c_i^0.*

    Proof. (See Appendix IX) ∎

Lemma 1 says that since the utility of the bidder is only c_i^0-dependent, i.e. the incompleteness of payoff-relevant information comes only from one element of the bidder's type, c_i^0, and q_i does not affect the utility of the bidder, then the equilibrium strategy of the bidders will also be only dependent on c_i^0 alone.

Proposition 1.6 *(Efficiency - the Impossibility Result)* An auction with the two-dimensional bid and two-dimensional type space with corruption cannot be efficient.

Proof. (See Appendix X) ■

Before we move on and show examples of the subjective belief model, we would like to see how the equilibrium might look like under the original game with a strategic public official and a strategic central planner in a finite game with discrete type and discrete strategy type. We can show an example with symmetric tie-breaking rule, discrete type and discrete strategy space in which there is a multiplicity of equilibria with equilibrium bid that is constant over initial costs and the equilibrium bribe that weakly decreases in initial costs. The intuition of this example is that bribes that will give the high-cost bidder a strictly positive profit if he/she wins, will also give the low-cost bidder a strictly positive profit if he/she wins, given a certain bid. The low-cost bidder can therefore overbribe the high-cost bidder slightly (in the limit, an infinite small amount) and increase the probability of winning without any significant change in the utility if he/she wins. This strategy of the low-cost bidder is preferable than to undercut the bid slightly (in the limit, an infinitely small amount) because undercutting the bid slightly does not increase the probability of winning as much as overbribing slightly. Overbribing slightly will increase his/her score by 1 given the public official's strategy while undercutting slightly will increase his/her score by only slightly. These strategic moves of the bidders are similar to the strategic moves of the bidders under the subjective belief model as we will see in the next sections.

1.4.1 Subjective Beliefs Model

In this section, we simplify the model by assuming the following two conditions: (1) the public official is a non-strategic or dummy player whose moves are determined by nature and are consistent with the dominant strategy of a strategic public

official; the central planner is a non-strategic or dummy player whose moves are determined by nature and are consistent with the dominant strategy of a strategic player; (2) in an N-player game, the nonstrategic public official moves according to a pair-wise comparison instead of a group-wise comparison as we will explain further below. Since both the public official and the central planner are dummy players, we allow the beliefs of the bidders on how the public official and the central planner move in the case of indifferences over possible actions to be subjective. In other words, the bidders do not have to correctly predict the moves of the public official and the central planner at the equilibrium. The actual moves of the public official and the central planner may therefore be inconsistent with the bidders' subjective beliefs. Condition one therefore allows us to assume that bidders' beliefs about the move of the public official and the central planner in the case of a tie of bribes and scores in which the public official and the central planner are indifferent over actions to take to be *subjective* beliefs instead of the objective beliefs. Subjective beliefs are common knowledge. We consider two examples where bidders behave differently under uncertainty. One is an example in which both bidders make decisions based on the best possible scenario over a set of probabilities. In this example, each bidder of the two or N bidders believes that in the case of a tie of bribe and scores, he/she will be favored by the public official and the central planner with probability one. Second is an example of the opposite case in which bidders make decisions over a set of actions based on the worst possible scenario they can possibly get over a set of probabilities[2]. In this example, each bidder believes that in the case of a tie of bribes and scores, the other bidder will be favored by the public official and the central planner with probability one[3].

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[2]This is what is also called the *Maxmin* decision rule (Gilboa and Schmeidler, 1989; Knight,1921; Bewley, 1986).

[3]To axiomatize the different subjective beliefs of the bidders and represent it in a utility-functional form, we may use Chateauneuf, Eichberger, and Grant (2007) (CEG). These *neo-additive* beliefs can be represented by the multiple priors form. The notion of Nash Equilibrium

Condition two allows us to simplify our calculation on the powers and combinations of the probabilities of the bidders winning in the case of an N-bidder auction. The difference between pair-wise and group-wise is essentially this: evaluating the probability of winning of a bidder i over bidder j, group-wise comparison takes into account the values (or parameters of interest) of all other bidders, while pair-wise comparison only takes into account the values (or parameters of interest) of bidder i and j.

The following Lemma will give a formal proof of how a strategic corrupt public official whose utility is only the bribe he/she receives will behave. This strategy of a strategic public official will underlie our assumption of how a non-strategic public official is expected to move.

Lemma 1.2 *(Dominant Strategy of A Strategic Public Official) Suppose a public official has a utility function as follows: $u_A = \sum_{k \in I} f_k p_k$, where $f_i \in \Re^1_+$, $0 \leq p_i \leq 1$, and $\sum_{i=1}^N p_i = 1$. Then, the solution to the maximization problem of the public official, $max_{\{p_i\}_{i \in I}} . u_A$, s.t. $f_i \in \Re^1_+$, $0 \leq p_i \leq 1$, and $\sum_{i=1}^N p_i = 1$, is given by the following: $p_i[f_i - max_{k \in I} . f_k] = 0$, $\forall i \in I$.*

Proof. (See Appendix XI) ■

Note that by "dominant strategy" here, we mean that regardless of what the bidders' bribes are, a strategic public official will always play the above class of strategies. These strategies themselves among this class of strategies are not unique (in the case of a tie, the public official is indifferent among a set of mixed

in the model under uncertainty aversion is weaker since perfect consistency between beliefs and the actual plays fails. However, in our examples, since uncertainty is over the strategies of a fictitious player (i.e. the public official or the central planner) and not over the other strategic bidders' strategies, we do not need to check for these inconsistencies.

strategies). Hence, the above strategies are dominant only among classes of strategies but not among strategies.

Similarly, the strategy that underlies the move of a non-strategic central planner is the dominant strategy of a strategic central planner, which is given by the following:

Lemma 1.3 *(Dominant Strategy of A Strategic[4] Central Planner) Suppose a central planner has a utility function as follows:* $u_P = (q_1\text{-}c_1)p_1 + (q_2\text{-}c_2)p_2$. *Then, the solution to the maximization problem of the central planner,* $max_{p_1,p_2}.u_P$, *s.t.* $0 \leq p_1, p_2 \leq 1$, *is given by the following:* $p_i[(q_i^m - c_i)\text{-}max_{k\in\{1,2\}}.q_k^m - c_k] = 0$, $\forall i \in I$.

Proof. (The proof is similar to the Lemma above. See Appendix XI) ∎

Positive Bidders   We are going to assume that there are two types of bidders whom we are going to call the "positive" bidders and the "negative" bidders. Positive bidders makes decisions based on the best possible scenario while negative bidders makes decisions based on the worst possible scenario. The set of subjective beliefs of the bidders in a two-player game can be illustrated as follows

r_i = subjective belief of i on {1 wins, 2 loses} if $\{q_1^m\text{-}c_1 = q_2^m\text{-}c_2\}$, $r_i \in [0,1]$

o_i = subjective belief of i on $\{q_1^m = 1, q_2^m = 0\}$ if $\{f_1 = f_2\}$, $o_i \in [0,1]$

Note that the probability space of the prior beliefs of the bidders are the same that is in the interval [0,1] for both r_i and o_i In the first example of positive bidders, we assume the following.

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[4]"Strategic" here means maximizing social welfare, $q_i\text{-}c_i$, without considering different types of auctions. The strategy space for a social planner is the probabilities of winning assigned to bidder 1 and bidder 2.

Condition 1.1 Positive Bidders *(2- player and N-player games)*

1. The public official is a non-strategic player or a dummy player. The uncertainty over the public official's behavior is illustrated as follows:

$$q^m = \left(\begin{array}{c} \left(\begin{array}{c} (1,0), \text{ if } f_1 > f_2 \\ (0,1), \text{ if } f_1 < f_2 \end{array} \right) \\ (1,0) \text{ with probability } o_i, \text{ if } f_1 = f_2 \\ (0,1) \text{ with probability } (1-o_i) \text{ if } f_1 = f_2 \end{array} \right), \; o_i \in [0,1], i=1,2. \text{ The subjective}$$

probabilities of the bidders on the public official's behavior are as follows: bidder 1's subjective belief is $o_1 = 1$ and bidder 2's subjective belief is $o_2 = 0$.

2. The central planner is a non-strategic player or dummy player. The uncertainty over the central planner's moves can be illustrated as follows:

$$\pi = \left(\begin{array}{c} \left(\begin{array}{c} (1,0), \text{ if } q_1^m - c_1 > q_2^m - c_2 \\ (0,1), \text{ if } q_1^m - c_1 < q_2^m - c_2 \end{array} \right) \\ (1,0) \text{ with probability } r_i, \text{ if } q_1^m - c_1 = q_2^m - c_2 \\ (0,1) \text{ with probability } (1-r_i) \text{ if } q_1^m - c_1 = q_2^m - c_2 \end{array} \right), \text{ where } r_i \in [0,1], \; i=1,2,$$

$\pi = (\pi_1, \pi_2)$ is the probability of bidder 1 and bidder 2 winning respectively. Bidder 1's subjective belief is $r_1 = 1$ and bidder 2's subjective belief is $r_2 = 0$.

3. Probability of the bidders winning is based on pair-wise comparison and not group-wise comparison. The difference between a pair-wise comparison and a group-wise comparison can be illustrated by the following tables.

Let for example, bribes are f=(50,50,100). Then, based on pair-wise comparison, the probabilities of the bidders winning given that bidder 1 and 2 offer the same bribe that is strictly smaller that bidder 3's bribe are given by the following table.

Table 1.2: Probability of Bidder Winning Based on Pair-wise Comparison

$i \backslash -i$	1	2	3	p_i
1	1	$p_1(c_2 \geq c_1 - 1)$	$p_1(c_3 \geq c_1 + 1)$	$p_1(c_2 \geq c_1 - 1)p_1(c_3 \geq c_1 + 1)$
2	$p_2(c_1 \geq c_2 - 1)$	1	$p_2(c_3 \geq c_2 + 1)$	$p_2(c_1 \geq c_2 - 1)p_2(c_3 \geq c_2 + 1)$
3	$p_3(c_1 \geq c_3 - 1)$	$p_3(c_2 \geq c_3 - 1)$	1	$p_3(c_1 \geq c_3 - 1)p_3(c_2 \geq c_3 - 1)$

Each cell represents the probability of winning of a row-bidder against one other column-bidder given only the bribes of these two bidders (pair-wise comparison). The probability of bidder 1 winning, for example, is the product of the cells of row 1, $p_1(c_2 \geq c_1 - 1)p_1(c_3 \geq c_1 + 1)$. Group-wise comparison table is given by the following table:

Table 1.3: Probability of Bidder Winning Based on Group-Wise Comparison

$i \backslash -i$	1	2	3	p_i
1	1	$p_1(c_1 \leq c_2)$	$p_1(c_3 \geq c_1 + 1)$	$p_1(c_1 \leq c_2)p_1(c_3 \geq c_1 + 1)$
2	$p_2(c_2 \leq c_1)$	1	$p_2(c_3 \geq c_2 + 1)$	$p_2(c_2 \leq c_1)p_2(c_3 \geq c_2 + 1)$
3	$p_3(c_1 \geq c_3 - 1)$	$p_3(c_2 \geq c_3 - 1)$	1	$p_3(c_1 \geq c_3 - 1)p_3(c_2 \geq c_3 - 1)$

*Note that the difference from the pair-wise comparison. Here, each cell represents the probability of winning of a row-bidder against one other column-bidder given the bribes of **all** of the bidders (group-wise comparison).* ∎

These two conditions essentially allow the utility function of the bidders to be written as follows:

1. Two-player game:

$$u(c, f, q^m | c_i^0, o_i, r_i) = (c_i - c_i^0 - f_i)(p(s_i^m \geq s_{-i}^m)), \tag{1.12}$$

$$p(s_i^m \geq s_{-i}^m) = p(c_{-i} \geq c_i - 1)p(f_i \geq f_{-i}) + \tag{1.13}$$

$$p(c_{-i} \geq c_i + 1)p(f_{-i} > f_i), \forall i = 1, 2 \tag{1.14}$$

2. N-player game:

$$u(c, f, q^m | c_i^0, o_i, r_i) = (c_i - c_i^0 - f_i)(p(c_{-i} \geq c_i - 1)^{N-1} p(f_i \geq f_{-i})^{N-1} +$$

$$\sum_{j=1}^{N-2} \binom{N-1}{j} p(c_{-i} \geq c_i - 1)^{N-1-j} p(c_{-i} \geq c_i + 1)^j p(f_i \geq f_{-i})^{N-1-j} \quad (1.15)$$

$$p(f_i < f_{-i})^j + p(c_{-i} \geq c_i + 1)^{N-1} p(f_i < f_{-i})^{N-1}). \quad (1.16)$$

Note that the utility of the bidders now depend on the subjective beliefs, (o_i, r_i). Note that $\binom{N-1}{j} = \frac{(N-1)!}{(N-1-j)!(j)!}$ is the formula for a combination without replacement when order is not important.

The general structure of the game with positive bidders in which Condition 1 above holds given Lemma 1 can be written as follows:

$$\Gamma(N) = \{I = \{1, 2, ...N\}, \{s_i = (c_i, f_i)\}_{\forall i \in \{1,2,..\}},$$

$$\{u_i(c, f | c_i^0, o_i, r_i)\}_{\forall i \in \{1,2,...N\}}, \{c_i^0\}_{\forall i \in \{1,2,..\}}, \{F(c_i^0)\}_{\forall i \in \{,1,2,...\}}\},$$

$$u(c, f, q^m | c_i^0, o_i, r_i) = (c_i - c_i^0 - f_i)(p(c_{-i} \geq c_i - 1)^{N-1} p(f_i \geq f_{-i})^{N-1} +$$

$$\sum_{j=1}^{N-2} \binom{N-1}{j} p(c_{-i} \geq c_i - 1)^{N-1-j} p(c_{-i} \geq c_i + 1)^j p(f_i \geq f_{-i})^{N-1-j} p(f_i < f_{-i})^j +$$

$$p(c_{-i} \geq c_i + 1)^{N-1} p(f_i < f_{-i})^{N-1}).$$

Subjective beliefs (r,o) are common knowledge among bidders.

First, we can show examples with continuum type space and discrete-action strategy space (two-by-two and three-by-three) in which the equilibrium bids and bribes exists in declining step functions. The following is an example of N-bidder case with discrete type space and infinite strategy space.

Example 1.3 *Discrete Type Space and Infinite Strategy Space with N players (Multiplicity of Equilibria)*

Let: i=1,2,...N, and $\forall i \in I$:

Type space: $c_i^0 \in \{0,1\}$, $p(c_i^0){=}\frac{1}{2}$

Strategy and Strategy space: $(c_i,f_i){:}\{0,1\}{-}{>}\Re_+^2$

$u(c,f,q^m|c_i^0,o_i,r_i){=}(c_i{-}c_i^0{-}f_i)P_i,$ *where*

$P_i{=}(p(c_{-i}\geq c_i{-}1)^{N-1}p(f_i\geq f_{-i})^{N-1}+\sum_{j=1}^{N-2}\binom{N-1}{j}p(c_{-i}\geq c_i{-}1)^{N-1-j}p(c_{-i}\geq c_i{+}1)^j$

$p(f_i\geq f_{-i})^{N-1-j}p(f_i{<}f_{-i})^j+p(c_{-i}\geq c_i{+}1)^{N-1}p(f_i{<}f_{-i})^{N-1}).$

$\Gamma{=}\{I{=}\{1,2\},\{s_i{=}(c_i,f_i)\in \Re_+^2\}_{\forall i\in\{1,2\}},\{u_i(c,f|c_i^0,o_i,r_i)\}_{\forall i\in\{1,2\}},$

$\{c_i^0\}_{\forall i\in\{1,2\}},\{F(c_i^0))\}_{\forall i\in\{1,2\}}\}$

Equilibrium strategy profile: $c(c_i^0{=}1){=}c(c_i^0{=}0){-}1$, $f(c_i^0{=}0){>}f(c_i^0{=}1).$

There exists a multiplicity of equilibria. The following table shows the equilibrium bids and bribes that maximize the sum of the expected utilities of the bidders (Pareto Dominant equilibrium bids and bribes) as N increases (numbers are rounded up to 5 d.p.).(See Appendix XII).

We can show similar results for p $(c_i^0){=}\frac{2}{3}$ and $p(c_i^0){=}\frac{3}{4}$ and the following observations of Example 3 also apply to these examples. Example 3 with the finite type space and infinite strategy space shows the existence of an equilibrium in the class of game with a finite, two-element $\{0,1\}$ type space, and a strategy space in $\Re_+^2$. There are multiple equilibria. Similar to the examples with continuum type and discrete strategy space, the equilibrium bids and bribes we show in Example 3 take the form of: $c(c_i^0{=}1){=}c(c_i^0{=}0){-}1$, $f(c_i^0{=}0){>}f(c_i^0{=}1)$. We show the equilibrium bids that maximize the sum of the expected utilities of the bidders in this example

N	$c(c_i^0=0)$	$c(c_i^0=1)$	$f(c_i^0=0)$	$f(c_i^0=1)$	$u(c,f,q^m|c_i^0=0)$	$u(c,f,q^m|c_i^0=1)$
2	6	5	2	0	4	3
3	4.28571	3.28571	2	0	2.28571	1.28571
4	3.72973	2.72973	2	0	1.72973	.72973
5	3.46286	2.46286	2	0	1.46286	.45202
6	3.31114	2.31114	2	0	1.31114	.31114
7	3.21651	2.21651	2	0	1.21651	.21651
8	3.15405	2.15405	2	0	1.15405	.15405
9	3.11125	2.11125	2	0	1.11125	.11125
10	3.08118	2.08118	2	0	1.08118	.08118
20	3.00425	2.00425	2	0	1.00425	.00425
30	3.00024	2.00024	2	0	1.00024	.00024
40	3.00001	2.00001	2	0	1.00001	.00013
50	3	2	2	0	1	P_i
75	3	2	2	0	1	P_i
76	2	1	1	0	1	0
100	2	1	1	0	1	0
1000	2	1	1	0	1	0

decreases as N increases. The Pareto Dominant equilibrium bids in this example are equal to three and two for the low-cost bidder and the high-cost bidder respectively for a relatively low N. The Pareto Dominant equilibrium bribes in this example are equal to two and zero for the low-cost bidder and the high-cost bidder, respectively, for a relatively low N. The equilibrium bid converges to two and one for the low-cost bidder and the high-cost bidder, respectively. The equilibrium bribe converges to one and zero for the low-cost bidder and the high-cost bidder respectively. The equilibrium bid in this example decreases as cost increases while the equilibrium bid without corruption increases as cost increases. This suggests that the low-cost bidder who has the cost advantage to bribe more bid higher at the cost of increased inefficiency. This further suggests that once corruption is allowed, the bidders compete in offering the highest-possible bribes, or *overbribe* each other, instead of offering the highest-scored bids, or overbid each other, as

how the bidders would have done in an auction without corruption.

Example 3 shows that the equilibrium bid converges downward as N increases. This example predicts the size of the corruption and efficiency of an N-bidder auction. As N gets very large, the low-cost bidder offers a bribe of one and the high-cost bidder offers a bribe of zero. Hence, only for the high-cost bidder does the equilibrium bribe converges to zero, while for the low-cost bidder, the equilibrium bribe converges to a positive number. The low-cost bidder bids two and the high-cost bidder bids one. Hence, only for the high-cost bidder does the equilibrium bid converges to the true cost, while for the low-cost bidder, the equilibrium bid does not converge to the true cost. Note that in Example 3, the probabilities of the high- and low-cost bidders win are equal. We can also show that the higher the probability of $c_i^0=0$ is, the higher the number of bidders, N, needed for the bids and the bribes to converge. Although the auction is more cost-efficient as the number of bidders increases, the auction is never more quality-efficient. Similar to the argument in Dasgupta and Maskin (2000), we face constrained efficiency in which quality choice is randomized because of the loss of information about the bidders' qualities.

Negative Bidders Otherwise stated, the structure of the game is the same as of Example above (positive bidders). Let $p(c_i^0=0)=p(c_i^0=1)=\frac{1}{2}$. Given these conditions, the utility of the negative bidders can be written as follows:

$$
\begin{aligned}
u(c, f|c_i^0, o_i, r_i) &= (c_i - c_i^0 - f_i)(p(c_{-i} > c_i - 1)p(f_i > f_{-i}) + \\
p(c_{-i} &> c_i + 1)p(f_i \le f_{-i}), \forall i = 1, 2
\end{aligned}
$$

In words, each bidder believes that in the case of a tie of bribes, the other bidder will get the highest possible quality of one and he/she will get a quality of zero. In

the case of a tie of scores, each bider believes that the other bidder will win with probability one. Now, suppose we put an upper bound on the bidders' bid that is $c_i \leq \max_{c_i^0 = \{0,1\}} . c_i^0 = 1$. The following strategy is an equilibrium: $c(c_i^0 = 0) \to 1$, $c(c_i^0 = 1) = c(c_i^0 = 0) - 1$, $f(c_i^0 = 0) \to 0.999999998$, $f(c_i^0 = 1) \to 0.999999997$. At the equilibrium, $u(c_i^0 = 0) \to 0$ $(p(c_i^0 = 0) = \frac{1}{4})$, and $u(c_i^0 = 1) = 0$ $(p(c_i^0 = 1) = 0)$. This example suggests that negative bidders will be indifferent between entering the auction and not entering the auction. In other words, uncertainty over the moves of the public official and the central planner in the case of a tie of bribes and scores may deter bidders to enter the auction. Similar to Myerson's argument on subjective beliefs or inconsistency of beliefs among players (Myerson, 1991, p.251), in the model with a non-strategic public official, the bidders could enter the auction having an expected utility that is higher than it truly is (see the positive-bidders case above) or the bidders could opt not to enter the auction having a zero expected utility that is lower that it truly is (see the negative-bidders case).

1.4.2 Main Propositions

Proposition 1.7 *In an N-positive-bidder auction game with corruption above in which the type space is discrete, the strategy space is infinite, the central planner and the public official are non-strategic players and bidders' beliefs on the moves of the central planner and the public official are subjective beliefs, there exist multiple equilibria with respect to the bidders' subjective beliefs of the following form:* $c(c_i^0 = 0) = c(c_i^0 = 1) + 1$, $f(c_i^0 = 0) > f(c_i^0 = 1)$, $\forall i = \{1, 2\}$. *At these equilibria:* $\frac{\partial u(c, f | c_i^0, o_i, r_i)}{\partial c_i} \big|_{c^*, f^*} = - \frac{\partial u(c, f | c_i^0, o_i, r_i)}{\partial f_i} \big|_{c^*, f^*}, \forall c_i^0 = \{0, 1\}, \forall i = \{1, 2\}$.

Proof. (See Appendix XIII) ∎

Proposition 1.8 *In a two–negative-bidder auction game with corruption above in which $c_i \leq max_{c_i^0 = \{0,1\}}.c_i^0 = 1$, the type space is discrete, the strategy space (c_i, f_i) is in $[0,1] \times \Re_+^1$, the central planner and the public official are non-strategic players and bidders' beliefs on the moves of the central planner and the public official are subjective beliefs, there exists an equilibrium in pure strategy with respect to the bidders' subjective beliefs of the following form:* $c(c_i^0=0)=c(c_i^0=1)+1$, $f(c_i^0=0)>f(c_i^0=1)$, $\forall i = \{1,2\}$. *At this equilibrium:* $\frac{\partial u(c,f|c_i^0,o_i,r_i)}{\partial c_i}\big|_{c^*,f^*} = -\frac{\partial u(c,f|c_i^0,o_i,r_i)}{\partial f_i}\big|_{c^*,f^*}, \forall c_i^0 = \{0,1\}, \forall i = \{1,2\}$.

Proof. (See Appendix XIV) ■

One could extend the scope of this paper by taking bidders with different attitudes towards uncertainties and analyze how the existence of an equilibrium and an equilibrium strategy will change.

1.4.3 How much efficiency is lost?

Note that the probability of the bidder winning is not a function of the true quality of the bidders, and hence, the probability of the bidder winning in terms of quality is a perfect randomization. This is what is called "constrained efficiency" (Dasgupta and Maskin, 2000). In other words, what an auctioneer or a central planner can best hope for is cost minimization and but not full efficiency. This is inefficiency from the quality side. The convergence results of the equilibrium bids as the number of bidder increases to a very large number (1000) with and without corruption show us that corruption does tend to increase bids. The distributions of type are not the same in the models with and without corruption, however, we can still predict that the presence of corruption increases bids by the

following argument. The quality and cost in the model without a corruption are identically and independently distributed in the unit interval, while in the model with a corruption, Example 3, cost is distributed with equal probabilities for $c_i^0=0$ and $c_i^0=1$. However, in the model without a corruption, regardless of quality, the bid converges to the true cost that is 0 for $c_i^0=0$ and 1 for $c_i^0=1$, while in the model with a corruption, the bid never converges to the true cost for $c_i^0=0$ even though it does converge to the true cost for $c_i^0=1$. Notice, however, that the equilibrium bribe is positive only for $c_i^0=0$, while no bribe is offered by the high-cost bidder. Hence, this suggests the mark-up in the case of the low-cost bidder can be blamed partly on bribes.

1.5 Incentive Mechanism Designs: A Glimpse

Our attempt in this paper is to design an efficient incentive mechanism design in a procurement auction model when bidders' private information are multidimensional. We restrict to unobservable and non-contractible quality. Non-contractible quality means that either qualities are ex-post non-verifiable or ex-post verifiable but there is no legal enforcement to punish corrupt bidders and/or public officials. In some cases, this assumption is more realistic than earlier literatures that assume contractible qualities for a couple of reasons. One is that qualities of the bidders are most of the time not directly observable and ex-post are not perfectly verifiable. The most extreme case of imperfectly verifiable information is the case of non-verifiable information. Second, we may also assume that the quality is not contractible even though it is ex-post verifiable because, in the worst possible case, legal enforcement is not effective and hence, corrupt bidders and/or public officials are never caught and bidders are not deterred to bribe the public officials. The nov-

elty of the result is setting a procurement auction model with corruption into the generalized model of multidimensional and common values problem to show that the impossibility result theorem applies to this auction model. A social planner designs an efficient or socially optimal direct mechanism to directly retrieve the multidimensional private information of the bidders that matters for achieving efficiency.

1.5.1 Model and Example

We restrict the number of player to two, however, the results in this section still holds for N players. An individual player is denoted by i=1,2. The mechanism designer denoted by P is also the procurer and the social planner[5]. The social choice function is denoted by f(θ) that is a function of the players' types, θ. Denote $y_i(\theta)$ as the decision function for player i, where $y_i(\theta)$=1 if the procured good/service goes to player i, $y_i(\theta)$=0 otherwise. The monetary transfer to player i is denoted by $t_i(\theta)$. The function $\bar{y}_i(\theta_i)$ denotes the marginal decision function for player i given θ_i and all agents j$\neq$i reveal their types truthfully. Similarly, the function $\bar{t}_i(\theta_i)$ denoted the marginal transfer payment function to player i given θ_i and agents j$\neq$i reveal their types truthfully. The mechanism Γ implements that the social choice function f(θ) is there is an equilibrium strategy profile s* such that g(s*(θ))=f(θ), where g(s(θ)) is the outcome function given s(θ). The strategy set of each player i is denoted by S_i.

Otherwise stated, let the social choice function be:

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[5]Without a loss of generality, we can also assume that the mechanism designer who is also the procurer and the social planner is a player. The set-up of the model will be slightly different although it will not change the theoretical results.

$$f(\theta) = [y_1(\theta), y_2(\theta); t_1(\theta), t_2(\theta)] : \Theta_1 x \Theta_2 \to X,$$

$$\{y_i(\theta) : y_i(\theta)(v_i - max.(v_1, v_2)) = 0\}_{i=1,2}, v_i = q_i - c_i^0, (\sum_{i=1,2} t_i) = -t_P,$$

where X=the set of alternatives, θ_i=(q_i, c_i^0), θ=(θ_1, θ_2), $\theta \in \Theta_1 x \Theta_2$, Θ_i= common knowledge, $F(\theta_i)$=Uniform$[0,1]^2$,$\forall \theta_i \in \Theta_i$.

Define a direct mechanism: Γ=$(S_1, S_2, g(s))$, $S_i \in \Theta_i$, s$\in S = S_1 \times S_2$, and Γ implements $f(\theta)$ if: $g(s^* = \theta)$=$f(\theta)$, or $u_i(f(\theta), \theta_i) \geq u_i(f(\tilde{\theta}_i, \theta_{-i}), \theta_i)$, $\forall \tilde{\theta}_i \in \Theta_i, \forall i = 1, 2$.

Example 1.4 *Two-Dimensional Private Information*

Let $u_P = \sum_{i=1,2}(y_i(\hat{\theta})q_i - t_i); u(\hat{\theta}|\theta_i) = -y_i(\hat{\theta})c_i^0 + t_i; Max. U_s = \sum_{i=1,2} y_i(\hat{\theta})v_i$

Claim 1.1 *There does not exist an efficient mechanism in the above example.*

Proof. (See Appendix XV) ■

1.5.2   Main Theorems

In fact, we can put the claim above more formally by the following Theorem.

Theorem 1.1 *Define a Social Choice Function, $f(\theta)$=$(t(\theta), y(\theta))$, whose objective function is $y_i(\theta)((q_i - c_i^0) - max_{k=1,2}.(q_k - c_k^0))$=0, $\sum_i y_i(\theta)$=1, $y_i(\theta) \in [0,1]$, $\forall i = 1, 2$. The utilities of the procurer and the bidders are the following:*

$$u_P = \sum_{i=1,2}(y_i(\hat{\theta})q_i - t_i(\hat{\theta})); u(\hat{\theta}|\theta_i) = -y_i(\hat{\theta})c_i^0 + t_i(\hat{\theta}); U_s = \sum_{i=1,2} y_i(\hat{\theta})(q_i - c_i^0),$$

then there cannot be an efficient mechanism that implements f(θ).

Proof. (See Appendix XVI) ■

This theorem comes directly from the Jehiel and Moldovanu's impossibility result theorem (Jehiel and Moldovanu, 2001), which is also proven in Dasgupta and Maskin (2000) and Maskin (1992), that states that there is no efficient mechanism when there is at least one player (the bidders) whose private information (their qualities) affects the choice of the most efficient bidder but does not directly affect the owner(s) of that information (the bidders). This theorem can be re-stated as follows: if, under two or more different private signals, a bidder's expected valuation is the same, but the maximal valuation of all bidders that determines the most efficient bidder is not the same under these signals, then there cannot be an efficient mechanism. Jehiel and Moldovanu (2001) proves the impossibility theorem by showing that if an efficient mechanism is achieved then it must be the case that the private and social rates of information substitutions are equal, which is non-generic in the case of multidimensional and common-value type players.

Note that in the set-up of the model above, players' values are private and not common. However, because the efficiency of the mechanism is determined by some elements of the players' private information that do not affect their valuations, the impossibility result still holds. In other words, in general, it is not because bidders' valuations are common values but it is because of the loss of some of the bidders' private information, which determines the efficiency of the mechanism, that generates the impossibility result. From Proposition 3 of Dasgupta and Maskin (2000), we can directly apply the impossibility result theorem to our model as follows. Take $v_1(\theta_1, \theta_2) = -c_1^0$. We have $v_1((q_1, c_1^0), (q_2, c_2^0)) = v_1((\tilde{q}_1, c_1^0), (q_2, c_2^0))$, but $\text{argmax}_{1,2}.(q_1 - c_1^0, \ q_2 - c_2^0) \neq \text{argmax}._{1,2}.(\tilde{q}_1 - c_1^0, q_2 - c_2^0)$ for some θ. Then, there is

no efficient mechanism to implement f(θ) as it is defined above.

Let private information be separable in the following way:

$$Eu_i(t_i(\hat{\theta}),y_i(\hat{\theta}),\hat{\theta}|(\theta_i))=Eu_i(t_i(\hat{\theta}),y_i(\hat{\theta}),\hat{\theta}|v_i(\theta)),$$

where $v_i(\theta)$ is the private valuation of bidder i and is a function of the multi-dimensional private information θ. Moreover, let $w_i(\theta)$ be the social valuation of bidder i. Note that we allow bidders' private valuations to be common values in the following Theorem.

Theorem 1.2 *Define a Social Choice Function, $f(\theta)=(t(\theta),y(\theta))$, whose objective function is $y_i(\theta)(w_i(\theta)-min_{k=1,2}.w_k(\theta))=0$, $\sum_i y_i(\theta)=1$, $y_i(\theta)\in[0,1]$, $\forall i = 1,2$. Suppose bidders' utility is the following:*

$Eu_i(t_i(\hat{\theta}),y_i(\hat{\theta}),\hat{\theta}|(\theta_i)) = Eu_i(t_i(\hat{\theta}),y_i(\hat{\theta}),\hat{\theta}|v_i(\theta))$, where $v_i(\theta)=v_i(\tilde{\theta}_i,\theta_{-i})$, for some $\tilde{\theta}_i \in \Theta_i$,

but $argmin_{k=1,2}.\{w_k(\theta)\} \neq argmin_{k=1,2}.\{w_k(\tilde{\theta}_i,\theta_{-i}))$, then there cannot be an efficient mechanism.

Proof. (See Appendix XVII) ∎

An example of a utility function in which private information is separable as defined above is a quasi-linear utility function. We can show that for any quasi-linear utility of the bidders in which private information is separable in this sense and the private valuation of the bidder is the same under different private information, but the optimal social valuation of all bidders is not the same under these different private information, then there cannot be an efficient mechanism if an efficient mechanism is to maximize the social valuations of the bidders.

Corollary 1.4 *Define a Social Choice Function, $f(\theta)=(t(\theta),y(\theta))$, whose objective function is $y_i(\theta)(w_i(\theta)-min_{k=1,2}.w_k(\theta))=0$, $\sum_i y_i(\theta)=1$, $y_i(\theta)\in[0,1]$, $\forall i=1,2$. Suppose bidders' utility is quasi-linear:*

$Eu_i(t(\hat{\theta}),y(\hat{\theta}),\hat{\theta}|(\theta_i)) = t_i(\hat{\theta})-y_i(\hat{\theta})v_i(\theta)$, where $v_i(\theta)=v_i(\tilde{\theta}_i,\theta_{-i})$, for some $\tilde{\theta}_i \in \Theta_i$,

but $argmin_{k=1,2}.\{w_k(\theta)\} \neq argmin_{k=1,2}.\{w_k(\tilde{\theta}_i,\theta_{-i}))$, then there cannot be an efficient mechanism.

Proof. (The proof is similar to the proof of Theorem 2. See Appendix XVII)

∎

Note that we do not assume anything about the utility of the central planner. However, we assume that for some function of $v(\theta)$ and $u_0(\theta)$, the social objective is to minimize some (negative) valuation of the bidder, $w(\theta)$. For example, $v_i(\theta)=(c_i^0-\varepsilon q_i)$, $u_0(\theta)=\sum_{i=1,2}(y_i(\theta)(1-\varepsilon)q_i-t_i)$, $w_i(\theta)=c_i^0-q_i$.

1.6 Empirical Study: Inefficiency with High Numbers of Bidders

We examine a case study on Land Management and Policy Development Project from BAPPENAS (Indonesia's National Development Planning Agency) in 2006 and we perform empirical study on 1,404 auctions conducted by Indonesia's Department of Public Work in 2006[6]. In the empirical study, we run a fixed-effects regression. The regression is given by the following equation:

---

[6]This section is taken from Wihardja, 2007.

$$
\begin{aligned}
Ln(\%CostEfficiency) \;=\;& a + b(n-\bar{n}) + c(n-\bar{n})^2 + \\
& \sum_{i=1}^{7} I(Satkal) + \sum_{i=1}^{13} I(Prov) + \sum_{i=1}^{8} I(Category) + \\
& \sum_{i=1}^{10} I(Value) + \sum_{i=1}^{2} I(Metode)
\end{aligned}
$$

where:

I(.): Indicator variable

Ln(% Cost Efficiency):

LN of the percentage cost efficiency=LN $\left(\frac{\text{Initial Budget-Contract Price}}{\text{Initial Budget}}\text{x}100\%\right)$

(n-$\bar{n}$): Centered Number of Bidders = Number of bidders - Mean of number of bidders

(n-$\bar{n}$)^2: Centered Number of Bidders Squared = (Number of bidders - Mean of number of bidders)^2

Satkal: Department, Prov: Province, Category: Type of auctions, Value: Initial Budget, Metode: Method of the Auctions

We transform the dependent variable into the natural logarithmic form to normalize the residuals and we center the independent variables in order to avoid multicollinearity between the number of bidders and the squared number of bidders. We drop one observation that has a very high residual (an outlier). We drop observations that use Direct Selections/Auctions[7] and Direct Appointment

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[7]Public Selection and Direct Selection methods are used for consultant services while Public Auction and Direct Auction methods are used for construction and goods services.

methods. Direct Selections/Auctions methods are used for low values projects and hence observations that fall into Direct Selections/Auctions also fall into one of the dummy variables for "Value" (or initial budget). In order to avoid multi-collinearity, we drop these observations. Direct Appointments directly appoints one bidder and hence, it could not capture the effect of the number of bidders on the percentage cost efficiency. The following table is the result of the regression (see Appendix for the complete regression result):

Table 1.5: Regression Coefficients

Number of Observations	1332		
$F(46, 1285)$	11.95		
Prof>F	0		
R-Squared	.2996		
Root MSE	.82179		
Regression	Coefficient	t-value	P>|t|
b	.0098179	5.74	0
c	-.0000882	-6.93	0

The regression result suggests the concave relationship between the number of bidders and the natural log of the percentage cost efficiency. Both the linear and the quadratic coefficients are significant. The optimum point of the concave graph is at 149 bidders. In other words, percentage cost efficiency starts to decline at 149 bidders. The mean of the number of bidders in this study is 37.97166. Although the theoretical model above captures the competition effect as the number of bidders increases, this empirical study suggests that increasing the number of bidders can have a negative effect for high numbers of bidders above 149 bidders. The factors that could negatively affect the percentage cost efficiency of the auctions with high numbers of bidders may include an inefficient selection process with too many bidders that may not be directly related to the competition effect. A theoretical

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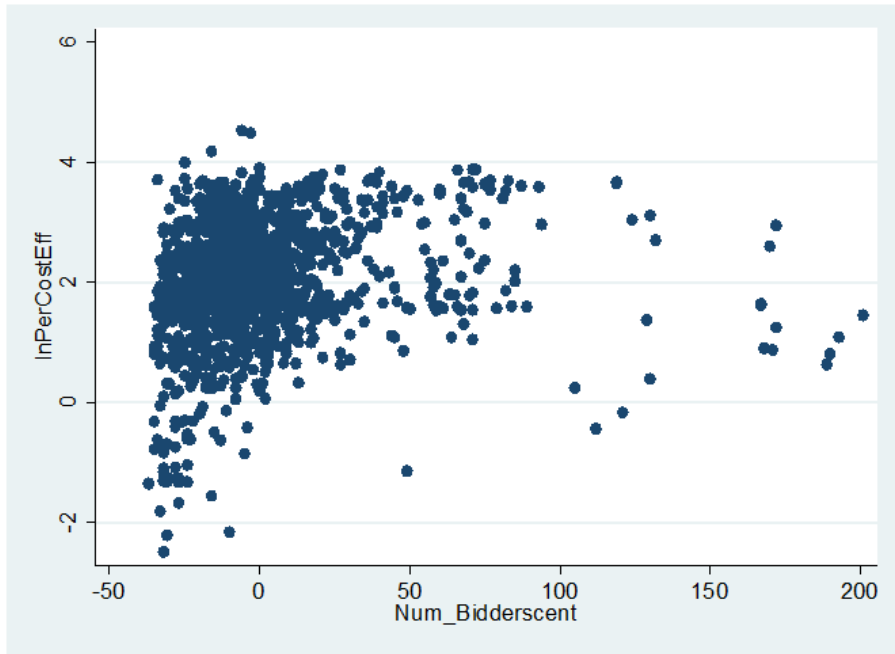
Figure 1.1: (Centered)Number of Bidders vs. (Ln)Percentage Cost Efficiency
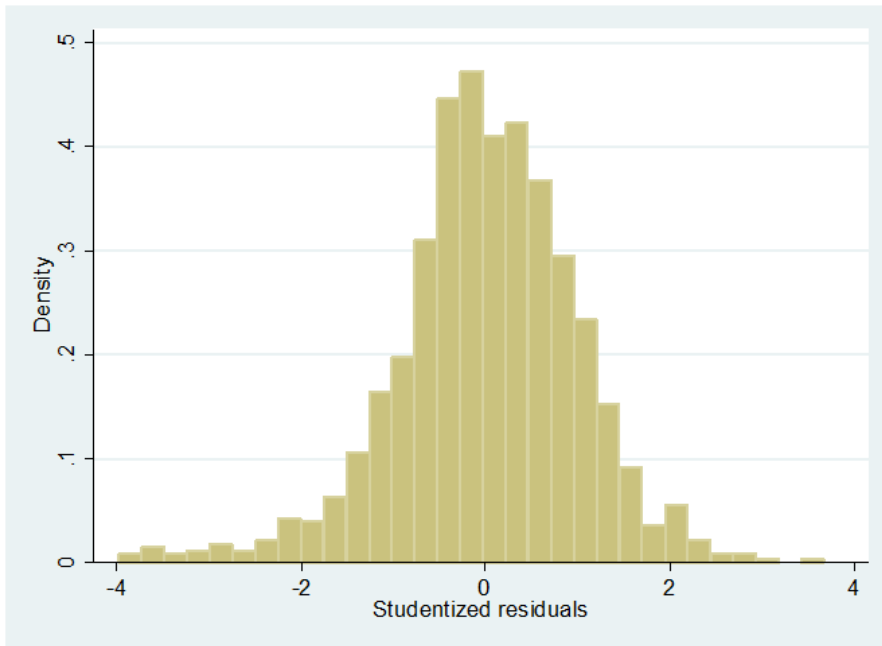
Figure 1.2: Normality of Residuals

model that could capture this effect and explaining the discrepancy between the theoretical predictions and the empirical study will be useful for future study.

The regression result also suggests that auctions conducted by pra-qualification public selection/auction have lower (log) percentage cost efficiencies than auctions conducted using pasca-qualification public selection/auction. Pra-qualification method requires bidders to submit their pre-qualifications, such as company profiles, at the registration process while pasca-qualification method does not require bidders to submit their pre-qualifications at the registration process.

1.7 Policy Analysis

Although the inefficiency result in auctions with corruption may not be surprising, what we have shown here is that in general, if quality is non-contractible, meaning that they are either not ex-post verifiable (case 1) or if they are ex-post verifiable (case 2), there is no effective legal punishment to be imposed on corrupt bidders nor public officials, then there is *no* mechanism that is efficient. We have shown theoretically and empirically how increasing the number of bidders can increase the efficiency of an auction even if corruption can be pervasive. We therefore recommend promoting the entries of more potential bidders in such a situation. One way to do it is through E-Procurement. E-Procurement increases access to potential bidders that may increase the number of bidders, on top of other advantages such as allowing greater transparency and monitoring. It also decreases interactions among bidders that previously could result in physical intimidation. All these partly solve the issues of nepotism and cronyism. Hence, E-Procurement auction is one possible alternative to solve inefficiency of auctions if corruption

can be pervasive. We however recommend that it is conducted for low-value projects and not high-value project to reduce risk of misdemeanors. We have also shown theoretically that under non-contractible quality, efficiency of an auction is constrained from the quality-side. Hence, if non-contractibility of quality comes from an ineffective legal system but monitoring quality is possible (case 2), then a possible way to increase efficiency of an auction is output-based contract. The study suggests that too many bidders above 149 bidders might start to give negative effects to the efficiency of the auctions. Hence, a cap on the number of bidders might prevent the negative effects on cost efficiency related to high numbers of bidders, such as an inefficient selection process, from taking place.

1.8   Conclusion

The main contribution of this paper is to show that the equilibrium bids and bribes in the presence of corruption with a discrete type space and an infinite strategy space decrease as the number of bidders increases. The analysis on the incentive mechanism design shows a disappointing result that when quality is not fully verifiable and quality is not contractible, there is no mechanism that is efficient. The second-best option is to minimize cost but to randomize the choice of quality. The empirical study on Semi E-Procurement from Indonesia's Department of Public Work in 2006 suggests that increasing the number of bidders starts to give a negative effect of the percentage cost efficiency at a high number of bidders. A theoretical model that could capture the discrepancy between the theoretical model in this paper and the empirical study is needed.

APPENDICES

Appendix I: Proof of Proposition 1

Proof. Let $s_i = q_i - c_i$.

$$u_i = (c_i - c_i^0)p(s_i \geq s_{-i}) \tag{1.17}$$

Substituting in $c_i = q_i - s_i$, we have:

$$u_i = (q_i - s_i - c_i^0)p(s_i \geq s_{-i}) \tag{1.18}$$

Let $\tilde{s}_i = q_i - \tilde{c}_i$:

$$u_i = (q_i - \tilde{s}_i - c_i^0)p(\tilde{s}_i \geq s_{-i}) \tag{1.19}$$

We have the utility as a function of v_i. Let us assume that s_i is increasing in v_i:

$$u_i = (v_i - \tilde{s}_i)p(\tilde{s}_i \geq s_{-i}) \tag{1.20}$$

$$u_i = (v_i - \tilde{s}_i)p(s^{-1}\tilde{s}_i \geq (q_{-i} - c_{-i}^0)) \tag{1.21}$$

$$u_i = (v_i - \tilde{s}_i)F(s^{-1}\tilde{s}_i) \tag{1.22}$$

$$\frac{du_i}{dv_i} = F(v_i) \tag{1.23}$$

at the equilibrium, by the Envelope Theorem, where the function $F(v_i)$ is the cumulative distribution function of $(q_i - c_i^0)$.

$$u(v_i) = \int_{\underline{v}_i}^{v_i} F(\delta_i)d\delta_i \tag{1.24}$$

by the boundary condition $u(\underline{v}_i) = 0$ by our assumption that s_i is increasing in v_i.

$$\int_{\underline{v}_i}^{v_i} F(\delta_i)d\delta_i = (q_i - c_i^0 - s_i)F(q_i - c_i^0) \tag{1.25}$$

$$s_i = v_i - \frac{\int_{\underline{v}_i}^{v_i} F(\delta_i)d\delta_i}{F(v_i)} \tag{1.26}$$

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as we have in Proposition 1 above.

$$\frac{ds_i}{dv_i}=1-\frac{F(v_i)^2-p(v_i)\int_{\underline{v}_i}^{v_i}F(\delta_i)d\delta_i}{F(v_i)^2}>0 \tag{1.27}$$

Our assumption is consistent.   We can check that at the equilibrium, $u(\underline{v}_i)=0$.

∎

Appendix II: Proof of Corollary 1

Proof. Differentiating the scoring rule of the bidder, s_i, at the equilibrium with respect to v_i, we have the result.   ∎

Appendix III: Proof of Proposition 2

Proof. Differentiating $c(v_i,c_i^0)$ with respect to q_i:

$$\frac{\partial c(v_i,c_i^0)}{\partial q_i}=\frac{\partial c_i^0}{\partial q_i}+\frac{\partial}{\partial q_i}\frac{\int_{\underline{v}_i}^{v_i}F(\delta)d\delta}{F(v_i)} \tag{1.28}$$

$$\frac{\partial c(v_i,c_i^0)}{\partial q_i}=\frac{\partial}{\partial q_i}\frac{\int_{\underline{v}_i}^{v_i}F(\delta)d\delta}{F(v_i)}=\frac{\partial}{\partial v_i}\frac{\int_{v_i^0}^{v_i}F(\delta)d\delta}{F(v_i)}\frac{\partial v_i}{\partial q_i} \tag{1.29}$$

$$\frac{\partial c(v_i,c_i^0)}{\partial q_i}=\frac{F(v_i)^2-\int_{\underline{v}_i}^{v_i}F(\delta)d\delta p(v_i)}{F(v_i)^2}(1)=1-\frac{\int_{\underline{v}_i}^{v_i}F(\delta)d\delta p(v_i)}{F(v_i)^2} \tag{1.30}$$

The cumulative and density distribution functions $F(v_i)$ and $p(v_i)$ are given by:

$$F(v_i)=\left[\begin{array}{l}\frac{(v_i+1)^2}{2},\ -1\leq v_i\leq 0\\[2mm]1-\frac{(1-v_i)^2}{2},\ 0<v_i\leq 1\end{array}\right] \tag{1.31}$$

$$p(v_i)=\left[\begin{array}{l}(v_i+1),\ -1\leq v_i\leq 0\\[2mm](1-v_i),\ 0<v_i\leq 1\end{array}\right] \tag{1.32}$$

Table 1.6: Proof of Proposition 2

0	0	.25	1
.1	.04935	.354025	.860603
.2	.094933	.4624	.794694
.3	.13335	.570025	.766063
.4	.1616	.6724	.759667
.5	.177083	.765625	.768707
.6	.1776	.8464	.79017
.7	.16135	.912025	.823086
.8	.126933	.9604	.867833
.9	.07335	.990025	.925911
1	0	1	1

For $-1 \leq v_i \leq 0$,

$$\frac{\partial c(v_i,c_i^0)}{\partial q_i} = 1 - \frac{\int_{-1}^{v_i^0} \frac{(\delta+1)^2}{2} d\delta p(v_i)}{\frac{(v_i+1)^4}{4}} = 1 - \frac{[\frac{1}{6}(\delta+1)^3|_{-1}^{v_i}](v_i+1)}{\frac{(v_i+1)^4}{4}} \tag{1.33}$$

$$\frac{\partial c(v_i,c_i^0)}{\partial q_i} = 1 - \frac{[\frac{1}{6}((v_i+1)^3-0)](v_i+1)}{\frac{(v_i+1)^4}{4}} = 1 - \frac{[\frac{1}{6}(v_i+1)^4]}{\frac{(v_i+1)^4}{4}} \tag{1.34}$$

$$\frac{\partial c(v_i,c_i^0)}{\partial q_i} = 1 - \frac{4}{6} = \frac{1}{3} > 0. \tag{1.35}$$

For $0 < v_i \leq 1$,

$$\frac{\partial c(v_i,c_i^0)}{\partial q_i} = 1 - \frac{\int_{-1}^{v_i} 1 - \frac{(1-v_i)^2}{2} d\delta p(v_i)}{\left(1-\frac{(1-v_i)^2}{2}\right)^2} = 1 - \frac{[\delta+\frac{(1-v_i)^3}{6}]_0^{v_i}(1-v_i)}{\left(1-\frac{(1-v_i)^2}{2}\right)^2} \tag{1.36}$$

$$\frac{\partial c(v_i,c_i^0)}{\partial q_i} = 1 - \frac{(v_i+\frac{(1-v_i)^3}{6}-(0+\frac{(1-0)^3}{6}))(1-v_i)}{\left(1-\frac{(1-v_i)^2}{2}\right)^2} = 1 - \frac{(s_i^0+\frac{(1-v_i)^3}{6}-(\frac{1}{6}))(1-v_i)}{\left(1-\frac{(1-v_i)^2}{2}\right)^2} \tag{1.37}$$

and we could show that:

$$\frac{\partial c(v_i,c_i^0)}{\partial q_i} = 1 - \frac{(v_i+\frac{(1-v_i)^3}{6}-(\frac{1}{6}))(1-v_i)}{\left(1-\frac{(1-v_i)^2}{2}\right)^2} > 0. \tag{1.38}$$

Let: Column 1: s_i^0; Column 2: $(s_i^0+\frac{(1-s_i^0)^3}{6}-(\frac{1}{6}))(1-s_i^0)$; Column 3: $(1-\frac{(1-s_i^0)^2}{2})^2$; Column 4: $\frac{\partial c(q_i,c_i^0)}{\partial q_i} = 1 - \frac{(s_i^0+\frac{(1-s_i^0)^3}{6}-(\frac{1}{6}))(1-s_i^0)}{(1-\frac{(1-s_i^0)^2}{2})^2}$.

Without corruption, the bid is increasing with the bidder's quality in the game with the initial probability distribution $F(q_i) = F(c_i^0) = $ Uniform [0,1]. ∎

Appendix IV: Proof of Proposition 3

Proof. Taking the derivative of c_i with respect to c_i^0:

$$\frac{\partial c(v_i, c_i^0)}{\partial c_i^0} = \frac{\partial}{\partial c_i^0} c_i^0 + \frac{\partial}{\partial c_i^0} \frac{\int_{\underline{v}_i}^{v_i} F(\delta) d\delta}{F(v_i)} \tag{1.39}$$

$$\frac{\partial c(v_i, c_i^0)}{\partial c_i^0} = 1 + \frac{\partial}{\partial v_i} \frac{\int_{\underline{v}_i}^{v_i} F(\delta) d\delta}{F(v_i)} \frac{\partial v_i}{\partial c_i^0} \tag{1.40}$$

$$\frac{\partial c(v_i, c_i^0)}{\partial c_i^0} = 1 - \left(1 - \frac{p(v_i) \int_{\underline{v}_i}^{v_i} F(\delta) d\delta}{F(v_i)^2}\right) > 0 \tag{1.41}$$

the bid increases with the cost for any prior probability distributions. ∎

Appendix V: Proof of Proposition 4

Proof. For any distribution of $F(q_i)$ and $F(c_i^0)$, the auction is efficient:

$$\frac{ds_i}{dv_i} = 1 - \frac{F(v_i)^2 - p(v_i) \int_{\underline{v}_i}^{v_i} F(\delta_i) d\delta_i}{F(v_i)^2} > 0 \tag{1.42}$$

The probability of the bidder winning depends positively on the bidder's quality:

$$\frac{ds_i}{dv_i} \frac{dv_i}{dq_i} = 1 - \frac{F(v_i)^2 - p(v_i) \int_{\underline{v}_i}^{v_i} F(\delta_i) d\delta_i}{F(v_i)^2} (1) > 0 \tag{1.43}$$

∎

Appendix VI: Proof of Proposition 5

Proof. For any distribution of $F(q_i)$ and $F(c_i^0)$, the auction is efficient:

$$\frac{ds_i}{dv_i} = 1 - \frac{F(v_i)^2 - p(v_i) \int_{\underline{v}_i^0}^{v_i} F(\delta_i) d\delta_i}{F(v_i)^2} > 0 \tag{1.44}$$

The probability of the bidder winning depends negatively on the bidder's cost:

$$\frac{ds_i}{dv_i} \frac{dv_i}{dc_i^0} = 1 - \frac{F(v_i)^2 - p(v_i) \int_{\underline{v}_i^0}^{v_i} F(\delta_i) d\delta_i}{F(v_i)^2} (-1) < 0 \tag{1.45}$$

∎

Appendix VII: Proof of Corollary 2

Proof. Let $s_i = q_i - c_i$.

$$u_i = (c_i - c_i^0) p(s_i \geq s_{-i})^{N-1} \tag{1.46}$$

Substituting in $c_i = q_i - s_i$, we have:

$$u_i = (q_i - s_i - c_i^0) p(s_i \geq s_{-i})^{N-1} \tag{1.47}$$

Let $\tilde{s}_i = q_i - \tilde{c}_i$:

$$u_i = (q_i - \tilde{s}_i - c_i^0) p(\tilde{s}_i \geq s_{-i})^{N-1} \tag{1.48}$$

We have the utility as a function of v_i. Let us assume that s_i is increasing in v_i:

$$u_i = (v_i - \tilde{s}_i) p(\tilde{s}_i \geq s_{-i})^{N-1} \tag{1.49}$$

$$u_i = (v_i - \tilde{s}_i) p(s^{-1}\tilde{s}_i \geq (q_{-i} - c_{-i}^0))^{N-1} \tag{1.50}$$

$$u_i = (v_i - \tilde{s}_i) F(s^{-1}\tilde{s}_i)^{N-1} \tag{1.51}$$

$$\frac{du_i}{dv_i} = F(v_i)^{N-1} \tag{1.52}$$

at the equilibrium, by the Envelope Theorem, where the function $F(v_i)$ is given in Appendix I.

$$u(v_i) = \int_{\underline{v}_i}^{v_i} F(\delta_i)^{N-1} d\delta_i \tag{1.53}$$

by the boundary condition $u(\underline{v}_i) = 0$ by our assumption that s_i is increasing in v_i.

$$\int_{\underline{v}_i}^{v_i} F(\delta_i)^{N-1} d\delta_i = (q_i - c_i^0 - s_i) F(q_i - c_i^0)^{N-1} \tag{1.54}$$

$$s_i = v_i - \frac{\int_{\underline{v}_i}^{v_i} F(\delta_i)^{N-1} d\delta_i}{F(v_i)^{N-1}} \tag{1.55}$$

as we have in Proposition 1 above.

$$\frac{ds_i}{dv_i} = 1 - \frac{F(v_i)^{2(N-1)} - (N-1)F(v_i)^{N-2} p(v_i) \int_{\underline{v}_i}^{v_i} F(\delta_i)^{N-1} d\delta_i}{F(v_i)^{2(N-1)}} > 0 \tag{1.56}$$

Our assumption is consistent. ∎

Proof. $\dfrac{\partial c(v_i,c_i^0)}{\partial N} = \dfrac{\int_{\underline{v}_i}^{v_i}(F(\delta)^{N-1})(\ln F(\delta))d\delta F(v_i)^{N-1}-\ln F(v_i)(F(v_i)^{N-1})\int_{\underline{v}_i}^{v_i}F(\delta)^{N-1}d\delta}{(F(v_i)^{N-1})^2}$

$$= \frac{\int_{\underline{v}_i}^{v_i}(\ln F(\delta))F(\delta)^{N-1}d\delta - \int_{\underline{v}_i}^{v_i}(\ln F(v_i))F(\delta)^{N-1}d\delta}{(F(v_i)^{N-1})} \leq 0, \forall v_i \in [-1,1],$$

$\because \ln F(v_i) > \ln F(\delta), \forall \delta : \underline{v}_i \leq \delta \leq v_i.$ ∎

Appendix IX: Proof of Lemma 1

Proof. First, we denote the utility of the bidders without first assuming the dominant strategy of the agent, and we assume that the strategy of the bidders is a function of both quality and cost. Therefore, we have the following:

$$u(c(\tilde{t}_i),f(\tilde{t}_i),c(t_{-i}),f(t_{-i}),q^m|t_i) \tag{1.57}$$

$$= (c(\tilde{t}_i)\text{-}c_i^0\text{-}f(\tilde{t}_i))(p(s_i^m \geq s_{-i}^m|f(\tilde{t}_i) \geq \tag{1.58}$$

$$f(t_{-i}))p(f(\tilde{t}_i) \geq f(t_{-i}))+p(s_i^m \geq s_{-i}^m|f(\tilde{t}_i)<f(t_{-i}))p(f(\tilde{t}_i)<f(t_{-i}))) \tag{1.59}$$

Denote q^m by q^{m_i} when $f(t_i) \geq f(t_{-i})$ and by q^{m-i} when $f(t_i)<f(t_{-i})$. Also, note that q^m is a function of bribes. Then, writing the utility of bidders after substituting for the terms q^m gives us:

$$u(c(\tilde{t}_i),f(\tilde{t}_i),c(t_{-i}),f(t_{-i}),q^m|t_i) = \tag{1.60}$$

$$(c(\tilde{t}_i)\text{-}c_i^0\text{-}f(\tilde{t}_i))(p(q_i^{m_i}(f(\tilde{t}_i),f(t_{-i}))\text{-}c(\tilde{t}_i) \geq \tag{1.61}$$

$$q_{-i}^{m_i}(f(\tilde{t}_i),f(t_{-i}))\text{-}c(t_{-i}))p(f(\tilde{t}_i) \geq \tag{1.62}$$

$$f(t_{-i}))+p(q_i^{m-i}(f(\tilde{t}_i),f(t_{-i}))\text{-}c(\tilde{t}_i) \geq \tag{1.63}$$

$$q_{-i}^{m-i}(f(\tilde{t}_i),f(t_{-i}))\text{-}c(t_{-i}))p(f(\tilde{t}_i)<f(t_{-i}))) \tag{1.64}$$

After we substitute the agent's scoring rule, the expected utility of the bidders depends on one exogenous variable, c_i^0, that is, the utility of the bidder is c_i^0-dependent

(i.e. it only depends non-trivially on c_i^0). The incompleteness of payoff-relevant information is only in the variable c_i^0. In contradiction, suppose the bidder's strategy depends on both the cost and quality. The incentive compatibility constraints that must hold at the optimal strategies are given by the following inequalities for $t_i = (c_i^0, q_i)$ and $\tilde{t}_i = (c_i^0, \tilde{q}_i)$:

$$u(c(t_i), f(t_i), c(t_{-i}), f(t_{-i}), q^m | t_i) =$$
$$(c(t_i) - c_i^0 - f(t_i))(p(q_i^{m_i}(f(t_i), f(t_{-i})) - c(t_i)) \geq$$
$$q_{-i}^{m_i}(f(t_i), f(t_{-i})) - c(t_{-i}))p(f(t_i)) \geq$$
$$f(t_{-i})) + p(q_i^{m_{-i}}(f(t_i), f(t_{-i})) - c(t_i)) \geq$$
$$q_{-i}^{m_{-i}}(f(t_i), f(t_{-i})) - c(t_{-i}))p(f(t_i)) < f(t_{-i})))$$

$$\geq$$

$$u(c(\tilde{t}_i), f(\tilde{t}_i), c(t_{-i}), f(t_{-i}), q^m | t_i) =$$
$$(c(\tilde{t}_i) - c_i^0 - f(\tilde{t}_i))(p(q_i^{m_i}(f(\tilde{t}_i), f(t_{-i})) - c(\tilde{t}_i)) \geq$$
$$q_{-i}^{m_i}(f(\tilde{t}_i), f(t_{-i})) - c(t_{-i}))p(f(\tilde{t}_i)) \geq$$
$$f(t_{-i})) + p(q_i^{m_{-i}}(f(\tilde{t}_i), f(t_{-i})) - c(\tilde{t}_i)) \geq$$
$$q_{-i}^{m_{-i}}(f(\tilde{t}_i), f(t_{-i})) - c(t_{-i}))p(f(\tilde{t}_i)) < f(t_{-i})))$$

similarly:

$$u(c(\tilde{t}_i), f(\tilde{t}_i), c(t_{-i}), f(t_{-i}), q^m | \tilde{t}_i) =$$
$$(c(\tilde{t}_i) - c_i^0 - f(\tilde{t}_i))(p(q_i^{m_i}(f(\tilde{t}_i), f(t_{-i})) - c(\tilde{t}_i)) \geq$$
$$q_{-i}^{m_i}(f(\tilde{t}_i), f(t_{-i})) - c(t_{-i}))p(f(\tilde{t}_i)) \geq f(t_{-i}))$$
$$+ p(q_i^{m_{-i}}(f(\tilde{t}_i), f(t_{-i})) - c(\tilde{t}_i)) \geq$$
$$q_{-i}^{m_{-i}}(f(\tilde{t}_i), f(t_{-i})) - c(t_{-i}))p(f(\tilde{t}_i)) < f(t_{-i})))$$

$$\geq$$

$$u(c(t_i),f(t_i),c(t_{-i}),f(t_{-i}),q^m|\tilde{t}_i) \quad =$$

$$(c(t_i)\text{-}c_i^0\text{-}f(t_i))(p(q_i^{m_i}(f(t_i),f(t_{-i}))\text{-}c(t_i) \quad \geq$$

$$q_{-i}^{m_i}(f(t_i),f(t_{-i}))\text{-}c(t_{-i}))p(f(t_i) \quad \geq$$

$$f(t_{-i}))\text{+}p(q_i^{m_{-i}}(f(t_i),f(t_{-i}))\text{-}c(t_i) \quad \geq$$

$$q_{-i}^{m_{-i}}(f(t_i),f(t_{-i}))\text{-}c(t_{-i}))p(f(t_i) \quad < \quad f(t_{-i})))$$

The two inequalities above show a contradiction: the strategies, c_i and f_i, depend non-trivially on both cost and quality

. ∎

Appendix X: Proof of Proposition 6

Proof. The proof can be referred directly to Jehiel and Moldovanu, 2001, Maskin and Dasgupta, 2000, or Maskin 1992. Also, see section on Incentive Mechanism Design of this paper. ∎

Appendix XI: Lemma 2

Proof. The Lagrangian to the constrained optimization problem is given by:

$$\mathcal{L}\text{=}f_1p_1\text{+}f_2p_2\text{+}f_3p_3\text{-}\lambda(\textstyle\sum_{i=1}^3 p_i\text{-}1)\text{+}\lambda_1p_1\text{+}\lambda_2p_2\text{+}\lambda_2p_2\text{-}\lambda_1'(p_1\text{-}1)\text{-}\lambda_2'(p_2\text{-}1)\text{-}\lambda_3'(p_3\text{-}1)$$

We can show that the Kuhn-Tucker first-order conditions and by checking the second order conditions will give us the solution. ∎

Appendix XII: Example 3

Example 3: Finite Type Space and Infinite Strategy Space (Multiplicity of Equilibria) (Proof *by hand* is omitted. Available upon request.)

The following is the numerical calculation by using *Mathematica* for n=2 to find a Pareto Dominant Equilibrium:

n := 2

i := i

j := j

u := (a - 0 - i)

v := (a - 1 - 1 - j) (3/4)

a := a

P:=(p^(n-1))(r^(n-1))+$\sum_{j=1}^{m=n-2}$(p^(n - 1 - j)) (q^j) ((n - 1)!/((j)! ((n-1 - j)!)) ((r^(n - 1 - j)) (s^ j)))) + (q^(n - 1)) (s^(n - 1))

NMaximize[{u + v,

(a - 1 - 1 - 0 - 0) (P /. {p -> 0, q -> 1, r -> 1, s -> 1}) <= u,

(a - 1 - 1 - 1 - 0) (P /. {p -> 0, q -> 1, r -> 1, s -> 1}) <= v,

(a - 1 - 1 - 0 - .01) (P /. {p -> 0, q -> 1, r -> 1, s -> 1}) <= u,

(a - 1 - 1 - 1 - .01) (P /. {p -> 0, q -> 1, r -> 1, s -> 1}) <= v,

(a - 1 - 1 - 0 - j) (P /. {p -> 1/2, q -> 1/2, r -> 1, s -> 1}) <= u,

(a - 1 - 1 - 1 - j) (P /. {p -> 1/2, q -> 1/2, r -> 1, s -> 1}) <= v,

(a - 1 - 1 - 0 - j - .01) (P /. {p -> 1/2, q -> 1/2, r -> 1, s -> 1}) <= u,

(a - 1 - 1 - 1 - j - .01) (P /. {p -> 1/2, q -> 1/2, r -> 1, s -> 1}) <= v,

(a - 1 - 1 - 0 - i) (P /. {p -> 1, q -> 0, r -> 1, s -> 1}) <= u,

(a - 1 - 1 - 1 - i) (P /. {p -> 1, q -> 0, r -> 1, s -> 1}) <= v,

(a - 1 - 1 - 0 - i - .01) (P /. {p -> 1, q -> 0, r -> 1, s -> 1}) <=u,

(a - 1 - 1 - 1 - i - .01) (P /. {p -> 1, q -> 0, r -> 1, s -> 1}) <= v,

(a - 1 - .01 - 0 - 0) (P /. {p -> 0, q -> 1, r -> 1, s -> 1/2}) <= u,

(a - 1 - .01 - 1 - 0) (P /. {p -> 0, q -> 1, r -> 1, s -> 1/2}) <= v,

(a - 1 - .01 - 0 - .01) (P /. {p -> 0, q -> 1, r -> 1, s -> 1/2}) <=u,

(a - 1 - .01 - 1 - .01) (P /. {p -> 0, q -> 1, r -> 1, s -> 1/2}) <= v,

(a - 1 - .01 - 0 - j) (P /. {p -> 1/2, q -> 1/2, r -> 1, s -> 1/2}) <= u,

(a - 1 - .01 - 1 - j) (P /. {p -> 1/2, q -> 1/2, r -> 1, s -> 1/2}) <= v,

(a - 1 - .01 - 0 - j - .01) (P /. {p -> 1/2, q -> 1/2, r -> 1, s -> 1/2}) <= u,

(a - 1 - .01 - 1 - j - .01) (P /. {p -> 1/2, q -> 1/2, r -> 1, s -> 1/2}) <= v,

(a - 1 - .01 - 0 - i) (P /. {p -> 1, q -> 0, r -> 1, s -> 1/2}) <= u,

(a - 1 - .01 - 1 - i) (P /. {p -> 1, q -> 0, r -> 1, s -> 1/2}) <= v,

(a - 1 - .01 - 0 - i - .01) (P /. {p -> 1, q -> 0, r -> 1, s -> 1/2}) <= u,

(a - 1 - .01 - 1 - i - .01) (P /. {p -> 1, q -> 0, r -> 1, s -> 1/2}) <= v,

(a - 1 - 0 - 0) (P /. {p -> 0, q -> 1, r -> 1, s -> 1/2}) <= u,

(a - 1 - 1 - 0) (P /. {p -> 0, q -> 1, r -> 1, s -> 1/2}) <= v,

(a - 1 - 0 - .01) (P /. {p -> 0, q -> 1, r -> 1, s -> 1/2}) <= u,

(a - 1 - 1 - .01) (P /. {p -> 0, q -> 1, r -> 1, s -> 1/2}) <= v,

(a - 1 - 0 - j) (P /. {p -> 1/2, q -> 1/2, r -> 1, s -> 1/2}) <= u,

(a - 1 - 1 - j) (P /. {p -> 1/2, q -> 1/2, r -> 1, s -> 1/2}) <= v,

(a - 1 - 0 - j - .01) (P /. {p -> 1/2, q -> 1/2, r -> 1, s -> 1/2}) <= u,

(a - 1 - 1 - j - .01) (P /. {p -> 1/2, q -> 1/2, r -> 1, s -> 1/2}) <= v,

(a - 1 - 0 - i) (P /. {p -> 1, q -> 0, r -> 1, s -> 1/2}) <= u,

(a - 1 - 1 - i) (P /. {p -> 1, q -> 0, r -> 1, s -> 1/2}) <= v,

(a - 1 - 0 - i - .01) (P /. {p -> 1, q -> 0, r -> 1, s -> 1/2}) <= u,

(a - 1 - 1 - i - .01) (P /. {p -> 1, q -> 0, r -> 1, s -> 1/2}) <= v,

(a - .01 - 0 - 0) (P /. {p -> 0, q -> 1, r -> 1, s -> 0}) <= u,

(a - .01 - 1 - 0) (P /. {p -> 0, q -> 1, r -> 1, s -> 0}) <= v,

(a - .01 - 0 - .01) (P /. {p -> 0, q -> 1, r -> 1, s -> 0}) <= u,

(a - .01 - 1 - .01) (P /. {p -> 0, q -> 1, r -> 1, s -> 0}) <= v,

(a - .01 - 0 - j) (P /. {p -> 1/2, q -> 1/2, r -> 1, s -> 0}) <= u,

(a - .01 - 1 - j) (P /. {p -> 1/2, q -> 1/2, r -> 1, s -> 0}) <= v,

(a - .01 - 0 - j - .01) (P /. {p -> 1/2, q -> 1/2, r -> 1, s -> 0}) <= u,

(a - .01 - 1 - j - .01) (P /. {p -> 1/2, q -> 1/2, r -> 1, s -> 0}) <= v,

(a - .01 - 0 - i) (P /. {p -> 1, q -> 0, r -> 1, s -> 0}) <= u,

(a - .01 - 1 - i) (P /. {p -> 1, q -> 0, r -> 1, s -> 0}) <= v,

(a - .01 - 0 - i - .01) (P /. {p -> 1, q -> 0, r -> 1, s -> 0}) <= u,

(a - .01 - 1 - i - .01) (P /. {p -> 1, q -> 0, r -> 1, s -> 0}) <= v,

(a - 0 - 0) (P /. {p -> 0, q -> 1, r -> 1, s -> 0}) <= u,

(a - 1 - 0) (P /. {p -> 0, q -> 1, r -> 1, s -> 0}) <= v,

(a - 0 - .01) (P /. {p -> 0, q -> 1, r -> 1, s -> 0}) <= u,

(a - 1 - .01) (P /. {p -> 0, q -> 1, r -> 1, s -> 0}) <= v,

(a - 0 - j) (P /. {p -> 1/2, q -> 1/2, r -> 1, s -> 0}) <= u,

(a - 1 - j) (P /. {p -> 1/2, q -> 1/2, r -> 1, s -> 0}) <= v,

(a - 0 - j - .01) (P /. {p -> 1/2, q -> 1/2, r -> 1, s -> 0}) <= u,

(a - 1 - j - .01) (P /. {p -> 1/2, q -> 1/2, r -> 1, s -> 0}) <= v,

(a - 0 - i) (P /. {p -> 1, q -> 0, r -> 1, s -> 0}) <= u,

(a - 1 - i) (P /. {p -> 1, q -> 0, r -> 1, s -> 0}) <= v,

(a - 0 - i - .01) (P /. {p -> 1, q -> 0, r -> 1, s -> 0}) <= u,

(a - 1 - i - .01) (P /. {p -> 1, q -> 0, r -> 1, s -> 0}) <= v,

(a + 1 - .01 - 0 - 0) (P /. {p -> 0, q -> 1, r -> 1/2, s -> 0}) <= u,

(a + 1 - .01 - 1 - 0) (P /. {p -> 0, q -> 1, r -> 1/2, s -> 0}) <= v,

(a + 1 - .01 - 0 - .01) (P /. {p -> 0, q -> 1, r -> 1/2, s -> 0}) <=u,

(a + 1 - .01 - 1 - .01) (P /. {p -> 0, q -> 1, r -> 1/2, s -> 0}) <=v,

(a + 1 - .01 - 0 - j) (P /. {p -> 1/2, q -> 1/2, r -> 1/2, s -> 0}) <= u,

(a + 1 - .01 - 1 - j) (P /. {p -> 1/2, q -> 1/2, r -> 1/2, s -> 0}) <= u,

(a + 1 - .01 - 0 - j - .01) (P /. {p -> 1/2, q -> 1/2, r -> 1/2, s -> 0}) <= u,

(a + 1 - .01 - 1 - j - .01) (P /. {p -> 1/2, q -> 1/2, r -> 1/2, s -> 0}) <= v,

(a + 1 - .01 - 0 - i) (P /. {p -> 1, q -> 0, r -> 1/2, s -> 0}) <= u,

(a + 1 - .01 - 1 - i) (P /. {p -> 1, q -> 0, r -> 1/2, s -> 0}) <= v,

(a + 1 - .01 - 0 - i - .01) (P /. {p -> 1, q -> 0, r -> 1/2, s -> 0}) <= u,

(a + 1 - .01 - 1 - i - .01) (P /. {p -> 1, q -> 0, r -> 1/2, s -> 0}) <= v,

(a + 1 - 0 - 0) (P /. {p -> 0, q -> 1, r -> 1/2, s -> 0}) <= u,

(a + 1 - 1 - 0) (P /. {p -> 0, q -> 1, r -> 1/2, s -> 0}) <= v,

(a + 1 - 0 - .01) (P /. {p -> 0, q -> 1, r -> 1/2, s -> 0}) <= u,

(a + 1 - 1 - .01) (P /. {p -> 0, q -> 1, r -> 1/2, s -> 0}) <= v,

(a + 1 - 0 - j) (P /. {p -> 1/2, q -> 1/2, r -> 1/2, s -> 0}) <= u,

(a + 1 - 1 - j) (P /. {p -> 1/2, q -> 1/2, r -> 1/2, s -> 0}) <= v,

(a + 1 - 0 - j - .01) (P /. {p -> 1/2, q -> 1/2, r -> 1/2, s -> 0}) <= u,

(a + 1 - 1 - j - .01) (P /. {p -> 1/2, q -> 1/2, r -> 1/2, s -> 0}) <= v,

(a + 1 - 0 - i) (P /. {p -> 1/2, q -> 1/2, r -> 1/2, s -> 0}) <= u,

(a + 1 - 1 - i) (P /. {p -> 1/2, q -> 1/2, r -> 1/2, s -> 0}) <= v,

(a + 1 - 0 - i - .01) (P /. {p -> 1/2, q -> 1/2, r -> 1/2, s -> 0}) <= u,

(a + 1 - 1 - i - .01) (P /. {p -> 1/2, q -> 1/2, r -> 1/2, s -> 0}) <= v,

a >= 0, i >= i, j >= j, u >= 0, v >= 0}, {a, i, j}]

{7., {a -> 6., i -> 2., j -> 5.55112*10^-17}}

Appendix XIII: Proof of Proposition 7

Proof. The utility function of the positive bidder is given by the following:

$u(c,f,q^m|c_i^0)=(c_i-c_i^0-f_i)(P_i)$,

$P_i=(p(c_{-i} \geq c_i-1)^{N-1}p(f_i \geq f_{-i})^{N-1}+\sum_{j=1}^{N-2} \binom{N-1}{j}p(c_{-i} \geq c_i-1)^{N-1-j}p(c_{-i} \geq c_i+1)^j$

$p(f_i \geq f_{-i})^{N-1-j}p(f_i<f_{-i})^j+p(c_{-i} \geq c_i+1)^{N-1}p(f_i<f_{-i})^{N-1})$.

The incentive compatibility constraints are satisfied at these equilibria showing that the solution to the F.O.C. above is a solution to a maximization problem and not a minimization problem. It is sufficient to show that the marginal utility of the bid and the marginal disutility of the bribe for each type of the bidder are equal at these equilibrium bid and bribe:

1. The marginal utility of the bid is equal to:

$$\frac{\partial u(c, f | c_i^0, o_i, r_i)}{\partial c_i} = (N-1)(1 - F(c_i - 1) +$$

$$p(c_i - 1))^{N-2}(-p(c_i - 1))F(f_i)^{N-1} +$$

$$\{\sum_{j=1}^{N-2} \binom{N-1}{j}[(N-1-j)(1 - F(c_i - 1) +$$

$$p(c_i - 1))^{N-2-j}(-p(c_i - 1))$$

$$(1 - F(c_i + 1) + p(c_i + 1))^j F(f)^{N-1-j}(1 - F(f))^j +$$

$$(j)(1 - F(c_i + 1) + p(c_i + 1))^{j-1}(-p(c_i + 1))(1 - F(c_i - 1) +$$

$$p(c_i - 1))^{N-1-j}(1 - F(f_i))^j (F(f_i))^{N-1-j}]\}$$

$$+(N-1)(1 - F(c_i + 1) + p(c_i + 1))$$

$$^{N-2}(-p(c_i + 1))(1 - F(f_i))^{N-1}$$

2. The marginal utility of the bribe is equal to

$$\frac{\partial u(c, f | c_i^0, o_i, r_i)}{\partial f_i} = (N-1)F(f_i)^{N-2}(p(f_i))(1 - F(c_i - 1) + p(c_i - 1))^{N-1} +$$

$$\{\sum_{j=1}^{N-2} \binom{N-1}{j}[(N-1-j)(F(f_i))^{N-2-j}(p(f_i))$$

$$(1 - F(f_i))^j (1 - F(c_i - 1) +$$

$$p(c_i - 1))^{N-1-j}(1 - F(c_i + 1) + p(c_i + 1))^j +$$

$$(j)(1 - F(f_i))^{j-1}(-p(f_i))(F(f_i))^{N-1-j}(1 - F(c_i - 1) +$$

$$p(c_i - 1))^{N-1-j}(1 - F(c_i + 1) + p(c_i + 1))^j]\} +$$

$$(N-1)(1 - F(f_i))^{N-2}(-p(f_i))$$

$$(1 - F(c_i + 1) + p(c_i + 1))^{N-1})$$

3. We can check for both $c_i^0 = \{0,1\}$, $\frac{\partial u(c,f|c_i^0,o_i,r_i)}{\partial c_i}|_{c^*,f^*} = -\frac{\partial u(c,f|c_i^0,o_i,r_i)}{\partial f_i}|_{c^*,f^*}$

Q.E.D. ∎

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Appendix XIV: Proof of Proposition 8

Proof. The utility function of the negative bidder is given by the following:

$$u(c,f|c_i^0, o_i, r_i)=(c_i-c_i^0-f_i)(p(c_{-i}>c_i-1)p(f_i>f_{-i})+p(c_{-i}>c_i+1)p(f_i \leq f_{-i})),\forall i=1,2$$

The incentive compatibility constraints are satisfied at this equilibrium only up to $c_i=1$, showing that the solution to the F.O.C. above is a saddle point. It is sufficient to show that the marginal utility of the bid and the marginal disutility of the bribe for each type of the bidder are equal at these equilibrium bid and bribe in $(c_i,f_i):[0,1]$ x $\Re_+^1$:

1. The marginal utility of the bid is equal to:

$$\frac{\partial u(c, f|c_i^0, o_i, r_i)}{\partial c_i} = (p(c_{-i} > c_i - 1)p(f_i > f_{-i}) +$$
$$p(c_{-i} > c_i + 1)p(f_i \leq f_{-i})) +$$
$$(c_i - c_i^0 - f_i)(-p(c_i - 1)(F(f_i) - p(f_i))$$
$$-p(c_i + 1)(1 - F(f_i) + p(f_i)))$$

2. The marginal utility of the bribe is equal to:

$$\frac{\partial u(c, f|c_i^0, o_i, r_i)}{\partial f_i} = -(p(c_{-i} > c_i - 1)p(f_i > f_{-i}) +$$
$$p(c_{-i} > c_i + 1)p(f_i \leq f_{-i})) +$$
$$(c_i - c_i^0 - f_i)((1 - F(c_i - 1))p(f_i) -$$
$$(1 - F(c + 1))p(f_i))$$

3. We can check for both $c_i^0=\{0,1\}$, $\frac{\partial u(c,f|c_i^0,o_i,r_i)}{\partial c_i}|_{c^*,f^*} = -\frac{\partial u(c,f|c_i^0,o_i,r_i)}{\partial f_i}|_{c^*,f^*}$.

Q.E.D. ∎

Appendix XV: Proof of Example 4

Proof. Note that the bidders' expected utility is only a function of the cost, but not quality.

1. Suppose the true type of bidder i is $\hat{\theta}_i = (\tilde{q}_i, c_i^0)$, then the incentive compatibility constraint that must hold if $\theta_i = \tilde{\theta}_i$ is:

$$\bar{t}_i(\tilde{\theta}_i) - \bar{y}_i(\tilde{\theta}_i)c_i^0 \geq \bar{t}_i(\bar{\theta}_i) - \bar{y}_i(\bar{\theta}_i)c_i^0$$

2. Suppose now the true type of bidder is $\bar{\theta}_i = (\bar{q}_i, c_i^0)$, then the incentive compatibility constraint that must hold if $\theta_i = \bar{\theta}_i$ is:

$$\bar{t}_i(\bar{\theta}_i) - \bar{y}_i(\bar{\theta}_i)c_i^0 \geq \bar{t}_i(\tilde{\theta}_i) - \bar{y}_i(\tilde{\theta}_i)c_i^0$$

3. By (1) and (2) above, the allocation and payment rules, $\bar{t}_i(.)$ and $\bar{y}_i(.)$:

$$\bar{t}_i(\bar{\theta}_i) - \bar{y}_i(\bar{\theta}_i)c_i^0 = \bar{t}_i(\tilde{\theta}_i) - \bar{y}_i(\tilde{\theta}_i)c_i^0$$

But then, bidder with $\theta_i = \bar{\theta}_i$ and $\theta_i = \tilde{\theta}_i$ will be indifferent between reporting $\hat{\theta}_i = \bar{\theta}_i$ and $\hat{\theta}_i = \tilde{\theta}_i$. Suppose:

$$\text{argmax}_{i=1,2}.(v_1(\tilde{\theta}_1, \theta_2), v_2(\tilde{\theta}_1, \theta_2)) \neq \text{argmax}_{i=1,2}.(v_1(\bar{\theta}_1, \theta_2), v_2(\bar{\theta}_1, \theta_2)).$$

This event occurs with positive probability given the distribution of types. Hence, it is impossible to implement an efficient auction mechanism. Fix:

$$\theta_1 = (q_1, c_1^0) = (0,0), \ \theta_2 = (q_2, c_2^0) = (\tfrac{1}{2}, 0).$$

Socially optimal (efficient) rule will allocate the procured project to bidder 2. However, there is no incentive compatible mechanism that can implement

this socially optimal allocation since bidder 1 will be indifferent between reporting $\hat{\theta}_i=\theta_i$ and $\hat{\theta}_i=(\tilde{q}_i,c_i^0)$, for any $\tilde{q}\in[0,1]$. $\blacksquare$

Appendix XVI: Proof of Theorem 1

Proof. By the Revelation Principle, we can restrict the choice of mechanisms to a direct mechanism.

1. By Claim 1, the incentive compatibility constraints require that the bidder's indifference curve is a vertical line in the (c_i^0,q_i) space: (see proof of Claim 1 above)

$$\bar{t}_i(\theta_i)\text{-}\bar{y}_i(\theta_i)c_i^0=\bar{t}_i(\tilde{\theta}_i)\text{-}\bar{y}_i(\tilde{\theta}_i)c_i^0,\forall\theta_i,\tilde{\theta}_i\in\Theta_i, \text{ s.t. } \theta_i=(q_i,c_i^0),\tilde{\theta}_i=(\tilde{q}_i,c_i^0).$$

2. The indifference curve for the social planner who implements the SCF is a 45% line in the (c_i^0,q_i) space.

3. A SCF is truthfully implementable if the indifference curves of the social planner and the bidders in the (c_i^0,q_i) space coincide. Suppose not. Fix θ_i where $\{\theta_i : i = \text{argmax}_{k=1,2}.(q_k\text{-}c_k^0|\theta_1,\theta_2)\}$ and θ_i lies below or on the 45% line at (0,0). Without a loss of generality, let i=1. Then, an efficient mechanism will locate the good to bidder 1. Now, suppose bidder 2, the losing bidder, reports $\tilde{\theta}_2=(c_2^0,1)$, the highest point that lies on bidder 2's indifference curve $\{\bar{t}_2(\theta_2)\text{-}\bar{y}_2(\theta_2)c_2^0=\bar{t}_2(\tilde{\theta}_2)\text{-}\bar{y}_2(\tilde{\theta}_2)c_2^0\}$. This point lies above or on the 45% line at (0,0). If $\text{argmax}_{i=1,2}.(q_i\text{-}c_i^0|\theta_1,\theta_2)=\text{argmax}_{i=1,2}.(q_i\text{-}c_i^0|\theta_1,\tilde{\theta}_2)$ then it must be that $\tilde{\theta}_2=\theta_1=(1,1)$. For some $\{\theta: p(\theta)>0)$, $\text{argmax}_{i=1,2}.(q_i\text{-}c_i^0|\theta_1,\theta_2)\neq\text{argmax}_{i=1,2}.(q_i\text{-}c_i^0|\theta_1,\tilde{\theta}_2)$. A contradiction.

4. Hence, by (1) to (3), there is no mechanism that is both efficient and incentive compatible. $\blacksquare$

Appendix XVII: Proof of Theorem 2

Proof. 1. Let $v_i(\theta) = v_i(\tilde{\theta}_i, \theta_{-i})$, for some $\theta_i, \tilde{\theta}_i \in \Theta_i$, $\theta_i \neq \tilde{\theta}_i$,

$\text{argmin}_{k=1,2}.\{w_k(\theta)\} \neq \text{argmin}_{k=1,2}.\{w_k(\tilde{\theta}_i, \theta_{-i})\}$.

2. Incentive Compatibility requires:

(i) $Eu_i(t_i(\theta), y_i(\theta), \theta | v_i(\theta)) \geq Eu_i(t_i(\tilde{\theta}_i, \theta_{-i}), y_i(\tilde{\theta}_i, \theta_{-i}), (\tilde{\theta}_i, \theta_{-i}) | v_i(\theta))$

(ii) $Eu_i(t_i(\tilde{\theta}_i, \theta_{-i}), y_i(\tilde{\theta}_i, \theta_{-i}), (\tilde{\theta}_i, \theta_{-i}) | v_i(\tilde{\theta}_i, \theta_{-i})) \geq Eu_i(t_i(\theta), y_i(\theta), \theta | v_i(\tilde{\theta}_i, \theta_{-i}))$

$\Rightarrow Eu_i(t_i(\theta), y_i(\theta), \theta | v_i(\theta)) = Eu_i(t_i(\tilde{\theta}_i, \theta_{-i}), y_i(\tilde{\theta}_i, \theta_{-i}), (\tilde{\theta}_i, \theta_{-i}) | v_i(\theta))$

Bidder i will be indifferent between reporting θ_i and $\tilde{\theta}_i$.

3. By our assumption, $\text{argmin}_{k=1,2}.\{w_k(\theta)\} \neq \text{argmin}_{k=1,2}.\{w_k(\tilde{\theta}_i, \theta_{-i})\}$, then, $f(\theta)$ is not implementable. ∎

Appendix XVIII: Regression Result, Empirical Study

The following is the description of the fixed-effect variables.

Satkal: Department

1. Badan Pembinaan Konstruksi dan SDM

2. Balitbang

3. Direktorat Jenderal Penataan Ruang

4. Direktorat Jenderal Bina Marga

5.   Direktorat Jenderal Cipta Karya

6.   Direktorat Jenderal Sumber Daya Air

7.   Sekretariat Jenderal

Prov: Province

1.   Central

2.   East Java

3.   DKI Jakarta

4.   West Java

5.   Central Java

6.   DKI Yogyakarta

7.   North Sumatera

8.   South Sumatera

9.   East Kalimantan

10.   South Sulawesi

11.   Maluku

12.   Banten

13.   Gorontalo

Category: Type of auctions

The auctions are categorized as the following:

1.	Goods (in Rp.)

2.	Consultant Service

3.	Street

4.	Street Maintenance

5.	Building

6.	Bridge

7.	Community Management

8.	Village Street

9.	Clean Water Provision

10.	Community Street

11.	Drainage

12.	Residential Community

13.	Small reservoir

14.	Drinking

15.	Construction Building

16.	Water Sewerage

17.	Sewage.

18.   Other Services

Value: Initial Budget

1. <=100million

2. >100million and <=200million

3. >200million and <=500million

4. >500million and <=1billion

5. >1billion and <=3billion

6. >3billion and <=5billion

7. >5billion and <=10billion

8. >10billion and <=25billion

9. >25million and <=50billion

10. >50billion

Metode: Method of the Auctions

1.   Public Selections/Auctions with Pasca-Qualifications

2.   Public Selections/Auctions with Pra-Qualifications

3.   *Direct Selections/Auctions with Pasca-Qualifications

4.   *Direct Selections/Auctions with Pra-Qualifications

5.   *Direct Appointment with Pasca-Qualifications

6.   *Direct Appointment with Pra-Qualifications

*=no data/ dropped

Table 1.7: Regression

Source	SS	df	MS
Model	371.12104	46	8.0678487
Residual	867.804204	1285	.675334011
Total	1238.92524	1331	.930822873

Table 1.8: Regression, cont.

Number of obs	1332
F(46,1285)	11.95
Prob>F	.000
R-Squared	.2996
Adj R-squared	.2745
Root MSE	.82179

Note: Category 15 is omitted.

Table 1.9: Regression, cont.

LnPerCostEff	Coef.	t	P>|t|
Num_Bidder	.0098179	5.74	0.000
Num_BidderSq	-.0000882	-6.93	0.000

Table 1.10: Regression, cont.

Satkal2	.6413851	1.90	.058
Satkal3	.0812997	.48	.633
Satkal4	.025225	.16	.870
Satkal5	-.0394326	-.27	.787
Satkal6	.4356443	2.47	.014
Satkal7	-.2619483	-1.36	.173

Table 1.11: Regression, cont.

Prov2	.9255826	9.5	.000
Prov3	.0399416	.25	.806
Prov4	.2436976	2.23	.026
Prov5	-.0377443	-.35	.728
Prov6	.4798776	3.69	.000
Prov7	.1279765	.85	.394
Prov8	-.49795	-1.28	.202
Prov9	.7069094	2.29	.022
Prov10	-1.354866	-7.67	.000
Prov11	.0765659	.09	.928
Prov12	-.7580284	-2.32	.021
Prov13	-.3846256	-1.80	.073

.

Table 1.12: Regression, cont.

Category2	.9984222	2.72	.007
Category3	.1427126	.98	.325
Category4	.1886267	1.19	.234
Category5	.5297576	3.37	.001
Category6	1.043102	4.33	.000
Category7	.3607561	2.08	.038
Category8	-.0627995	-.34	.736
Category9	-.4422209	-.74	.457
Category10	.3355173	1.7	.089
Category11	.2356982	1.14	.255
Category12	-.0162866	-.06	.948
Category13	.6991261	1.33	.182
Category14	-.4860328	-2.04	.042
Category16	-.0103385	-.02	.983
Category17	.4324898	.87	.385
Category18	.7480788	2.54	.011

.

Table 1.13: Regression, cont.

Value2	.2400642	1.06	.288
Value3	.43351	2	.046
Value4	.4831737	2.18	.029
Value5	.4775163	2.07	.039
Value6	.6273924	2.53	.012
Value7	.294342	1.13	.260
Value8	.3115373	1.03	.305
Value9	-.0337986	-.07	.942
Value10	2.396304	4.63	.000
Metode2	-.7872117	-2.18	.029
Constant	1.319907	4.65	.000

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CHAPTER 2

THEORY OF ENDOGENOUS INSTITUTION AND EVIDENCE

FROM AN IN-DEPTH FIELD STUDY IN INDONESIA

(with Iwan Jaya Azis[1])

2.1   Introduction

Although there have been many studies on institutions, there has been little field
study on institutions.   Moreover, institutions have often been understood to be
exogenous factors that affect welfare with little thoughts given to the endogene-
ity issues of the formation of institutions.   North (1990) wrote, "What makes
for efficient markets?   If poor countries are poor because they are the victims
of an institutional structure that prevents growth, is that institutional structure
imposed from without or is it endogenously determined or is it some combination
of both?... Still to be undertaken is systematic empirical work that will identify
the costs and underlying institutions that make economies unproductive" (p.134-
135).   Indeterminacy and context-specificity of institutions make traditional social
science empirical study on institutions difficult because neither deductive nor in-
ductive analysis is sufficient to explain the complexity of institutions (Greif, 2006).
In this paper, we study the theory of endogenous institutions in the light of in-
stitutions in Indonesia by using an in-depth field study on institutions conducted
in five districts in Indonesia.   During our field study, we collected primary data
on the net effect of local capture on welfare, local leadership, and participation
level as well as various social indicators.   We conducted interviews with local key

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[1]The empirical study in this paper was conducted with the assistance of the researchers at
KPPOD.

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informants including Regents/ Mayors, other high-ranking public officials, political parties, oppositions, NGO's, local media, business associations, and poor-family card holders and quantified our primary data into scale-based indicators. We then show how these institutional elements are correlated with various indicators of both the current and lagged socioeconomic conditions that suggest the endogeneity of institutions.

There are limitations to our field study. For example, we are unable to explain fully why institutions and socioeconomic conditions in Balikpapan were ranked high according to our field study while the secondary data on GRDP suggested an increasingly unequal society with declining or low sectoral average annual growths compared to its overall average annual GRDP growth before and after the decentralization in sectors that directly affect the poorest of the poor, including animal husbandry, forestry, fishery, and private social community services. Factors that could limit our field study include not interviewing a sufficient number of participants that come from the poorest of the poor societies and the opposition groups, partial district surveys instead of comprehensive district surveys at one point of time instead of over a period of time, insufficient comparisons made between the poor and the elites with respect to institutional access within a district instead of across districts, and a small number of districts surveyed. Our field study however enables us to get a rough, first estimation of the quality of institutions and socioeconomic conditions in these districts.

We study Greif's (2006) theory of institutional change and enrich Greif's model with institutional complexes in the context of Indonesia in the post-decentralization period. This helps to explain the phenomena of endogeneity of institutions observed in our field study. We find that the concepts of self-reinforcement factors

and quasi-parameters as defined in Greif (2006) play important roles in explaining the persistence of poor growth or low welfare and poor qualities of institutions in Indonesia. Self-reinforcement factors in this study may include the level of education, the level of political awareness and health awareness of the citizens as well as the level of public information. We argue that initial socioeconomic conditions are associated with some self-reinforcement factors that shape institutional complexes, including the participation level, local capture and local leadership, that contribute to generating welfare. This creates an evolution between welfare and institutions in the presence of some self-reinforcement factors. The model could explain the persistence of poor growth or low welfare and poor qualities of institutions in Indonesia by introducing the concept of negative self-reinforcement or self-undermining factors, such as low level of education and low political and health awareness of citizens.

This paper provides a game-theoretical approach to illustrate the two most important concepts in the theory of endogenous institutions (Greif 2004, 2006), self-reinforcement and quasi-parameter, in the context of institutions in Indonesia. Game theoretical approach has been used to model institution since the works by Ullmann-Margalit (1977) and Schotter (1981). We then integrate Greif's game theoretical approach with Azis' typology of leadership model (2008) to better predict the long-run progress of districts in the contexts of institutions in the post-decentralization period in Indonesia. This model is able to explain the persistence of low welfare level and poor-quality institutions through institutional mechanisms, such as local capture, local leadership, and participation level as well as local accountability. Similar to Greif's approach, we do not attempt to highlight all institutional mechanisms to explain institutional changes through game theory. But we would like to capture the self-reinforcement factors that could self-reinforce the

existence of an institution, particularly in game-theoretical model, that we believe to be most appropriate for the context of institutions in Indonesia. In general, self-reinforcement factors work through quasi-parameters that are defined as parameters in the short run but as variables in the long-run. As a parameter, a quasi-parameter could *self-enforce* a behavior, but as a variable, a quasi-parameter could *self-reinforce* or *self-undermine* a behavior. We also illustrate how decentralization in Indonesia, which has shortened the political distance between local leaders and local elites, could exacerbate the quality of institutions in a poor district that had diminished quality to begin with. This poor district can be associated with self-undermining factors such as low education that can be further associated with low local accountability, rendering local policies more corruptible.

2.2 Literature Review

Endogenous institutions have been discussed in literature as early as Myrdal's *An American Dilemma* (1944). In what he calls "the theory of the vicious cycle," Myrdal argues that white prejudice and discrimination keep the Negro oppressed and more oppressions in turn exacerbate white prejudice. Moreover, he argues that the original change of either white prejudice or Negro oppression could set a different future trajectory that spirals either upward or downward. North (1990) defines institutions as rules of the game in a society that consist of three main elements: formal rules, informal constraints, and enforcements. Institutional equilibrium is defined as "a situation where given the bargaining strength of the players and the set of contractual bargain that made up total economic exchange, none

of the players would find it advantageous to devote resources in restructuring the agreements" (p.86).

Among the more recent theories on endogenous institutions are those of Greif (2006) and Acemoglu (2008). Greif's (2006) theory of endogenous institutional change argues that institutionalized rules, beliefs, norms, and actions constitute an equilibrium if players find it optimal to follow the institutionalized rules, which would in turn generate behaviors. The two most important ideas in Greif's theory of endogenous institutional change are the concepts of self-reinforcements and quasi-parameters. Using the historical studies on the Genoese and Maghribis traders, game theoretical analysis on inter-agency relationship is discussed. Interclan mutual deterrence, arms race, and cooperation under external threats are also explored. Acemoglu (2008) discusses the reasons a dysfunctional institution continues to persist, and relates to the theory of endogenous institutions. He argues that distributions of resources and initial political institutions affect the *de facto* and *de jure* political power that affect the economic institutions and political institutions of the next period. Economic institutions and political institutions further affect the economic growth and the distributions of resources in the period after next. This framework illustrates the evolution between distribution of resources or growth and institutions, and thus, the endogeneity of institutions.

Myerson (2004) contends that focal points, such as institutions, justice, and truthful equilibria, determine an equilibrium play in the case of a multiplicity of equilibria of a coordination game. It further exhibits that the importance of institutions as focal points and coordinating instruments. This paper also shows that the equilibrium-selection process of a focal point is not trivial and may depend on the power of the players. Acemoglu and Robinson (2007) show an equilibrium that

is called captured democracy. The *de facto* investment on political power by the elites is high enough that the economic institution is captured by the elites despite democratic political institution. In the context of decentralization in Indonesia, the *de jure* political structure in the post-decentralization period is democracy. However, because local regulations are now regulated at the local level and political leaders are now directly elected by the people, more opportunities arise for local elites to become politically closer to the local leaders or local regulators. This increases the level of local capture and investments in the *de facto* political power by the local elites post-decentralization. Hence, what we see in some districts in Indonesia in the post-decentralization period, despite the *de jure* democratic political regime, are economic institutions that are captured by local elites.

Alesina and Spolaore (2005) argue that decentralization is predicted after a fall of an autocratic regime. Their argument helps to explain the nature of decentralization in Indonesia in that it immediately followed the fall of the Soeharto regime. They argue that decentralization is a way of constraining Leviathans, or autocratic rules, particularly when mobility is high, because tax competition among localities may offer a substitute for fiscal constraints on taxing power (Brennan and Buchanan, 1980). Moreover, decentralization is not only a way of achieving limited government intervention, but also a way of promoting competition (Hayek, 1959). Another related theory is that of "market preserving federalism," (Weingast, 1995) which argues that moving away from a central government solves the problem of property rights, by imposing limitations preventing the central rule from expropriating too much. They further argue that, "when a dictator falls, even if the nation does not break up, at least it becomes more decentralized." The statement that democratization leads to decentralization has also been proven empirically.

Cai and Treisman (2005) find that there are two effects of capital flows liberalization: competition and polarization. The result is not a convergence, but a polarization of policies and government qualities if unit homogeneity assumption fails. This paper helps to explain the possible factors that could result in the failures of decentralization and the divergence of welfare among districts in Indonesia. Azis (2008) studies the effect of a higher degree of local capture on welfare. This paper helps to capture the effects of decentralization in Indonesia through institutional constraints including higher degrees of local capture. The model in this paper endogenizes the net effect of local capture on welfare given the initial level of poverty, inequality, participation level and local leadership. Using a typology of leadership, he argues that the net effect of local capture on welfare can be both negative and positive (what is also termed the "backward bending curve of local capture on welfare") depending on the poverty level, participation level and local leadership. The long-run progress can be categorized into complete, deteriorating, incomplete, and stagnant progress.

The following papers show some possible solutions to poor qualities of institutions. Della-Giusta (2008) offers a different approach to development issues by introducing a trust-based system of intermediation. This theory argues that the lack of depth of trust-based intermediation may result in a market-based legal system in which only those who can afford legal fees could have access to deliveries of goods or secure contract enforcements. Serra (2008) conducts an experimental study showing that the most effective monitoring on bribery is a combined top-down and bottom-up monitoring. Wade (1988) argues that collective action is cheaper in terms of state resources than private property and state control regimes to better utilize common-pool resources. Empirically and analytically, collective action yields better outcomes than what these theories predict, including Olson's

logic of collective action. Hirschman (1970) argues that there are two possible actions for the citizens when a state deteriorates: exit or voice. When exit is not an option, such as in the case of monopoly or an authoritarian state, then voice will prevail. However, he argues that when exit is not a possible option, then voice may not be effective because there is no threat to exit. On the other hand, when exit is too easy, then voice, which is often more costly and requires collective action, becomes less likely, thus impeding changes from within. The ideal situation occurs when exit is possible, but not exceedingly easy. In a political system, both a totalitarian government and multi-party system might fail to promote development. In the case of the former, both exit and voice are impossible. In the latter case, exit is freely available and members may often exit whenever there is a disagreement. Dixit (2004) discusses the issues on middle-country trap. At some middle level of development, information networks that sustain small economic activities could no longer support contract enforcement. Although state institutions are needed, the scale of activity is not yet large enough to justify the costs of establishing them. Moreover, there are political obstacles associated with people who have sunk stakes in the old system, preventing the establishment of a new system.

2.3 A Note on The Theory of Endogenous Institutional Change (Greif, 2006)

In sustaining the fundamentals of the theory of endogenous institutional change, it is important to remember that individuals' choices of behaviors are governed by beliefs and norms, as well as social and cultural rules, and not only their pursuits of

self-interested goals. In consideration of this, one must acknowledge that individuals are *Homo Sociologicus* (Social Man), instead of *Homo Economicus* (Economic Man). Their behaviors are shaped by social environments and norms. In particular, Greif argues that not only do individuals act based on social and normal rules, but also that these individuals are rational decision-makers; their behaviors are strategic in the sense that their preferences on outcomes are consistent and their choices of behaviors are motivated by consequences. In other words, *Homo Socialogicus* is consistent with rational decision-making and strategic behaviors. Greif's argument is based on experimental results regarding rationally altruistic behaviors, such as the Dictator Game experiment by Andreoni and Miller (2002). Here, they observe that altruistic behaviors are consistent with a well-behaved preference ordering or Generalized Axiom of Revealed Preference. Considering Varian (1982) and Afriat's theorem (1967), this experiment shows that the observed altruistic behaviors are derived from utility-maximization. From these results, Greif further contends that altruistic behaviors are consistent with backward induction and reputation-based arguments. In organizational terms, a society can be either "collectivist" or "individualistic". A collectivist society has a "segregated" form of social structure, where each individual interacts socially and economically within a particular group. An individualistic society has an "integrated" form of social culture, where each individual is not distinguished by any particular group. This social structure is an important basis for its culture and cultural beliefs. As a collectivist country, Indonesia and hence its institutions might be subject to a collectivist strategy in which intra-agency instead of inter-agency relationship is more likely to prevail.

It is important to define some terms on endogenous institution and institution as an equilibrium, which we take from Greif (2006). Institution is defined as a

system of rules, beliefs, norms, and organizations that together imply a regularity of (social) behavior. In the context of corrupt institution, rules may constitute a regulation of payment of bribes such as the amount paid, how, and to what effect. Organizations may constitute the state administration, police, courts of law. Beliefs and internalized norms may constitute the notion that the responses of the state, police, and courts to bribery renders it profitable to take and the belief that paying the bribe is the least costly way to advance one's interest. An institution is an equilibrium if it constitutes the structure that influences behavior, while the best behavioral responses of agents to this structures reproduce the institution. The fact that players play against institutionalized rules explains the phenomenon of a persistence of an institution that constitutes some implied behaviors. Persistence or inertia, institutional path dependence, or steady-state equilibrium in institutional setting are among the names used in describing the study of endogenous institutional change.

The two important features to study the theory of endogenous institutional change are *quasi-parameters* and *self-reinforcement factors*. Quasi-parameters are parameters that determine self-enforcibility in the short run but are endogenously determined and hence variables in the long run. Myerson (2004) argues that justice, institution, and truthful equilibrium determine what self-enforcing behaviors arise. However, Greif's theory offers the explanation that justice, institution and truthful equilibrium itself are results of some evolutionary change of beliefs and behaviors that in the long run may persist or cease to exist. In the context of decentralization, economic gains from cooperation by local leaders, local elites, and citizens can be regarded as quasi-parameters that change over time given cooperation or non-cooperation in the previous period, or given self-reinforcement or self-undermining factors as a result of implied behaviors in the previous period.

Quasi-parameters may therefore take the form of payoffs of the players that change over time, such as economic gains in the next period from playing a certain strategy today. Implied behaviors may change due to a change in exogenous parameters, such as payoffs, an idea posted by game theory, but as implied behaviors change, these exogenous parameters may endogenously change resulting in either neutral, positive, or negative self-reinforcement.

Positive self-reinforcement of an implied behavior as a result of a change in quasi-parameters results in the persistence of that implied behavior. In other words, this implied behavior is positively self-reinforced. Negative self-reinforcement of an implied behavior as a result of a change in quasi-parameters results in undermining of that implied behavior. After some periods, this implied behavior ceases to exist as it negatively self-reinforces. Neutral self-reinforcement of an implied behavior results in no change of that implied behavior. To clarify the description of self-reinforcement, an implied behavior is called positively, neutrally, or negatively self-reinforcing if the existence of this implied behavior changes the quasi-parameter that makes this implied behavior more, neutrally, or less likely to self-reinforce respectively. Persistence of an implied behavior is the result of positively or neutrally self-reinforcing implied behavior. Quasi or exogenous parameters may not change if there is no observable change in behavior. Extinction of an implied behavior is the result of negatively self-reinforcing implied behavior. An increase of the payoff from cooperation tomorrow if there is a cooperation today is an example of positive self-reinforcement factors in which cooperation today makes cooperation tomorrow more likely.

Institutional changes take place in different settings called *institutional complexes*. These institutional complexes determine the evolutionary process of insti-

tutions. In Greif's example, institutional complexes explain why the abolition of slavery comes faster in the Christian world than in the Muslim world. The fact that Christianity follows Roman law enables the new European states to reassert control gradually over slavery, while Islam is a religion that regulates not only the religious life but also the economic, political, and social life, rendering the abolition of slavery a violation to the sacred law.

To understand the path-dependent nature of institutions, Greif argues that there are three ways that past institutions may affect current institutions: *coordination*, *inclusion*, and *environment* effect. Coordination effect arises from shared observable events. Inclusion effect arises from the tendency of some elements of past institutions to be included in current institutions. Environment effect arises from the fact that current institutions exist under some path-dependent institutional environment. *Fundamental asymmetry* between past institutions and alternative institutions, where institutionalized rules have not yet been formed in new situations, suggests that history shapes beliefs and norms as well as the rules of the game for the choice of behaviors in new situations. Past institutional elements remain in people's minds, thus helping to shape the initial conditions of new institutions. In other words, history projects the dynamic of institutional change and trajectories. Focal point or coordination effect arises from this asymmetry in the case of multiple equilibria in order to select one institution out of many others. In the context of Indonesia, it may be that people may never try to behave non-corruptly because they never see others behave non-corruptly out of fears of being cheated. This shows coordination failures to behave non-corruptly, which becomes the focal point.

Empirical studies on endogenous institutions include those on Genoa and

Venice. Genoa in the period from 1096-1194 provides an example of institutional failures because of negative reinforcements of arms races, from the previously self-enforcing mutual deterrence, that were triggered by political and economic incentives of Genoese clans to control the city as economic prosperity increased. Interclan cooperation was built up during the period of external threat from the new German emperor in 1154, although this cooperation subsided as the threat subsided. The new institution of Non-Genoese Podestà failed to refrain the clan-like patronage networks in the long-run from clan rivalry. Venice in the period from 1032-1172, on the other hand, provides an example of institutional success because positive enforcements of Venice's republican magistracy, established in 1032, reinforced stability. In 1032, elected monarchy was changed into a republican magistracy. This new institution self-reinforced cooperation among clans. Among the features that make this political institution self-enforcing were the rules ensuring that only one family member could be on any committee reducing the establishment of patronage networks, the rules weakening clan identities while fostering the norms of loyalty to the city, and the magisterial rules preventing clans from establishing political faction through a patronage system.

In the context of institutions in Indonesia, payoffs from certain behaviors today, such as cooperative behaviors by local leaders, local elites, and citizens, are affected by socioeconomic conditions of the citizens today, namely the level of education and political awareness. This occurs because the level of education and the political awareness of the citizens may determine the type of local leadership through local elections by the citizens, thus determining the welfare of the citizens today. These factors together with implied behaviors of the citizens, local leaders and local elites form other institutional complexes, such as the net effect of local capture on welfare and participation level. This affects the level of welfare today that

determines socioeconomic conditions in the subsequent period that determines the payoffs from cooperation tomorrow, and so on. Hence, factors such as the level of education can be self-reinforcement or self-undermining factors. For instance, in a very poor district, common citizens lack education and political awareness. Because of this, local accountability is low and local policies are more likely to be distorted by the local leaders under strong influences of the local elites. The absence of education and political awareness make low welfare self-reinforce itself because of the higher likelihood that local policies are distorted. The absence of education and political awareness are examples of negative self-reinforcement or self-undermining factors. High education and political awareness, typically associated with richer districts, provide examples of positive self-reinforcement factors.

A parametric change may fail or be delayed in changing beliefs and implied behaviors if it does not result in a change or immediate change of observable outcome or action, or it is not observable by players. In other words, although there may be a parametric change, if players' beliefs about what equilibrium is going to be played does not change, institution persists. The more crucial point of this theory is the explanation of why players fail to coordinate. Ability to coordinate alone, mutually benefiting players, is not enough to make them coordinate and cooperate. Sunk costs associated with coordinating change, the free-rider problem, distributional issues, uncertainties, limited understanding of alternatives, and asymmetric information are among the factors that prevent coordination from arising. More importantly, implicit mutual trusts or distrusts that are formed from the past behaviors of the players and are institutionalized in people's mind may shape the focal point for players to either coordinate or defect. Other factors that determine persistence of institution include limited attention capacity of observ-

able changes in the rule, habits or routines that overweigh judgement, and other cognitive processes. Moreover, the reputation-based model in private-order institutions might not be sufficient since they might be influenced by the public-order institutions. Furthermore, "the capacity of institutions to change are functions of history" (Greif, 2006, p.209). Consider very poor people with no health awareness in a very poor district. National free health care service might fail in this poor district because poor people do not even have the money to afford transportation to the nearest local community health centre. Or, they may lack the incentive to use this free health care service because they are unaware that they are sick, since they may be uneducated about health.

2.4 Laying Out Game Theoretical Foundation of Endogenous Institutions

"The changes among the citizens after the 1997/1998 Asian Financial Crisis include citizens becoming more emotional (or aggressive), decreasing business self-conscience, deeper feeling towards one own's region, creating racial and religious conflicts more easily, growing independent institutions." Anonymous (from the author's field study, Kota Bogor, Indonesia, May 27, 2008)

We often blame poor economic performance of Indonesia compared to its neighbors on weak institutions, including the culture of corruption among public officials, non-performing and corrupt law and enforcement bodies, and abuses of property rights. However, it does not offer a much deeper explanation as to why the culture of corruption and the other weak legal and property right institutions persist in some countries and cease to exist in others. Singapore was once considered a

country where corruption was pervasive, however, the increased wages of public officials and the establishment of an anti-corruption body transformed Singapore into a country free from corruption. Many believed that the culture of corruption was born in the Soeharto era when he ruled over the country for 32 years. However, after 10 years of Soeharto's fall in 1997, we have still yet to see an improvement in institutions that eliminate corruption among public officials, judicial bodies, as well as abuses of property rights. One example is the corruption in public procurement auction that reached $3.9 billion (US dollars) in 2006 alone. One of Indonesia's leading economists wrote that poverty, inequality and corruption were still central issues in Indonesia despite the strengthening financial sector after the 1997-1998 Asian financial crisis (Soesastro, 2008).

We examine the cause of persistence in the lack of institutions through the theory of endogenous institutional change as in Greif, 2006, and later, we will enrich Greif's model with evidence from the authors' field study in Indonesia. As the quote above implies, an economic or political crisis, such as the 1997-1998 Asian financial crisis, may alter behavior, perhaps rendering one more emotional or aggressive, and even result in more egoism towards one's race, ethnicity, or religion. In turn, these changes may create more incidences of social conflicts and corruption. Additionally, the feeling of dissatisfaction among the citizens towards the government endangers even more aggression, resulting in more incidences of social and political conflicts. The longer term impact is principally poorer quality of institutions, characterized by more and more corrupt bureaucrats and citizens.

To illustrate the endogeneity of qualities of institutions, we take an infinitely repeated, two-player Coordination game. Game theoretical approach to institutions has been discussed in early literatures on institutions to illustrate cooperative or

non-cooperative behaviors that could shape different types of institutions (North, 1990,1991; Greif, 2006). North (1990,1991) argues that repeated interactions, smaller groups, and more complete information about other members' past behaviors help to build cooperation. The players in the two-player game are a local leader and a local elite. The pure strategies of both the local leader and the local elite are 'Good Cooperation' or cooperate (G) and 'Bad Cooperation' or defect (B). To make the model more realistic, we introduce local citizens as players in this game. The total payoffs of the player can illustrate the level of welfare in the society. If the local leader and the local elite as well as the citizen behave well or cooperate (G), we refer to these as cooperative behaviors in the society, which may be associated with positive local capture, a non-corrupt institution, or a politically stable society. Positive local capture is exemplified by an establishment of social programs by local elite groups with support from the local governments or by donations from local elites to finance public educational recreations or public parks, such as in the case of Yogyakarta. If they all defect (B), we refer to these as non-cooperative behaviors, which may be associated with negative local capture, a corrupt institution, or a politically unstable society. Negative local capture is exemplified by collusion between local leaders and local elites leading to corruption, whether or not the citizens participate in the corrupt institutions. In each period, a local leader (representing local leaders) and a local elite (representing local elites) as well as a citizen (representing citizens) meet. Note that in the above payoff matrix, bad cooperation by the local leader and the local elite but good cooperation by the local citizen give lower payoffs to both the local leader and local elite than if they all cooperate. In reality, there are some cases in which their payoffs are higher.

A local leader in one period represents the elected local leaders in a district

for that period, while a local elite in one period represents the local elites in the same district for that period. A citizen in one period also represents the citizens in that district for that period. Information is perfect and complete. As an example, we assume that institutional complexes are generated from the implied rational behaviors of the local leaders, local elites, and local citizens, including the effect of local capture on welfare. Implied behaviors and institutional complexes are therefore endogenous variables. Social and economic conditions that we argue become self-reinforcement factors are also endogenous variables that are associated with the level of welfare, which is affected by institutional complexes. Exogenous factors may include natural disaster or changes of central government's policies that affect payoffs of local leaders, local elites, and citizens, as well as social, economic, and political structures. We argue that Coordination game could better illustrate real-life cases in the context of cooperation between local leaders and local elites (as well as among local citizens in the three-player game) than Prisoners' Dilemma game, which is the game that is discussed in Greif, 2004-2006. What is the circumstance under which negative, neutral, or positive reinforcement exists and what incentive mechanism can we offer to reform institution?

Example 2.1 *Coordination Game*

G=Good Cooperation, B=Bad Cooperation

$$
\begin{array}{c|cc}
LE/LL & G & B \\
\hline
G & a_t, a_t & c, b \quad , a_0 > b, c < 0 \\
B & b, c & 0, 0
\end{array}
$$

Definition 2.1 *(Greif, 2006) Self-reinforcement factors can be categorized into the following types:*

1. *Positive, if a_{t+1}-$a_t>0$*

2. *Neutral, if a_{t+1}-$a_t=0$*

3. *Negative, if a_{t+1}-$a_t<0$*

Lemma 2.1 *(Greif, 2006) In an infinitely repeated, Coordination game above, cooperative behaviors by the local leader and the local elite are self-reinforcing given that the self-reinforcement factor is either positive or neutral, while cooperative behaviors by the local leader and the local elite are not self-reinforcing given that the self-reinforcement factor is negative, for any discount factor.*

Proof. (i) Non-corrupt institution with neutral reinforcement, where a_{t+1}-$a_t=\epsilon=0$, is self-reinforcing since non-corrupt institution is a Nash Equilibrium in the one-stage game.

(ii) Non-corrupt institution with positive reinforcement, where a_{t+1}-$a_t=\epsilon>0$, is self reinforcing since non-corrupt institution with positive reinforcement is a Nash Equilibrium in the one-stage game.

(iii) Non-corrupt institution with negative reinforcement, where a_{t+1}-$a_t=\epsilon<0$, is not self-reinforcing since after some T periods, $a_T<b$, and players will deviate from the cooperative strategy.

Q.E.D. ∎

Case 2.1 *Negative self-reinforcement factors can be associated with a low-level of welfare in the following way. In a poor district, citizens are uneducated. High costs of educating the citizens about health to make health programs work effectively may*

make implementing health programs unattractive to local leaders and local elites in the long-run. Hence, they stay away from health care provision altogether.

Consider the following three-player Coordination game below. This example illustrates the persistence of high welfare and good cooperation of the local leader, the local elite and the citizen and the persistence of low welfare and bad cooperation among the same players. Suppose cooperative behaviors of the local leader, the local elite and the citizen is a sufficient and necessary condition for a high quality institution, while non-cooperative behaviors constitute a necessary and sufficient condition for a low quality institution.

Example 2.2 *Three-Player Coordination Game*

	$LL \backslash LE$	G	B
Good Cooperation (G) by the Citizen (C):	G	a_t, a_t, a_t	$6,0,6$
	B	$3\text{-}\varepsilon, 4, 4$	$6,6,\text{-}1$

	$LL \backslash LE$	G	B
Bad Cooperation (B) by the Citizen (C):	G	$7, 7, \text{-}1$	$3\text{-}\varepsilon, 6, 6$
	B	$6, 0, 6$	$3, 3, 3$

There are three players: Local Elite (LE), Local Leader (LL), and Citizen (C)

Each of the players has two possible pure strategies in the one-stage game: Good Cooperation (G) and Bad Cooperation (B).

There are two pure one-stage Nash Equilibrium: (G,G,G) and (B,B,B)

Let a_0 be the payoff of each of the players from all cooperate. Assume $a_0=10$, and $a_{t+1}\text{-}a_t \geq (\text{ or } <)0, t=0,..\infty$. Similar to the proof of Lemma 1 (Example 1-

the two-player Coordination game) above, (G,G,G) is self-reinforcing (or not self-reinforcing) for any discount factor.

Welfare is the sum of the payoffs of the local leader, the local elite, and the citizen. If (G,G,G) is self-reinforcing, then the society (the local leader, the local elite, and the citizen) could earn 30 in period 0, and $30+t\epsilon$, for $t>0$, assuming $a_{t+1}-a_t = \epsilon$ for all $t>0$ (time-invariant self-reinforcement factor). This can be called the high-welfare society. If (G,G,G) is not self-reinforcing, then (B,B,B) is the only sub-game perfect Nash Equilibrium in pure strategies in this infinitely repeated game (Friedman, 1971) and the society earns 9 in period $t\geq0$. This can be called the low-welfare society.

Starting from (G,G,G), any defector will be "punished" by a lower payoff given the other two players do not defect. However, the degree of punishment is different for the local leader, the local elite, and the citizen who defect. A local leader who defects from (G,G,G) is punished the least with a decrease in the payoff of $(7+\varepsilon)$, the local elite who defects is punished with a decrease in the payoff of (10), and the citizen who defects is punished with a decrease in the payoff of (11). The degree of punishment from defecting is inversely related to political power. Starting from (B,B,B), any good cooperation will be "punished" by a lower payoff given the other two players do not cooperate. The degree of punishment from cooperating in this case is positively related to political power. However, starting from (B,B,B), welfare will be improved if one of the players cooperates.

An example of (G,G,G) is when all players cooperate well, which can be associated with "good institution" and positive local capture. An example of (G,B,G) is when the local elite defects from good cooperation, and because the local leader and the citizen do not defect, the defecting local elite will be punished, perhaps by

incarceration, although welfare will decrease from that of the high-welfare state of (G,G,G). An example of (B,G,G) is when the local leader defects from good cooperation, and because the local elite and the citizen do not defect, the defecting local leader will be punished. An example of (G,G,B), which can be associated with positive local capture, is when the citizen defects from good cooperation, and because the local leader and the local elite do not defect, the defecting citizen, such as a common businessman, will be punished. Since the local leader has the most political power, punishment to the defecting local leader is the least severe but the loss to welfare is the greatest.

An example of (B,B,B) is when all players defect, which can be associated with "bad institution" and negative local capture. An example of (G,B,B) is when the local leader initiates good cooperation, in which case welfare increases, although the local leader's payoff is lower because the local elite and the citizen still defect. Failures of good policies because the local elite and the citizen are not cooperating are examples of this case. An example of (B,G,B) is when the local elite initiates good cooperation, in which case welfare increases, although the local elite's payoff is lower because the local leader and the citizen still defect. Collusion, cronyism, or nepotism between the local leader and a specific common businessman could hurt the local elite. An example of (B,B,G), which can be associated with negative local capture, is when the citizen initiates good cooperation, in which case welfare increases, although the citizen's payoff is still lower because the local leader and the local elite still defect. Collusion, cronyism, or nepotism between the local leader and local elite hurt a common businessman. Since the local leader has the most political power, initiation of a good cooperation by the local leader increases welfare the most, followed by the local elite and then the citizen.

The welfare matrix given the players' strategies is given by the payoff matrices below. The highest welfare is achieved when every player displays good cooperation (G,G,G). A defect by the local leader will yield a welfare of (11-ε), a defect by the local elite will yield a payoff of (12), while a defect by the citizen will yield a payoff of (13). The lowest welfare is attained when every player displays bad cooperation (B,B,B). A good cooperation by the local leader will yield a welfare of (15-ε), a good cooperation by the local elite will yield a payoff of (12), while a good cooperation by the citizen will yield a welfare of (11). Here, we assume that the local leader is the most dominant player in affecting welfare. A defect by the local leader will decrease the welfare by the greatest degree but a good cooperation by the local leader will also increase welfare by the greatest degree. The local elite plays the second most dominant role in affecting welfare, followed by the citizen. The welfare matrices is given by the following tables:

	$LL\backslash LE$	G	B
Good Cooperation (G) by Citizen (C):	G	30	12
	B	11-ε	11

	$LL\backslash LE$	G	B
Bad Cooperation (B) by Citizen (C):	G	13	15-ε
	B	12	9

In order to make the above game theoretical more realistic, we will give real-life examples from our field study for each of the possible sets of strategies above.

Case 2.2 *Let:*

(LL) Local Leaders be Mayors/ Vice-Mayors/ Heads of local government's departments/ other high-ranked public officials with power to regulate policies

(LE) Local Elites: members of ASMINDO (furniture), KADIN (businesses), GAPENSI (contractor) etc., with ability to influence local policies directly

(Citizens) Local Citizens: (or representatives of common citizens) People's NGO's, poor families, etc., without ability to influence local policies directly

1.   (G,G,G)

Balikpapan, East Kalimantan: A balanced city

The high welfare of Balikpapan could be attributed to the balanced cooperation among the local leaders, local elites, and the citizens. This is illustrated by the high level of participation by its citizens, even the poor and illiterate citizens. The participation level was noted by all participants of the field study as being maximal through the regular Monday Morning Forum or the "Coffee Morning" with all executive officials including the sub-district leaders, and hence information flowed to and from the locals, even the poor and illiterates. At the sub-district levels, regular socialization events took place to inform the locals about new local government regulations, for instance. The Mayor also held regular meetings with local businesses every month. The participants in this forum include the micro, small, medium, and large businesses, and all other stakeholders who were involved in the topic being discussed at the Forum. All stratas of the community were involved.

2.   (B,B,B)

Manggarai Barat: The "Memo" system in Public Procurement Auctions

Public procurement auction in Manggarai Barat, de facto, was never conducted, and the high degree of cronyism prohibited those who were not close to the executive or legislative officials from getting a government project. This "memo" system of

procuring a project made contractors come to see and beg the Regent to write a memo to the procurers in order to give them government projects. Local capture only could only make local regulations to bias towards the low-scale contractors, many of which were owned by the legislative members. In fact, the head of the biggest contractors association, GAPENSI, was the head of the legislative body. De facto and de jure were very different. The legislative body as the controlling body of the executive had not been effective either, because political control was not accompanied by technical control. Still, those who owned the projects controlled the projects. What was ironic was that citizens never lost their hope of winning the public projects by directly meeting with the Regent in person. All sides, namely the local leaders, the local elites, and the citizens, were involved in this process.

3.   (G,B,B)

Yogyakarta: Relocation of Pasar Klithikan Pakuncen

A few years ago, used-good street sellers in three locations in Yogyakarta were removed to a new location. There had been resistance by these street sellers out of fear that the relocation of their places might cause a reduction in the number of buyers. This had been troublesome to the Mayor, although after the mandate to reallocate, the newly established market, Pasar Klithikan, had not experienced a reduction in the number of its visitors. This case might exemplify how non-cooperation by the local elites (more established used-good street sellers) and citizens (ordinary used-good street sellers) might create trouble for the local leaders.

4.   (B,G,B)

Prabumulih: Corruption in Public Planning Project of Technical Roads and Bridge

In 2004, the head of local department of public work of Prabumulih city and a professor of University Muhamadiyah Palembang were found guilty of corruption in public planning project of technical roads and bridges that had caused a loss of 489.403.200 Rupiah. Both are jailed to three months in prison. This charge involves only a local leader and a citizen.

5.   (B,B,G)

Manggarai Barat: The Binongko-Cold Storage case

Binongko is the house for handicapped children in Labuan Bajo that accommodates around fifteen handicapped children in Manggarai Barat and is equipped with a swimming pool or a bathtub for regular physical therapy. About 100 children in St. Damian Cancar, a sister handicapped house of Binongko, are circulated and brought to Binongko for physical therapy. In recent years, particularly in 2004, the case between Sister Virgula, the pioneer of the Binongko House for handicapped children, and a Singaporean–owned fish cold storage was hotly debated. The fish cold storage was built right beside Sister Virgula's Binongko Rehabilitation House in Labuan Bajo. Building a fish cold storage besides a rehabilitation house was disturbing since a fish cold storage polluted the sea where these handicapped children take sea-water baths for their physical therapy and moreover, during the fish seasons, the air would smell of fish. Although the local government had issued an official date when this cold storage had to move, up until now, it has not. There had been many demonstrations protesting the construction for this fish cold storage because of the harmful polluting effects on these children. After a period of failures to remove the cool storage, Sister Virgula finally gave in and gathered some money from donators to build its own swimming pool for the children's physical therapy that had cost approximately Rp. 1.000.000.000, 00. After the changing of the old

Regent of Manggarai to the new Regent of Manggarai Barat, the new local government was not supportive and complaints by the Binongko's House about the Cold Storage were not heard. Demonstrations were conducted.

6. (B,G,G)

Prabumulih: High Number of Legal Charges on Corruption against Public Officials

In 2004, the Mayor of Prabumulih, Drs. H. Rachman Djalili MM, was charged with corruption on land ownership (or "pembebasan tanah") for a local government office that was known as "Pangkul Gate." The corruption charge involved as much as Rp.3.000.000.000,00. He was finally freed by the "Mahkamah Agung", but his staff was found guilty. It was suspected that some public officials asked someone to buy the land from the citizens at a price lower than the market price before the project was run, and this land was bought by the local government at a price above the market price. In separate cases, two department heads were found guilty of corruption. Local government's secretary and some of its staff were also found guilty of corruption. Though corruption by local leaders often involves some local elites or local citizens, however, in the case of civil charges in procuring land for the Mayor's office in 2004, only high-ranking public officials were prosecuted with the civil charges.

7. (G,B,G)

Prabumulih: Legal Charges on Corruption against Local Elites

"Defect" by local elites is exemplified by corruption charges by local businesses or prominent people (or local elites) in Prabumulih. There were at least four civil

charges against local businesses or prominent people, such as the head of a high school, between January 1997 and June 2008 that we recorded from the judicial body in Prabumulih for corrupting public funds. Only these local businessmen or prominent people were prosecuted with the civil charges without any local leader nor citizen being involved. Again, corruption by local elites causes a loss to the society, including local leaders and citizens, on top of having these local elites incarcerated.

   8. *(G,G,B)*

An example of "Defect" by citizens could be more general daily-life, law-breaking cases, such as stealing. We did not focus on behaviors of common citizens in our field study because these cases are more trivial, and difficult to find. Stealing public possessions creates a welfare loss to local leaders and local elites, on top of having the citizens put in jail.

Case 2.3 *Positive self-reinforcement factors can be associated with a high level of welfare. Consider the case of Balikpapan. The capability of the citizens to participate in regular local forums conducted by the government increase local participation, thus generating higher welfare. Negative self-reinforcement factors can be associated with a low level of welfare. Consider the case of Sragen. The incapability of the citizens to participate in free health-care programs because of low education may make the implementation of other health-care programs unattractive to local leaders and local elites. Moreover, the citizens who lack health awareness do not consider going to health clinics to be beneficial.*

The incentives and disincentives of the players to act may depend on some self-reinforcement factors. These self-reinforcement factors are the forces behind the persistence of the evolution between welfare and the quality of institutions.

Under negative self-reinforcement factors, low welfare evolves with poor quality of institutions in which the local leader, the local elite, and the citizen behave "mischievously" or non-cooperatively. Conversely, under positive self-reinforcement factors, high welfare evolves with high quality of institutions in which the local leader, the local elite, and the citizen behave cooperatively. In order to break the persistence of non-cooperative equilibrium of low welfare and poor quality of institution, a district needs to change the self-reinforcement factors to motivate the local leader, the local elite, and the citizen to behave well. The example above shows that an increase, no change or a decrease in the payoff from cooperation tomorrow if there is cooperation today is an example of a positive, neutral and negative self-reinforcement factor respectively. Self-reinforcement factors that underlie these changes in payoffs, or the quasi-parameters, include the level of education and the political or health awareness of the citizens in the districts. Three elements that determine the evolution between welfare and qualities of institutions and could explain the persistence of non-cooperative or cooperative equilibrium, are the initial welfare of the district, the self-reinforcement factors and the qualities of institutions.

Past behaviors that have become a culture institutionalized in people's beliefs and norms are more difficult to change than one might predict. In other words, past institutions, in particular one that has turned into a culture, matter. In order to change people's beliefs of corrupt government in Indonesia, for example, the new leaders must transform the bad image of government by creating a body with leaders of high integrity in order to prevent an institutionalized distrust in government. Moreover, in order to erase the culture of corruption, there must be a reform in the beliefs and norms of the people for a stable equilibrium, which may be more gradual. Furthermore, as mentioned above, past institutional elements

determine the initial conditions of the new institutions and the capacity of the current institution to change. An institution does not grow independently. It has players, namely the stakeholders of the rules. An unjust law with a wise judge might result in a more rational outcome than a just law with an unwise judge. In the context of corruption, an institution entails changing the beliefs of how others might behave and what one believes is right in order to induce good behaviors. Therefore, corruption that has become a culture requires a more complex process in order to change. This process involves a significant investment of time as it requires changes in observable behaviors.

Institutional complexes that make a costly transitional change may explain why corruption is more persistent in Indonesia than it is in other countries, such as in Singapore. The recent case of reformation in the bureaucracy of Indonesia (June 2008), changes in the remuneration of public officials and personnel changes in the tax and custom offices under the Ministry of Finance did not guarantee success. It showed that the pilot project on the tax and custom offices was a failure. Hence, it is necessary to note that a change in rules and regulations or the establishment of new rules and regulations may not be effective if they are not followed by changes in beliefs that result in new found motivation to follow these rules and regulations. Thus, all institutional elements, not only rules and organizations matter. Serra, 2008, shows the importance of a combined bottom-up and top-down approaches. When applied to political settings, the presence of self-reinforcement factors may suggest that intrinsic personal values of individuals are important, honesty, for instance.

Other external factors aside from the few elements mentioned above may also be significant. Allowing the establishment of relationships between public officials

and citizens, allowing public officials to directly appoint citizens as participating bidders, and repeated interactions between public officials and citizens increase the incentives for public officials and citizens to coordinate to corrupt. Repeated interactions will allow public officials and citizens to form beliefs about how the others will behave, thus facilitating coordination of corruption. Frequent job rotations among public officials, prohibiting family members from participating or regulators from indirectly getting involved in bidding in public procurement auctions may prevent networks of cronyism among policy makers, public officials, and citizens, thus reducing the incentives to corrupt (e.g. the case of Venice). Hence, randomized instead of organized matching and fewer networks between public officials and citizens may prevent coordination to corrupt. Incentive mechanism designs must also change negative reinforcement of non-corrupt institutions. In other words, non-corrupt behaviors must be rewarded with higher payoffs in the following periods. Also, good reputation of public officials or citizens must be rewarding rather than harmful. Non-corrupt institutions must bring economic gains in terms of better public services and higher national economic performance, and thus, a higher standard of living. As long as an institution remains negatively self-reinforcing, no institutional change can be expected. Other incentive mechanism designs include collective punishments and rewards based on past behaviors of all, rather than only a few players, and the internalization of greater social identities (e.g. Venice). For example, a public official should identify him/herself as a public official and a law enforcer who serves the country, instead of just a public official. In the worst possible case, a completely new system, including new norms, new beliefs, new rules, new organizations, and new implied behaviors, must be introduced. The theory of endogenous institutional change enables us to find an incentive mechanism design that creates an environment where change of

institutions can occur. We argue that in the long-run a stable improvement in the qualities of institutions and welfare relies on the self-reinforcement factors.

2.5 Endogenous Institutions in the Decentralization Period in Indonesia

We have seen in Example 1 and 2 above how an institution may or may not self-reinforce cooperative behaviors. In the context of endogenous institutions, we formalize evidence gathered from our field survey conducted in Indonesia between June 9 and July 31, 2008, in five districts in Indonesia[2]. During this field study, we interviewed local key informants in each district to collect primary data on local capture, local leadership, and participation level. We also collected secondary data on social indicators. Specific indicators, including questions asked of various local key informants, for these four variables are given in Appendix I. In this section, we are going to combine Greif's game theoretical approach to endogenous institutions as it is described in the previous section with the typology of leadership model by Azis (2008) (see Appendix II). The table in Appendix II shows the topology of leadership of the original model (Azis, 2008). By combining these models, we attempt to better illustrate the endogeneity of institutions in the context of Indonesian institutions during the post-decentralization period, in which institutional constraints take effect mainly in the forms of high degree of local capture and other changes in political structures, particularly with regards

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[2]The following section is based on the field survey on the effect of local capture on welfare in the post decentralization era in Indonesia, conducted between June 9 - July 31 2008 in five districts in Indonesia (see Azis and Wihardja, 2008). See Appendix I for how the field survey was conducted and the summary of primary and secondary data on the five districts collected during the field study.

to local elections. By quality of leadership (Azis, 2008), we mean the integrity of local leader. By quantity of local leadership, we mean the degree to which a leader is effective in generating local revenues and economic growth. A Type-A leader is one who could increase local budget under some degrees of local capture. A Type-B leader is one who uses the benefits of local capture for his/her own private benefit and thus, does not contribute to the local budget. A Type-C leader is one who does not only use the benefit of local capture for his/her own private benefit, but also corrupts the local budget, such as a kleptocratic local government.

We find a correlation between various social indicators and institutional elements, namely local capture, local leadership, and participation level. To test for causality, we lag the time for the variables on socioeconomic conditions. We find a correlation between socioeconomic conditions in the pre- and early decentralization period and institutional elements, namely, local leadership, participation level, and the effect of local capture on welfare in the post-decentralization period, suggesting the endogeneity of institutions. To explain this correlation, we provide a theoretical model that illustrates the evolution between welfare and qualities of institutions in the presence of some self-reinforcement factors that may generate different types of progresses in the long run. In this model, institutions are endogenous and the manner in which institutions and welfare evolve is affected by some self-reinforcement factors that depend on initial welfare and past institutions.

The model in this paper also shows how one could endogenize the participation level and local leadership assumed to be exogenous in Azis, 2008. It could also explain the persistence of low welfare and poor-quality institutions in some districts in Indonesia in the presence of negative self-reinforcement or self-undermining factors, such as low education. How these self-reinforcement factors could generate

the evolution between welfare and qualities of institutions is illustrated in the game-theoretical approach in the previous section. (Also see the term "persistence" of a dysfunctional institution in Acemoglu, D., 2008). We argue that starting with an initial welfare, a district is associated with some socioeconomic factors, such as the level of education and political awareness of the citizens, that could be the negative, neutral, or positive self-reinforcement factors to the progress of the district. These self-reinforcement factors generate certain institutional complexes, such as local accountability, local capture, participation level, and the local leadership. These institutional complexes along with exogenous factors in turn affect welfare in the next period.

We find that in the presence of self-reinforcement factors, the evolution between welfare and qualities of institutions that could persist may be associated with complete, incomplete, stagnant, or deteriorating progress as discussed in Azis, 2008. We propose that the initial welfare and past institutions affect future institutional trajectory through election of local leadership, the effect of local capture on social welfare, the participation level and so on. The self-reinforcement factors in Greif's model on endogenous institutions help to explain the self-reinforcing forces behind the different types of progress discussed in Azis, 2008.

From the field survey, we observe that of the five districts studies in Indonesia, one of them, Manggarai Barat, is identified to have deteriorating progress. By deteriorating progress, we mean that this district experiences the negative effects from increasing local capture on welfare in the post-decentralization era because of incompetent leadership and high levels of poverty as well as low participation levels that can be associated with uneducated and politically uninformed citizens. Two districts (Prabumulih and Sragen) are identified with stagnant progress, mean-

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ing negative local capture is present with relatively moderate poverty levels but low quality of local leadership. Prabumulih is an oil-and-gas producing region, although corruption among local leaders is pervasive as is evident from the recent records of legal corruption charges among public officials, including heads of departments. Sragen has local program aimed at reducing poverty rates, unemployment rates, and improving infrastructures even though the quality of local leadership is ranked low based on our in-depth interviews. The other two districts are characterized by complete progress, meaning they experience positive effects from increasing local capture on welfare in the post decentralization era because of competent leadership and low poverty levels as well as high participation levels that can be associated with educated and politically informed citizens.

From our observation, the district identified with deteriorating progress is a poorly developed region with a high poverty rate above 25%, poor basic infrastructures, and a below-average literacy level below 90%, as well as low Human Development Indexes of below 70. Its economic condition is characterized by low GRPD's per capita excluding oil and gas of below Rp.2 million and a low ratio of the local revenue to the total local budget of below 5% implying a high dependency on the central government's funds. Moreover, besides having poor social and economic conditions, this less developed district also tends to have ow participation levels and a high intimidation level as compared to more developed regions. However, these might be the endogenous effects of having poorly educated and politically unaware citizens who elect bad local leaders.

In order to determine the causality of social conditions on institutions, we take different social indicators including the 1999 Human Development Index, the 1999 Human Poverty Index, the 2000 Infant Mortality Rate, and the 2003 Literacy Rate

(see Appendix III) and plot them against institutional indicators from our field study, namely local capture, local leadership and participation level. These graphs show some evidence that poor social conditions negatively affect institutional elements. The causality between welfare and institutions in the post-decentralization era is harder to determine because there has not been data since the decentralization. Moreover, changes in institutional elements take time. In the evolution process, local leadership, participation level and local capture will constitute the new institutional elements of a district, which in turn affect welfare in the next period. Welfare endogenously affects the new institution, and so this become an evolutionary process. In the following section, we will enrich Greif's theory of endogenous institutional change by combining it with Azis' model to explain the phenomenon of endogenous institutions in Indonesia, taking initial socioeconomic conditions and past institutions as the initial determinants of future and long-run institutional trajectory.

2.5.1 Decentralization in the Midst of Political and Economic Crisis

Some literature suggests that the decentralization in Indonesia is predicted as a derivative of the fall of an autocratic ruler and it took place to appease people's hostility over the 1997-1998 financial crisis. The regional autonomy tax was passed under high uncertainties, in which political hostility showered GOLKAR, which was the political party of the then president of Indonesia, the armed forces, and the then president himself. Relying on information from political experts, under these uncertain circumstances, the then president was convinced that decentralization would save him from electoral supports at the sub-national level, thus the law

was passed. Consistent with the theories that argue decentralization constraints Leviathans and promotes competitions and that decentralization is a predictable outcome of a fall of autocratic rule, the extreme decision to decentralize might have occurred under pressures to save old authoritarian-era legislators from political hostilities. Furthermore, it served to appease the people's hostility during the 1997 financial and political crisis to win electoral votes without much thoughts to consequences. Some literature already suggests that decentralization in poor developing countries proves to be stable.

As Alesina and Spolaore (2005) predict, "in practice, the discussion of what form of decentralization to adopt is also related to the level of development... countries with a low level of development may simply not be able to leave to localities independent handling of public finance... especially in poor and rural regions of developing countries, central government intervention may be unavoidable for reason of technical competence... underestimating this problem may lead to serious problems from poor institutional design" (p.142). Decentralization in Indonesia may worsen welfare through low-quality institutions in low-welfare districts.

Although decentralization and democracy are two separate concepts, the fall of the autocratic ruler brings a more democratic environment to the post-decentralization period in Indonesia. Przeworski (2005) argues that democracy in poor countries is not stable because the marginal utility of rich political leaders in defaulting in electoral result and separating from the newly elected government to dictate is lower than the cost of losing freedom, while the marginal utility of poor political leaders in doing so is higher than the cost of losing freedom if utilities of political leaders are concave. Thus, democracy is not stable in poor countries. Although the political environment becomes more democratic in the post-decentralization

period, this effect seems to be eroded by a higher degree of local capture because of the closer political distance between local leaders and local elites. Our model in the last sub-section may explain why democracy under a high degree of local capture might be unstable.

2.5.2 How Past Institutions and Initial Conditions Affect Institutional Trajectories?

As we have seen, an "institution" is described by Greif as a system that consists of rules, organizations, beliefs and internalized norms, and implied regularity of behaviors. This system is in equilibrium if the implied regularity of behaviors to follow the rules are best-responses to the beliefs and internalized norms that are formed. Many policies in Indonesia, for example, the policies that were erected after the decentralization in 1999, failed to achieve their objectives simply because the institution was not in equilibrium. The following tables (Table 2.1-2.4) illustrate how some policies that were regulated in recent years in Indonesia might fail or succeed to be in equilibrium as it is defined in Greif's model, and hence fail or succeed to achieve their objectives.

Table 2.1: Examples of Institutions in Indonesia - Rule

	Rule
1	Issuing business licenses
	Ministerial Decree of Home Affairs, No.24, '06
2	National regulations on firing workers ("pesangon")
	(National Law No.13, '03, Ch.IX-X)
3.	Amendments regarding conducts of Public Procurement Auctions
	Presidential Decrees No. 80, '03 and Instructions No.8, '06

These are simple examples of institutions in disequilibrium as described in Greif

Table 2.2: Examples of Institutions in Indonesia - Organization

Organization
1. One-Stop-Service (OSS)
Local businesses
2. Private companies
Central government
Business Associations
3. Procurement Committee
Bidders

Table 2.3: Examples of Institutions in Indonesia - Belief and Internalized Norm

Belief and Internalized Norm
1. Business license issuance involves bribes and cronyism
Business license issuance does not involve bribes and cronyism
2. Recession will occur
Recession will not occur
3. Procurement committee could be bribed; punishment are ineffective
Procurement committee could not be bribed;punishments are effective

(2006) and are presently evident in Indonesia. For instance, after the issuance of a national regulation requiring private firms to provide monetary benefits should they fire a permanent worker, private firms now hire their workers only temporarily in fear that there will be another financial crisis in the near future that they will have to fire workers. The regulation that was intended to increase the welfare of workers thus backfired.

From the evidence of the field survey, we build a model that combines Greif's institutional change theory and Azis's typology of leadership. The evidence of the field study enriches both models by providing institutional details and real-life examples. We will first explore the social, economic, and political explanations underlying the disparity in local capture, participation level, and local leadership between less developed and more developed countries. We will use Greif's institutional dynamic process and game-theoretical approach to explain institutional change and institutional trajectories as functions of past institutions and initial

Table 2.4: Examples of Institutions in Indonesia - Implied Behavior

Implied Regularity of Behavior (failures and successes)
1.Bribe-taking activities occur, investment decreases
Bribe-taking activities do not occur, investment increases
2.Companies hire workers temporarily
Companies continue to hire permanently
3.Mark-ups and kick-backs continue to be pervasive
Start procuring goods and services according to the laws

conditions that endogenize the type of local leadership and the effect of local capture on social welfare as well as participation level through self-reinforcement factors. Endogenous variables in this process are the institutional elements, namely local leadership, local capture, and participation level, while the quasi-parameters are the time-variant payoffs of local leaders, local elites and citizens. These time-variant quasi-parameters are the self-reinforcement factors that can be associated with different levels of welfare, that depend on socioeconomic conditions, such as the level of education, political and health awareness of the citizens. Uneducated citizens who are incapable of participating in government social programs provide less incentive for local leaders and local elites to implement social programs because of high costs of educating the citizens to make the programs work effectively. Establishing a health care program might incur losses in the long-run if the citizens believe in magical doctors (or Dukun in Indonesian) instead of medical doctors. In some parts of the paper, we will regard interchangeably the quasi-parameter and the underlying factors of the quasi-parameter, such as the level of education, as the self-reinforcement factors.

Greif (2006) argues that past institutions affect the evolutionary process of a new institution through three factors: environment, inclusion, and coordination effects that play roles in determining future trajectories of institutional change as a function of past institutions. Environment effects explain why institutions that

could better adapt to the past institutions are more likely to be adopted as new institutions. Inclusion effects explain why past institutions rather than new institutions are more likely to be adopted as new institutions. Coordination effects explain why past institutions are focal points in the case of multiple selections under the new institutions. The tables below (Table 2.5-2.6) set the initial conditions and the three effects on institutional change as a function of past institutions. Table 2.7-2.8 show the initial conditions for less and more developed regions, and possible outcomes that arise based on both the initial conditions and past institutions. As mentioned above, past institutions create fundamental asymmetry and, together with initial conditions, generate certain institutional complexes. Given past institutions and initial conditions, certain self-reinforcement factors arise that determining the evolution of institutions and welfare.

Table 2.5: Indicators of Initial Social Conditions

Initial Social Conditions	Indicators
Social Indicators	Poverty Level
	Education
	Health
	Unemployment

Table 2.6: Past Institutions

Effects	Sub-indicators	Explanations
Environment	Political	The role of central government
		The role of local government
		The role of (local) People's Representative Body
	Social	National social insurance programs
		National micro-finance programs
Inclusion	Institutional	The past local capture
		The past corruption/collusion/nepotism
Coordination	Legal system	The reward and punishment/ other legal system

In these tables, we show that all five districts are affected by the past institutions equivalently. However, the five districts are affected differently by their initial social conditions. We argue that different initial social conditions are as-

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Table 2.7: Initial Social Conditions and Past Institutions - Less (More) Developed Regions

Past institutional effects & Initial conditions	Less (More) Developed Regions
Initial Social Conditions	High (Low) poverty level, IMR, unemployment; low (high) literacy rate
Environment (political and social)	The persistence of central government control
	An increase in the role of local leaders
	A less effective role of People's Rep. Body
	Continued national social programs
	Continued national micro-finance programs
Inclusion (institutional)	An increase in local capture
	Inherited past corruption/collusion/nepotism
Coordination (legal system)	Continued ineffective legal punishments

Table 2.8: Possible Outcomes - Less (More) Developed Regions

Possible Outcomes in Less (More) Developed Regions
a. Social and micro-finance programs are inefficient (efficient)
b. Low (High) quantity-quality local leaders are elected
because of low (high) political awareness of the citizens
c. Policies tend to be top-down (bottom-up)
d. Citizens do not (do) serve as a controlling body
e. Participation level is low (high) , access to information is poor (easy),
and intimidation level is high (low)
f. The effect of local capture on social welfare is negative (positive)
because local accountability is low (high) (c, d and e)
=> Deteriorating (Complete) progress; Incomplete (stagnant) progress,
if quantity-quality of local leadership is high (low)

sociated with different self-reinforcement factors that could develop into different institutional complexes. A district with a high poverty level can be associated with low education and low political as well as health awareness of the citizens, thus generating payoffs to the local leaders and local elites as well as the citizens from cooperation in such a way that leads to negative local capture. Low qualities of institutions because of negative self-reinforcement factors generate lower welfare in the next period. The existence of negative self-reinforcement factors, such as low level of education and low political and health awareness, can make

the evolution between low welfare and poor qualities of institutions persist in the long-run. We will call this "deteriorating" progress (Azis, 2008). Conversely, the existence of positive self-reinforcement factors, such as the high level of education and high political and health awareness, can make the evolution between high welfare and high qualities of institutions to persist in the long-run. We will call this "complete" progress. In the case of the less to moderately developed region, in which high quantity-quality of local leadership emerges, it will be termed "incomplete" progress. In the case of moderately to more developed region, in which low quantity-quality of local leadership emerges, it will be termed "stagnant" progress. Based on our field study, we argue that "incomplete" progress is unstable, and a region in this state will eventually fall into either complete, deteriorating, or stagnant progress.

2.5.3 Evidence of Endogenous Institutions

The results from the field survey show that based on the typology of Azis (2008), the less developed regions as defined in the above section of the five districts studied are associated with deteriorating progress, the more developed regions are associated with complete progress, and the more developed region with low quality of local leadership is associated with stagnant progress. None fall into incomplete progress. In Figure 1, we show that the net effect of local capture is correlated to the social conditions[3]. Social conditions are measured by poverty rate, IMR,

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[3]The indicator on "local capture" in areas of public procurement auctions, local regulations, and social programs as specified in the questionnaires of the field study measures the effects of the relationship between local leaders and local elites in these three areas. This indicator, however, measures the intensity of "negative" local capture by the designs of the questions while the intensity of the "positive" local capture is captured from the questions on the quality of leadership in organizing social programs and the quantity of leadership in generating and managing local revenues and GRDP growth by establishing relationships with private sectors. The latter indicators question how local leaders use their relationship with private sectors to
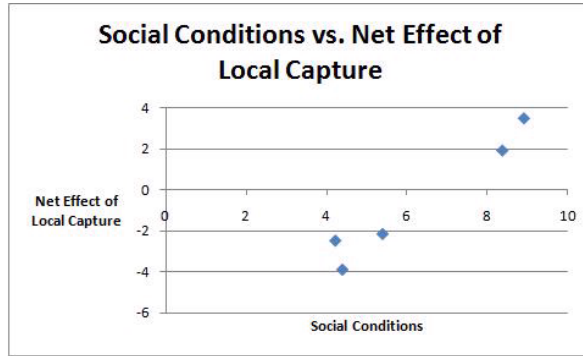
Figure 2.1: Social Conditions (2008) vs. Net Effect of Local Capture (2008)
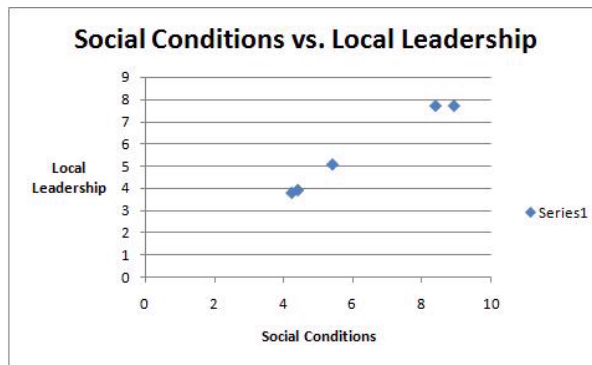
Figure 2.2: Social Conditions (2008) vs. Leadership (2008)

literacy rate, and unemployment rate. We also show correlations between local leadership and social conditions (Figure 2). Participation level is also positively correlated with social conditions (Figure 3).

Although we cannot determine the causality of these variables, we show that various social indicators in the pre-decentralization or early post-decentralization periods affect the net effect of local capture on welfare, local leadership and participation level in the post-decentralization period. We show that the high Human Poverty Index in 1999 is associated with negative net effects of local capture on

increase local revenues and economic growth as well as to implement social programs. The net effect of local capture is equal to positive local capture minus negative local capture.

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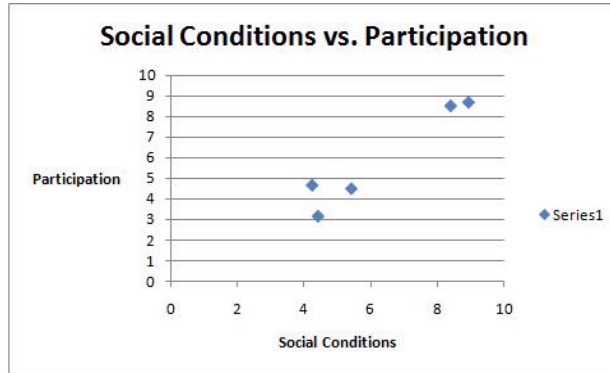
Figure 2.3: Social Conditions (2008) vs. Participation (2008)
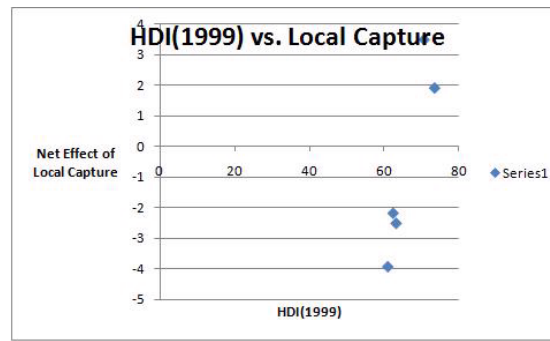
Figure 2.4: HDI(1999) vs. Local Capture (2008)

welfare (Figure 5), low quality-quantity local leadership (Figure 9), and low participation level (Figure 13). Other plots (Figure 4, 6, 7, 8, 10, 11, 12, 14, 15), except for literacy rates, show the relationships between these social indicators in 1999, 2000, and 2003 and institutional elements in 2008 that support our hypothesis that poor social conditions are associated with low quality institutions, and vice versa. They further show that social conditions in current period could affect qualities of institutional elements in the future.
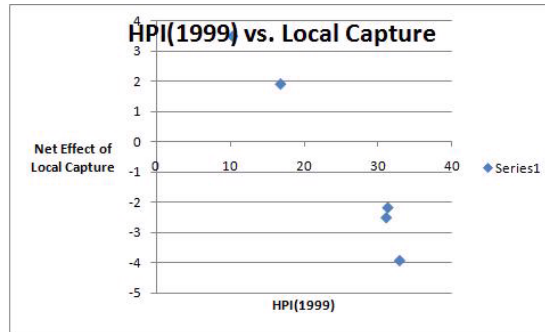
Figure 2.5: HPI (1999) vs. Local Capture (2008)
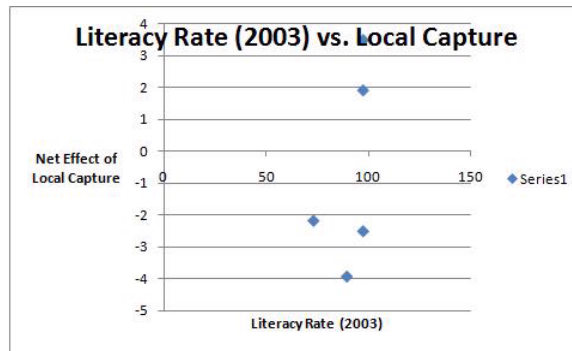
Figure 2.6: Literacy Rate (2003) vs. Local Capture (2008)
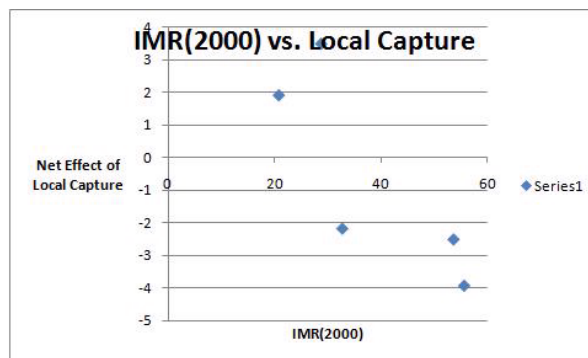
Figure 2.7: IMR(2000) vs. Local Capture (2008)

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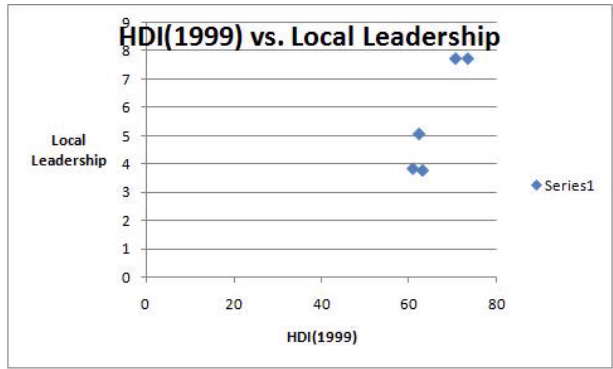
Figure 2.8: HDI(1999) vs.Leadership (2008)
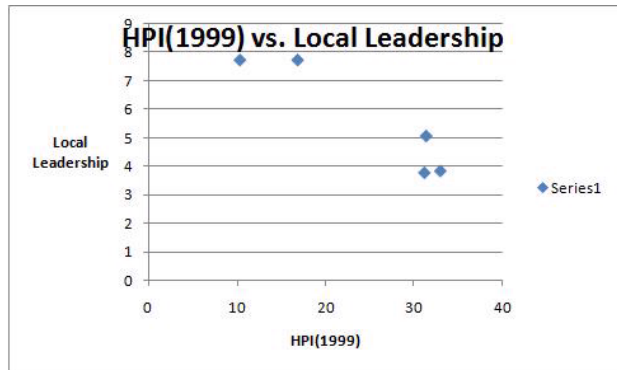
Figure 2.9: HPI (1999) vs. Leadership (2008)
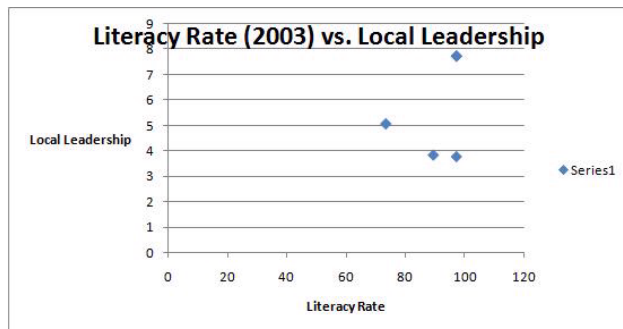
Figure 2.10: Literacy Rate (2003) vs. Leadership (2008)
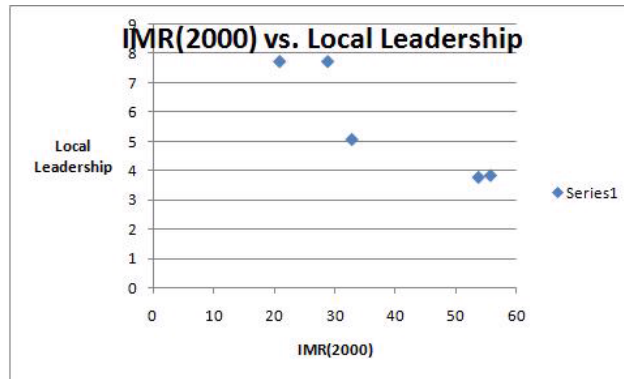
Figure 2.11: IMR(2000) vs. Leadership (2008)
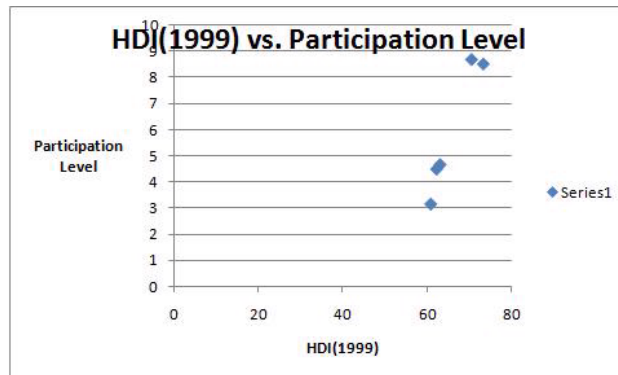
Figure 2.12: HDI(1999) vs. Participation (2008)
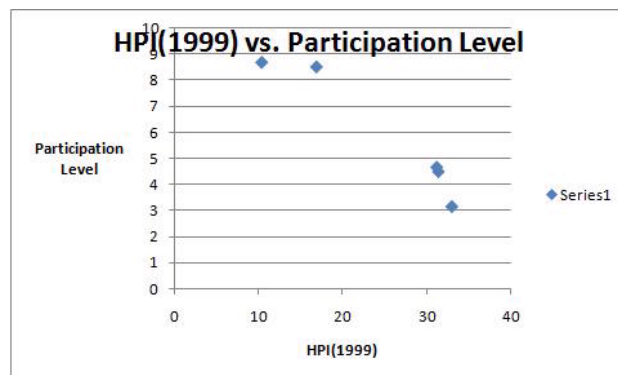
Figure 2.13: HPI(1999) vs. Participation (2008)
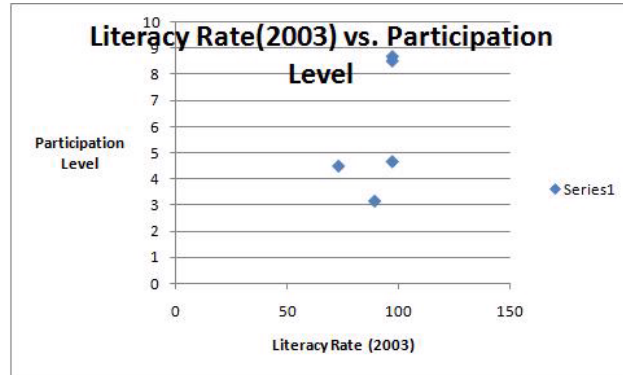
Figure 2.14: Literacy Rate (2003) vs. Participation (2008)
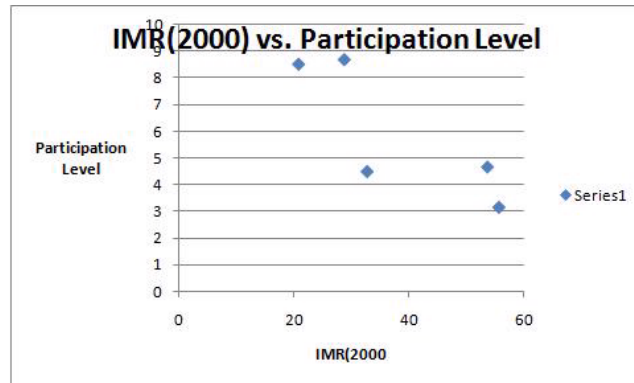
Figure 2.15: IMR(2000) vs. Participation (2008)

2.5.4 Proposition on The Endogenous Institutional Change Model

In this section, we will show an example of how institutions can be endogenized, leading to long-run progress or a persistence in the evolution between welfare and institutions. We will assume that initial conditions consist of the socioeconomic conditions and past institutions as we have in the previous section. Participation level, local leadership, the net effect of local capture are considered endogenous variables. This is slightly different from the typology of leadership model in Azis, 2008, in which local leadership is exogenous. In the example that follows we

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show how the presence of self-reinforcement factors associated with different initial conditions could reinforce different types of progress.

The five districts surveyed are categorized into four types of institutions, which we will call *Institution 1, weak Institution 1,* and *Institution 2* as well as *weak Institution 2.* These categories are distinguished by their self-reinforcement factors and institutional complexes. In other words, the four types of institutions are different with regards to their initial socioeconomic conditions that create different self-reinforcement factors and institutional elements, namely local leadership, local capture, and participation level. Institution 1 is associated with good socioeconomic conditions, positive self-reinforcement factors, and positive institutional elements, namely high quantity-quality of local leadership, high participation level, and positive net effect of local capture on welfare. Institution 2 is associated with poor socioeconomic conditions, negative self-reinforcement factors, and negative institutional elements, namely low quantity-quality of local leadership, low participation level, and negative net effect of local capture on welfare. Weak Institution 1 is associated with moderate socioeconomic conditions and neutral self-reinforcement factors, but is associated with negative institutional elements, namely low quality of local leadership (Type B/C), low participation level, and negative net effect of local capture on welfare. Weak Institution 2 is associated with moderate socioeconomic conditions and neutral self-reinforcement factors, but is associated with positive institutional elements, namely high quantity-quality of local leadership, high participation level, and positive net effect of local capture on welfare. Although there are four types of institutions that we consider, none of the five districts we studied falls into the category of weak Institution 2.

Four types of Institutions: Institution 1, Weak Institution 1, Institution 2, and Weak Institution 2   We divide institutions in the five districts studied into four types. Institution 1 is associated with high levels of initial socioeconomic conditions, high participation level, and high quantity and/or quality leadership (Type A) as well as positive net effect of local capture on welfare (Table 2.9)[4].

Table 2.9: Institution 1 - Initial Conditions

Institution 1	Initial conditions
1	Low poverty rate
2	Low inequality
3	Other social indicators: low IMR, high literacy rate, low unemployment rate
4	High quantity-quality of local leadership
5	High participation level
6	Positive local capture

Examples of districts that fall into the "Institution 1" category based on our field study are Balikpapan and Yogyakarta City (Table 2.10).   Based on the evaluations of indicators (see Appendix I), these two regions receive the following values for indicators in socioeconomic conditions, participation level, and local leadership as well as the net effect of local capture on welfare:

Weak Institution 1 is characterized by moderate socioeconomic conditions but low participation level, and low quality of local leadership (Type B/C) as well as negative net effect of local capture on welfare.   Two districts that fall into the "Weak Institution 1" category are Prabumulih and Sragen (Table 2.11).

Institution 2 is associated with low initial socioeconomic conditions, low quantity-quality of local leadership (Type C), low participation level, and negative net effect

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[4]We will exclude the inequality variable in our analysis because of a lack of data.

Table 2.10: Institution 1 - Balikpapan and Yogyakarta City

Indicators\City	Balikpapan	Yogyakarta City
Poverty Level	9.5	7.5
IMR	8.75	9
Literacy Rate	8.75	9
Unemployment Rate	8.75	8
Average Socioeconomic Conditions	8.91 (Good)	8.375 (Good)
Participation Rate	8.67 (High)	8.375 (High)
Local Leadership	8.125/7.33 (High/High)	8.125/7.33 (High/High)
Local Capture	3.5 (Positive)	1.92 (Positive)

Table 2.11: Weak Insitution 1 - Prabumulih and Sragen

Indicators\City	Prabumulih	Sragen
Poverty level	7.3	2
IMR	1.5	5.5
Literacy rate	9.1	4.9
Unemployment	5.3	9.2
Average socioeconomic conditions	5.8 (Moderate)	5.4 (Moderate)
Participation Level	4.67 (Low)	4.5 (Low)
Local Leadership	2.875/4.57(Low/Low)	4.625/6 (Low/High)
Local Capture	-2.5 (Negative)	-2.17 (Negative)

of local capture on welfare (Table 2.12)[5].

Table 2.12: Institution 2 - Initial conditions

Institution 2	Initial conditions
1	High poverty rate
2	High inequality
3	Other social indicators: high IMR,
	low literacy rate, high unemployment rate
4	Low quantity-quality of local leadership
5	Low participation level
6	Negative local capture

A district that falls into the "Institution 2" category according to the field study is Manggarai Barat (Table 2.13). Based on the evaluations of indicators, this region receives the following values for indicators in the initial socioeconomic conditions, participation levels, local leadership, and the net effect of local capture

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[5]We will exclude the inequality variable in our analysis because of a lack of data.

on welfare:

Table 2.13: Institution 2 - Manggarai Barat

Indicators\City	Manggarai Barat
Poverty Level	1.5
IMR	1.5
Literacy Rate	6.67
Unemployment Rate	8
Average Socioeconomic Conditions	4.4 (Bad)
Participation Level	3.167 (Low)
Local Leadership	4.125/3.67 (Low/Low)
Local Capture	-3.92 (Negative)

None of the districts from our field study falls into the "Weak Institution 2" category. Weak Institution 2 might be less likely to arise than other institutions because high quality of institutions in the long run will generate high socioeconomic conditions. All types of Institutions are associated with the following factors (Table 2.14):

Table 2.14: (Weak) Institution 1 & 2 - Common Factors

(Weak) Institution 1 & 2	Factors affecting endogeneity
	effects on quasi parameters
1	Central government's role still exists
2	The role of local leaders increase
3	The role of DPRD become less effective
4	National social programs and
	micro-finance programs are present
5	Past local capture, corruption,
	collusion, and nepotism continue to exist
6	Legal punishment/system is ineffective

Claim 2.1 *The endogenous institutional effect of the initial socioeconomic conditions and the past institutions, namely the environment effect, the inclusion effect, and the coordination effect, are the participation level, the type of local leadership ,and the net effect of local capture on welfare. In Institution 1, participation level tends to be high, high quantity-quality leadership (Type A) is more likely to be*

elected, and the net effect of local capture on welfare is positive. In Institution 2, participation level tends to be low, low quantity-quality leadership (Type C) is more likely to be elected, and the net effect of local capture on welfare is negative. In weak Institution 1, participation level tends to be low, low quality leadership is more likely to be elected (Type B or C), and the net effect of local capture on welfare is negative. In weak Institution 2, participation level tends to be high, high quality leadership is more likely to be elected (A), and the net effect of local capture on welfare is positive.

The claim above is based on our field study. In order to distinguish between weak institutions 1 and 2, in which initial socioeconomic conditions are moderate, we consider the specifics of the initial conditions that make one institution have a low quality of institution and the other a high quality of institution. For example, weak institution 1 could be associated with regions that are rich in natural resources thus reducing will to reform institutions. Conversely, weak institution 2 could be associated with regions that are poor in natural resources, thus motivating people to work harder to reform institutions. These examples also suggest that initial conditions determine the capacity in which new institutions develop. For example, a district with uneducated citizens and politically unaware voters, or low participation of the citizens may not be capable of electing good leadership, preventing the district from reforming.

The above primary and secondary data, which we collected during our field study, could not fully explain some contradicting observations that were derived from other sources, such as the GRDP data from the Indonesia's statistical body collected outside the field study. In the case Balikpapan, for example, the average annual GRDP growth between 2000 and 2007 was nine percent, however, the

growth in animal husbandry is seven percent, in forestry is minus one percent, in forestry is two percent, in private social community services is four percent. These are the sectors that could directly affect the poorest of the poor societies. The banking sector, which is a sector that is more likely to benefit the higher income groups of citizens grows at an average of thirty one percent annually. This suggests an increasingly unequal society. In early April 2009, the firefighting service department and officials of the Balikpapan city administration were accused of marking up the budget to procure firefighting equipments and vehicles. Despite the high score on local leadership including the local bureaucracy, Balikpapan is not a city free of corruption. According to some news, East Balikpapan area was also noted for being left-behind in terms of its development from the other areas, especially the city areas. The glitters of the city areas might therefore conceal the marginalized areas in Balikpapan, which were not observed during our field study. Inflation was also generally higher than the national average between 2002 and 2007, which could make poverty rate higher that what the official statistics revealed. Our observations from the field study cannot fully explain these anomalies. The limitations of our field study in this case are insufficient participants who come from the poorest of the poor societies, a lack of comparisons between the poor and the elites within Balikpapan instead of across districts with respect to institutional access, and the length of time we observed the city.

Propositions on Endogenous Institutions in the Decentralization Period in Indonesia

In order to illustrate that self-reinforcement factors could generate an evolution between welfare and qualities of institutions, we assume that self-reinforcement factors exist in the forms of differences in the payoffs from cooperation today

and tomorrow. These time-variant payoffs are what Greif calls *quasi-parameters*. These quasi-parameters, we claim, are themselves endogenous, and are affected by the initial conditions and past institutions, namely the environment, inclusion, co-ordination effects. A higher payoff from cooperation tomorrow to some or all of the players if there is cooperation today is associated with a positive self-reinforcement factor, while a lower payoff from cooperation tomorrow if there is cooperation today is associated with a negative self-reinforcement factor. An unchanged payoff from cooperation tomorrow if there is cooperation today is associated with a neutral self-reinforcement factor.

We can now model Institution 1, weak Institution 1, and Institution 2 as a game theoretical model of endogenous institutional change with quasi-parameters (Greif, 2006). We will assume that weak Institution 2 is an unstable institution that over time will fall into one of the other three types. As an illustration, we take the three-player coordination game above. In this model, we see how self-reinforcement factors reaffirm initial trajectories that lead to either a complete, stagnant, or deteriorating progress through the incentives of the players to initiate good cooperation (associated with positive local capture) or bad cooperation (associated with negative local capture).

Proposition 2.1 and 2.2

(Weak) Institution 1(2) at time t: a(t)-a(t-1)$\geq$(<)0, a_0=10

	LL\LE	G	B
Good Cooperation(G) by Citizens(C):	G	a_t,a_t,a_t	6,0,6
	B	3-ε,4,4	6,6,-1

	LL\LE	G	B
Bad Cooperation(B) by Citizens(C):	G	7,7,-1	3-ε,6,6
	B	6,0,6	3,3,3

Rules at t: local regulations and central regulations (environment effects)

Beliefs and norms at t: corruption/collusion/nepotism of

past institutions (inclusion effects),

legal laws and punishment (coordination effects)

Organizations at t: local leaders, local elites, citizens

Implied behaviors at t: G=Good Cooperation, B=Bad Cooperation

Take an example of Institution 1: Balikpapan. In this district, because the initial socioeconomic conditions are high, citizens are capable of participating in the political arena. Because the citizens are politically informed and participation level is high, a high quantity-quality of leadership is elected (Type A). If the local leader, the local elites, and the citizens cooperate, local capture is positive and welfare increases. Because welfare increases, a better leader is elected in the following period and participation level is higher. The payoff from all cooperating in the next period is even higher. In the long run, more cooperation among the local leader, local elites and citizens are established. This is evident from the growing business activities with the supports of the local government.

Take an example of Weak Institution 1: Prabumulih. In this district, despite the high initial socioeconomic conditions because of oil and gas, quality of local leader is low (Type B/C) and participation level is low. Cooperation by the local leader and the local elites as well as the citizens does not increase welfare or even decreases welfare because low quantity-quality of local leader reaps the benefits from cooperation or initiates projects for private gains. However, because the district is rich in rubber, and other natural resources, the citizens are able to maintain a moderate standard of living. It is known that villagers are able to maintain fixed incomes by working in rubber plantations and sharing the incomes with the owners, while city dwellers are more likely to fall into poverty. There is no gain from cooperation in the next period by cooperating in the current period. In the long run, cooperation among local leader, local elites and citizens are stagnant.

Take an example of Institution 2: Manggarai Barat. In this district, the initial socioeconomic condition is poor, participation level is low, and hence, quality of local leadership is low (Type C). Cooperation today may result in bad projects, such as the Aldira project in which cooperation by local leader, local elites, and citizens to plant new Tapioca seeds fails because of the wrong choice of season (low quality and unprofessional leaders without sufficient local accountability), thus lowering welfare. An even worse quality local leader is elected in the following period and participation level is lower. The gain from cooperation in the next period is therefore lower. In the long run, less cooperation among local leader, local elites and citizens are established. This is evident from the shrinking business activities.

Although our field study reveals no district that we study that falls into weak Institution 2, a possible example of weak Institution is Blitar City, in which so-

cioeconomic condition is moderate, and the local leadership is relatively good. We might argue that weak institution 2 might arise despite poor natural resources because citizens work hard to establish high-quality institutions and because of this, a good local leader is elected.

Proposition 2.1 *In a three-player Coordination game of Example 3 above, under Institution 1 and weak Institution 1, cooperative behaviors by local leaders, local elites, and local citizens are (weakly) self-reinforcing for any discount factor.*

Proof. Under positive self-reinforcement or neutral self-reinforcement, (G,G,G) is a one-stage Nash equilibrium in each period. Hence, no unilateral deviation is profitable. Playing (G,G,G) in every period constitutes a sub-game perfect Nash Equilibrium. ∎

Proposition 2.2 *In a three-player Coordination game of Example 3 above, under Institution 2, cooperating is not self-reinforcing for any discount factor.*

Proof. Under negative self-reinforcement, at some period t, (G,G,G) is no longer a one-stage Nash equilibrium. The citizens at some period T will have an incentive to deviate to playing B. ∎

Although there is no observation of weak Institution 2, we claim that under weak Institution 2, cooperative behaviors by local leaders, local elites, and local citizens, are weakly self-reinforcing for any discount factor because socioeconomic condition is only moderate in this district, which is possible only if self-reinforcement is zero. Although both weak Institution 1 and 2 have zero self-reinforcement factors, each has its own institutional complexes.

Claim 2.2 *In a three-player Coordination game of Example 3 above, under weak Institution 2, cooperating is weakly self-reinforcing for any discount factor.*

The evolution between welfare and qualities of institutions in the presence of self-reinforcement factors is shown in Figure 16. In the long-run, Institution 1 can be associated with "complete" progress; Institution 2 can be associated with "deteriorating" progress; weak Institution 1 and 2 can be associated with "stagnant/ incomplete" progress respectively (Azis, 2008).
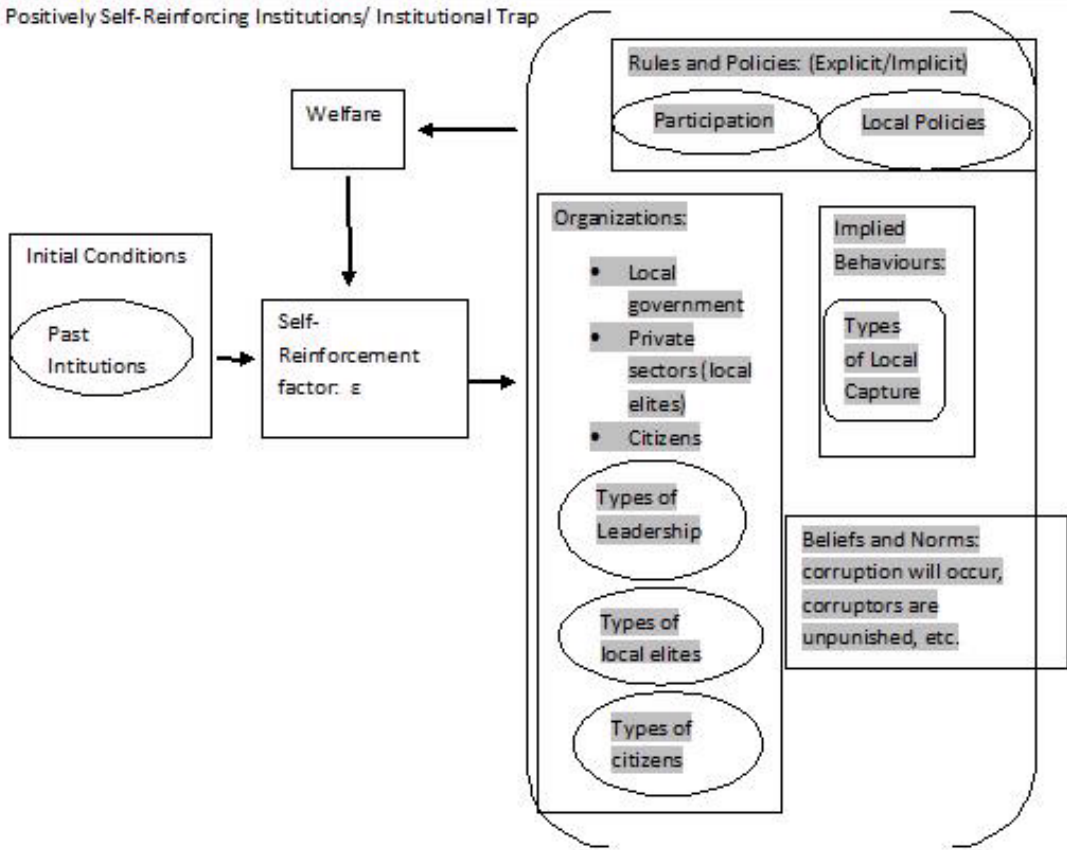
Figure 2.16: Evolution of Intitutions and Welfare

2.5.5 The Path from Dictatorship to Democracy

The previous section shows how the quality of institutions is endogenous to the level of welfare. We show a particular example of a poor district, in which some negative self-reinforcement factors are present that will eventually deteriorate both the quality of institutions and the welfare of the district resulting in declining progress. From this result, we will show that the process towards democracy from dictatorship in Indonesia will not be easy, and might lead to a more serious outcome, such as a revolution. Sukma (2003) writes that the democratic regime in Indonesia after three decades of dictatorship with no rule of law exists with no democratic rule of game. There is still no effective legal system nor a democratic competition. Physical pressures and threats are still used as political weapons. Local conflicts cannot be resolved because, unlike the previous period, the military cannot be used. These are *de facto* rules of the game in the post-Soeharto era in Indonesia. After Indonesia decentralized, taking effect in 2001, *de jure* democratic rules consisted of direct local elections, decentralized fiscal policies, increased shares of local revenues from local natural resources. It was out of a selfish political motivation to appease the public that the decentralization law was passed right after the political and economic turbulences in 1997-1998. At the time, that local institutions were still very weak and socioeconomic conditions of the people in many districts were still very poor. Instead of having a more democratic political regime, in which there is a fair election, freedom to speak, and access of information to the citizens, many regions experienced a reversal to democracy in which the *de jure* democratic rule exists in the absence of a democratic rule of the game. In many regions, especially poor districts, local leaders were elected by poor, uneducated and uninformed citizens, making the local leader a local King without accountability from above (central government) nor below (citizens).

Moreover, Indonesia decentralized at a time when the roots of corruption have not been completely eliminated and the power of the old King has not truly vanished. Although there have been some efforts by a newly built independent anticorruption body (KPK in Indonesian) to reform, the post-Soeharto institutions, most of which are inherited from the past, could not make a clean government sustainable at the level of welfare of the people. One of the main reasons that the culture inherited from the Soeharto era is difficult to eliminate is that the political change after the fall of Soeharto was not a complete change from the Soeharto era, but an *incrementalism* (Cassing, 2000). The next appointed president was one of his close associates and the new cabinet was full of his cronies and family. Only political rivals could slowly change this. It is therefore not surprising that the appointments of local district leaders and central government officials are not completely free of influence from the former regime. As a result, instead of uprooting corruption, corruption spreads to localities and lower level state departments and organizations. Local capture as a result of closer political distance between local elites and local leaders erodes the fruits of the new democratic regime, as local elections are financed by local elites who capture local policies after the seats are won.

We are going to show a simple example of what could happen if *de jure* democratic regime exists with lawless rules of game. There might be a revolution in which the democratic system collapses. Suppose there are three players in this game: a local leader, a local elite, and a local citizen. For simplicity, the local leader distributes c portion of the local revenues, R, in each period to the citizen. Because central government taxes regions after the decentralization not on local revenues but on local expenditures, the taxes owed to the central government is t, the tax rate, times whatever is left for the local government expenditure, *(1-*

c)R, which is equal to *t(1-c)R.* Hence, the net local government expenditure is *(1-t)(1-c)R,* which we assume can be used by the local leader to buy ballots, finance personal legal cases, or repay debts to campaign contributors namely the local elite. In each period, the local elite makes an investment in political power, *I,* that is a function of the net local government expenditure, *(1-t)(1-c)R_t.* The higher the net local government expenditure, the higher one invests in political power because the expected share by cooperating with the local leader is higher. In this case, suppose local elites invest in political power for their own benefit and not the benefit of the citizen, in which case they will invest more if the expected wealth is less. For simplicity, assume that $I_t=i(1-t)(1-c)R_t$, where $i \geq 0$. The parameter i may measure the political distance of the local elite to the local leader. The closer the political distance, the higher i is because there is a higher probability that cooperation with the local leader results in a profitable outcome for the local elite. Because of this cooperation, local capture can be negative or positive depending on the participation level of the citizen. The participation level of the citizen depends on the level of welfare of the citizen in the previous period, because, as we have shown, participation level is endogenous with respect to the level of welfare of the citizen. For example, more educated citizens could participate more. Assume that the participation level is $P_t=pW_{t-1}$, where $p \geq 0$ Moreover, the local revenue R is a function of the social condition of the citizen, which is a function of the level of welfare of the citizen in the previous period. For example, healthier citizens are more productive. Assume that $R_t=W_{t-1}$. The welfare of the citizen is the sum of the local government's transfers plus the effect from local capture that can be either negative or positive. The welfare of the citizen can be written as follows:

$$W_t = cR_t + (P_t - k)(I_t)$$

This says that the degree of local capture that affects the citizen is equal to the investment in political power made by the local elites weighted by the degree of local accountability that is equal to the participation level minus a constant k. If the participation level is above the critical level k, then investment in political power is positive, while it is negative if the participation level is below this critical level k. Thus, cooperation between a local leader and a local elite without sufficient local accountability from the citizen usually becomes detrimental to the citizen. The constant k measures the underlying formal and informal institutions that regulate cooperation by local leader and local elite, other than the participation of the citizens. Higher values of k correspond to higher levels of participation needed to induce positive local capture, or they may mean weak formal legal institutions, for example. By our assumption, we can write the welfare of the citizen as follow:

$$W_t = cW_{t-1} + (p(W_{t-1}) - k))(i(1-t)(1-c)W_{t-1})$$

$$W_t = (c - ki(1-t)(1-c))W_{t-1} + (pi(1-t)(1-c)(W_{t-1})^2)$$

Consider the following case:

$$(c - ki(1-t)(1-c)) \leq 0$$

$$pi(1-t)(1-c) \geq 0$$

The second inequality is always true for p and i greater than or equal to zero, and t and c less than or equal to one. Re-arranging the first inequality:

$$c \leq \frac{ki(1-t)}{1 + ki(1-t)}$$

In this case, the portion of the local revenue that is distributed to the citizen is small enough compared to the degree of negative local capture, *ki,* and the portion of the local revenues minus the distribution to the citizens that goes to the local government, *(1-t).* The lower the portion of local revenue distributed to the citizen, the more likely that the inequality holds. The higher the degree of negative local capture, *ki,* and/or the higher the portion of the local revenues less the distributions to the citizens that goes to the local government, *(1-t)*, the more likely that the inequality holds. Figure 17 plots the possible trajectory of welfare over time given these two inequalities hold:
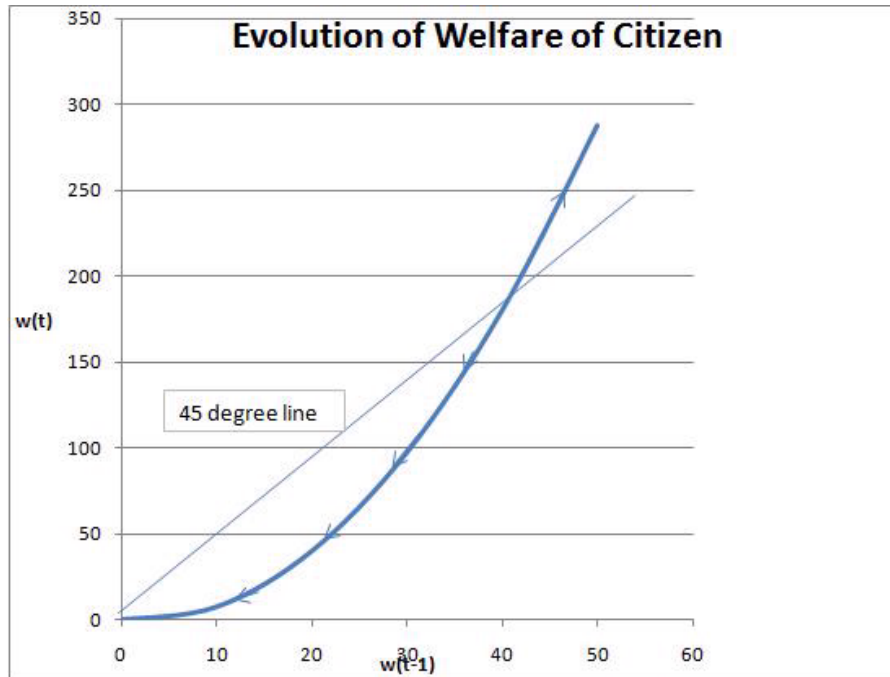
Figure 2.17: The Process to Revolution

What we see from the graph is a declining level of welfare to the point zero if W_0 is small enough. At W=0, a revolution could occur, in which case people will become dissatisfied enough and revolt. A breakdown of democracy and another institutional change might occur.

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2.6 Policy Recommendation

From the previous result, we introduce new insights on institutional reform. Initial welfare entails different institutional complexes that set different capacities to reform. Our results have two major policy implications. One is that institutional reform must ensure some level of welfare in which high qualities of institutions will be sustainable. Efforts to reform institutions may therefore include ensuring that low-ranked public officials receive sufficient wages and other welfare benefits to support their families. Well-paid public officials could also corrupt, as is evident in developed countries, but we argue that not paying public officials sufficiently could exacerbate institutional problems. In the context of Indonesia, Seda (2001) inserts, "although Soeharto is no longer in power today, however, petty corruption in the Indonesian government as well as in society at large is very likely to continue for a long time. There are several sets of conditions that are conducive for corruption to endure (King 2000:608). One set of conditions pertains to the social economic status of government bureaucrats. Their salaries are notoriously low and have not kept pace with the cost of living, particularly in the major cities."

Second, because initial welfare is associated with different institutional complexes and set different capacities to reform, institutional reform must be targeted differently among different districts. In the case of a very poor district, for example, before institutional reform can occur, citizens must be capable of participating in the social programs. We call this type of institutional reform a *welfare-based* approach.

It is also important to note that in order to change an endogenous system, policy reforms need to be *multidimensional*. Policy reforms will only work to change an

evolution between low welfare and poor quality of institution if it is approached from multiple angles, improving *both* welfare and quality of institution. Myrdal (1944) wrote, "a rational policy will never work by changing only one factor" (p.77). This is particularly true in the case of an endogenous system. In order for the system to work well, these two variables must reinforce each other. Moreover, Greif (2006) writes that,"rather than focusing only on helping countries specify rules, it will have to seek to change organizations, beliefs, and intertransactional linkages" (p.403).

One important observation that we made during the field study was that corrupt poor districts tend to carry many mega or white-elephant projects despite the rampant poverty. It has been known that white elephant or mega projects may elicit high mark-ups because of their size and value and these illegal payments are shared between the local government and the local elites who implement the projects. It is therefore recommended that independent watchdogs be able to recognize this.

Endogenous institution creates an evolution between welfare and qualities of institutions. In order to break the cycle, an *exogenous* shock is sometimes needed. This shock may come from outside the system, such as a natural disaster (e.g., the case of Aceh) or adopting Western or formal style institutions, or it may come from within, such as a sudden demand for a change or "voice" (Hirschman, 1970), such as a revolution. Dixit (2004) writes that the institutional reform is often faced with the question of whether to adopt Western laws or to keep local customs, or, in other words, whether to induce external shock therapy or to allow gradualism. However, he argues that typically, the best choice is a subtle combination. In some cases, in Indonesia, for example, exogenous shocks from outside the system such

as modern medical treatment without adjustment to the local customs, in this instance traditional medical treatment, might not work. A health care program that gives free health care services might not work if the local people do not believe in medical treatment but believe in magical treatment (or Dukun, in Indonesian). Again, it must be adjusted to the institutional complexes, namely cultural beliefs, norms, and social as well as political conditions. Dixit (2004) further calls for the need of country-specific knowledge to generate policy prescription for a one specific country. Hence, institutional reforms must also be *context-based.*

Dixit (2008) argues that a relation-based contract enforcement that is based on localization of information and honesty is not sustainable after some level of development, or some size of economic activities because of constraints on communication technology. Because of this, middle-income countries, such as Indonesia, might be trapped in a situation in which relationship-based contract enforcement no longer works, but the size of the economic activities or level of development is not big enough to afford a rule-based contract enforcement. Moreover, issues surrounding collective action and political incentives of those who stand to lose from a change in institutions make institutional transition still more difficult. In most cases, the relation- and rule-based systems coexist. Dixit argues that the best combination between relation- and rule-based systems will depend on the history and economic prospects of each country. In the context of Indonesia, institutions are still dominated by relation-based systems.

We discuss the importance of participation level in determining the long-run progress of a district in Indonesia[6]. The importance of participation level in curb-

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[6]This argument is supported by an Analytical Network Process (see Appendix IV) that is performed for each district that ranks the level of participation as the most influential factor to determine welfare among the poverty level and inequality given a network of factors that could influence welfare. ANP is a pairwise comparison - based analysis given a network of factors that could determine a variable, which in this case is welfare. Author's opinions are used to make

ing corruption is ingeniously captured by Serra (2008), who conducts an experimental study on bribery games that show that combining bottom-up and top-down monitoring on corruption is most effective even if the institution is weak. Trust-based, informal institutions may also help to attenuate institutional constraints (Della -Giusta, 2008). Providing access of information to voters, thus avoiding a narrow flow of information to only specific interest group is necessary (Economic Review, RIETI, 2009). Some specific interests groups with access to the government can overcome asymmetric information between the government and voters. Hence, specific interest groups have an informational advantage over general voters about government internal information in order to organize activities. However, these specific groups could hurt the majority of voters by organizing activities that serve the group interests only. In general, access of information to general voters is necessary because the failure to retrieve government information could distort the outcome of the election, and as a result, create a vicious cycle of bad leadership and low welfare with poor and uninformed participation of voters.

In summary, policy implications on institutional reform are subtle. However, this study highlights a few possible ways to reform. Institutional reform must be welfare-based and context-based to allow adjustments to different institutional complexes and capacities to reform as well as different cultural beliefs, norms, political and social conditions. Due to the endogeneity of the system, it must come from some exogenous shocks such as formal (or rule-based) institutions. It might be that these exogenous shocks come from a sudden demand for change or revolution. Moreover, institutional reform must be multidimensional due to the endogenous nature of the problem, requiring both variables, welfare and institutions, to reinforce.

the pairwise comparisons.

In the context of Indonesia during the post-decentralization period, reforms must focus on local institutions. Due to the closer political distance between local leaders and local elites and the political and fiscal transfer of authority from the central government to the local leaders, the degree of local capture increases and in many cases, local leaders become "local kings". Thus, one possible way to reform both institutions and welfare is to have the central government introduce incentive systems that both punish corrupt local leaders, for instance, by an establishment of an anti-corruption body and reward districts that achieve some targeted social indicators, for instance, giving awards to districts that are able to consistently reduce poverty level. Another possibility could be to introduce a combined top-down and bottom-up approach as is suggested by Serra (2008). Central government must be able to provide legal rules to ensure participation of citizens in regulating local policies, and must be able to empower the citizens to raise their voices and demand for change (Hirschman, 1970). Relationship-based systems, such as cooperation between local leaders and local elites, must be combined with rule-based institutions. Thus, investments in rule-based institutions may also be necessary. Because of the heterogeneity of Indonesian districts, welfare-based and context-based approaches are also important.

2.7 Conclusion

In this paper, we first lay out a game theoretical model to illustrate the endogenous system of institution through self-reinforcement factors based on Greif, 2006. We then use real-life case studies gathered from our field study in Indonesia to rationalize our game theoretical model. We place this model in the context of institutions in Indonesia, based on the past institutions and socioeconomic condi-

tions of the districts we visited. We categorize these districts into different types of institutions by their initial socioeconomic conditions based on the evidence from our field study, and propose possible institutional trajectories and progresses in the long-run. We support our propositions by game theoretical analysis to model the economic incentives for local leaders, local elites, and citizens to behave in a way that could self-reinforce good or bad quality institutions.

We show that institutions are not exogenous and the policy implications on institutional reform could be more complicated. Districts with low level of socioeconomic conditions have different institutional complexes than districts with high level of socioeconomic conditions. Because of the poor socioeconomic conditions, participation level tends to be high, local capture tends to hurt the citizens, and quality of leadership tends to be low. Moreover, we agree with Greif's remark (2006) that initial socioeconomic conditions and past institutions determine the capacity of how an institution can change. Efforts to reform may fail simply because poorly educated and politically unaware citizens do not have the capability to participate in government programs or elect good local leaders. It is true that wealthy countries also face issues of bad institutions. Hence, there are other factors aside from socioeconomic conditions that affect institutions. However, we argue that low level of welfare could make institutional reforms even more difficult. For a policy recommendation, we suggest that institutional reforms be taken differently among regions with different levels of welfare, accounting for different institutional complexes and capacities in which institutions are formed. We also suggest that policies to reform endogenous institutions must be multidimensional and exogenous to the system.

Our results on the diversity of progress among districts in Indonesia could

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be related to the Cai and Treisman (2005) paper in that these districts are not homogeneously endowed. The fact that some regions have strong power of political and business elites that tend to dominate both political and economic institutions in this *de jure* democratic country may partly correspond to what Acemoglu and Robinson (2002) call "captured democracy." In these districts, the *de jure* political democracy has been captured by *de facto* investments by the elites. Democracy in Indonesia might have been failing because it exists with a high degree of local capture in the post-decentralization period. Barseghyan and Guerdjikova (2008), Acemoglu et. al. (2002) might refer to a naturally rich but relatively poor district like Prabumulih as experiencing a "reversal of fortune" or a curse of rich natural resources. This is also evident in some districts in East Indonesia, especially those with rich natural resources. In Barseghyan and Guerdjikova (2008), the cause of reversal of fortune is related to the low bargaining power of the citizens.

The purpose of this paper is to understand the driving force behind the persistence of low welfare and poor qualities of institutions. The game theoretical model used in this paper merely illustrates how this driving force could self-reinforce or self-undermine the existence and quality of an institution. A more sophisticated game theoretical model could be useful to better understand the evolution of institutions.

Moreover, more empirical studies are needed to advance the studies on institutions. A more comprehensive district survey studied over a period of time and more districts surveyed could improve the quality of our field study. In a district with rich natural resources, such as the city of Balikpapan, an unequal society is more likely to emerge. The glitters of some parts of the city could easily conceal the other parts of the city where the marginalized groups of citizens live. Hence,

it is easier to conduct a biased interview by interviewing only those who are in the circle of the elites while being completely blind to the marginalized society. A higher number of participants from the poorest of the poor societies is necessary. Interactive, deductive, inductive, context-specific, and evidence-based model complemented by comparative and counterfactual analyses is the empirical method that is proposed in Greif (2006), which we believe is the appropriate method to use. Other methods, such as the Analytical Network Process, could enrich our field study.

There are two main reasons why neither pure deductive nor inductive method alone is not sufficient to study institution: it cannot predict the endogenous outcomes given a set of exogenous and observable features of the situation because of a multiplicity of equilibria; and observable endogenous variables are not sufficient to give a meaningful theoretical model of institution (Greif, 2006). Our model could be improved by eliminating a multiplicity of outcomes or indeterminacy that could still arise given an initial socioeconomic condition. For example, given a moderate socioeconomic condition, both low and high quality of institution could arise (Weak Institution 1 and 2). Moreover, it could be improved by distinguishing different types of beliefs, norms, other institutional elements that could give rise to the same initial socioeconomic condition. For example, in the case Prabumulih and Sragen, both districts have moderate socioeconomic conditions, however, each of districts has different institutional elements that give rise to the same level of socioeconomic condition. In the case of Prabumulih, rich natural resources combined with poor quality of leadership yield moderate socioeconomic condition. However, in the case of Sragen, moderate natural resources combined with "forced" local government programmes yield moderate socioeconomic condition. In the long-run, these two districts will have different types of institutions

and progress. This work is miniscule when compared to the works left to be done in endogenous institutions and institutional reforms.

APPENDICES

Appendix I: Summary Reports of Five Districts Field Survey in Indonesia (summer 2008) (Azis and Wihardja, 2008)

The field study is conducted in five districts in Indonesia: Balikpapan in East Kalimantan, Yogyakarta in D.I. Yogyakarta, Sragen in Central Java, Manggarai Barat in NTB, and Prabumulih in South Sumatra. With the help of a local autonomy watchdog, KPPOD, the author and a member of KPPOD visited each district. In each district, we interviewed the Regent/Mayor (except in Prabumulih), high-ranked public officials, political parties, oppositions such as losing political candidates, business associations, NGO's, local media, and poor-family card holders. We spent one to two hours for each interviews and three to one week in each district. Questionnaires were prepared prior to the field study that were approved by Institution Review Board at Cornell University for confidentiality of the participants. All interviewed were tape-recorded and transcribed. After the interviews, the author and field researchers from KPPOD discussed to quantify the results from the interviews into scale-based indicators. The primary indicator table and secondary indicators are given below. The following guidelines are the sample guidelines used to interview our participants. The results are in the tables proceeding the guidelines.

Indicators:

I. Primary Indicators:

Local Leadership	Quantity (PAD Growth/GRDP Growth)	Fund management from local capture to increase local economy (PAD and GRDP growth)
		Establishment of private-public enterprises
		The level of investment created from private-public enterprises
	Quality (Corruption/ Collusion/Nepotism	The intensity of corruption/collusion/Nepotism by the Mayor/Regent
		Private benefit vs. public benefit from local capture
		Efforts to elimininate corruption, collusion, and nepotism, and efforts to improve welfare
		Social Programs
Participation Level	MUSRENBANG	Effectiveness of bottom-up project planning process (MUSRENBANG)
	Access to information	Political awareness/ Access of information to poor and illiterate people
		Transparency of local budget
		Responsiveness of complaints
	Freedom to speak	Level of intimidations
Local Capture	Public procurement auctions	
	Formulating local regulations	
	Social programs	
Welfare	Poverty	What are the factors related to local capture?
	Inequality	What are the factors related to local capture?
	Health	What are the factors related to local capture?
	Education	What are the factors related to local capture?
	Unemployment	What are the factors related to local capture?

Figure 2.18: Primary Indicator

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II. Secondary Indicators: (source)

1. Quantity of Welfare

a. Growth of RGDP in constant price (RGDP)

b. RGDP per capita in constant price (RGDP)

c. (PAD)/ (Total Budget APBD) (APBD)

d. Growth of (total) investment (Industry/Trade/Cooperative Dept., or others)

e. (Profit from BUMD)/PAD (APBD)

f. (Realized budget for 9-year compulsory education)/(Pop. 5-14 yrs old) (APBD, City/Regency In Figures)

g. (Budget for road construction)/(#km's of roads severely damaged) (APBD, City/Regency in Figures)

h. (Budget for health)/(the number of poor people) (APBD, City/Regency in Figures)

2. Quality of Welfare

a. Human Development Index (City/Regency in Figures)

b. Poverty rate (Social Welfare Dept., or others)

c. Gini ratio (Social Welfare Dept. or others)

d. Infant Mortality Rate (Health Dept.)

e. Literacy Rate (Education Dept.)

f. Crime rate (Social Welfare Dept.)

g. Unemployment (Human Resource Dept.)

h. Local public - private sector partnership in physical infrastructure constructions (LKPJ)

i. Local public- private sector partnership in building joint-ventures (LKPJ)

j. Local public - private sector partnership in health sector (LKPJ)

k. Local public - private sector partnership in education (LKPJ)

l. Local public - private sector partnership in crime prevention (LKPJ)

m. Government programme in SME's (micro-finance, soft-loans) (LKPJ)

3. Participation

a. Regular forum between local government and stakeholders (coffee morning, etc) (LKPJ)

b. APBD publication in local media/website (Local Media/Website)

c. (#of female DPRD)/(Total #of DPRD) (DPRD)

d. Health, Education, and Poverty Reduction (Social Welfare Dept. and other Dept.'s)

e. Information to gov' programs in health, education, and poverty reduction (LKPJ)

Note:

PAD=local revenues, APBD= local budget

BUMN= state companies, LKPJ=Responsibility Boldness Report

DPRD=local People's Representatives Body

Sample Guideline for Interview 1:

Assessment Sheets(For Regents/Mayors)

Interviews should be conducted with 4-5 questions (1-hour). The three topics that should be kept in mind when interviewing are:

A.   The motives of Regents/Mayors in establishing relationship with local businesses: private or public interest?

B.   Vision and Mission: what are the notable achievements?

C.   Background: is the Regent/Mayor used to be a local businessman who might be very skilled in establishing local business connection and in managing funds?

The following questions might help answer those questions: (always relate to local capture)

1.   Programs on investment?

2.   Programs on welfare?

3.   Notable changes from previous programs/ achievements?

4.   Regular Forum with Local Businesses?

Sample Guideline for Interview 2:

Assessment Sheets

(For BAPPEDA/ DPRD/ Political Parties/ other Local Public Officials)

This questionnaire is addressed to Mayor's/Regent's, however, some of the questions are sensitive that cannot be directly addressed to Mayor's/ Regent's. Hence, in order to answer the questions in these questionnaires, they can be addressed to BAPPEDA, DPRD, political parties, etc.

Part 1: In-depth interview. With these assessments, we should be able to identify the progress of the districts (complete, incomplete, stagnant, deteriorating).

Section I & II: Endogenous Institution and Decentralization (Ask if necessary)

Section III: Local Capture

A.   General (Ask if necessary)

B.   Public Procurement Auction

21.   How is auction conducted? Public auction, direct selection, direct appointment?

22.   How can the local association of contractors (GAPENSI) affect the process of the auction?

23.   Is there any association that is usually given government projects?

24.   Is there a controlling body for these activities:

1.   Budget allocation

2.   *Internationally accepted qualities*

25.   *Is sub-contracting allowed? Any effort to reduce sub-contracting?*

C.   *Local Regulation (Ask all)*

D.   *Social Program (Ask all)*

(Interviewers: identify the intensity of local capture)

Section IV: Local Leadership

A. Quantity

1.   *How is the relationship between the Mayor/Regent with local businesses in generating local revenues and production? (What has been realized?)*

2.   *How is the relationship between the Mayor/Regent with local businesses in establishing public-private business partnership, including government holding shares in private companies?*

3.   *How is the relationship between the Mayor/Regent with local businesses to improve both local and foreign investments?*

B. Quality

51.   *Has the Mayor/Regent been charged with corruption/collusion/nepotism? (If there is any specific case the interviewer knows of, address it here).*

52.   *During the Mayor/Regent, is he/she also active in running businesses?*

53.   *What are the efforts by the leader to combat corruption, nepotism, and collusion?   What are the efforts by the leader to increase the standard of liv-*

ing/ social conditions of the citizens, such as infrastructure, poverty alleviation, inequality, participation?

(Interviewer: Identify the type of local leadership- type A, B, or C)

Section V: Participation

1.   Has a regular meeting between government officials and representative citizens been held? Who attends it? What sorts of local policies, public projects, etc., that are the fruits from this meeting?

2.   Who are the stakeholders?

3.   Is there any access to and from poor and illiterate citizens?

4.   How transparent is the budget planning statement (APBD)?

5.   Can citizens give their inputs or report their complaints in the formulation and implementation of local and national public projects?   How effective is this?

(Interviewer: Identify the level of participation)

Section VI: Welfare (Ask all)

Section VII: Others (Ask if necessary)

Part 2: ANP. With these assessments, we should be able to identify the factors and to what extent they affect the quantity and quality of welfare.

Section VIII: ANP (Ask all)

Appendix I.1: Balikpapan

Appendix I.11: Balikpapan - Secondary Data (Source: In-depth Interviews, Balikpapan City in Figures, East Kalimantan Province in Figures, LKPJ, APBD & other data collection from governmental departments and participants.)

Table 2.15: Balikpapan - Secondary Data

Economic	Figures
Growth of GRDP in constant price (inlc. oil & gas)	3.23% (2005), 5.4% ('06)
Growth of GRDP in constant price (excl. oil & gas)	7.52%* (2005), 6.14%* ('06)
GRDP per capita in constant price (incl.oil & gas)	Rp.26.713.000,00 ('05)
GRDP per capita in constant price (excl. oil & gas)	Rp.14.480.068,00 ('05), Rp.14.747.546,00 ('06)
PAD/ APBD	10.32%(2005), 9.64%('06), 8.83%('07)
Growth of Investment	13.5% ('07), 55.27% ('08)
Level of Investment	Rp. 4.401.733.830.000,00 ('07), Rp.6.834.660.560.000,00('08)

Social	Figures
Poverty Rate (Level)	3.69% ('06)
Poverty Rate (Negative Growth)	2.895% ('02-'06)
Inequality	.23('03?), 0.09('05)
IMR	28.76 ('00)
Literacy Rate	96.75% ('05)
Unemployment	8.89% (2005)
HDI	70.6 ('99), 73 ('02), 76.1 ('05)
HDI Growth 2002-2005	4.25%

Appendix I.12: Balikpapan - Primary Data (Source: In-depth Interviews)

Table 2.16: Balikpapan - Primary Data

Indicator	Sub-Indicator (equal weights)	Scale
Local Leadership (Quantity)	Fund Management	9
	Joint Public-Private Partnership	5
	Attracting Investment	8
Local Leadership (Quality)	(Absence of) Corruption/Collusion/Nepotism	9
	Public (vs. Private) Interest	7.5
	Efforts to eliminate C/C/N	8
	Innovations of Social Programs	8
Local Capture	Public Procurement Auctions	5
	Local Regulations	5
	Crowding out of Social Programs	5
Participation	Effectiveness of MUSRENBANG	8
	Access to information	9
	Freedom to speak (vs. Intimidation)	9
Initial Social Conditions	Poverty Level (2006)	9.5
	IMR (2000)	8.5
	Literacy Rate (2005)	8.75
	Unemployment Rate (2006)	8.75

Appendix I.2: Manggarai Barat

Appendix I.21: Manggarai Barat - Secondary Data (Source: In-depth Interviews, Manggarai Barat in Figures, NTT Province in Figures, LKPJ, APBD & other data collection from governmental departments and participants.)

Table 2.17: Manggarai Barat - Secondary Data

Economic	Figures
Growth of GRDP in constant price (inlc. oil & gas)	3.07% ('05), 3.68%*('06)
Growth of GRDP in constant price (excl. oil & gas)	3.07%('05), 3.68%*('06)
GRDP per capita in constant price (incl.oil & gas)	Rp.1.682.000,00 ('05), Rp.1.694.034,98*('06)
GRDP per capita in constant price (excl. oil & gas)	Rp.1.682.000,00 ('05), Rp.1.694.034,98*('06)
PAD/ APBD	3.90%('05), 2.35%('06), 3.21%('07)
Growth of Investment	-
Level of Investment	-
Social	Figures
Poverty Rate (Level)	29.51%('03), 29.13%('04), 29.28%('06)
Poverty Rate (Growth)	.78%('03-'06) (no data in '02)
Inequality	.268 ('06), .28 ('07)
IMR	55.65 ('00)
Literacy Rate	88.74%('05)
Unemployment	(Estimated 6%) ('07)
HDI	(no data) ('99,'02),63.2 ('05)
HDI Growth 2002-2005	(new district)

Appendix I.22: Manggarai Barat - Primary Data (Source: In-depth Interviews)

Table 2.18: Manggarai Barat - Primary Data

Indicator	Sub-Indicator (equal weights)	Scale
Local Leadership	Fund Management	3
(Quantity)	Joint Public-Private Partnership	5
	Attracting Investment	3
Local Leadership	(Absence of) Corruption/Collusion/Nepotism	3
(Quality)	Public (vs. Private) Interest	4.5
	Efforts to eliminate C/C/N	4.5
	Innovations of Social Programs	4.5
Local Capture	Public Procurement Auctions	9
	Local Regulations	6.5
	Crowding out of Social Programs	7.5
Participation	Effectiveness of MUSRENBANG	3
	Access to information	2.5
	Freedom to speak (vs. intimidation)	4
Initial Social Conditions	Poverty Level (2006)	1.5
	IMR (2000)	1.5
	Literacy Rate (2005)	6.6
	Unemployment Rate (2006)	8

Appendix I.3: Yogyakarta City

Appendix I.31: Yogyakarta City - Secondary Data (Source: In-depth Interviews, Yogyakarta City in Figures, D.I. Yogyakarta in Figures, LKPJ, APBD & other data collection from governmental departments and participants.)

Table 2.19: Yogyakarta City - Secondary Data

Economic	Figures
Growth of GRDP in constant price (inlc. oil & gas)	4.88%('05), 3.96%('06)
Growth of GRDP in constant price (excl. oil & gas)	4.88%('05), 3.96%('06)
GRDP per capita in constant price (incl.oil & gas)	Rp.10.109.232,70 ('05), Rp.10.322.561,79 ('06)
GRDP per capita in constant price (excl. oil & gas)	Rp.10.109.232,70 ('05), Rp.10.322.561,79 ('06)
PAD/ APBD	22.4%('05), 18.3('06), 18.55%('07)
Growth of Investment	-
Level of Investment	-
Social	Figures
Poverty Rate (Level)	10.13% ('06)
Poverty Rate (Growth)	27.686%('02-'06)
Inequality	-
IMR	20.81('00); 4.9 ('06)
Literacy Rate	97.10%('06)
Unemployment	7.04%
HDI	73.4('99), 75.3('02), 77.7('05)
HDI Growth 2002-2005	3.19%

Appendix I.32: Yogyakarta City - Primary Data (Source: In-depth Interviews)

Table 2.20: Yogyakarta City - Primary Data

Indicator	Sub-Indicator (equal weights)	Scale
Local Leadership	Fund Management	8
(Quantity)	Joint Public-Private Partnership	7
	Attracting Investment	7
Local Leadership	(Absence of) Corruption/Collusion/Nepotism	8.5
(Quality)	Public (vs. Private) Interest	9
	Efforts to eliminate C/C/N	7.5
	Innovations of Social Programs	7.5
Local Capture	Public Procurement Auctions	5.5
	Local Regulations	7
	Crowding out of Social Programs	5
Participation	Effectiveness of MUSRENBANG	8
	Access to information	8.5
	Freedom to speak (vs. intimidation)	9
Initial Social Conditions	Poverty Level (2006)	7.5
	IMR (2000)	9
	Literacy Rate (2005)	9
	Unemployment Rate (2006)	8

Appendix I.4: Sragen

Appendix I.41: Sragen - Secondary Data (Source: In-depth Interviews, Sragen in Figures, Central Java Province in Figures, LKPJ, APBD & other data collection from governmental departments and participants.)

Table 2.21: Sragen - Secondary Data

Economic	Figures
Growth of GRDP in constant price (inlc. oil & gas)	5.16% ('05), 5.18%('06)
Growth of GRDP in constant price (excl. oil & gas)	5.16%('05), 5.18%('06)
GRDP per capita in constant price (incl.oil & gas)	Rp.2.710.505,85 ('05), Rp.2.836.602,94('06)
GRDP per capita in constant price (excl. oil & gas)	Rp.2.710.505,85 ('05), Rp.2.836.602,94('06)
PAD/ APBD	7.53% ('07), 7.04%('08)
Growth of Investment	25.65% ('06), 8.33% ('07)
Level of Investment	-

Social	Figures
Poverty Rate (Level)	33.69% ('00), 27.11%('01), 24.28% ('05), 23.72%('06), 21.35%('07)
Poverty Rate (Growth)	15.164%('02-'06)
Inequality	.280 ('06), .283 ('07)
IMR	32.74('00); 14 ('06)
Literacy Rate	74.89% ('05)
Unemployment	4.19%('05)
HDI	62.3('99), 64.9('02), 66.6('05)
HDI Growth 2002-2005	2.62%

Appendix I.42: Sragen - Primary Data (Source: In-depth Interviews)

Table 2.22: Sragen - Primary Data

Indicator	Sub-Indicator (equal weights)	Scale
Local Leadership	Fund Management	6
(Quantity)	Joint Public-Private Partnership	4
	Attracting Investment	6.5
Local Leadership	(Absence of) Corruption/Collusion/Nepotism	4
(Quality)	Public (vs. Private) Interest	4.5
	Efforts to eliminate C/C/N	5
	Innovations of Social Programs	5
Local Capture	Public Procurement Auctions	7.5
	Local Regulations	8
	Crowding out of Social Programs	7.5
Participation	Effectiveness of MUSRENBANG	4
	Access to information	7
	Freedom to speak (vs. intimidation)	2.5
Initial Social Conditions	Poverty Level (2006)	2
	IMR (2000)	5.5
	Literacy Rate (2005)	4.9
	Unemployment Rate (2006)	9.2

Appendix I.5: Prabumulih

Appendix I.51: Prabumulih - Secondary Data (Source: In-depth Interviews, Prabumulih in Figures, South Sumatra Province in Figures, LKPJ, APBD & other data collection from governmental departments and participants.)

Table 2.23: Prabumulih - Secondary Data

Economic	Figures
Growth of GRDP in constant price (inlc. oil & gas)	4.12%* ('05), 4.55%*('06)
Growth of GRDP in constant price (excl. oil & gas)	6.88%*('05), 6.95%*('06)
GRDP per capita in constant price (incl.oil & gas)	Rp. 8.172.484,00 ('04), Rp.8.491.158,00 ('05)
GRDP per capita in constant price (excl. oil & gas)	Rp. 5.559.000,00 ('05)
PAD/ APBD	4.76% ('06), 3.97%('07)
Growth of Investment	1.1%('06), 1.6%('07), 1.33%('08)
Level of Investment	-

Social	Figures
Poverty Rate (Level)	9.33% ('06)
Poverty Rate (Growth)	- (No data in '02)
Inequality	.232 ('06), .210 ('07)
IMR	53.66 (Muara Ilir, '02)
Literacy Rate	97.72%
Unemployment	14.04%
HDI	71.1 ('05)
HDI Growth 2002-2005	(new district)

Appendix I.52: Prabumulih - Primary Data (Source: In-depth Interviews)

Table 2.24: Prabumulih - Primary Data

Indicator	Sub-Indicator (equal weights)	Scale
Local Leadership (Quantity)	Fund Management	4.5
	Joint Public-Private Partnership	5.5
	Attracting Investment	4
Local Leadership (Quality)	(Absence of) Corruption/Collusion/Nepotism	1
	Public (vs. Private) Interest	4
	Efforts to eliminate C/C/N	2
	Innovations of Social Programs	4.5
Local Capture	Public Procurement Auctions	8.5
	Local Regulations	6.5
	Crowding out of Social Programs	6
Participation	Effectiveness of MUSRENBANG	5
	Access to information	4.5
	Freedom to speak (vs. intimidation)	4.5
Initial Social Conditions	Poverty Level (2006)	7.3
	IMR (2000)	1.5
	Literacy Rate (2005)	9.1
	Unemployment Rate (2006)	5.3

Appendix II:

Quality\Quantity	(Net) High GRDP Growth because of High Quality-Quantity Leader ($\frac{\partial F(.)}{\partial \sigma}$ >0)	(Net) Low GRDP Growth because of Low Quantity-Quality Leader ($\frac{\partial F(.)}{\partial \sigma}$ <0)
Low Initial Poverty & Inequality; High Participation because of high education and high political awareness ($\frac{\partial H(.)}{\partial \sigma}$ >0)	(Complete Progress) • Type A • Extremely Good – Moderate Social Welfare Indicators + High Participation Level	(Stagnant Progress) • Type B/C • Extremely Good – Moderate Social Welfare Indicators + High Participation Level
High Initial Poverty & Inequality; Low Participation because of low education and low political awareness ($\frac{\partial H(.)}{\partial \sigma}$ <0)	(Incomplete Progress) • Type A • Extremely Bad – Low Social Welfare Indicator + Low Participation Level	(Deteriorating Progress) • Type B/C • Extremely Bad – Low Social Welfare Indicators + Low Participation Level

Figure 2.19: Typology of local leadership (Azis, 2008)

Appendix III: (BPS Data Statistics) HDI, HPI, IMR, and Literacy Rates

	HDI(1999)	HDI (2002)	HDI(2005)	HPI(1999)	HPI(2002)	IMR(2000)	Lit(2003)	Lit(2004)	Lit(2005)
Balikpapan	70.6	73	76.1	10.3	8	28.76	97.3	97.67	96.75
Manggarai Barat	60.9	60.3	63.2	32.9	33	55.65	89.39	90.04	88.74
Yogyakarta	73.4	75.3	77.7	16.8	14.3	20.81	97.22	96.69	96.24
Sragen	62.3	64.9	66.6	31.3	24.8	32.74	73.29	72.62	74.89
Prabumulih	63.1	64.2	71.1	31.1	28.8	53.66	97.23	97.49	97.72

Figure 2.20: HDI, HPI, Infant Mortality Rate, Literacy Rate (BPS)

Appendix IV: Analytical Network Process
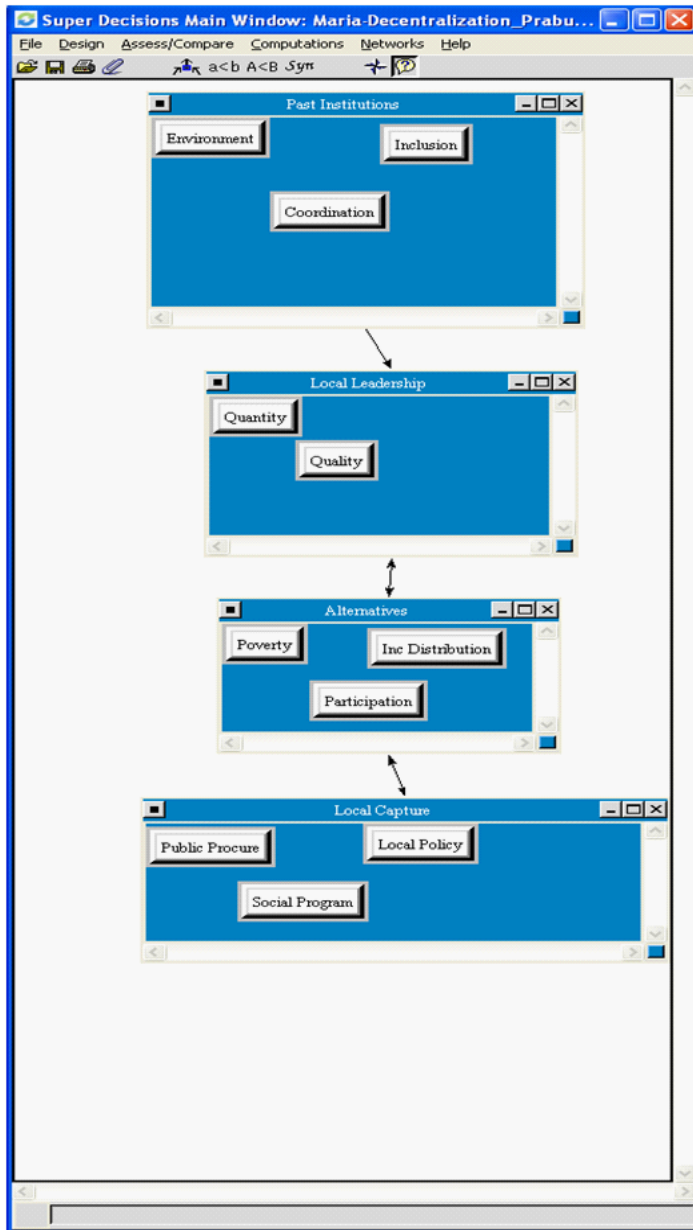
Analytical Network Process of Endogenous

Institution

Graphic	Alternatives	Total	Normal	Ideal	Ranking
	Inc Distribution	0.0849	0.1698	0.3191	3
	Participation	0.2660	0.5321	1.0000	1
	Poverty	0.1491	0.2981	0.5603	2

Figure 2.21: ANP: Balikpapan
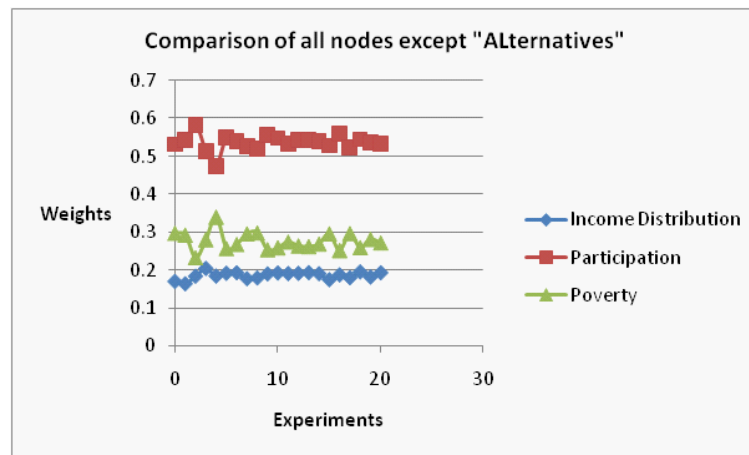
Figure 2.22: Sensitivity Analysis, Balikpapan

Graphic	Alternatives	Total	Normal	Ideal	Ranking
	Inc Distribution	0.0788	0.1577	0.2890	3
	Participation	0.2728	0.5456	1.0000	1
	Poverty	0.1484	0.2968	0.5439	2

Figure 2.23: ANP: Manggarai Barat
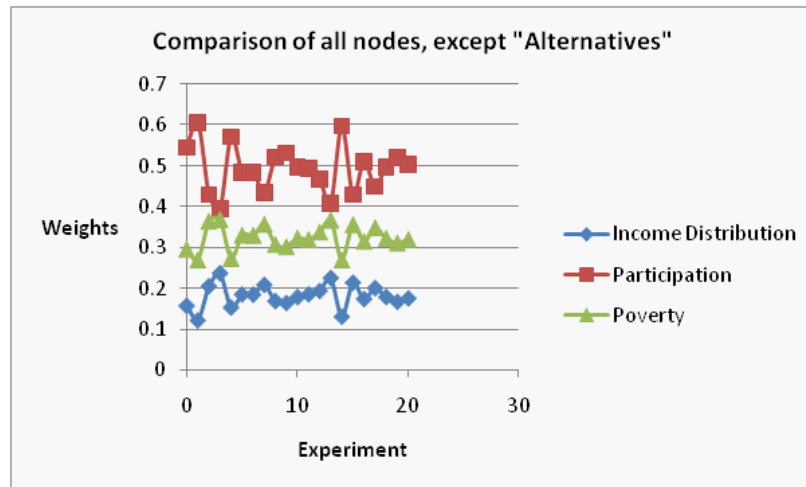
Figure 2.24: Sensitivity Analysis, Manggarai Barat

Graphic	Alternatives	Total	Normal	Ideal	Ranking
	Inc Distribution	0.0658	0.1316	0.2411	3
	Participation	0.2730	0.5459	1.0000	1
	Poverty	0.1613	0.3225	0.5908	2

Figure 2.25: ANP: Yogyakarta City
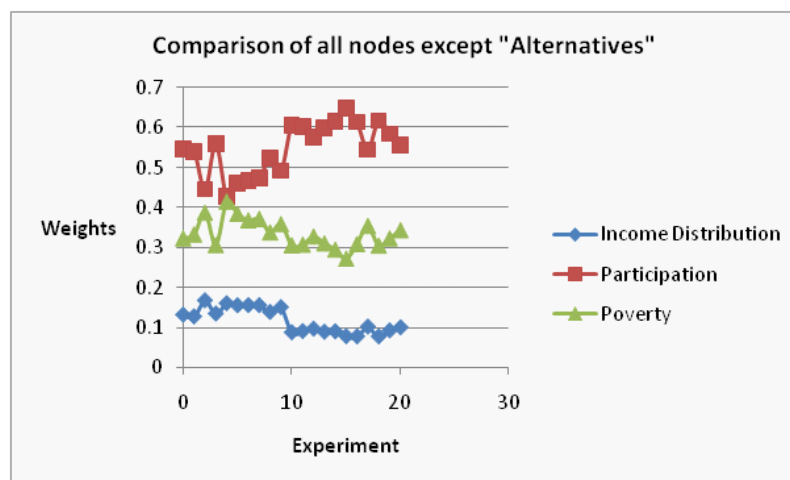
Figure 2.26: Sensitivity Analysis, Yogyakarta City

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Graphic	Alternatives	Total	Normal	Ideal	Ranking
	Inc Distribution	0.0395	0.0789	0.1240	3
	Participation	0.3184	0.6368	1.0000	1
	Poverty	0.1421	0.2843	0.4464	2

Figure 2.27: ANP: Sragen
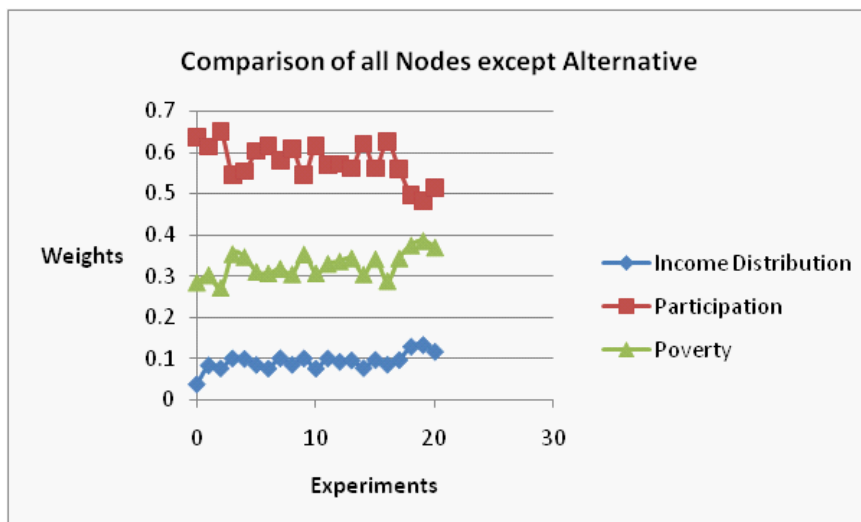
Figure 2.28: Sensitivity Analysis, Sragen

Graphic	Alternatives	Total	Normal	Ideal	Ranking
	Inc Distribution	0.0670	0.1340	0.2708	3
	Participation	0.2473	0.4946	1.0000	1
	Poverty	0.1857	0.3714	0.7510	2

Figure 2.29: ANP: Prabumulih
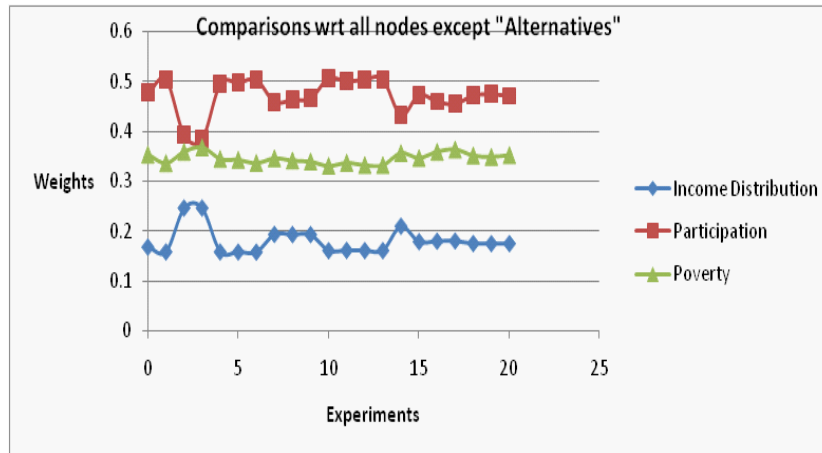
Figure 2.30: Sensitivity Analysis, Prabumulih

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CHAPTER 3

INFORMATION AND COORDINATION: TOWARDS EAST ASIAN REGIONAL FINANCIAL INTEGRATION

"In macroeconomic models with imperfect information, strategic complementarities arise also naturally. The economy can get stuck at a low activity equilibrium and there may exist a role for policy to move to a better equilibrium." (Vives, 1990)

3.1 Motivation

The primary motivation for this paper is to study how East Asian countries could better coordinate themselves to achieve greater cooperation. This paper begins with coordination analysis from the perspective of information theory. Information is a fundamental issue in any coordination problem. It is very important to discuss this issue in the context of coordination and cooperation because an *accidental* distrust among agents could create a vicious cycle between more distrust and more non-cooperative behaviors. It is also an institutional issue as institutions are places of information exchange. Institutional issues resemble those of a public good namely free-riding problem and collective action.

To understand this, consider the following simple example. There are two individuals who try to cooperate. Cooperation is better than non-cooperation for both individuals, but a defect by an opponent while cooperating is worse than non-cooperation. These individuals could be either mischievous or good-natured that are private information. The mischievous type is more likely to defect while the good-natured type is more likely to cooperate. However, because of some history,

the belief about the other individual's type is biased towards mischievous that this belief will discourage cooperation. Thus, each individual never learns about the good nature of the opponent. This initial belief creates a cycle of distrust and non-cooperation. The only way to initiate cooperation, leaving out other frictions and exogenous shocks that could affect the incentives to cooperate except for the initial beliefs and the observable actions, is to reveal the individuals' types. Hence, information in this case is a necessary condition. It is, however, not a sufficient condition because cooperation will only occur if both individuals are good-natured. Thus, information becomes very important if there is an accidental distrust among individuals that would discourage cooperation.

We first show theoretically that in a simple strategic complementary investment game with partially-informed agents who both have private information about their own fundamentals and private and public information about the others agents' fundamentals, agents with low and intermediate fundamentals may prefer less transparency in revealing information than agents with high fundamentals. If transparency is endogenous, then we might be facing an adverse selection problem or the *lemon car* issue. In this situation, the only agents who will not reveal their types are the worst-fundamental agents.

We then conduct an empirical study to analyze the effect of economic fundamentals on the transparency of central banks. We show that one-year lagged inflation, ratio of broad money to foreign exchange reserves, and ratio of current account deficit to nominal GDP affect the transparency of central banks after controlling for the other economic and non-economic factors, namely the level of development or GDP per capita, the exchange rate regimes, polity, region-specific biases, occurrence of crisis, and year-effect or general worldwide time trend. Coun-

tries with higher inflation, higher ratio of broad money to foreign exchange reserves, and high ratio of current account surpluses to nominal GDP tend to have lower transparency. This study also highlights the fact that economic fundamentals and economic institutions could be endogenous. That is, countries with higher economic fundamentals tend to have higher transparency that in turn creates higher economic fundamentals, and so on. Other observations include the convergence or catching-up bias, in which countries with lower initial levels of transparency tend to have higher growths of transparency.

In many real-life cases, transparency is endogenous, and reputation effects or adverse selection biases arise. These might not be significant in a large group, such as a worldwide cross-country community, because there are many non-fundamental factors that could affect the level of transparency such that transparency does not sufficiently signal fundamentals. However, they are more prevalent in a smaller group, such as a regional community, because the non-fundamental factors such as region-specific biases are better controlled and information travels faster (see "localization of information" (Dixit, 2004) and "diminishing anonymity" (Greif, 2006)). Moreover, in a small group, there is a higher probability of future interactions. We argue that transparency-aversion by low-fundamental countries cannot completely explain the non-seeking behaviors towards regional institutions, whose members would have to abide by some laws regulating the adoption of some transparency measures, because of the reputation effects or adverse selection biases. Instead of transparency aversion, all countries except the lowest-fundamental countries will become transparency-seeking.

We show that economic fundamentals could not explain the variations in the transparency of central banks of eight ASEAN+3 countries. We find that varia-

tions and anomalies surrounding the transparency of central banks in these countries can be explained by the inherent levels of democracy. This suggests that the quality of economic institutions may not depend only on economic fundamentals but also on polity. Policy issues and efforts towards regional financial integration should therefore consider all of these factors. We also examine the non-economic factors that could slow progress towards regional integration among the ASEAN+3 countries, including military and security issues as well as sociocultural factors.

This paper highlights not only the importance of information in coordination, but also the issues of institutions, including the endogenous system of institutions. An institution is a place of information exchange that enables countries to make transactions, borrow and lend, as well as invest. Many countries would turn to the IMF because it is the only way that other countries would lend to these countries under the monitoring and surveillance measures. The reserve pooling fund of the ASEAN+3 that amounts to at least US$80 billion, as in February 2009, could only work if all countries agree to follow some set of monitoring and surveillance measures. The assistance of the IMF on Asian countries in the 1997-1998 crisis are accompanied by pressures to adopt transparency measures. At the other extreme, failures of an institution to properly regulate the monitoring and surveillance measures could lead to a crisis, such as the 2007 global financial crisis. Hence, institution is a way of exchanging information that helps coordination, where a failure of exchanging information could be detrimental. An institutionalized Asian regional financial arrangement is needed for the ASEAN+3 countries to coordinate better in the economic sector while an institutionalized Asian Community is crucial for the Asian countries to coordinate better in both their economic and non-economic sectors.

Moreover, a regional institution could also better collect information and solve asymmetric information issues because of the close proximity of member countries. Despite the urgency for better coordination among East Asian countries especially after the 1997-1998 Asian financial crisis and during the 2007 global financial crisis, there has not been any economic institution officially established. Economic explanations, however, seem to be limited and unsatisfying. This is a case in which we witness how economic institutions and politics intertwine. This paper also highlights the importance of an institution as a place of information exchange, and just like a public good, it faces collective action or free-riding problems.

This paper consists of two main parts: theory and empirical study (part 1), and application (part 2). In the first part of the paper, we analyze the optimal publicity of private information among partially informed agents, such as central banks, ministries of finance, or other countries' representatives (call them "countries"), when they sit down together to discuss regional policy issues. Each country knows its own true fundamentals but not the others' fundamentals, and hence incompleteness of information is asymmetric. We assume that each country makes an investment decision given random private and public information about the true economic fundamentals of these countries. A concrete example of this model may be seen with countries that invest through the Sovereign Wealth Funds. Investments are strategic complements. The contribution of this paper in the literature of social value of public information is to introduce a K-dimensional true fundamental corresponding to the K countries and an asymmetry of incompleteness of information among partially informed agents. Assuming the precision of public signals is exogenously given and does not convey any information about the fundamentals, we show that for some intermediate values of the fundamentals, in which a multiplicity of equilibria exists in the complete information game, a mul-

tiplicity of equilibria recovers in the incomplete information game if the relative precision of private to public information is sufficiently low. Hence, lower precision of public information might be preferable in order to avoid coordination failure if there is a high probability of low-investment or Pareto-dominated equilibrium being played because of some non-fundamental volatilities or sunspots. Moreover, if there are some bad reputation effects from revealing bad fundamental on the countries' payoffs that are not captured in the payoffs from investment, then there are countries with low and intermediate fundamentals that are better off with a lower level of transparency than full revelation. We conduct an empirical study to test the hypothesis that economic fundamentals, controlling for non-economic fundamentals, affect the level of transparency of central banks.

In the second part of the paper, we apply our theory to the policy issues surrounding the Asian regional financial arrangement and regional integration. We argue that there are three main barriers to institutionalizing regional financial arrangements and moving towards regional integration. First, we argue that distrust that is prolonged by US military presence in Japan after the Sino-Japan war, religious shrines honoring Japanese war-time heroes, and Japanese textbooks that do not expose the true history of the Sino-Japan war could be a barrier to integration in the asymmetric information environment. An accidental distrust could create a vicious cycle of distrust and non-cooperation. The policy question here is how we could break this vicious cycle. We argue that greater strides towards economic integration in the midst of recovery from the Asian financial crisis and the current global financial crisis are positive shocks that could break the cycle of distrust and non-cooperation. Second, we argue that asymmetric bargaining power of powerful countries, particularly China could create a barrier to regional financial integration because distribution of power might be problematic.

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China has a disproportionately gigantic population, geography, amount of strategic commodities, international reserves, and trade surplus. Moreover, China's nuclear weapons escalate its power and could create security disagreements with its ASEAN neighborhood who signed the Bangkok Treaty of Nuclear Weapons Free Trade Zone in 1995. This could create a disincentive for China and other countries to move towards greater integration. We briefly discuss how the threat points of the ASEAN+3 countries with asymmetric bargaining power, coalitional analysis, and a consensus-based decision-making process could affect the outcomes of bargaining. Third, we argue that transparency-aversion that is predicted by the theoretical model and worldwide empirical study could have been a barrier to institutionalizing a regional financial arrangement and move towards greater integration. As an institution is established, member countries have to comply to some transparency measures. However, this transparency-aversion effect is eroded by reputation effects and adverse selection biases as well as international pressures to adopt transparency measures. Thus, eventually, all countries, except countries with the lowest fundamentals, become transparency-seeking and adopt transparency measures. Hence, transparency-aversion related to low economic fundamentals does not seem to be the salient issue in regional integration among ASEAN+3 countries. One of non-fundamental issues that could affect preferences towards transparency is the degree of democracy, which affects attitudes towards regional openness. This seems to be a more compelling explanation of non-cooperative attitudes because we find that less democratic countries are more opaque. Other issues surrounding the establishment of an institutionalized regional financial arrangement are social and cultural factors, as well as the lack of international support, such as the IMF in fears of double standards and moral hazard.

3.2   Literature Review

Morris and Shin (2002) show that, with a Keynesian Beauty Contest utility function, more transparency of public information increases welfare only if the precision of the public information is relatively high, as compared to the precision of the private information.   Given a slightly different model than that of Morris and Shin (2002), Angeletos and Pavan (2004) show that when investors' strategies are complementary and social value also takes into account externality of aggregate investment, then transparency of public information is necessarily good for welfare.   Such is not the case, however, when investors' strategies are strongly complementary, such that a multiplicity of equilibria exists for high precision of public information.   They show that in the strong-complementary model, high precision of public information might be detrimental if there is a high probability of the low-investment equilibrium being played in the case in which a multiplicity of equilibria arises.   Svensson (2005) however shows that the anti-transparency contention of Morris and Shin's (2002) result is often misinterpreted and in fact, the result is actually pro-transparency.   He shows that given the highest possible critical point (i.e. the worst possible scenario) as a function of the share of the beauty contest term in the utility function, the area of sets of parameters of the relative precision of public information to private information, in which transparency decreases welfare is relatively small.   The main difference between Morris and Shin's (2002) results and those of Angeletos and Pavan (2004) is the uniqueness of equilibrium in Morris and Shin's (2002) model as compared to the multiplicity of equilibria in Angeletos and Pavan's Model (2004).   Tong (2006) endogenizes the precision of private information in Morris and Shin's (2002) model, and shows that higher precision of public information lowers (or "crowds out") the precision of private information, and the overall effect on dispersion of information is ambiguous.

Cooper (1999) argues that the main factor of coordination failures at the macro-economic level is the "risk-dominant" factor. He provides experimental results that show failure to achieve the Pareto-Dominant Equilibrium in the case of coordination games. Vives (1990) shows that a Bayesian game with a parameterized family of supermodular games is itself a supermodular. Hence, the existence of an equilibrium theorem for a supermodular game applies directly to the incomplete information Bayesian game. Topkis (1998) proves the existence of a greatest and lowest Nash equilibria in a supermodular game. Milgrom and Roberts (1990) introduce an adaptive learning solution concept for dynamic stability in super-modular games with finite strategies.

In Geraats (2006), transparency of central banks is studied across and within different monetary policy regimes. Geraats (2008) shows that transparency among central banks has been increasing in the past decade. Countries that show significant increases in transparency tend to have with high initial levels of inflation and higher economic development. Transparency is therefore positively correlated with initial level of inflation and GDP per capita. Transparency is also negatively correlated with subsequent level of inflation and positively correlated with GDP per capita in the same year. Inflation targeters are associated with high transparency, low inflation and high GDP per capita. Dincer and Eichengreen (2007) show that central banks in advanced countries are more transparent than central banks in emerging markets, which are defined as middle-income countries with significant links to international financial markets. They also show that GDP per capita significantly affects the level of transparency. Transparency index, however, affects inflation persistence, inflation variability, and output variability, suggesting that transparency and economic indicators are co-determined or endogenous. Crowe and Meade (2008) show that reforms of central bank independence is pos-

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itively correlated with initial level of central bank independence, initial inflation, and democracy. They further show a negative correlation with flexibility of exchange rate regime. Transparency increase, albeit only significant in developed countries, is positively correlated with overall governance quality measures, central bank independence, and exchange rate flexibility.

Bernanke (2004) argues that transparency helps the public to better predict the central bank's monetary objectives, thereby increasing welfare by aligning the public's expectation with the central bank's objectives. Azis (2008) argues that one of the criteria that determines how successful Regional Financial Arrangement can be is the issue of macro-coordination and coordination failure as the benefit and cost, respectively. Soesastro (2008) argues that East Asian regional cooperation is indispensable in the midst of the 2007 global financial crisis, and gives a chronology of actions and policy meetings that have occurred in attempts to achieve East Asian regional financial integration.

3.3 Theoretical Model: Exogenous Precision of Public Information

3.3.1 Examples

The following are real-life examples that motivate our model and of how our model may apply.

1. Public information sharing and macroeconomic coordination: People's Bank of China agreed in 2004-2005 to inform other Asian central bankers should they

de-peg the Yuan and move to the managed floating exchange rate. On July 20, 2005, People's Bank of China announced their intention to de-peg the Yuan to the Asian central bankers and move to the managed floating exchange rate, and on July 21, 2005, they did so. Immediately after that, Bank Negara Malaysia, the central bank of Malaysia followed China's decision, de-pegged the Ringgit and moved to the managed floating exchange rate. This kind of information sharing among the central banks is never known to the public nor other financial institutions such as the Asian Development Bank, nor is sensitive information on macroeconomic policies leaked to the public.

2. Sovereign Wealth Funds are state-owned investments funds. Some SWFs are controlled by central banks who invest in financial assets. The most traditional investment instruments for SWFs are government bonds of industrialized nations, although some invest in riskier assets. Some SWFs have economic and fiscal importance, while some are state savings coming from excess foreign exchange reserves or revenues from oil and other commodities. Unlike foreign exchange reserves, whose purpose is to safeguard sovereign countries against liquidity crisis, the main objective of SWFs is to maximize long-term return. Sovereign Wealth Funds have been attracting the attention of investors and regulators because of their growing size and number, and their potential to influence financial markets. Another growing issue is security, as investments are made not because of economic reasons but political reasons. The inadequate transparency of SWFs is also a growing concern. Assets under management of SWFs reached US$3.3 trillion in 2007, born mostly from the Asian countries with massive foreign exchange reserves and the Middle Eastern countries with rising revenues from oil exports. The seven SWFs with assets over US$100 billion are the Abu Dhabi Investment Authority, the Government Pension Fund of Norway, the Government of Singapore

Investment Corporation, the Kuwait Investment Authority, the China Investment Corporation, the Singapore's Temasek Holdings, and the Stabilization Fund of the Russian Federation.

3.3.2 Model

Suppose there are K "countries" (for central banks, ministries of finance, or countries' representatives) that meet regularly to discuss regional policies at the Asian Regional Financial Arrangement's Economic Review and Policy Dialogue meetings. In the case of Asian Regional Financial Arrangement, K=13, corresponding to the 10 ASEAN countries plus China, Japan, and South Korea. Each country knows its own fundamental but does not know the fundamental of the other countries. Each country however receives two types of information, namely private and public information, about the other countries. Given this information, the country makes investment decisions in all of the countries, including its own. For example, central banks who have excess reserves and hold Sovereign Wealth Fund (SWF) make foreign investments in stocks, bonds, property, precious metals and other financial instruments. Another example is the inter-ministrial coordination as part of an inter-regional development strategy by investing in environment, transport, communication infrastructures, or energy in the region in which decisions over spending priorities are made by ministries of finances[1]. Or, if central banks' information is fully shared with the private sector who then make

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[1]An example of this is the case of mainstreaming trade policies in national development strategies among African countries by providing trade financing, building trade capacities, improving trade facilitation, and addressing negative impacts of trade liberalization (UNECA, 2004). Inter-ministrial coordination, in particular across ministries of finance is needed in achieving these goals through their roles in approving spending priorities as well as their roles in regulating complementary policies. Investments as parts of these goals include investments on environment, transport, communication infrastructures, and energy.

a foreign investment, then we may assume that the central banks make investment decisions as if they are the private investors. We are interested in how the precision of public information, given the precision of private information, affects individual countries' investment strategies to invest in their own countries (domestic investments) and in other countries (foreign investments) when there are K fundamentals and incompleteness of information about the K fundamentals is asymmetric.

We assume that the precision of public information is exogenously given and does not convey any information about the fundamentals of the countries. For example, member countries are requested to reveal some specific information at the regional meetings rather than choosing information to reveal. Basel II is an example of disclosure requirement for banks globally. IMF's Article IV publication and IMF's public data dissemination, albeit voluntary, could set standard disclosures of macroeconomic data. This will enable us to derive how the precision of public information affects the equilibrium level of investments, assuming sources come only from private and public information. We assume that domestic investment strategy is monotonic in the true fundamental, while foreign investment is monotonic in private information about those foreign countries. Monotonicity of strategies allows us to derive critical values of domestic and foreign investment that depend on public signals. For any true fundamental above a critical value that depends on the private signal, a country will invest in its own country. For any private information about another country that is above a critical value that depends on the public signal, a country will invest in that country. Public information is therefore used as a public signalling device to coordinate strategies among countries. An equilibrium concept therefore resembles that of the correlated equilibrium. At equilibrium, no country will deviate from the prescribed strategy. We

also show that multiple equilibria recover in the incomplete information game for some interval of the fundamentals in which a multiplicity of equilibria exists in the complete information game.

Notation

There are K countries denoted by i=1, ..K. Each country i has private information about its type denoted by θ_i. The type of each country is the fundamental of that country. High fundamental means the economy is in good condition, while low fundamental means that economy is in bad condition. The distribution of the type is uniform in the unit interval $[0,1]^2$. Each country has two sources of information, namely private and public information. The precision of private signal is equal across all countries. The private information can be written as:

$$x^i = \theta + \varepsilon^i, \forall i \in N,$$

where $x^i=(x_i^i, x_{-i}^i)=K\times 1$, $\varepsilon^i=(\varepsilon_i^i, \varepsilon_{-i}^i)=K\times 1$, ε_j^i is i.i.d. across and within country i's information, $\forall i,j \in N$, $\varepsilon_i^i=0$, $\varepsilon_{j\neq i}^i \sim N(0,\sigma_x^2)$, $\varepsilon^i \sim N(0,\Omega_{x^i}^2)$, and $\Omega_{x^i}^2 =$

$$
\begin{array}{cccc}
\sigma_x^2 & 0 & 0 & 0 \\
0 & \sigma_x^2 & 0 & 0 \\
0 & 0 & (i,i)=0 & 0 \\
0 & 0 & 0 & \sigma_x^2
\end{array}.
$$

The public information can be written as:

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[2]Without a loss of generality, we may assume that θ is uniformly distributed in real line (improper distribution). We choose this proper distribution that allows us to take conditional probability with respect to θ when precisions of public information are endogenous. In various places in this paper, we will assume θ to be uniformly distributed in real line (improper distribution).

$$z = \theta + \xi,$$

where z=K×1, ξ=K×1, ξ_j is i.i.d, $\xi_j \sim N(0, \frac{1}{P_j})$, P_j is the level of precision of public

information of country j, $P_j = \Re, \forall j \in N$, $\xi \sim N(0, \Omega_z^2)$, and $\Omega_z^2 = \begin{matrix} \frac{1}{P_1} & 0 & 0 & 0 \\ 0 & \frac{1}{P_2} & 0 & 0 \\ 0 & 0 & ... & 0 \\ 0 & 0 & 0 & \frac{1}{P K} \end{matrix}$.

The strategy of each country is to make decisions on where to invest denoted by k^i=K x 1, where k^i is the investment of country i on country 1 to K, k_j^i is the j-th row of k^i, k_j^i is the investment of country i on country j, k_j^i=[0,1], $\forall$j,i=1,...K. A strategy k^i is a mapping: $k^i : \Re^{4K} \to \Re^K$, that is an investment strategy of country i is a mapping from the private signals of K countries (K dimensions), the public signals of K countries (K dimensions), the precision of the private signals of K countries (K dimensions), and the precision of the public signals of the K countries (K dimensions). Note: because the utility from an investment in one country is additively separable from the utilities from investments in other countries, we can write the investment strategy in a country: $k_j^i : \Re^4 \to \Re, \forall j = 1, ...K$.

The utility function of each country exhibits a strong strategic complementarity of investment (Angeletos and Pavan, 2004):

$$u_i = (\theta + i_{K>1} - 1)'k^i,$$

where θ is a K x 1 vector with θ_k in its k-th row, k^i is a K x 1 vector with its k-th row equal to k_k^i, $i_{K>1}$ is a K x 1 indicator function, $i_{K_k>1}$ is the k-th row of $i_{K>1}$, $i_{K_k>1}$=1 if $K_k > 1$, $i_{K_k>1}$=0 if $K_k \leq 0$, and $K_k = \sum_{j=1}^K k_k^j$. Note: the utility from investing in country k alone is equal to $(\theta_k + i_{K_k>1} - 1)k_k$ and the utility is the

sum of the utilities from investing in country 1 to K. Without uncertainty, there exists a multiplicity of equilibria for $\theta_i=[0,1]$ that is either $k_i^j = 1$ for all j=1,...K (all countries invest in country i), or $k_i^j=0$ for all j=1,...K (all countries do not invest in country i). This utility function exhibits increasing first differences in the players' actions, but exhibits only weak supermodularity in a player's own actions, i.e. $\frac{\partial^2 f_i(s_i,s_j)}{\partial s_{im}\partial s_{ik}} = 0$, for all m$\neq$k[3]. In the incomplete information game, the utility is taken at the expectation: $Eu_i=E[(\theta+i_{K>1}-1)'k^i]$.

The Nash equilibrium strategy for country i is denoted by:

$$k^{i*}=\text{argmax}.Eu_i(k^i|k^{-i*},\theta,x^i,z,P,\sigma_x^2),\forall i=1,....K.$$

Given (x^i,z,P,σ_x^2), k^{i*} is the Nash Equilibrium investment strategy of country i and k^* is the Nash Equilibrium. Note: for simplicity, we assume there is no budget constraint. In other words, the available funds to invest are high enough to allow countries to invest the maximum amounts of investment in all countries. This allows us to focus only on informational issues.

Lemma 3.1 *Country i's expected fundamental of country j$\neq$i conditional on private and public information is given by: $(\theta_j|x_j^i, z_j) \sim N(\frac{\frac{1}{\sigma_x^2}}{P_j+\frac{1}{\sigma_x^2}}x_j^i + \frac{P_j}{P_j+\frac{1}{\sigma_x^2}}z_j, \frac{1}{P_j+\frac{1}{\sigma_x^2}})$.*

Proof. (See Appendix 1) ∎

Corollary 3.1 *Let θ_j be uniformly distributed in the real line (improper distribution). Analogous to the uniform distribution in the unit interval, country i's*

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[3]A supermodular game (Cooper, 1999) must satisfy the following properties: 1. the strategy set (k^i) is a lattice, 2. the payoff function increases in the first difference in the players' actions (in k^i and k^{-i}), 3. the payoff function is supermodular in a player's actions (in k^i given k^{-i}). Hence, this game is a supermodular game.

expected fundamental of country $j \neq i$ conditional on private and public information

is given by: $(\theta_j | x_j^i, z_j) \sim N(\frac{\frac{1}{\sigma_x^2}}{P_j + \frac{1}{\sigma_x^2}} x_j^i + \frac{P_j}{P_j + \frac{1}{\sigma_x^2}} z_j, \frac{1}{P_j + \frac{1}{\sigma_x^2}}).$

Proof. (See Appendix 2) ∎

We can write in matrix form:

$$E(\theta|(x^i, z)) = (\Omega_z^2)^{-1}((\Omega_{x^i}^2)^{-1} + (\Omega_z^2)^{-1})^{-1} z + (\Omega_{x^i}^2)^{-1}((\Omega_{x^i}^2)^{-1} + (\Omega_z^2)^{-1})^{-1} x^i.$$

$$E(\theta|(x^i, z)) = \begin{pmatrix} \frac{\frac{1}{\sigma_x^2}}{P_1 + \frac{1}{\sigma_x^2}} x_1^i + \frac{P_1}{P_1 + \frac{1}{\sigma_x^2}} z_1 \\ \frac{\frac{1}{\sigma_x^2}}{P_2 + \frac{1}{\sigma_x^2}} x_2^i + \frac{P_2}{P_2 + \frac{1}{\sigma_x^2}} z_2 \\ \cdots \\ x_i^i \\ \cdots \\ \frac{\frac{1}{\sigma_x^2}}{P_K + \frac{1}{\sigma_x^2}} x_K^i + \frac{P_K}{P_K + \frac{1}{\sigma_x^2}} z_K \end{pmatrix}$$, where $\frac{1}{\sigma_x^2}$ is the absolute precision of

private information and P_i is the absolute precision of public information of country i.

Strong Strategic Complementary Investments

The following example with strong strategic complementary investments will show the effect of public information on coordination among the countries, in particular when a multiplicity of equilibria arises.

Lemma 3.2 *For each of the element in $k^i = \{k_k^i\}$, and i,k=1,...K:*

$k_k^i = 1$ *if* $\theta_k + i_{K_k > 1} - 1 \geq 0,$

$k_k^i = 0$ *if* $\theta_k + i_{K_k > 1} - 1 < 0,$

Investment strategy is therefore a corner solution.

By the above lemma, we know that the investment strategies are going to be corner solutions that is investment strategies in a country by another country or by its own country are equal to either zero or one. Denote the precision of public information of country i by P_i. Country i "fully reveals" its fundamental if $P_i=\infty$, and "babbles" if $P_i<\infty$. First, let us suppose there are three countries. Following Angeletos and Pavan (2004), we assume that strategies are monotonic. That is the investment strategy of each country is to invest in its own country if the true economic fundamental is higher than some critical value that depends on the public signal, while each country is to invest in other countries if the private signals about those countries are higher than some critical values that depend on the public signal. Public information is therefore used as a public signalling device for countries to coordinate their strategies and predict other countries' actions. The equilibrium concept for the investment strategies thus resembles the correlated equilibrium concept. We are particularly interested in determining the optimal level of precision of public information on coordination given the true fundamental is between zero and one. This is the "critical" values in which a multiplicity of equilibria exists in the complete information game (Angeletos and Werning, 2006). Given that precision of public information is exogenous and does not signal any information about fundamentals, we derive the equilibrium levels of investments given the relative precision of private to public information (Proposition 1 and 2).

Proposition 3.1 *1. The investment strategy of country i, for i=1,2,3, is given by the following:*

(i) $k_i^i=1$ if $\theta_i \geq \theta^*(z_i)$; $k_i^i=0$, otherwise,

where $\theta^*(z_i)$ solves:

$$\theta_i + (1 - \int_{-\infty}^{x(z_i^*) - \theta_i} \frac{1}{\sigma_x \sqrt{2\pi}} \exp.(\frac{-u^2}{2\sigma_x^2}) du)(1 + \int_{-\infty}^{x(z_i^*) - \theta_i} \frac{1}{\sigma_x \sqrt{2\pi}} \exp.(\frac{-u^2}{2\sigma_x^2}) du) - 1 = 0.$$

(ii) for $j \neq i, k_j^i = 1$ if $x_j^i \geq x^*(z_j)$; $k_j^i = 0$, otherwise,

where $x^*(z_j)$ solves:

$$(w_{x_j^i} x_j^i + w_{z_j} z_j) + (1 - \int_{-\infty}^{\theta(z_j^*)} \frac{1}{\sigma_\theta \sqrt{2\pi}} \exp.(-\frac{(u - E(\theta_j | x_j^i, z_j))^2}{2\sigma_\theta^2}) du) +$$

$$(\int_{-\infty}^{\theta(z_j^*)} \frac{1}{\sigma_\theta \sqrt{2\pi}} \exp.(-\frac{(u - E(\theta_j | x_j^i, z_j))^2}{2\sigma_\theta^2}) du)$$

$$(1 - \int_{-\infty}^{x(z_j)} \frac{1}{\sigma_{\bar{x}} \sqrt{2\pi}} \exp.(-\frac{(u - E(x_j^{-j \neq i} | x_j^i z_j))^2}{2\sigma_{\bar{x}}^2}) du) - 1 = 0,$$

$(\theta_j | x_j^i . z_j)$ is distributed with mean $E(\theta_j | x_j^i, z_j) = (w_{x_j^i} x_j^i + w_{z_j} z_j)$ and

variance $\sigma_\theta^2 = \frac{1}{\frac{1}{\sigma_{\bar{x}}^2} + P}$,

$x_j^{-j \neq i} = (\theta_j + \varepsilon_j^{-j \neq i} | x_j^i . z_j)$ is distributed mean $E(w_{x_j^i} x_j^i + w_{z_j} z_j)$ and

variance $\sigma_{\bar{x}}^2 = \frac{1}{\frac{1}{\sigma_{\bar{x}}^2} + P} + \sigma_x^2$,

2. Local solutions $\theta^*(z_i)$ and $x^*(z_i)$ exist for some values of P and σ_x^2:

$$|D_{x,\theta} F(x(z_i), \theta(z_i); z_i)| \neq 0.$$

Proof. *(See Appendix 3)* ∎

Proposition 3.2 *1. The investment strategy of country i, for $i = 1, \ldots K$ is given by the following:*

(i) $k_i^i = 1$ if $\theta_i \geq \theta^*(z_i)$;

$k_i^i = 0$, otherwise,

where $\theta^*(z_i)$ solves: $\theta_i + \sum_{j=1}^{K-1} \frac{(K-1)!}{(K-1-j)!j!}(1 - \int_{-\infty}^{x(z_i^*)-\theta_i} \frac{1}{\sigma_x\sqrt{2\pi}} \exp.(\frac{-u^2}{2\sigma_x^2})du)^j$

$(\int_{-\infty}^{x(z_i^*)-\theta_i} \frac{1}{\sigma_x\sqrt{2\pi}} \exp.(\frac{-u^2}{2\sigma_x^2})du)^{K-1-j} - 1 = 0.$

(ii) $k_j^i = 1$ if $x_j^i \geq x^*(z_j)$;

$k_j^i = 0$, *otherwise,*

where $x^*(z_j)$ solves:

$(w_{x_j^i} x_j^i + w_{z_j} z_j) + (1 - \int_{-\infty}^{\theta(z_j^*)} \frac{1}{\sigma_\theta\sqrt{2\pi}} \exp.(-\frac{(u-E(\theta_j|x_j^i,z_j))^2}{2\sigma_\theta^2}du)$

$\sum_{j=0}^{K-2} \frac{(K-2)!}{(K-2-j)!j!}(1 - \int_{-\infty}^{x(z_j^*)} \frac{1}{\sigma_{\bar{x}}\sqrt{2\pi}} \exp.(\frac{-(u-E(x_j^{-j\neq i}|x_j^i,z_j))}{2\sigma_{\bar{x}}^2})du)^j$

$(\int_{-\infty}^{x(z_j^*)} \frac{1}{\sigma_{\bar{x}}\sqrt{2\pi}} \exp.(\frac{-(u-E(x_j^{-j\neq i}|x_j^i,z_j))}{2\sigma_{\bar{x}}^2})du)^{K-2-j} +$

$(\int_{-\infty}^{\theta(z_j^*)} \frac{1}{\sigma_\theta\sqrt{2\pi}} \exp.(-\frac{(u-E(\theta_j|x_j^i,z_j))^2}{2\sigma_\theta^2}du)$

$\sum_{j=1}^{K-2} \frac{(K-2)!}{(K-2-j)!j!}(1 - \int_{-\infty}^{x(z_j^*)} \frac{1}{\sigma_{\bar{x}}\sqrt{2\pi}} \exp.(\frac{-(u-E(x_j^{-j\neq i}|x_j^i,z_j))}{2\sigma_{\bar{x}}^2})du)^j$

$(\int_{-\infty}^{x(z_j^*)} \frac{1}{\sigma_{\bar{x}}\sqrt{2\pi}} \exp.(\frac{-(u-E(x_j^{-j\neq i}|x_j^i,z_j))}{2\sigma_{\bar{x}}^2})du)^{K-2-j} - 1 = 0,$

$(\theta_j|x_j^i.z_j)$ is distributed with mean $E(\theta_j|x_j^i,z_j) = (w_{x_j^i} x_j^i + w_{z_j} z_j)$ and

variance $\sigma_\theta^2 = \frac{1}{\frac{1}{\sigma_x^2}+P}$.

$x_j^{-j\neq i} = (\theta_j + \varepsilon_j^{-j\neq i}|x_j^i.z_j)$ *is distributed mean $E(x_j^{-j\neq i}|x_j^i.z_j) = (w_{x_j^i} x_j^i + w_{z_j} z_j)$*

and

variance of $\sigma_{\bar{x}}^2 = (\frac{1}{\frac{1}{\sigma_x^2}+P} + \sigma_x^2)$.

2. Local solutions $\theta^*(z_i)$ and $x^*(z_j)$ exist for some values of P and σ_x^2 :

$|D_{x,\theta}F(x(z_i),\theta(z_i); z_i)| \neq 0.$

Proof. (See Appendix 4) ∎

Corollary 3.2 *For a two-country case, $x^*(z_i)$ is given by $x^*(z_i)=A-\frac{P}{\frac{1}{\sigma_x^2}}z_i$, and $\theta^*(z_i)$ solves: $\theta_i+(1-\int_{-\infty}^{x(z_i^*)-\theta_i}\frac{1}{\sigma_x\sqrt{2\pi}}\exp.(\frac{-u^2}{2\sigma_x^2})du)-1=0.$, for $i=1,2$ (see Table 3.1).*

<div align="center">

Table 3.1: Critical Values for a 2-country Case

P	$\frac{P}{\frac{1}{\sigma_x^2}}$	**z**	$\boldsymbol{\theta^*(\mathbf{z})}$	$\mathbf{x}^*(z)$
1	1	1	.12-.13	-1
10	10	1	0-.01	-10
.5	.5	1	.7-.8	-.5
1	1	2	.02-.03	-2
10	10	2	0-.01	-20
.5	.5	2	.1-.2	-1

</div>

3.3.3 Numerical Examples and Observations

Solving for the implicit functions, $x^*(z_i)$ and $\theta^*(z_i)$, can be very complex. We resort to numerical examples. In the following numerical examples, we show the critical values of $\theta^*(z_i)$ and $x^*(z_i)$ that solve the non-linear equations system above: $F(\theta^*(z_i),x^*(z_i);z_i)=0$ for a wide range of parameters. This enables us to get an idea of what kinds of functions $\theta^*(z_i)$ and $x^*(z_i)$ are. The following table (Table 3.2) summarizes the initial parameters to get $(\theta^*(z_i),x^*(z_i))$, including the absolute precision of private and public information, the relative precision of private and public information, and the public signals z_i. We fix the number of countries equal to 3. We vary the relative precision of private to public information by either varying the precision of public signal while keeping the precision of private signal fixed, or vice versa. We vary the public signal in the range of [-1000 to 1000], and first set K=3.

The following properties of $x(z_i)$ and $\theta(z_i)$ are observed for K=3. We use at

Table 3.2: Initial Parameters	
$\mathbf{K=3},\frac{1}{\sigma_x^2}=1$(or $P_i=1$)	$\frac{\frac{1}{\sigma_x^2}}{P_i}=[.0001\text{-}10000]$
$z_i=[\text{-}1000\text{-}1000]$	$(\theta^*(z_i),x^*(z_i)|z_i,P_i,\frac{1}{\sigma_x^2})$

least six-decimal working precision (see Appendix 5). First, we observe that $\theta^*(z_i)$ and $x^*(z_i)$ co-move. This is not surprising since strategies are complements. If domestic investment of a country is higher, other countries will best-respond by investing more in that country. Second, we observe that fixing the precision of private information and increasing the precision of public information, or decreasing the relative precision of private to public information, increases the level of investment or decreases the values of $\theta^*(z_i)$ and $x^*(z_i)$ if the realization of public information, z_i, is sufficiently large, $z_i>.25$. It further decreases the level of investment or increases the values of $\theta^*(z_i)$ and $x^*(z_i)$ if the realization of public information, z_i, is sufficiently low, $z_i < .25$. At $z_i=.25$, $\theta^*(z_i)$ and $x^*(z_i)$ do not change in the relative precision of private to public information.

Claim 3.1 *Given the precision of public information is exogenous and does not signal any information about the fundamentals of the countries, in the case of K=3, for high relative precision of private to public information, increasing the precision of public information while keeping the precision of private information fixed, weakly decreases $\theta^*(z)$ and $x^*(z)$ for $z\geq.25$ while increasing $\theta^*(z_i)$ and $x^*(z_i)$ for $z<.25$.*

This second observation suggests that if public signal is sufficiently low, with high precision of public information, other countries will expect the true economic fundamental of that country to be approximately close to the public signal, which is low, reducing the incentive to invest. The reverse is true for high public signals.

The following table (Table 3.3[4]) shows examples of this observation for $z_i \geq .25$ and $z_i < .25$.

Table 3.3: Example of Claim 3.1

$K=3, \frac{1}{\sigma_x^2} = 1$	$\frac{\frac{1}{\sigma_{\bar{x}}^2}}{P} = .0001$	$\frac{\frac{1}{\sigma_{\bar{x}}^2}}{P} = 1$	$\frac{\frac{1}{\sigma_{\bar{x}}^2}}{P} = 10000$
z=-.5	(1,14796)	(.622147,1.42428)	(.250025,.250088)
z=.4	(0,-4000),(1,5796.53)*	(.189758,.0276531)	(.249995,.249982)

We can show that the critical values of $\theta^*(z_i)$ and $x^*(z_i)$ do not change if we change the absolute precision of public information or the absolute precision of private information while keeping the relative precision of private to public information constant. In other words, what matters is not the absolute precision but the relative precision. Similar results are shown in Svensson (2005) in response to Morris and Shin's Keynesian Beauty Contests model (2002) in which the optimal precision of public information depends on the relative precision rather than the absolute precision.

Claim 3.2 *Given the precision of public information is exogenous and does not signal any information about the fundamentals of the countries, in the case of K=3, it is the relative precision of private information to public information that affects the investment level, and not the absolute precision of private nor public information.*

We also observe that both $\theta^*(z_i)$ and $x^*(z_i)$ decrease in z_i for any relative precision of private to public information (see Appendix 6).

Claim 3.3 *The higher the public signal, the lower $\theta^*(z_i)$ and $x^*(z_i)$ are, for any relative precision of private to public information.*

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[4]*=Multiplicity of equilibria

Moreover, we observe that $\theta^*(z_i)$ is more sensitive to changes in z_i as the precision of public information increases while fixing the precision of private information, or if the relative precision of private to public information decreases. This suggests that the lower the relative precision of private to public information, the more sensitive investment strategies are to changes in public signals. For sufficiently low precision of public information for some given precision of private information, the slope of $\theta^*(z_i)$ with respect to z_i is flat at $\theta^*(z_i)=.25$. Similarly, $x^*(z_i)$ is more sensitive to changes in z_i as the precision of public information increases while fixing the precision of private information, or if the relative precision of private to public information decreases. As the relative precision of private to public information increases, the slope of $x^*(z_i)$ with respect to z_i becomes flat at $x^*(z_i)=.25$. The critical values of $\theta^*(z_i)$ is bounded above by 1, in which countries will not invest for any fundamental, and bounded below by 0, in which countries will invest for any fundamental.

Claim 3.4 *The lower the relative precision of private to public information, the more sensitive $\theta^*(z_i)$ and $x^*(z_i)$ are to changes in public signal.*

One of the main results of this study is that a multiplicity of equilibria can be shown to exist in the incomplete information game with a critical fundamental and high precision of public information (see Figure 1 and 2). We show that a multiplicity of equilibria exists for $z_i = [0,1)$ as the precision of public information increases while fixing the precision of private information, or if the relative precision of private to public information decreases. Except at $z_i=.25$, there are two equilibria, the high and the low equilibria. At $z_i=.25$, there are three equilibria, the high, the intermediate, and the low equilibria. For very low relative precision of private to public information, the two critical points for theta are $\theta^*(z_i)=0$ and
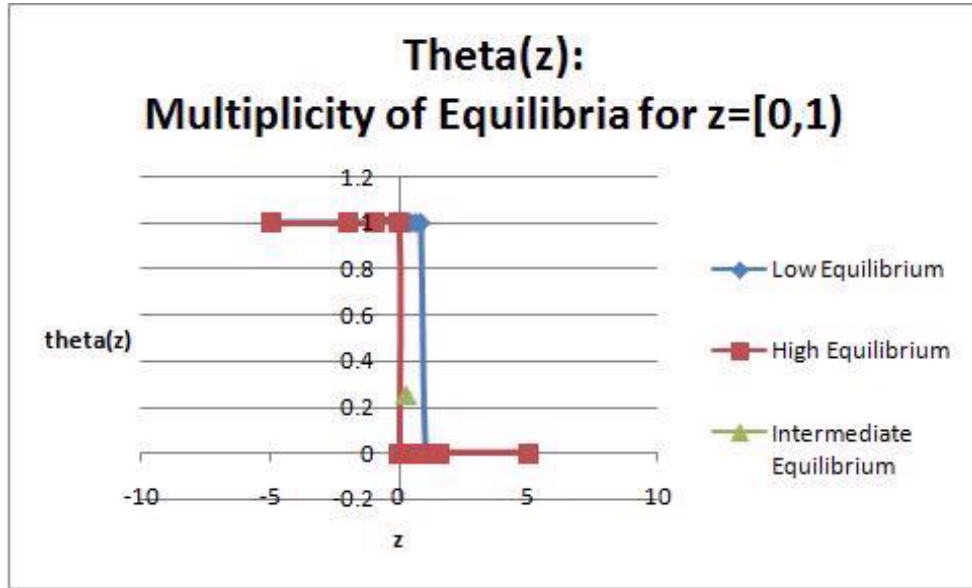
Figure 3.1: Multiplicity of Equilibria, $\theta(z)$.

$\theta^*(z_i)=1$. Hence, either countries invest domestically for all values of the fundamental, or do not invest domestically for all values of the fundamental, similar to the case of complete information. For both the critical values, $\theta^*(z_i)$ and $x^*(z_i)$, in the case of multiple equilibria, the low-investment equilibrium is lower than some equilibrium investment level at lower transparency with a unique equilibrium and the high-investment equilibrium is higher than some equilibrium investment level at lower transparency with a unique equilibrium. Multiple equilibria arise at a relative precision of private to public information as low as one fourth.

Claim 3.5 *Given the precision of public information is exogenous and does not signal any information about the fundamentals of the countries, the critical values, $\theta^*(z_i)$ and $x^*(z_i)$, are unique for $z_i=[0,1)$, for high relative precision of private to public information, but are multiple for low relative precision of private to public information. In the case when a multiplicity of critical values arises, there are high and low critical values, $\theta^*(z_i)$ and $x^*(z_i)$, for $z_i=[0,1)$, and there are high,*
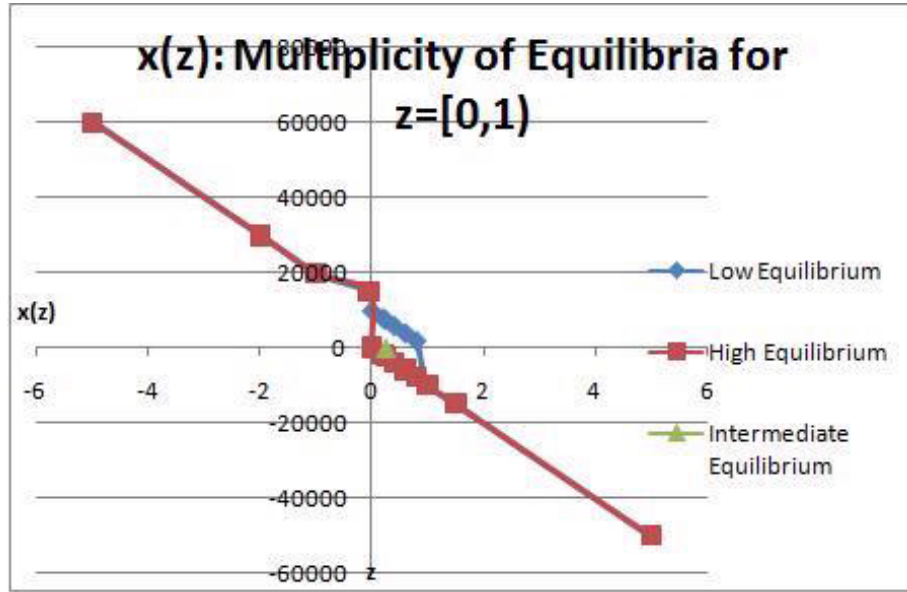
Figure 3.2: Multiplicity of Equilibria, x(z).

intermediate, and low critical values, $\theta^*(z_i)$ and $x^*(z_i)$, at $z_i=.25$ given $K=3$.

Proposition 3.3 *Given the precision of public information is exogenous and does not signal any information about the fundamentals of the countries, in the case of $K=3$, lower precision of public information might be preferable for intermediate fundamentals, $\theta_i = [0,1)$, in which a multiplicity of equilibria arises at high precision of public information and there are non-fundamental volatilities or sunspots that dictate the low-investment equilibrium to be played with a high probability.*

Proof. If the level of investment is higher under high relative precision of private to public information, in which equilibrium is unique, than that of under low relative precision of private and public information, in which equilibrium is not unique and the low equilibrium is played, then choosing sufficiently high relative precision of private to public information to avoid a multiplicity of equilibria is optimal. ∎

This proposition says that a country with an intermediate fundamental might choose lower precision of public signal if the multiplicity of equilibria that arises as information becomes more complete will be more likely to create coordination failures than coordination. Hence, if the precision of public information is exogenous and the low equilibrium is played when a multiplicity of equilibria arises, then a country will choose sufficiently low precision of public information to eliminate the multiplicity of equilibria. This result is analogous to the result of the model with one-dimensional fundamental and symmetric incompleteness of information (Angeletos and Pavan, 2004).

High precision of public information allows countries to coordinate better on multiple levels of investment, as is argued by Angeletos and Werning (2006). Intuitively, with low precision of public information, partially-informed agents are informatively constrained to coordinate among themselves resulting in a unique equilibrium. Conversely, with high precision of public information, partially informed-agents are better able to coordinate among themselves if the underlying complete-information game has a multiplicity of equilibria. Morris and Shin (2002) and Amato, Morris and Shin (2002) also suggest that high precision of public information might be detrimental if the precision of private information is high enough relative to the precision of private information. In this case, people overreact to the public information that is relatively imprecise compared to the private information. Although both Angeletos and Werning's model and Morris and Shin's model suggest that high transparency may not always be good, they offer slightly different insights as to why high transparency is not always good for welfare.

Now, assume that the fundamental is uniformly distributed in the real number

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(improper distribution). We can show that the utilities of countries with $\theta \geq 1$ are maximized at the highest level of transparency or full revelation, while the utilities of countries with $\theta < 0$ are unchanged with respect to the level of transparency, because these countries will not invest in their own countries regardless of the investments of the other countries. Suppose now there are informational externalities from revealing bad fundamentals such as bad reputation, and hence, countries with $\theta < 0$ will be strictly better off without transparency.

Proposition 3.4 *For K=3, suppose there are negative informational externalities from revealing low fundamentals. The utilities of countries with $\theta \geq 1$ are maximized at P=∞ (full revelation) and the utilities of countries with $\theta < 0$ are maximized at P=0 (no revelation). The utilities of countries with critical fundamentals, $0 \leq \theta < 1$, are maximized at $\infty \geq P \geq 0$ depending on the fundamental and the non-fundamental volatilities or sunspots in the case of a multiplicity of equilibria.*

Proof. (1) It is trivial to prove that the utilities of countries with $\theta \geq 1$ are maximized at full revelation. (2) From Proposition 3, intermediate-fundamental countries might choose a low level of transparency depending on which of the equilibria is played in the case of multiple equilibria. In both cases of low and high equilibrium, whether a country will be better off with more or less transparency depends on the fundamentals of the countries. For both the low and high equilibrium, as the relative precision of private to public information changes, the graphs of $\theta^*(z)$ and $x^*(z)$ also change, in which the level of investments of countries with dissimilar fundamentals will be affected differently. Take $x^*(z)$: for any equilibria, the graph $x^*(z)$ is downward sloping and intersects the x-axis at some value of public signal. It rotates clockwise as the relative precision of private to public in-

formation decreases (see Claim 3.4). As the relative precision of private to public information approaches zero, every country will invest in countries with fundamentals above the intersection point, because $x^*(z)$ will approach negative infinity at $z=\theta$. Conversely, no country will invest in countries with fundamentals below the intersection point because $x^*(z)$ will approach positive infinity at $z=\theta$. Note that we only consider the low and high equilibrium, and not the intermediate equilibrium, which only occurs at $z=.25$. In the case of improper distribution, this event occurs with probability zero. (3) Countries with $\theta < 0$, will be indifferent between revealing and babbling because these countries will not invest domestically regardless whether or not other countries will invest. However, because of negative externalities, such as bad reputation, they will strictly prefer not to reveal. ∎

Proposition 3.5 *(Transparency-aversion) Suppose there are negative informational externalities from revealing low fundamentals. For K=3, there are some countries with $\theta < 1$ that will be better off at a lower level of transparency than full revelation.*

Proof. For countries with $\theta < 0$, non-transparency is always better than transparency. For countries with $0 \leq \theta < 1$, lower transparency might be preferred depending on the fundamentals and the non-fundamental volatilities or sunspots in the case of multiple equilibria. ∎

Note that in order to prove the monotonicity of transparency, at which the utilities of intermediate-fundamental countries are maximized, with respect to the fundamentals, a more elaborate proof is needed to solve the expected utility maximization problem with respect to the precision of public information.

3.3.4   K-country Case

We show that most of the observations we find in the 3-country case still hold in the 13-country case (corresponding to the ASEAN + 3 countries). Increasing the number of countries from 3 to 13 while keeping the strategic complementarity of investment the same will increase the level of investment. This observation is intuitive since the probability that at least one other country invests is higher if K is higher. All of the above observations for K=3 continue to hold except the cutting value for a public signal to be considered "sufficiently high" or "sufficiently low" is not $z_i=.25$, but $z_i=0$. This is because the higher the number of countries, the more effective is the public signal in coordinating strategies because there are more potential countries to invest. Since strategies are strategic complements, then given a higher number of countries, a lower value of public signals ($z_i=0$) is the pivoting point above which a lower relative precision of private to public information will increase the level of investment. Analogous to the 3-country case, in the 13-country case, a multiplicity of equilibria prevails if $z_i=[0,1)$ at high precision of public information.

Corollary 3.3 *Given the precision of public information is exogenous and does not signal any information about the fundamentals of the countries, in the case of K=13, lower precision of public information might be preferable for intermediate fundamentals, $\theta_i = [0,1)$, in which a multiplicity of equilibria arises at high precision of public information and there are some exogenous factors, such as sunspots, that dictate the low-investment equilibrium to be played with a high probability.*

Corollary 3.4 *For K=13, suppose there are negative externalities from revealing low fundamentals. The utilities of countries with $\theta \geq 1$ are maximized at $P=\infty$*

(full revelation) and the utilities of countries with θ<0 are maximized at P=0 (no revelation). The utilities of countries with critical fundamentals, 0≤ θ<1, are maximized at ∞ ≥P≥0 depending on the fundamental and the non-fundamental volatilities or sunspots in the case of a multiplicity of equilibria.

Corollary 3.5 *(Transparency-aversion) Suppose there are negative informational externalities from revealing low fundamentals. For K=13, there are some countries with θ < 1 that will be better off at a lower level of transparency than full revelation.*

The corollaries above for the K-country case come directly from observations of our numerical examples for K=13 that show similar patterns as the case for K=3.

Strategic Substitutes

We analyze the robustness of our results regarding the multiplicity of equilibria under strategic substitutability of investment. The utility of the investing countries is as follows: $u_i=(\theta-i_{K>1}-1)'k^i$, where the indicator variable i is similarly defined as it is in the previous section and all other elements of the game are unchanged. With this utility function, investments are strategic substitutes. The complete information game with this utility function has a unique equilibrium in dominant strategy for the parameters $\theta_i \leq 1$ (never invest), $\theta_i > 2$ (always invest). There is a multiplicity of equilibria for the parameters $\theta_i = (1,2]$. As we can show, in the incomplete information game, a multiplicity of equilibria for the parameters $\theta_i = (1,2]$ recovers for low relative precision of private to public information. We also show that $\theta^*(z_i)$ increases in z_i but $x^*(z_i)$ decreases in z_i for any relative precision of private to public information.

Given the precision of public information is exogenous and does not signal any information about the fundamentals of the countries and investments are strategic substitutes, the critical values, $\theta^*(z_i)$ and $x^*(z_i)$, are unique for $z_i \geq 2$ and $z_i < 1$, for any relative precision of private to public information. The critical values, $\theta^*(z_i)$ and $x^*(z_i)$, are unique for $z_i = (1,2]$, for high relative precision of private to public information, but are not unique for low relative precision of private to public information. Increasing the precision of public information while fixing the precision of private information changes the sensitivity of $\theta^*(z_i)$ and $x^*(z_i)$ with respect to changes in z_i.

3.3.5 Extensions: Endogenous Precision of Public Information

Important information may be shared not only during official regional meetings. Information may be shared while central bankers eat dinners, play golf, or sing in a Karaoke bar. There is no limit to how much information is revealed. Hence, the precision of public signal, i.e. how much private information is shared publicly, is not exogenous. Angeletos and Werning (2004) show how the precision of public signals, such as prices, can be endogenous, and is a function of private signal.

In the previous section, we consider the case of exogenous public information in which the precision of public information does not signal the fundamentals. This is the case, for example, when countries are dictated to reveal specific information. Now, consider the case in which the precision of public information is endogenous and hence, signals some information about the fundamentals of the countries. This is the case when countries have discretions to set the level of precision of public

information. Suppose the precision of public signal is revealed prior to announce-
ments of public information. The two-stage process of announcements of precision
of public information prior to investment choices constitutes a signalling game in
which announcements of the precision of public information in the first stage may
convey the fundamentals of the countries that affect investment strategy in the
second stage. What differentiates this model from the previous model is the fact
that the precision of public information in stage one may signal the fundamentals
of the countries, $\theta^*(z_i|P)$ and $\mathrm{x}^*(z_i|P)$, when in the two-stage signalling game, the
Perfect Bayesian Nash Equilibrium is separating.

In a two-stage signalling game, investment strategies may depend on the an-
nouncements of precision of public signal if the equilibrium is separating. In
general, the concept of Perfect Bayesian Nash Equilibrium is used in this sig-
nalling game, where the following requirements must be satisfied: the precision of
public information, P*; investment strategies, $\theta^*(\mathrm{z}|\mathrm{P})$ and $\mathrm{x}^*(\mathrm{z}|\mathrm{P})$, and the belief
system, μ, constitute a Perfect Bayesian Nash Equilibrium if $\{\mathrm{P}^*, \theta^*(\mathrm{z}|\mathrm{P}), \mathrm{x}^*(\mathrm{z}|\mathrm{P})\}$
are sequentially rational at each information set given the beliefs, and beliefs are
consistent with the equilibrium strategies. In order to calculate the critical val-
ues of investments, we will need the conditional expectations of the fundamentals
given public information and the precision of public information that may signal
the fundamentals. These conditional expectations given the fundamental in some
interval are given in the Lemma below.

Lemma 3.3 *Country i's expected fundamental of country $j \neq i$ conditional on pri-
vate and public information as well as θ_j being in some intervals $= [a, b]$, $(\theta_j | x_j^i, z_j, \theta_j =
[a, b])$, has a truncated normal distribution with mean and variance equal to:*

$$E(\theta_j | x_j^i, z_j, \theta_j = [a, b]) = \mu + \frac{\phi(\frac{a-\mu}{\sigma}) - \phi(\frac{b-\mu}{\sigma})}{\Phi(\frac{b-\mu}{\sigma}) - \Phi(\frac{a-\mu}{\sigma})}\sigma$$

$$Var(\theta_j|x_j^i, z_j, \theta_j = [a,b]) = \sigma^2[1 + \frac{(\frac{a-\mu}{\sigma})\phi(\frac{a-\mu}{\sigma})-(\frac{b-\mu}{\sigma})\phi(\frac{b-\mu}{\sigma})}{\Phi(\frac{b-\mu}{\sigma})-\Phi(\frac{a-\mu}{\sigma})} - (\frac{\phi(\frac{a-\mu}{\sigma})-\phi(\frac{b-\mu}{\sigma})}{\Phi(\frac{b-\mu}{\sigma})-\Phi(\frac{a-\mu}{\sigma})})^2],$$

where $\mu = \frac{\frac{x_j^i}{\sigma_x^2}+P_j z_j}{\frac{1}{\sigma_x^2}+P_j}$, $\sigma^2 = \frac{1}{(\frac{1}{\sigma_x^2}+P_j)}$, Φ and ϕ are the CDF and PDF of a standard normal distribution respectively.

Proof. (See Appendix 7). ∎

This model is limited to the extent that in reality, agents or countries do not reveal the precision of their public announcements. Even if public information is given in terms of the quantity of information an agent reveals, it is still unclear whether there is some more important information kept hidden by an agent that could reduce the precision of the shared information. Take, for instance, the transparency of the financial market in the United States. It might seem that banks and funds were transparent in revealing their performance, but in reality, there had been a lot of off-balance-sheet transactions that were unknown to potential investors. In other words, the precision of public information is a relative measure and not an absolute measure that does not have a clear-cut standard. However, without knowing the precision of their public announcements, expectations over their fundamentals given private and public information are difficult to derive.

For simplicity, suppose there are only two possible levels of precision of public information, namely F for full revelation and B for babbling. Each country may choose either to reveal their information or stay quiet and not reveal their information. Assume that the fundamental is uniformly distributed in the real number (improper distribution). From our previous result, we show that countries with high fundamentals ($\theta \geq 1$) will choose to reveal their information, while countries with low fundamentals ($\theta < 0$) will choose not to reveal their information. Countries with intermediate fundamentals ($0 \leq \theta < 1$) may or may not choose to reveal

their information. In the case of intermediate fundamentals, there is a critical point above which a country will choose transparency over non-transparency and below which a country will choose non-transparency over transparency. This is because for both the low and high equilibrium in the case of multiple equilibria and for the case of the unique equilibrium, there are some values of the public signal at which the graphs of $\theta^*(z)$ and $x^*(z)$ touch or intersect the x-axis. There is a pivoting point about each of these intersection points (some of these pivoting points are the intersection points themselves), around which the downward-sloping graphs of $\theta^*(z)$ and $x^*(z)$ rotate clockwise as the precision of public information increases for some fixed precision of private information (see Claim 3.4). Note: we only consider the high and low equilibrium, and not the intermediate equilibrium that only occurs at a point in z. In the case of improper distribution, the probability of z or θ equal to this point is zero. Countries with fundamentals above a pivoting point will prefer transparency over non-transparency while countries with fundamentals below this pivoting point will prefer non-transparency over transparency.

Lemma 3.4 *Suppose transparency of a country does not reveal the fundamental of this country and there are only two possible levels of precision of public information: full revelation (F) and babbling (B). In the case of K countries, there is a critical value at which a country with a fundamental above this critical value will be better off at F and a country with a fundamental below this critical value will be better off at B.*

Proof. At zero precision of public information, or B, given non-zero fixed precision of private information, both $\theta^*(z)$ and $x^*(z)$ are flat at some positive value below infinity. At infinite precision of public information, or F, given non-zero fixed precision of private information, the slope of $x^*(z)$ approaches negative

infinity and x*(z) intersects the x-axis at some z (see Claim 3.4). At infinite precision of public information, or F, given non-zero fixed precision of private information, the graph $\theta^*(z)$ approaches one for all values below some z and zero for all values above this value of z. This holds for the low and high equilibria in the case of multiple equilibria, and the unique equilibrium. The intermediate equilibrium may occur only at a point in z, which occurs with probability zero. ∎

When the level of precision is endogenous, there are reputation effects that associate revealing information with high fundamentals and staying quiet with low fundamentals. Let the fundamentals associated with revealing information be in the interval of $[a^F, b^F]$ and the fundamentals associated with staying quiet be in the interval of $[a^B, b^B)$, where $a^F = b^B$. Taking the derivatives of the conditional mean with respect to both a and b, the above lemma shows that the expected fundamental given the interval a and b that is associated with either revealing or staying quiet increases in both a and b. This means that if only those countries with fundamentals in $[a^F, b^F]$ will reveal and countries in $[a^B, b^B)$ will stay quiet, then $E(\theta_j | x_j^i, z_j, F) > E(\theta_j | x_j^i, z_j, B)$. Since investment strategy is non-decreasing in fundamental, it is always better for a country, except the countries with the lowest fundamental, to reveal than not to reveal. In the most extreme case, we may observe the *lemon car* issue, in which all countries will choose to reveal except countries with the lowest level of fundamental (Economics Review, RIETI, 2009). Geraats (2002) shows that in a simple model of endogenous transparency of central banks, the unique pure-strategy perfect equilibrium is transparency for all types, i.e. the *lemon car* problem does occur.

Proposition 3.6 *Suppose the level of transparency of a country could partly reveal*

the fundamental of this country and there are only two possible levels of precision of public information: full revelation (F) and babbling (B). All countries, except countries with the lowest fundamentals, will choose F.

Proof. Starting from the countries at the high end of $[a^B, b^B)$, i.e. countries whose fundamentals are close to b^B, these countries will choose revealing over babbling because the other countries' expectation of their fundamentals given their fundamentals are in $[a^B, b^B)$ is lower than their true fundamentals. The expected fundamental of the countries who choose babbling is even lower. More countries will choose revealing. Using this induction, only the countries with the lowest fundamentals will choose B. ∎

What makes the endogenous transparency model powerful is that it could drive countries to adopt transparency measures without mandates. More work on this endogenous model is needed. In real life, transparency of a country or a central bank is partly exogenous and partly endogenous. Sovereign countries have sovereign rights to choose the level of transparency, but there are transparency standards by which they are obliged to comply, such as the IMF's Article IV Publication or the Basel II Accord.

3.3.6 Further Remarks: Critiques and Applications

We have assumed that central bankers, ministries of finance, and other country's representatives make investment decisions. It is true that it is atypical, except in the case of Sovereign Wealth Funds. In other words, central bankers, ministries of finance, and other country's representatives are not investors. Moreover, assuming that policy coordination depends on information about the fundamentals alone

is too simplistic. Diplomatic, strategic, and political factors may matter more than just economic factors. For example, despite a bad economic fundamental, a country might invest in another country because of strategic commodities, such as oil, gas, uranium, or nuclear technologies.

Another criticism of the model in this paper is that some public officials do have access to other countries' information that is not publicly available. All IMF Country Reports are distributed to the Executive Directors of the IMF member countries. We may argue, however, that in this case the precision of private information about the other countries can be made very high. Analogously, a public official who could have prevented the country from falling into crisis may not know the fundamental of the country, and hence, fails to save the country. Private investors, for example, might know more than public officials from their daily business activities.

Optimal transparency is not a matter of being pro- nor anti - transparency. But to answer the question whether pro- or anti-transparency is optimal might simplify a lot of important issues. Hiding bad information over a collapsing bank for example, might be preferable in order to provide a blanket guarantee[5] and prevent a bank run. Once the blanket guarantee is provided, the bank can be publicly announced as being under supervision. However, for the same situation, hiding bad information over a collapsing bank while having a third party find out about the situation might damage the central bank's credibility.

In response to the critiques above that might arise, we leave it to the readers to judge when our model is appropriate to apply. It is true that the issue of transparency on macroeconomic fundamentals is very broad that any model would

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[5] A blanket guarantee is a declaration by the government that all deposits and perhaps other financial instruments will be guaranteed (Refence: Banking Glossary).

seem to oversimplify the situation. However, what we attempt in this paper is to focus on one dimension of it, namely the issue of information on coordination in a case when strategic decisions can be categorized as being complements or substitutes. Multiple equilibria in both the complete and incomplete information games that we have shown are not uncommon. In fact, in many real-life cases, it is more likely that a multiplicity of equilibria rather than a unique equilibrium arises. Hence, our theoretical result above is not surprising. What we hope to determine is whether coordination can be better achieved in the case of a multiplicity of equilibria by constraining the level of public information that can serve as public signals.

The role of institution to regulate transparency measures is important. The Basel II Accord, for example, is the second version of the Basel Accord that regulates minimum capital requirements, supervisory review process, and disclosure requirements. Disclosure requirements are transparency measures in which banks are supposed to release relevant financial data in a timely fashion to the public, for example, through their websites. Proper regulation on transparency measures is indispensable, as is evident in the global financial crisis that started in 2007. One of the reasons for the global financial crisis is the lax regulation on transparency among mortgage banks, hedge funds, and investment banks.

The above investment model with public-private information and partially informed agents fits the real-life examples of countries with Sovereign Wealth Funds that invest in other countries. This situation become more relevant since the total assets and number of Sovereign Wealth Funds have been growing rapidly (Azis, 2009). This is partly because of excess foreign exchange reserves of the Asian countries and petrodollars of the Middle-Eastern countries. East Asian interna-

tional reserves amounted to US$4 trillion in 2008. In 2007, Asian and Middle Eastern countries had invested 43 billion Euro in European and American countries through their Sovereign Wealth Funds. The IMF had estimated that there were more than 20 Sovereign Wealth Funds financed by petrodollars and foreign exchange reserves with total assets of between US$1.9 trillion and US$2.9 trillion around the world. Another study shows that the total asset under management of SWF reached US$3.3 trillion (Wikepedia). It is expected to grow by US$1 trillion per year. Among the concerns about Sovereign Wealth Funds are security issues, that a country might "buy" other countries and might therefore control domestic issues, including tax regulations on companies whose assets partly belong to foreign governments. What this paper shows is that the role of information among these partially informed agents is indispensable, and affects the investment strategies among these countries.

3.4 Empirical Study

In this empirical study, we are going to test the above theoretical propositions by testing how transparency of central banks could be affected by the economic fundamentals. Our theoretical propositions suggest that central banks with low and intermediate economic indicators can be associated with a lower level of transparency than full revelation. Empirical studies on transparency of an economic institution and economic fundamentals are difficult because most of the effects of transparency come not only from economic incentives but also political, social, and other incentives, and even a third variable that may affect both transparency and fundamentals, such as the level of development or the GDP per capita. Thus, it is hard to separate between the two factors and to determine the direction of

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the cause and causality. The second obstacle is that there is no clear-cut criteria of having a good or bad economic fundamental. The third obstacle is that some of economic indicators experience sudden shocks, such as hyperinflation or rapid exchange rate appreciation, or consistent anomalies, such as the extremely high ratio of broad money to foreign exchange reserves of the United States of America and Australia. We will address these obstacles in the next section. The fourth obstacle is that some of the variables of interest might be correlated.

In order to address the first obstacle, endogeneity of the variables, we will take a panel data that run between 1998 to 2005 across 83 countries. We use multilevel mixed-effect linear regression that combines both fixed-effect and random-effect models. This could identify the persistency of effects of the independent variables on the dependent variables over time. In order to address the second obstacle, we will show how certain economic indicators may affect transparency. It is not only a question of whether good economic fundamentals increase transparency, but also the intuition behind how certain economic indicators may affect transparency. For example, high ratio of current account deficit to nominal GDP could be associated with a low fundamental because it could speculate an attack on the exchange rate if there is a sudden capital inflow reversal and the foreign exchange reserve is low. However, countries with high capital account surpluses might boast upon their investment booms. In order to address the third obstacles we eliminate observations that we identify as outliers or anomalies that could distort the regression. In order to address the fourth obstacle, we check the robustness of our results by orthogonalizing the independent variables.

There are at least a few variables that past literature has suggested could affect transparency of a central bank. These include: the level of development or

the GDP per capita (Geraats, 2008; Dincer and Eichengreen, 2007), the independence of central banks (Crowe and Meade, 2008), the level of inflation (Geraats, 2008), the exchange arrangement and monetary regime (Geraats, 2008; Dincer and Eichengreen, 2007; Crowe and Meade, 2008), and the rule of law (Dincer and Eichengreen, 2007). We will show how economic fundamentals of a country namely unemployment rate, inflation, real exchange rate appreciation, ratio of broad money to foreign exchange reserves, and ratio of current account balance to nominal GDP affect the transparency of the central bank, controlling for the level of development, exchange rate arrangements, polity, region, crisis, and year.

3.4.1 Data

Dependent Variable: Transparency Index of Central Banks

We use the Dincer and Eichengreen (2007) transparency index data for central banks in 100 countries over five continents. This transparency index is based on Eijffinger-Geraats transparency measures for central banks (Eijffinger and Geraats, 2006) that consist of five pillars: political transparency, economic transparency, procedural transparency, policy transparency, and operational transparency. Policy transparency focuses on the openness of policy objectives, economic transparency focuses on the openness of economic information that is used to formulate monetary policy, procedural transparency focuses on the openness of the procedures that are used to formulate monetary policy, policy transparency focuses on the disclosure of policies taken, and operational transparency focuses on the openness of the implementation of policy actions. The questionnaires for this survey are given in Appendix 8. This is the largest data for transparency of central banks

that was collected over the period of 1998 to 2005 for 100 central banks, gathered from the central banks' websites, statues, annual reports, and other published documents.

Out of these 100 central banks, we drop fourteen countries because there is no data on one or more variable(s) of interest. These countries are: European central bank because of the difficulty in measuring an aggregate economic fundamental of the European Monetary Union; The Bermuda, Cuba, East Caribbean because there is no data on most of the variables of interests; (if unemployment rate is included as a regressor) Aruba, Ethiopia, Malawi, Nigeria, Rwanda, Sierra Leon, Solomon Islands, Tajikistan, Vanuatu, Yemen, Zambia because there is no systematic measurement on unemployment rate. Since there are other countries in our observations that are in the same regions as these eliminated countries, we avoid selection bias.

Independent Variable 1: Economic Fundamentals

There are four main economic indicators that we consider: inflation, the ratio of broad money to foreign exchange reserves (the inverse reserve ratio), the ratio of current account balance to nominal GDP, and the real exchange rate appreciation/depreciation. The data is taken annually from the International Financial Statistics and CEIC Data. Data on the ratio of broad money to foreign exchange reserves for some countries that are missing from the IFS and CEIC are taken from the ratio of broad money to total reserve from indexmundi.com, which upon investigation, does not deviate significantly much from the ratio of broad money to foreign exchange reserves from the IFS and CEIC. Accounting for inflation and the ratio of current account balance to nominal GDP, there are two economic

indicators used in Sachs, et.al. (1996) to measure liquidity assets (the ratio of broad money to foreign exchange reserves) and the overvaluation of exchange rate (real exchange rate appreciation[6]). Inflation could indicate a decreasing purchasing power, overheating economy, and/or distortion to terms-of-trade caused by appreciation of exchange rate.

We observe outliers and anomalies in our observations of these economic fundamentals. In our data, Bulgaria was recorded as having a 1000% inflation in 1998. There were four other outliers of more than 200% inflation that we eliminate. We dropped the ratio of broad money to foreign exchange reserves of the United States and Australia that were much higher than other countries (more than 100 for the USA and more than 40 for Australia, while the average was 6). In order to predict the effects, we plotted the graphs of these variables alone against the transparency index (see Figure 3-6). Because of the indications of quadratic relationships, we take both the linear and quadratic terms of these variables, except for inflation.

Independent Variable 2: Socioeconomic Fundamentals

The quality of economic institution could depend not only on economic fundamentals but also on social and political fundamentals. In order to account for the effect of social conditions, we take data on a socioeconomic variable, namely the unemployment rate. Data on unemployment rate is particularly difficult because most of the African countries do not collect such data. There are four

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[6]Sachs, et.al. (1996) use trade-weighted real exchange rate.
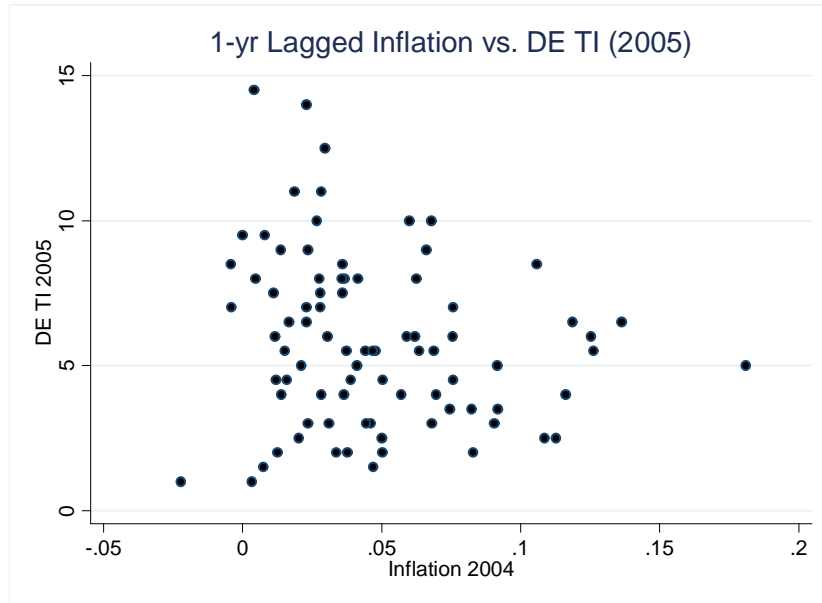
Figure 3.3: Inflation 2004 vs. DE TI 2005
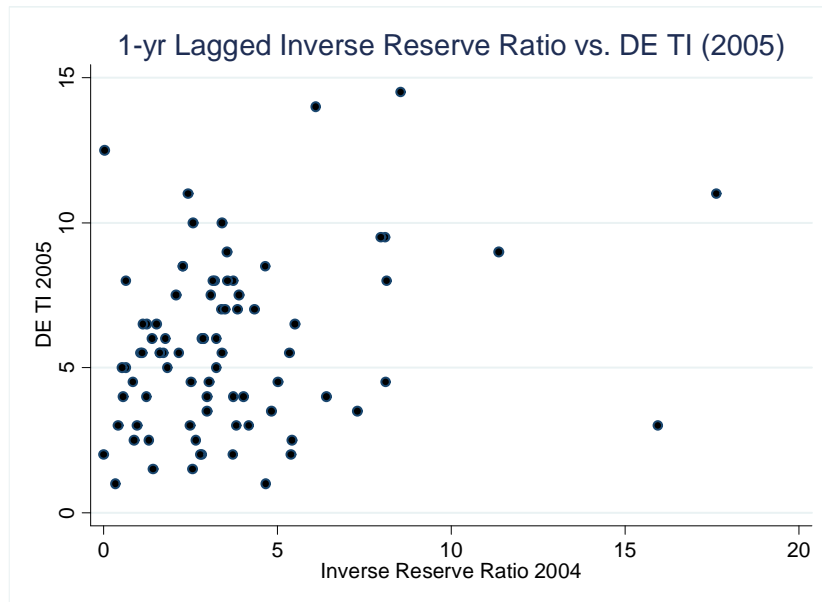
Figure 3.4: Inverse Reserve Ratio 2004 vs. DE TI 2005
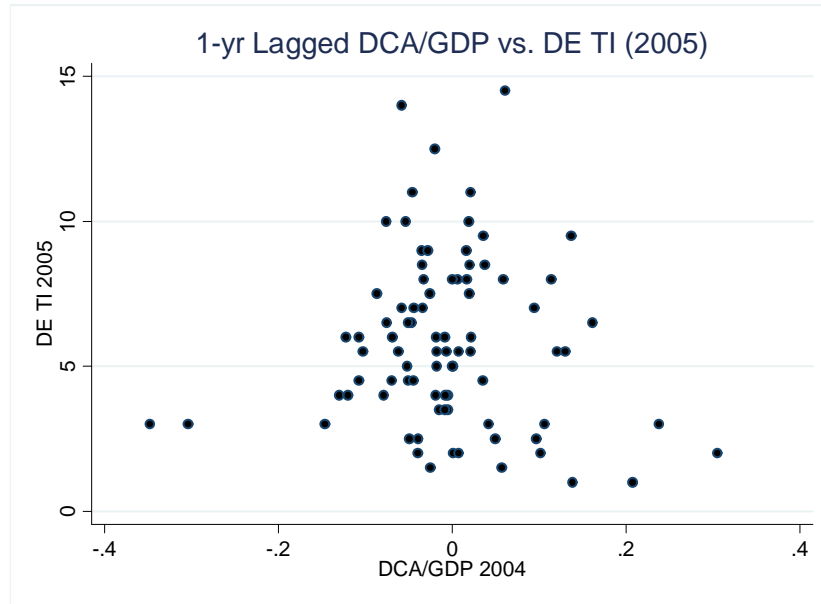
Figure 3.5: DCA/GDP 2004 vs. DE TI 2005

countries in East Africa, two countries in West Africa, one country in Latin America and the Caribbean, two countries in the Melanesia, one country in Central Asia, and one country in Western Asia, whose unemployment rates are not systematically collected. The unemployment data is collected from the IFS, CEIC, indexmundi.com, and other websites. High unemployment rate might weaken the economic fundamental of a country. Because of the indication of quadratic relationship of unemployment rate, we take both the linear and quadratic relationships (see Figure 7).

Independent Variable 3: Political Fundamentals

We take an index on the level of democracy from the Polity IV Project conducted by the Center for Systemic Peace[7]. The index is equal to the democratic index mi-

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[7]The data is available at:
http://www.systemicpeace.org/polity/polity4.htm.
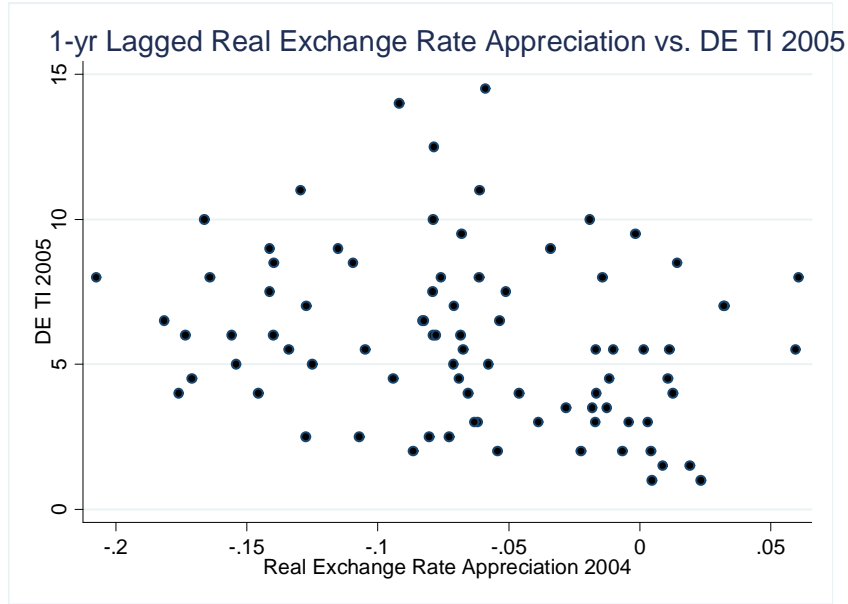
Figure 3.6: Real Exchange Rate Appreciation (-) 2004 vs. DE TI 2005

nus the autocratic index. The democratic index measures three main pillars: the presence of institutions and procedures through which citizens can express effective preferences about alternative policies and leaders, the existence of institutionalized constraints on the exercise of power by the executive, and the guarantee of civil liberties to all citizens in their daily lives and in acts of political participants (Marshall and Jaggers, 2009). The autocratic index measures the competitiveness of political participation, the regulation of participation, the openness and competitiveness of executive recruitment and constraints on the chief executives. Each of the democratic and autocratic index ranges from 0 to 10, and the polity index ranges from -10 (most autocratic) to 10 (most democratic). A two-variable scatter plot of polity index and transparency is given in Figure 8. Because the index is categorical, from -10 to 10, we run fixed-effect dummy variables on polity instead of assuming a continuous linear relationship.
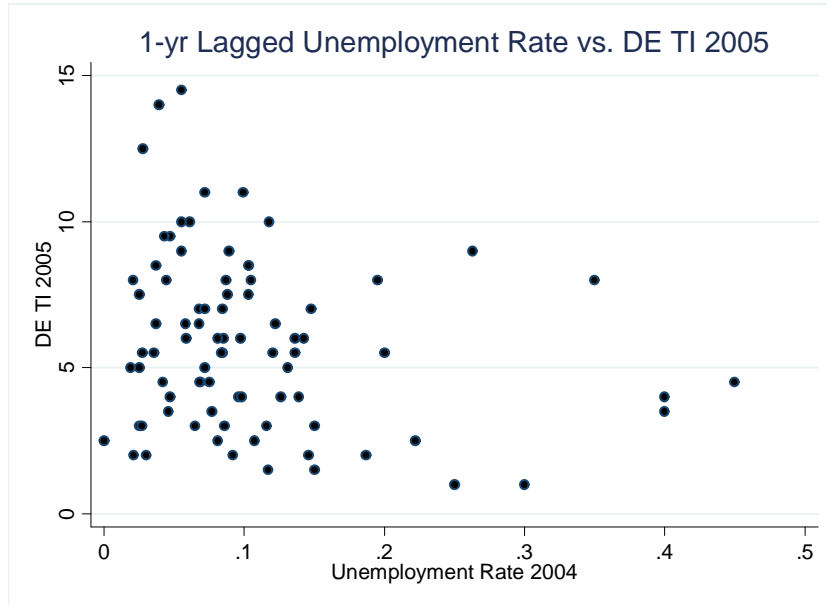
Figure 3.7: Unemployment Rate 2004 vs. DE TI 2005
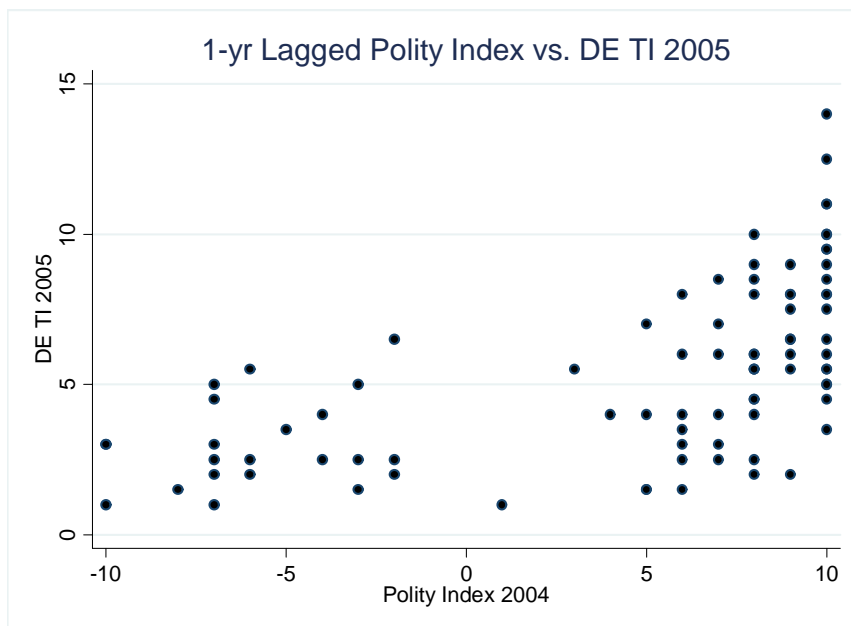
Figure 3.8: Polity Index 2004 vs. DE TI 2005
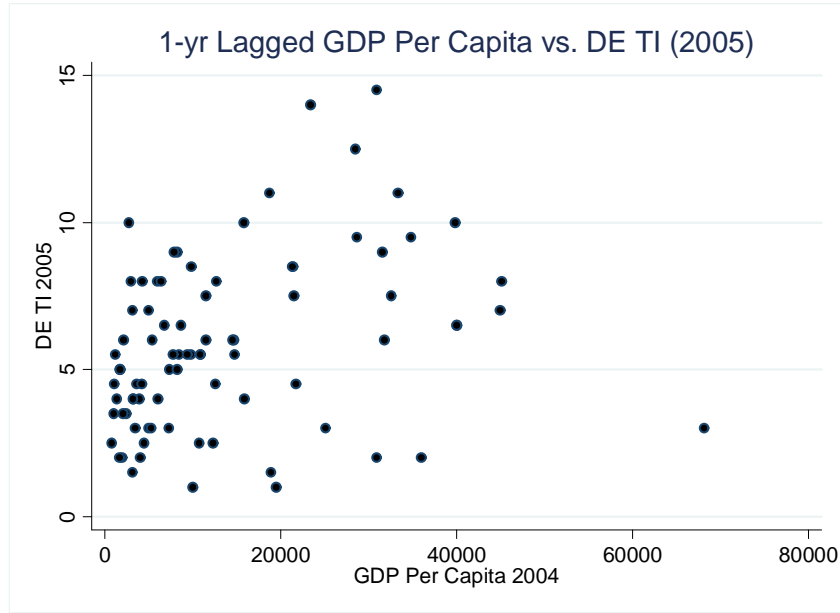
Figure 3.9: GDP per Capita 2004 vs. DE TI 2005

Independent Variables 4: The Level of Development

The level of development may capture other eliminated biases that are specific to development of a region. These include institutional differences, development priorities, technology, social indicators and so on. Because of the prediction of a quadratic relationship between GDP per capita and transparency index (see Figure 9), we take both linear and quadratic terms in our regression. The data on GDP per capita is taken mostly from indexmundi.com.

Controlling Variables: Exchange Arrangement, Crisis, Year, Region

We control our regression by the exchange rate arrangement that is shown to be strongly correlated with transparency index, the occurrence of financial crisis in the late 1990's/early 2000's possibly because of international pressures on

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countries in crisis to adopt transparency measures, the year or time-effect that might pick up the worldwide trend on transparency, and the region to control for region-specific biases that could be cultural or geographic. The exchange arrangements are categorized into eight arrangements as they are defined by the IMF: exchange arrangements with no separate legal tender (1), currency board arrangements (2), other conventional fixed peg arrangements (3), pegged exchange rates within horizontal bands (4), crawling pegs (5), exchange rates within crawling bands (6), managed floating with no pre-announced path for the exchange rate (7), and independently floating (8). The source of this data is the IMF's De Facto Classification of Exchange Rate Arrangement and Monetary Policy Frameworks[8]. The effect of exchange arrangement on transparency is given in Figure 10. We do not control for monetary policy framework because of the lack of early data, which would have reduced the size of our original panel data. We argue that the effects on monetary policy framework could be picked up by other variables that underlie the establishment of a particular monetary policy framework, such as the GDP per capita of the country. The countries that are considered to be in crisis or experience spillover effects from countries in crisis are: Argentina, Brazil, Hong Kong, Hungary, Indonesia, Peru, Philippines, Thailand, Venezuala (Mexican crisis); Argentina, Brazil, Czech Republic, Hong Kong, Hungary, Indonesia, Korea, Malaysia, Mexico, Pakistan, Philippines, Poland, Singapore, South Africa, Taiwan Province of China, Vietnam (Asian crisis); Argentina, Belarus, Bolivia, Brazil, Colombia, Czech Republic, Ecuador, Georgia, Hong Kong, Indonesia, Korea, Mexico, Moldova, Pakistan, Paraguay, Poland, South Africa, Tajikistan, Thailand, Turkey, Turkmenistan, Ukraine, Uruguay, Uzbekistan, Venezuela (Russian

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[8]These reports are available from 2003-current year at: http://www.imf.org/external/np/mfd/er/index.asp. The earlier reports are available in the IMF's Annual Reports of Exchange Arrangement and Exchange Restrictions.
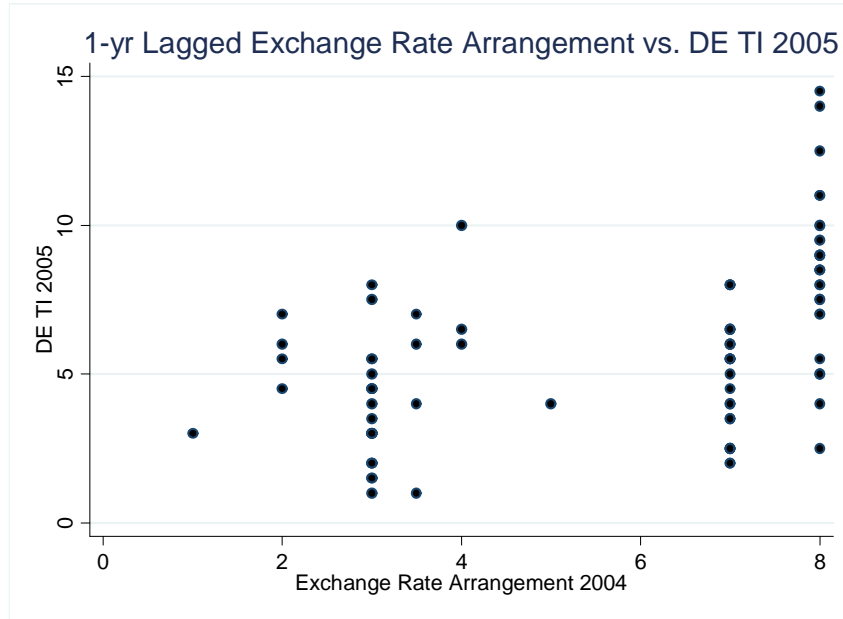
Figure 3.10: Exchange Rate Arrangement 2004 vs. DE TI 2005

crisis)[9]. The region dummy variables total to 19. We categorize each country into one of the following regions: (Africa) 1=E. Africa, 2=N. Africa, 3=S. Africa, 4=W. Africa; (Americas) 5=Latin America and Caribbean, 6=C. America, 7=S. America, 8=N. America; (Oceania) 9=Australia and New Zealand, 10=Melanesia; (Asia) 11=C. Asia, 12=E. Asia, 13.S. Asia, 14=S-E Asia, 15=W. Asia; (Europe) 16=E. Europe, 17=N. Europe, 18=S. Europe, 19=W. Europe. Based on the available data, the regression is run in the years of 1999, 2001, 2003, 2004, 2005.

3.4.2 Regression

The regression on the panel data is run using a multilevel mixed-effects linear regression. The fixed-effect is captured by specifying the fixed-effect dummies

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[9]This list is taken from NBA595, Economics of Financial Crisis, Cornell University, Spring 2008.

controlling for the year, region, and crisis as well as polity. The random-effect model is captured by specifying the grouping structures of the observations, which in this case is the country. We run a regression based on our hypothesis above (see Appendix 9). We test for robustness by running the regression with orthogonalized variables (using the Gram-Schmidt method[10]) and show that unemployment becomes insignificant while the results for the other variables remain robust. We drop the unemployment variable because of possible collinearity, and run a another regression without unemployment and the quadratic term on the ratio of current account balance to nominal GDP that we find is insignificant in the first regression. We test for robustness by running the regression with orthogonalized variables and find the results are robust. The following regression is the regression that we use:

$$
\begin{aligned}
DETI_{i,t} \; = \; & \alpha + \beta_1 GDPPERCAP_{i,t-1} + \beta_2 (GDPPERCAP_{i,t-1})^2 + \\
& \beta_3 EXREGIME_{i,t-1} + \beta_4 INFLATION_{i,t-1} + \\
& \beta_5 RESERVE_{i,t-1} + \beta_6 (RESERVE_{i,t-1})^2 \\
& \beta_7 RER_{i,t-1} + \beta_8 (RER_{i,t-1})^2 \\
& \beta_9 DCAGDP_{i,t-1} + \\
& + I(POLITY_{i,t-1}) + I(REGION_i) + I(CRISIS) + I(YEAR_t)
\end{aligned}
$$

where:

GDPPERCAP=GDP per capita

EXREGIME=exchange rate arrangement

INFLATION=inflation

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[10]State command: orthog.

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RESERVE=the ratio of broad money to foreign exchange reserves

RER=Real Exchange Rate appreciation (-)/ depreciation (+)

DCAGDP= the ratio of current account balance to nominal GDP

I(POLITY)=indicator variable on polity (-10=most autocratic, +10=most democratic)

I(REGION)=indicator variable on region (1-19)

I(CRISIS)=1 if country is in crisis in the last 8 years (1998-2005), =0 otherwise

I(YEAR)=indicator variable on year (1998-2005)

We expect the coefficient β_1 to be positive while β_2 to be negative to be consistent with the argument that a country with a higher level of development has more advanced communication technology and a human-capital advantage to support high quality economic institutions such as public data dissemination. This effect is expected to be diminishing. The effect of the exchange rate arrangement on transparency, β_3, is expected to be positive. That is, countries with a more independent or flexible exchange rate arrangement tend to be more transparent. The coefficient on inflation, β_4, is expected to be negative. Inflation could decrease the purchasing power of the citizens. It could be a sign of an overheating economy, and it could distort the terms of trade by causing the real exchange rate to appreciate. The linear and quadratic coefficients on the ratio of broad money to foreign exchange reserve, β_5 and β_6, are expected to be negative and positive respectively. Countries with higher foreign exchange reserves are more liquid with respect to their liquid assets and can better protect its exchange rate against devaluation should there be a capital inflow reversal, thus rendering them less prone

to a speculative attack. The quadratic term is evident from the graphs of the ratio against the transparency index.

The linear and quadratic coefficients on the real exchange rate appreciation (-)/depreciation (+), β_7 and β_8, are expected to be positive and negative respectively. Real exchange rate appreciation might indicate an overvalued exchange rate that is prone to a speculative attack. The linear coefficient of the ratio of current account balance to nominal GDP, β_9, is expected to be positive. Countries with high ratios of current account deficits to nominal GDP are more prone to capital inflow reversal and to speculative attack if foreign exchange reserves are low, real exchange rate is overvalued and/or the banking system is weak, which would imply low fundamentals. The question of whether this coefficient should be positive or negative is, however, subtle. Current account deficits do not necessarily mean low fundamentals because they might, for example, mirror capital account surpluses and reflect an investment boom. Some studies have also been done to show that current account deficit is not necessarily a sign of low fundamental (Ghosh and Ramakrishnan, 2006). We conjecture that the coefficient of polity is positive for high polity indexes. We expect the crisis indicator to be positive and significant to capture the pressures from the lending countries on crisis-hit countries to adopt transparency measures. We also expect the year-effect to be positive and significant to capture the increasing general trend of transparency across countries. Some region effects are significant to capture regional biases that might include climate, geography, biology, or culture.

The discussion of what constitutes a good economic fundamental is subtle. There are two types of fundamentals: macroeconomic fundamentals that fluctuate considerably over time, and structural fundamentals that do not fluctuate much

over time. Countries with high structural fundamentals could still experience crisis because of poor macroeconomic fundamentals. Macroeconomic fundamentals constitute variables including changes in real exchange rate, while structural fundamentals constitute variables such as exchange rate regime and hyperinflation. We use both macroeconomic fundamentals and structural fundamentals.

Another concern about the regression that one might address is that the change in real exchange rate might not be completely independent from the ratio of current account balance to GDP. As studied in Lee, Milesi-Ferretti, and Ricci (2006), the change in real exchange rate might be an adjustment from the current account balance to reach equilibrium. This collinearity is resolved by a robustness check running a regression with orthogonalized variables.

3.4.3   Result

The regression result is in Appendix 10, after dropping four observations that have very high residuals (outliers). We find that both the linear and quadratic terms of GDP per capita are positive and negative respectively with five and ten percent confidence interval. This is consistent with our prediction that countries with higher level of GDP per capita are associated with higher level of transparency.

The coefficient of the exchange rate arrangement is positive and significant at one percent confidence interval. Countries with more flexible exchange rate arrangements tend to have more transparent central banks. The coefficient of inflation is negative and significant at one percent confidence interval. Countries with higher inflation tend to have less transparent central banks. The linear and quadratic coefficients of the ratio of broad money to foreign exchange reserves

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are negative and positive respectively with one percent confidence interval, consistent with our hypothesis. Countries that are more liquid with respect to their assets tend to have more transparent central banks. The linear and quadratic coefficients of the changes of real exchange rate are negative and positive respectively with five percent confidence interval. This means that countries with real exchange rate appreciation tend to have higher levels of transparency, which is inconsistent with our hypothesis. One argument for the inconsistency is that it is not the changes in real exchange rate that affect transparency, but rather the exchange rate regime. Hence, changes in real exchange rate after we control for exchange rate regime are not good indicators of fundamentals that could affect transparency. We argue that there is no macroeconomic theory that explains this negative relationship. Changes in real exchange rate fluctuate considerably and can be considered as macroeconomic fundamentals while exchange rate regime can be considered a structural fundamental. What seems to be more relevant in our study are structural fundamentals rather than macroeconomic fundamentals.

The coefficient of the ratio of current account balance to the nominal GDP is negative and significant at five percent confidence interval, which is inconsistent with our hypothesis. We argue that this is because high current account deficits mirror high capital account surpluses, and countries with capital account surpluses, which might reflect an investment boom, are more confident in revealing their fundamentals.

The polity index is positive and significant only for the highest level of polity, or the most democratic regime. Region effects are significant and positive: (one percent confidence interval for the following regions) North America, Australia and New Zealand , Northern Europe; and (five percent confidence interval for the

following regions) Southern Africa. After controlling for the level of development, developed countries still show tendencies for higher transparency. Southern Africa has a significantly higher transparency than that of the controlled region, Eastern Africa, albeit with a lower coefficient than those of North America, Australia and New Zealand, and Northern Europe. Possible explanations include culture, biology, geography, and even weather or environment. The year or time-effect is significant at one percent confidence interval and positive for all years, except 1999, which means that countries worldwide in general experience an increasing trend in transparency. Transparency in 1999 did not change significantly from transparency in 1998. The crisis index is significant at one percent confidence interval and positive, which suggests that countries under crisis, particularly because of the four crises between 1998-2005 including the Asian, Russian, and Mexican crises, tend to have higher transparency indexes. This suggests possible international pressures in particular from the IMF, which helped those countries and required them to adopt transparency measures. These non-economic effects on transparency are consistent with our hypothesis.

To check for robustness because of the possible collinearity of variables, we run the regression with orthogonalized independent variables and the result remains robust. Some existing literature including Geraats (2008) and Crowe and Meade (2007) show that certain monetary policy frameworks could affect the level of transparency. However, we did not control for the monetary policy framework in our model because it is only available from 2001 onwards, and hence, we would have to drop our observations from 1998 to 2001, which would have reduced the explanatory power of most of the variables of interest[11].

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[11]We receive data on monetary policy framework prior to 2001 (1997-2005) from the IMF. However, due to inconsistencies in identifying monetary policy framework throughout this period, we do not use this data for the purpose of this paper.

3.4.4 Policy Implications: Endogeneity of Institution and Convergence Bias

The policy implications of this study lay in that the results from the empirical study, which suggest that some economic fundamentals of a country could affect the level of transparency of central banks, which in turn could be a proxy to the quality of economic institution. These economic fundamentals include GDP per capita (the level of development), inflation, the ratio of broad money to foreign exchange reserves, the ratio of current account balance to nominal GDP and the exchange rate regime. However, these are not the only factors that affect the quality of economic institution. The polity, unobserved region-effect, international pressure from lenders, and year-effect also affect the quality of economic institution.

This result gives a more fundamental explanation of the determinants of the quality of economic institution than what has been done in previous literature. In this case, the primary determinant is transparency. Controlling for the level of development and the exchange rate regime, countries with lower inflation, lower ratio of broad money to foreign exchange reserves, and lower ratio of current account balance to nominal GDP tend to have higher transparency. Moreover, countries in crisis tend to have higher transparency. Countries located in Southern Africa, North America, Australia and New Zealand, and Northern Europe tend to have significantly higher transparency than those of the controlled region of Eastern Africa after controlling for the other variables. In general, all countries tend to have higher transparency over time.

We distinguish between macroeconomic fundamentals and structural fundamentals. Macroeconomic fundamentals include the changes in real exchange rate

and structural fundamentals include the level of development, the exchange rate regime, (hyper)inflation, the ratio of broad money to foreign exchange reserves, and the ratio of current account balance to nominal GDP. We argue that the structural fundamental is a more relevant variable to study quality of institution than macroeconomic fundamental is. Of course, we cannot completely eliminate the fact that the level of transparency might affect the quality of the fundamentals, but the panel data of this study allows us to detect the persistency of the effects of these indicators on transparency over time.

A more meaningful implication of this empirical study is that the quality of economic institution is endogenous. Economic fundamentals may affect the quality of economic institution, which in turn affect the fundamentals. There is also a more general time-trend, as all countries generally experience an increasing level of transparency. In other words, even countries with low economic fundamentals and transparency will tend to experience an increase in their level of transparency over time. We can also show that the growth of DE TI from 1998 to 2005 is higher for countries with lower initial transparency index in 1998. This suggests the convergence or catching-up bias (see Figure 11).

Another interesting observation, although not directly related to this study, is the evidence of reversal of fortune (see Figure 12-14). In these figures, over time, we can show that GDP per capita could have a negative effect on the quality of political institution, such as the Rule of Index from the Worldwide Governance Indicators. Countries with very high values of GDP per capita with relatively low Rule of Law Index include Qatar, Kuwait, and United Arab Emirate. These are countries that are rich in oil, petroleum, and natural gas. These countries tend to be reluctant to improve their institutions because, even without high quality of

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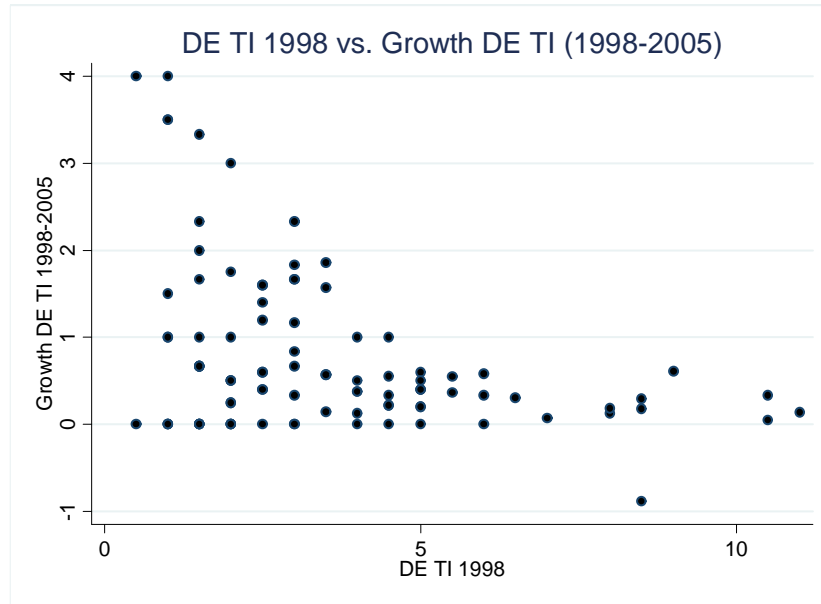
Figure 3.11: DE TI 1998 vs. Growth DE TI 1998-2005

institution, they could still enjoy high standards of living.

3.5 The Role of Information In The Process Towards East Asian Integration

3.5.1 History of Asian Regional Financial Arrangement

After the 1997-1998 Asian Financial Crisis, East Asian economists, some of whom were disappointed with the management of the crisis under the IMF, realized the need to establish an economic institution to safeguard the East Asian countries from another financial crisis and to facilitate regional economic cooperation. Since August 1997, Japan had already proposed an "Asian Monetary Fund". Thirteen countries consisting of the ten ASEAN countries plus China, Japan, and Korea,
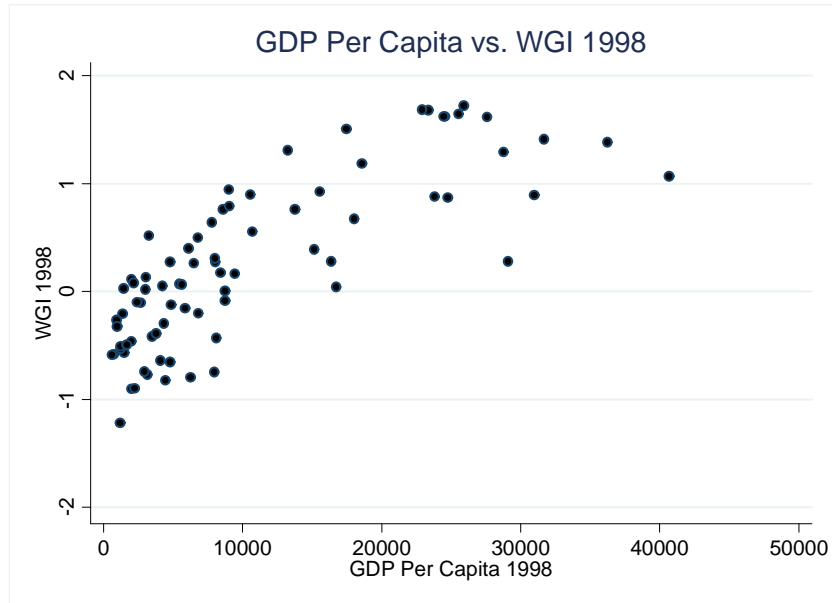
Figure 3.12: GDP per Capita 1998 vs. WGI 1998
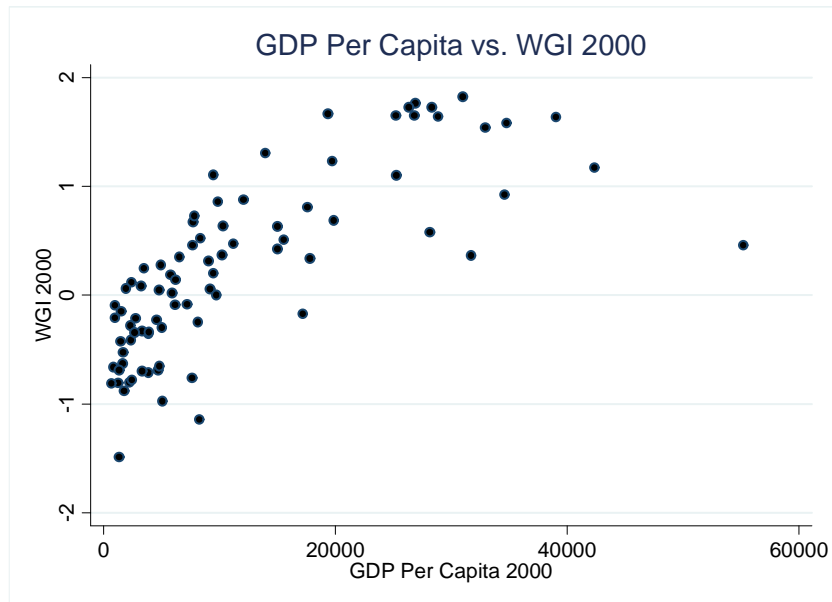
Figure 3.13: GDP per Capita 2000 vs. DE TI 2000
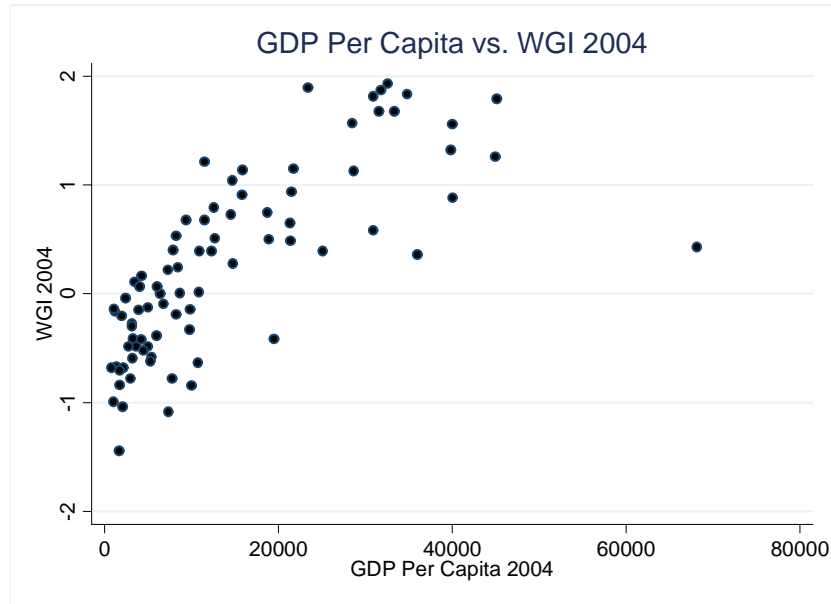
Figure 3.14: GDP per Capita 2004 vs. DE TI 2004

now termed the ASEAN+3 countries, gathered together in December 1997 in Kuala
Lumpur, Malaysia, to discuss the establishment of a regional economic institution.
This was the first summit to begin the Asian regional economic cooperation after
the 1997-1998 financial crisis. On May 6, 2000, Chiang Mai Initiatives Bilateral
Swap was initiated to facilitate bilateral swap arrangements and protect member
countries from short-term liquidity crisis as well as to supplement the existing bor-
rowing support facilities. By May 15, 2004, sixteen Bilateral Swap Agreements
were already made totalling to US$36.5 billion, and on the same day, finance min-
isters initiated the Asian Bond Market Initiatives, ASEAN+3 Research Groups,
and regional monitoring of short-term capital flows. They also agreed to adopt the
new Basel Capital Accord regulating banking laws. By this time, the ASEAN+3
countries had managed to agree on five main pillars of regional financial arrange-
ments, namely the Chiang Mai Initiatives, the Asian Bond Market Initiatives, the
regional surveillance and regional monitoring (which was consolidated in regular

policy meetings known as the Economic Review and Policy Dialogue or ERPD), and the ASEAN+3 Research Groups. On May 5, 2007, a self-managed reserve pooling arrangement was envisaged. On May 4, 2008, the Chiang Mai Initiatives were transformed into a much stronger Chiang Mai Initiatives Multilaterization. On October 25, 2008, a self-managed reserve pool amounting to US$80 billion based on the Chiang Mai Initiatives Multilaterization was created. The three countries, China, Japan and Korea, committed to provide 80 percent of the total fund of US$80 billion while the rests of the ASEAN countries contributed the remainder. On December 13, 2008, a trilateral summit among China, Japan, and Korea was held. In this meeting, the three countries reiterated their commitments to the Chiang Mai Initiatives Multilaterization and most importantly, this meeting was a development in their long-time reservation. On December 15, 2008, this foreign exchange reserve pool was envisaged to expand to US$120 billion from US$80 billion. On November 20 and 28, 2008, a technical-group meeting and deputy finance ministerial meeting were held to work out the technical details of the self-managed reserve pool. This self-managed reserve pool was expected to take effect in May 2009. On February 18, 2009, the Asian Development Bank kicked off studies to better facilitate cross-border, regional investment through the local Asian bond markets by aligning regulations, laws and policies on various local Asian bond markets. On February 19, 2009, ASEAN+3 countries met in Phuket, Thailand, to advance the agreement on expanding the reserve pool to US$120 billion in order to better safeguard member countries against liquidity crisis. Commitment for more integration was reiterated as Asian exports slumped. They envisaged an Asian economic community by 2015. Free flows of trade and tolerance for culture differences were among the projected means of achieving regional integration. East Asian countries' international reserve currently totalled close to US$4 trillion

(Soesastro, 2008). Asian currency and Asian Monetary Union have also been envisioned. The chronology of the ASEAN+3 regional financial arrangement is given in Appendix 11.

3.5.2 Economic Factors: Distrust, Asymmetric Power, and Transparency Aversion

Despite this seemingly accelerating regional cooperation effort among East Asian countries after the 1997-1998 financial crisis and the first time a regional financial arrangement was envisaged by the thirteen East Asian countries in 1997, this regional financial arrangement was never officially institutionalized, unlike for example, the European Monetary Union. No secretariat office of Asian regional financial arrangement was ever built. We argue using our theoretical propositions above and other game theoretical analysis that it is extremely difficult to institutionalize the existing regional financial arrangement in East Asia given its distinctive history, economic, and political background. We argue that economic fundamentals alone are not enough to fully explain the failure to institutionalize a regional financial arrangement. We further argue that political, security, military and sociocultural factors could be more serious in having slowed the progress towards an institutionalized Asian regional financial arrangement. A study shows that variations in the qualities of economic institutions, namely transparency of central banks, cannot be explained by economic fundamentals, but can be explained by polity. Institutionalizing an Asian regional financial arrangement could only take effect gradually because of these non-economic factors. Economic incentives, in fact, are more likely to bring East Asian countries toward greater integration during troubled times to counter the political, security, military and sociocultural factors.

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We will begin with three economic arguments based on game theoretical analysis to explain why it is difficult to institutionalize a regional financial arrangement. These three arguments are the values of trust, symmetry, and information.

The Value of Trust: Positive Economic Shocks vs. Security, Military, Political Issues

One of the reasons for miscoordination lays in institutionalized beliefs that discourage cooperative behavior. Consider a simple two-player coordination game where two equilibria exist, with the cooperative equilibrium Pareto-dominating the non-cooperative equilibrium. The players's beliefs of how other players behave will determine their strategies. Beliefs are formed by initial beliefs and observable actions afterwards if the games are repeated. Players can be "trapped" in the Pareto-dominated equilibrium in each period if initial beliefs dictate that they begin by playing the Pareto-dominated equilibrium and the next period's beliefs will dictate the players to play the Pareto-dominated equilibrium with an even stronger belief that the others will play the Pareto-dominated equilibrium. In the long-run, this institutionalized belief becomes social norms. Initial belief is thus a vital factor in determining future trajectories. On one extreme, an *accidental* distrust can create a vicious cycle, while on the other extreme, an accidental trust can create a virtuous cycle. History can therefore create a feeling of distrust for a long period of time. Given the history of the Sino-Japan war, it is not unreasonable to believe that in the case of East Asian countries, particularly China and Japan, the feeling of distrust dictates non-cooperation despite economic outcomes that Pareto-dominate this non-cooperative outcome. A stronger case of trust is the Prisoners' Dilemma game. In this case, the rational outcome is not an equilibrium. Hence, in order to achieve the rational, Pareto-Dominant outcome, a

stronger sense of trust is needed. Experimental studies, however, show that the predicted non-cooperative equilibrium does not necessarily prevail if the games are repeated. Thus, people do have an intrinsic desire to achieve cooperation. The question is how to initiate it.

Schelling (2007) introduces a solution to resolve the multiplicity of equilibria, such as in the case of the coordination game, that is a focal point. Basu's Taxi-Driver (2003) example or Myerson's (2004) justice, truthful equilibrium, and institution arguments illustrate Schelling's concept of a focal point to explain real-life phenomena that are subject to a multiplicity of equilibria. Myerson (2004) provides an argument that explains why, even in the case of a multiplicity of equilibria, our everyday lives are far from facing conflicts. Myerson explains more explicitly Schelling's idea of a focal point. He argues that a lot of situations we face and the self-enforcing actions we take are the result of an "arbitrator," such as an institution in a multiple-equilibria setting. In the Taxi-Driver example, Basu (2003) argues that we observe particular equilibria being played and not the other possible outcomes because of the existence of a set "rules" that set a "focal point" of actions. Self-interested individuals can expect an equilibrium to be played through this "focal point," and it is out of their selfish interest that they behave in this manner. To some extent, the role of an arbitrator or a focal point resembles the role of a coordination device in a correlated equilibrium. Suppose there were two possible economic outcomes in the case of East Asian regional economic cooperation context, and one of the outcomes Pareto-dominates the other outcome. We might argue that there could be a focal point that dictates these East Asian countries to behave non-cooperatively or choose the Pareto-dominated equilibrium. It could indeed be that past observations of non-cooperative behaviors during the war became institutionalized into implicit rules of social norms. Greif (2006) ar-

gues that, "even marginal changes in the rules of the game are not likely to cause behavioral changes, because past behavior constitutes a focal point." The Sino-Japan war, hence, could create not only an accidental distrust, but also a focal point for behaving non-cooperatively in the case of multiple outcomes. Moreover, the lack of institutions could be the cause of miscoordination because there is no focal point. The idea of the focal point becomes the basis of Myerson's concept of cooperative game theory (Myerson, 1991).

The feeling of distrust could have died away because the two countries must have intrinsic values to cooperate, especially in repeated interactions. However, in the case of Japan and China, it seems that this feeling of distrust is prolonged by some of the elements from the war that are still carried on today. An example of these is the presence of the U.S. military base in Japan that might worsen the relationship between Japan and China[12]. Economic incentives to integrate, similar to the European Union, might not work in East Asia because of the military power of the US in Japan, which creates a prolonged feeling of distrust between Japan and China. Another issue surrounding the prolonged distrust from the Sino-Japan lays in the education and communication sectors, as the history of the Sino-Japan war is never completely and truly disclosed in Japan. Most teenagers who have been educated in Japan never truly know the history of the Sino-Japan war. It has been recorded by many people that Japanese colonization was very cruel. The fact that the Japanese government does not fully reveal this history might create hatred among the war victims. Moreover, religious shrines to honor those who fought during the Sino-Japan have raised opposition from people who come from the formerly colonized countries.

The threat of a nuclear war could also prolong the feeling of distrust. China is

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[12]Private conversation with M. Fujita (RIETI, Japan) in August 2008.

the only country in East Asia that owns nuclear weapons and produces significant amounts of uranium. While the ASEAN countries had signed the treaty of South East Asian Nuclear Weapon Free-Zone (SEANWFZ) in Bangkok, Thailand, in 1995, none of the five nuclear weapon facilitators, including China, signed the SEANWFZ[13]. This threat could exacerbate the feeling of distrust against China. Nash Bargaining solution predicts that if China could threaten other countries with nuclear war in the case of a failure from bargaining, then this could reduce the expected payoffs of the less powerful countries from a negotiation. If the threat point is a nuclear war, then bargaining with China could be undesirable for the other countries.

To address the difficulty of cooperation that game theory already predicts, we begin our discussion of how to untangle the vicious cycle of distrust and non-cooperative behavior or to change the focal point that reinforces non-cooperative outcomes. An important policy question in the case of the self-reinforcing, endogenous, evolutionary system is how we can break the cycle. History suggests that this cycle could be broken or the process to reformation could be sped up by exogenous shocks that may come from outside or within the cycle. European countries, for example, are able to integrate both politically and economically through the European Union and the European Monetary Union despite the Second World War. In the case of the European countries, economic incentives had overpowered the non-cooperative inclinations from the past. The European Coal and Steel Community in 1950 had been able to integrate the European communities both economically and politically starting from six founding countries, including Belgium, France, Germany, Luxembourg, Italy, and the Netherlands. In 1957, the European Economic Community was established. In 1032, Venice was able to

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[13]China is also the only country among the five countries that own nuclear weapons that is not a member country nor a partner member country of NATO.

restore economic cooperation because the elected monarchy was changed into a republican magistracy (Greif, 2006). This is an example of how a central rule that changed political structures could end economic disintegration. The Tsunami in Aceh, Indonesia, had brought a silver lining to the region by ending the long-time civil war. Mt. Geumgang, a recreational park located in the demilitarized zone between North and South Korea, could be a beginning of peace resolution between the two countries. This recreational park was initiated by two sides: a South Korean business elite (Hyundai) who had a personal longing to visit his native land in the North and the North Korean government, who was probably more economically motivated. The September 11, 2001, terrorist attack had brought the American people closer together. These exogenous shocks had changed the social, economic, or political condition of a region, state or country. Factors that break the vicious cycle of distrust and non-cooperative behaviors, however, do not necessarily come from elements outside the system. They may also come from elements inside the system, namely through "voice" or demand for a change of the constituents (Hirschman, 1970). Hence, breaking a cycle of an endogenous system can come both from elements outside or within the system and can come gradually (e.g. the establishment of the European Union) or it can come in an instant (e.g. the peace resolution in Aceh).

In 1997-1998, some of the East Asian countries experienced a severe financial crisis, and currently are suffering from 2007 global financial crisis. The 1997-1998 Asian financial crisis and the 2007 global financial crisis can be exogenous shocks that call for a regional financial integration. The initiation of the regional financial arrangement was a sign that East Asian countries realized the need to break the cycle of non-cooperative behaviors and move towards regional economic integration. Looking to the future, the 2007 global financial crisis that was triggered

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by global economic imbalance, credit bubbles, and deregulation triggered an even greater regional economic integration to provide a firewall against financial crisis as economies slumped. The tendency to integrate in the presence of a threat is recorded by Greif among Genoese clan in 1155. Opposing Genoese clans in 1155 mobilized their resources to begin building walls around the city to protect themselves against the external threat from a new German emperor who intended to gain control over the northern Italian cities (Greif, 2006). These positive economic shocks could therefore counter the prolonged distrust and non-cooperative behavior since the Sino-Japan war. However, as East Asian countries regain their prosperity in the future, it might be that incentives to integrate will disappear and trigger non-cooperative behaviors, such was the case in Genoa in 1189-1194, when the external threat from the German emperor disappeared and economic prosperity and past investments in military ability made Genoese clans seek political dominance and engage in an arms race (Greif, 2006). This is probably why establishing a regional financial institution could be important in sustaining cooperative behaviors for the long-run.

The Value of Symmetry: Asymmetric Bargaining Power and Heterogeneity

We have partly explained why it can be very difficult to make countries commit to cooperation under institutionalized beliefs of distrust, although we argue it could be facilitated by positive economic shocks that call for regional financial integration. What we will discuss in this section is the asymmetric bargaining power, particularly that of China (see Tables 3.4-3.6).

Economically and population-wise, China could overpower all other countries

Table 3.4: Population, Area, Nuclear Weapon (Source: UNData)

Country	Population(est.'07)(000)	Area(km^2)	Nuclear Weapon
Brunei Darussalam	390	5,765	x
Cambodia	14,444	181,035	x
Laos	5,859	236,800	x
Malaysia	26,572	329,847	x
Myanmar	48,798	676,578	x
Philippines	87,960	300,000	x
Singapore	4,436	699	x
Thailand	63,884	513,120	x
Vietnam	87,375	331,689	x
China	**1,328,630**	**9,596,961**	**v**
Japan	127,967	377,873	x
Korea	48,224	99,538	x
Indonesia	231,627	1,904,569	x

in the region. China's population is more than the total population of the rest of the ASEAN+3 countries. Its area is approximately five times bigger than the second biggest country in terms of its area among the ASEAN+3 countries, namely Indonesia. China is financially dominant with the world's highest international reserve and trade balance. Not only economically, geographically, and demographically does China dominate the other countries in the region, but it is one of the five countries in the world that owns a nuclear weapon and is the only country in the region that has enough uranium production to produce uranium weapons.

Asymmetric power could make the decision-making process more complicated. At the moment, general policy decisions are based on consensus. Only in the case of disagreement or no consensus, will China or Japan dominate the decision-making process. Population-based decision-making could mean that China overpowers all other countries, which is undesirable for smaller countries. The consensus-based decision-making process results in a more equal division of power. Instead of China and Japan dominating in the case of no consensus, one voice from the less dominant countries could be included, for example.

Table 3.5: Strategic Commodities of ASEAN+3 (Source: CIA, WorldFact Book)

Country	Strategic Commodities
Brunei Darussalam	Petroleum, gas, timber
Cambodia	oil, gas, timber, gemstones, iron, ores, manganese
	phosphates, hydropower
Laos	timber, hydropower, gypsum, tin, gold, gemstones
Malaysia	tin, petroleum, timber, copper, iron, ore, natural gas,
	bauxite
Myanmar	petroleum, timber, tin, antimony, zinc, copper, tungsten,
	coal, marble, gemstones, precious stones, natural gas,
	lead, hydropower
Philippines	timber, petroleum, nickel, cobalt, silver, gold, salt, copper
Singapore	fish, deepwater ports
Thailand	tin, rubber, natural gas, tungsten, tantalum, lignite, timber
	lead, fish, gypsum, fluorite
Vietnam	phosphate, coal, manganese, bauxite, chromate,
	offshore oil, gas, forests, hydropower
China	coal, uranium, iron ore, petroleum, magnetite, natural gas,
	tin, tungsten, antimony, manganese, molybdenum,
	aluminium, lead, zinc, uranium,
	mercury, vanadium, hydropower (world's largest)
Japan	negligible natural resources, fish
Korea	coal, tungsten, graphite, molybdenum, lead, hydropower
Indonesia	petroleum, tin, natural gas, nickel, timber, bauxite, copper
	coal, gold, silver

USA

$\swarrow \nearrow \qquad \searrow \nwarrow$

$\rightarrow$

ASEAN+2 $\qquad \leftarrow \qquad$ China

$\leftarrow, \searrow, \nearrow$ =Surplus; $\qquad \rightarrow, \swarrow, \searrow$ =Deficit
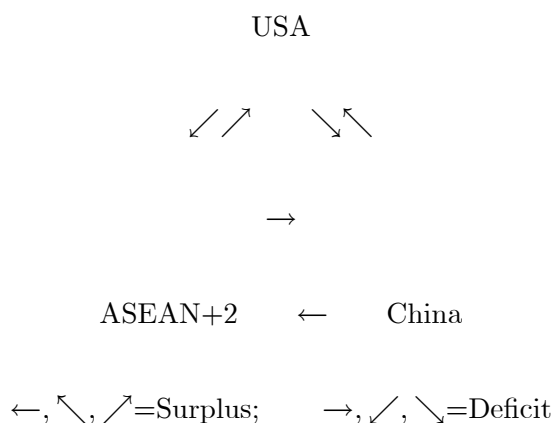
One way to measure the relative bargaining power among the ASEAN+3 countries is their trade surplus relative to other ASEAN+3 countries and to the U.S.A..

Table 3.6: Total Reserves, Trade Balance, Financial Account (Source: IFS)

Country\(in mil.US$)	Total Reserve-Gold	Trade balance	Financial Account
Brunei Darussalam	513570	6041	575
Cambodia	1157	-1056	324
Laos	328	-178	230
Malaysia	82132	36698	-11894
Myanmar	1235	2211	253
Philippines	20024	-6732	1351
Singapore	136260	43432	-18580
Thailand	65291	13844	5649
Vietnam	13384	-2776	3088
China	**1068490**	**217746**	**2642**
Japan	879682	81303	-102343
Korea	210317	32683	7104
Indonesia	41103	29660	2594

Consider the "trade triangle" above. China will have the most bargaining power given the size of its trade surplus. Non-symmetric Nash Bargaining Solution for cooperative games show that the unique solution in a bargaining game that satisfy the strong efficiency, individual rationality, scale covariance, and independence of irrelevant alternatives axioms is the solution to the maximization problem of the *generalized Nash product.* In a two-player game, for example, the degree of bargaining power, the power coefficient, will increase the expected utility of the player. Given the extremely strong bargaining power of China compared to the rest of the ASEAN+3 countries, China could overpower other countries and secure a significant amount of the surplus. One way to solve this asymmetric bargaining power in the case of China is to change the threat points. Decreasing the opponent's payoff or increasing his/her payoff at the threat point will increase the payoff of a player from bargaining.

There are three ways in which threat points can be constructed depending on the communication structures among the countries (Myerson, 1991). The three kinds of threat points from different communication structures are called the

equilibrium threat points, the minimax-value threat points, and the rational threat points. Let us consider the rational-threat theory. The rational threat points are useful to apply in situations where players could commit to a planned strategy at the threat point. This theory suggests that lowering the opponent's payoff at the threat point by, for example, acting antagonistically at the pre-play communication stage to create a more favorable disagreement payoff, could increase the negotiation payoff of the player. This is also called the *chilling effect*. ASEAN+2 countries could have credibly threatened to act aggressively against China should there be any disagreement among the ASEAN+3 countries in order to lower the size of the surplus that China would receive from the negotiation. For example, the ASEAN+2 countries could have committed to impose economic sanctions should they not end up in negotiation with China. In other words, in order to decrease the power of China, the ASEAN+2 countries could have committed to decrease the payoff of China at the threat point. However, there might not be any threat that is realistic because the power of China is so omnipresent that no country will rationally commit to ending their relationship with China.

Recently the ASEAN+3 countries expanded its coalition to ASEAN+6 adding India, Australia, and New Zealand. Some people speculate that this was done in order to reduce the power of China. Coalitional analysis could be done to find the optimal membership of the regional financial arrangement. It could also be that any bargaining process between China and ASEAN+2 countries will always render China better off as independent because of the omnipresent power. During the times of crisis, there are more incentives for countries to integrate. This could probably be modeled as a Nash bargaining problem in which the payoff for each country at the threat point is very low, such that the game is *feasible* even for a set of low feasible payoffs.

Another factor that might impede the progress of an institutionalized regional
financial arrangement is the number of the potential member countries. Intuitively,
the higher the number of players, the more complex it is to regulate and hence,
to institutionalize. This is exacerbated by the asymmetries and heterogeneity
among the countries. Heterogeneity among the ASEAN +3 countries, particularly
in terms of their level of development, might create different goals for setting up
a regional integration (see Table 3.7). While the main interests of low-income
countries such as Myanmar, Laos, or Cambodia are to eliminate poverty and other
social issues, the main interests of high-income countries like Japan, Korea, and
Singapore are to increase resilience to financial crisis by accumulating large foreign
reserves. Heterogeneity among ASEAN+3 countries makes setting up common
goals more difficult.

Table 3.7: GDP per Capita and Poverty of ASEAN+3 (Source: The WorldFact
Book, IndexMundi)

Country	GDP per Capita (US$)(Jan.'08)	Pop.below poverty line (%)
Brunei Darussalam	50,756	N.A.
Singapore	48,900	N.A.
China (Hongkong)	42,000	N.A.
Japan	33,800	N.A.
South Korea	24,600	15 (2003)
Malaysia	14,400	5.1 (2002)
Thailand	8,000	10 (2002)
China (Mainland)	5,300	8 (2006)
Indonesia	3,400	17.6 (2006)
Philippines	3,300	30 (2003)
Vietnam	2,900	14.75 (2007)
Laos	2,224	30.7 (2005)
Cambodia	1,942	35 (2004)
Myanmar	1,027	32.7 (2007)

The Value of Information: Pro- or Anti-Transparency

The role of information is indispensable in any strategic interaction, including strategies to cooperate. Under incompleteness of information, cooperation is even harder to achieve because it has to be supported by beliefs about the type of the other players and that the other players are also going to cooperate. Moreover, beliefs are difficult to change because it takes a series of observable actions. Transparency can resolve asymmetric information. By being transparent, there is no agency problem, including moral hazard and adverse selection (or the hybrid of moral hazard and adverse selection). Establishing an institution, in fact, can resolve the issue of uncertainty by putting forth a stable structure for human interactions and information exchange (North, 1990). Hence, establishing an institution can resolve at least some uncertainty entailed in cooperation. It has so far been evident that establishing an institution, such as the IMF, promotes greater transparency that may resolve not only uncertainty but also risks, perhaps by a country's publication of the IMF's Article IV that contains the country's macroeconomic data and a staff report, which reduces imprecision of information.

However, as we argue earlier, heterogenous countries with different fundamentals, might prefer different levels of transparency. Hence, *transparency-aversion* (see Transparency-Aversion proposition above) by some low- and intermediate-fundamental countries might discourage these countries from seeking the establishment of an institution in the first place. What we are going to discuss here is that although aversions to transparency could certainly impede the establishment of an institutionalized regional financial arrangement, their ill effects may be eroded or completely eliminated by the reputation effects and adverse selection biases. While aversions to transparency by some types of countries, in addition to

distrust and asymmetric bargaining power, could have slowed the progress toward institutionalizing an Asian regional financial arrangement, reputation effects and adverse selection biases might instead promote institution-seeking behaviors and institutionalization.

Economists and policy makers may already know that transparency, or symmetry of information, could facilitate more cooperation. Transparency in monetary policies is often stated as being necessary to align people's expectations to the targeted policies. Studies have also been done to show that not only does the level of development of a country increase the level of transparency of its central bank, but further that the level of transparency increases the GDP per capita in the same year or decreases the subsequent inflation of that country (Geraats, 2008, and Dincer and Eichengreen, 2007). Hence, pro-transparency rather than anti-transparency should have been favored by all regional countries who perceive cooperation as beneficial to their economies. Furthermore, all regional countries should have had the incentives to seek the establishment of an institutionalized regional financial arrangement that promotes transparency. The question becomes, why has the progress towards an institutionalized regional financial arrangement been slow?

Since transparency could facilitate more cooperation, it may seem self - contradictory that potential member countries may not favor the institutionalization of the current regional financial arrangement. Despite this, it is not clear whether individual countries will indeed *self-interestedly* seek transparency. In other words, one could say that transparency is indeed necessary for regional cooperation that is beneficial to the region and eventually one's own country, but it is unclear whether individual countries will seek transparency based on their own self-interests. The

problem resembles that of a public good, namely a collective action problem, a free-rider problem, or a problem in a Prisoners' Dilemma game. Each country will benefit from increased transparency by other countries, but may or may not prefer to be transparent itself. In the end, no institution is built.

What we show in the theoretical model in this paper is that countries with critical fundamentals may be better off under low transparency if there is a high probability of the Pareto-dominated equilibrium being played in the case of multiple equilibria. This is because a multiplicity of equilibria arises with a high level of transparency under incompleteness of information if a multiplicity of equilibria exists under completeness of information. Moreover, we can expect that low-fundamental countries will always choose non-transparency if there are negative externalities from revealing bad fundamentals, such as bad reputation. Hence, both the intermediate- and low-fundamental countries are better off under low-level of transparency or no transparency.

Now, suppose that under an institutionalized regional financial arrangement, member countries will have to oblige to a high level of transparency, for example by having to comply to regional surveillance and monitoring measures. Therefore, it may not be in the best interests of countries with either an intermediate or low fundamental to seek the establishment of an institutionalized regional financial arrangement, because under a high level of transparency these countries will be worse off.

However, in this case, transparency is endogenous as the choice exists of whether to select one's own level of transparency or be subject to regulation by seeking an institutionalized regional financial arrangement. In other words, each country can choose its own level of transparency by joining or not joining the institutionalized

regional financial arrangement. Under such a situation, the choice of transparency or transparency-seeking behavior could signal the fundamentals. Not seeking the establishment of an institutionalized regional financial arrangement may signal a low fundamental, while seeking the establishment of an institutionalized regional financial arrangement may signal a high fundamental. Under this endogenous transparency model, we might see all countries, except countries with the lowest fundamental (the *lemon car*), choosing to seek the establishment of an institutionalized regional financial arrangement because of the reputation effects and adverse selection biases.

Based on our theoretical study, therefore, we predict that although some countries may be more averse to transparency than others and hence less inclined to seek the establishment of an institutionalized regional financial arrangement, the degree of transparency-aversion is eroded by the reputation effects and adverse selection biases. Only the worst-fundamental countries could be expected to remain opaque. These reputation effects are exacerbated if these happen in a close community, such as the ASEAN+3 community, since there is a localization of information in a smaller community (Dixit, 2004). Moreover, in a small community, anonymity diminishes (Greif, 2006). Thus, the endogenous rather than exogenous transparency model is the more appropriate model for the case of ASEAN+3.

In order to show these reputation effects and adverse selection biases, we look at the transparency level of the ASEAN+3 countries through the publication of Article IV and participation in the IMF's Special Data Dissemination Standard (SDDS) and the IMF's General Data Dissemination Standard (GDDS) (see Figure 8). We do not use the DE Transparency Index because not all thirteen countries are studied. However, this binary data, i.e. publish or not publish and join or not

join, is probably preferable given the strategies of the players in the endogenous transparency model is binary. IMF's Article IV publication is voluntary[14]. GDDS and SDDS are the IMF's public data dissemination facilities to promote, among other objectives, transparency of macroeconomic and financial data. SDDS portrays a country's access to international capital market by providing data in the economic and financial sectors[15]. GDDS is less prescriptive than the SDDS and focuses on the improvement in data quality by identifying plans for improvements as well as associated needs for assistance in implementing these needs. This is in contrast with SDDS, in which the focus is on data dissemination by countries, which in general already meet high standards of data quality (IMF.org).

Table 3.8: Publication of Article IV, SDDS, GDDS of ASEAN+3 (Source: IMF.org)

Country	Article IV Publication	SDDS	GDDS
Brunei Darussalam	Yes	x	v
Cambodia	Yes	x	v
Laos	Yes	x	x
Malaysia	Yes	v	x
Myanmar	No	x	x
Philippines	Yes	v	x
Singapore	Yes	v	x
Thailand	Yes	v	x
Vietnam	Yes	x	v
China	Yes	x	v
Japan	Yes	v	x
Korea	Yes	v	x
Indonesia	Yes	v	x

We observe what might have been the *lemon car* phenomenon. Among the thirteen ASEAN+3 countries, only one country, Myanmar, does not publish the

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[14]Most of published documents by Executive Board, including IMF's Article IV, are "voluntary but presumed." This means that it needs member country's consent to published. Documents are not consulted with country's authorities, and once published, only limited changes can be made. (IMF Seeks View of Its Transparency Policy, March 25, 2009)

[15]We assume that participation in SDDS is a measure of transparency in which public data is disseminated in order to get access ot the international capital market. It might be that countries will not participate in SDDS for other reasons than to remain opaque.

IMF's Article IV, despite the fact that it had been encouraged among East Asian countries after the 1997-1998 Asian financial crisis. Not only does Myanmar not publish Article IV, but it also does not participate in the IMF data dissemination standards. Laos is the only country who publishes IMF's Article IV, but does not participate in any of the public data dissemination. Four countries participate in the IMF's GDDS instead of SDDS, which means that these countries, Brunei Darussalam, Cambodia, Vietnam, and China, do not seek access to the international capital market and/or have low data quality standards and they are currently being assisted by the IMF.

In order to check whether this observation is consistent with the *lemon car* phenomenon, we take six indicators of macroeconomic fundamental from 1997-2008. The macroeconomic fundamentals include: real GDP growth, the ratio of current account deficit to nominal GDP, the ratio of M2 to total reserve minus gold, the growth of private sector lending, inflation, and real exchange rate appreciation. Following Sachs, et.al. (1996), we use real exchange rate appreciation and private sector lending boom to measure the vulnerability of the fundamentals to speculative attacks and the ratio of M2 to total reserves minus gold to measure the reserve availability to protect the exchange rate from devaluation. Real GDP growth is a sign of productivity, recession or boom, and high or low unemployment rate. The ratio of current account deficit to nominal GDP measures how large capital inflows are, in which a high current account deficit with a low international reserve can trigger speculation. Inflation is a sign of overheating economy and might distort the term-of-trade. Figure 15 shows six indicators of fundamentals for ASEAN+3 countries in 2003 (the complete data is in the Appendix 12)[16].

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[16]The use of the year (2003) is debatable. We would like to measure how fundamentals affect transparency, and hence data to measure fundamentals should be before the transparecy measures, which is in 2009. More recent data on fundamental might be desirable. A lack of data for Mynmar impedes us to use a later data. Despite this issue, the result that Mynmar is

2003	%Real GDP	DCA/GDP	M2/Reserve,	Lending Boom	Inflation	%RER	Expert Ranking
Mynmar	0.0578835	0.121424	2.55857979	0.067191737	0.01	0.0126	13
Cambodia	0.087	-0.05018	1.02749899	0.262260249	0.0121	0.024	12
Laos	0.058	-0.032	1.94106075	-0.001954166	0.1549	-0.132	11
Philippines	0.0491542	0.003708	2.26876205	0.029153346	0.0345	0.0346	10
Vietnam	0.073	-0.04925	4.22248034	0.324	0.0322	0.0064	9
Indonesia	0.0477993	0.034079	3.22917063	0.192213629	0.0659	-0.091	8
Korea	0.031	0.019665	3.263	0.087	0.035	-0.007	7
Thailand	0.07	0.032	3.46920469	0.064020855	0.018	-0.078	6
Brunei	0.039222	0.46949	10.257	0.034153412	0.003	-0.002	5
China	0.1	0.027837	6.54865632	0.194983345	0.0116	0.011	4
Malaysia	0.0578835	0.121424	2.55857979	0.067191737	0.01	0.0126	3
Japan	0.015	0.029755	9.609	-0.039256361	-0.0025	-0.084	2
Singapore	0.035	0.226	1.19005999	0.028265763	0.0051	-0.003	1

Figure 3.15: ASEAN+3: Fundamental (2003) and Expert Ranking

What we observe here is that Myanmar is indeed ranked the lowest in terms of its fundamentals relative to its neighbors by an expert[17]. From the 2003 data, we see that although Myanmar's real GDP growth is accelerating, they have an extremely low foreign exchange reserve with respect to their broad money, extremely high inflation, and extremely high real exchange rate appreciation. With the exception of 2003, Myanmar also had a very high private lending. Although the year in which the fundamental measures are taken is lagged by six years because of the lack of complete, more recent data, the fact that Myanmar has the lowest fundamental among the countries seems to be robust. What is less obvious is whether Myanmar remains opaque because of its low fundamental or because of the fact that Myanmar is a military-regime country. If we are to consider rules of law

the country with the lowest fundamental is robust.

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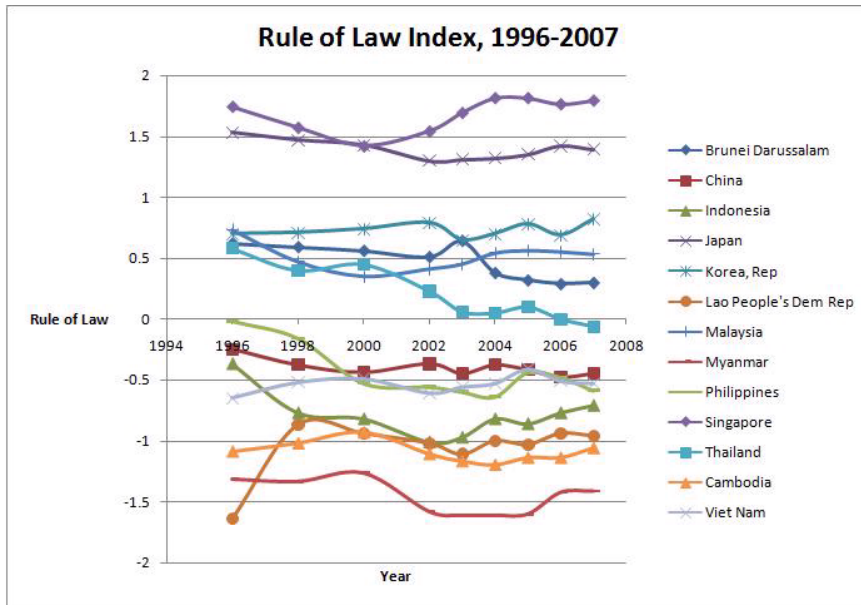
Figure 3.16: Rule of Law Index, 1996-2007, ASEAN+3

as important non-economic factors, then Myanmar's Rule of Law Index[18] (from the Worldwide Governance Indicators, 1996-2007) is also ranked lowest among neighboring countries (see Figure 16).

We also observe that the next least transparent country that does not participate in either of the IMF's public data dissemination standards, Laos, is ranked the third lowest by the expert in terms of its fundamental. Since Laos if not a military-regime country, this might strengthen our hypothesis that economic fundamentals could have affected transparency. Countries that participate in GDDS instead of SDDS are Brunei Darussalam, China, Vietnam and Cambodia. This means that these countries have a low quality of data dissemination and/or may not seek access to international capital market. The fact that Brunei Darussalam and China have relatively high fundamentals will contradict our hypothesis that these countries should have participated more actively in public data dissemina-

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[18]Rule of Law Index measures the "justness" and political freedom of a society that may affect the economic fundamental of a country.

tion. According to expert opinion, Singapore and Brunei Darussalam are two anomalies in the region, that despite their relatively high fundamentals, remain opaque in terms of its financial issues. In the case of Singapore, it may be related to the strong stance on an authoritarian leadership[19]. Brunei Darussalam remains opaque because it is a monarchial country and it does not seek international capital market because of a rich oil supply.

These anomalies, therefore, cannot be explained by economic-fundamental reasons, but can be explained by political reasons. Our study in the next section shows that these anomalies could be best explained by the level of democracy. This study suggests that the level of democracy is highly positively correlated with the level of transparency. Brunei Darussalam is a monarchial country. Myanmar, Vietnam and China are considered non-democratic countries, and Singapore and Cambodia are considered semi-democratic countries. Laos is ranked 141 out of 150 (second lowest behind Myanmar) in terms of its democracy in 2008 by the World Audit Democracy. This might explain why Brunei Darussalam, Myanmar, Vietnam, China, Laos and Cambodia remain opaque or do not actively participate in public data dissemination, while Singapore, despite being ranked first in terms of its fundamental, remains relatively opaque.

A compelling argument to draw here is that economic fundamentals, political and economic institutions are endogenous. This is probably why we see that countries such as Myanmar, Cambodia, and Laos, with no or low level of democracy and low Rule of Law (see Figure 16 and Figure 17) tend to be less transparent and have low fundamentals. Suppose we could start from no democracy, which causes less transparency, which then combined with low rule of law causes low fundamental,

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[19]In an economic forum in 2008, Lee Kwan Yew, reiterated Singaporean stance on authoritarian leadership without corruption.

causing even less democracy, and so on. In the case of ASEAN+3, variations in the level of transparency could not be explained by economic fundamentals alone, but also political fundamentals.

3.5.3 Polity, Social-Cultural Factors, and International Pressures

Polity

ASEAN+3 countries are heterogenous in terms of the level of democracy. Differences in the level of democracy among ASEAN+3 countries could affect the level of transparency and the level of political openness as well as attitudes towards regional integration of individual countries. Some countries that are less democratic such as China and Myanmar might be less willing to open up to the regional community. The rank of the central bank transparency of the countries studied in Dincer and Eichengreen (2007) (see Figure 17) correlates positively to the level of democracy (Table 3.9). China being the least democratic country has the lowest level of DE Transparency Index while the semi-democratic countries, namely Singapore and Malaysia, are ranked the second and third least transparent countries after China. Liberal Democratic countries, namely Japan and South Korea, are ranked the second and third most transparent countries. Hence, we see a strong correlation between the level of democracy and the central bank's transparency. Table 3.10 below shows the rank of democracy as indexed by the World Audit Democracy. Except for Thailand and Philippines, the rank of democracy in 2008 by the World Audit Democracy matches the rank of 2005 DE TI index. We show the polity index (democracy minus autocracy index) of the ASEAN+3,

except Brunei Darussalam, in Figure 18[20], which could explain the anomalies of transparency among the ASEAN+3 countries. In particular, countries with the lowest polity indexes namely Myanmar, Laos, Vietnam, and China are also the least transparent with regards to their public data dissemination (i.e. IMF's Article IV, SDDS/GDDS). Countries with the highest polity indexes in 2005, namely Japan, Philippines, Korea, Thailand, and Indonesia, are also the most transparent countries according to the DE TI 2005.

Table 3.9: Level of Democracy of ASEAN+3, Rule of Law of East Asia, Peerenboom

Level of Democracy	Countries
Non-Democratic	China, Hong Kong, Vietnam, Myanmar
Semi-Democratic	Singapore, Malaysia, Cambodia
(soft authoritarian, non-liberal, or electoral democracy)	
Liberal Democratic	Japan, Taiwan, South Korea

Table 3.10: WAD's Democracy Index of ASEAN+3 (Source: World Audit Democracy, 2008)

Country	Democracy 2008 (out of 150)	DE TI 2005 Rank
Japan	30	2
South Korea	33	3
Indonesia	70	5
Singapore	74	6
Malaysia	82	7
Thailand	86	4
Philippines	88	1
Cambodia	112	-
China	120	8
Vietnam	126	-
Laos	141	-
Myanmar	150	-
Brunei Darussalam	(Monarchial)	-

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[20]In the figure, China and Laos do not show because they overlap Vietnam.
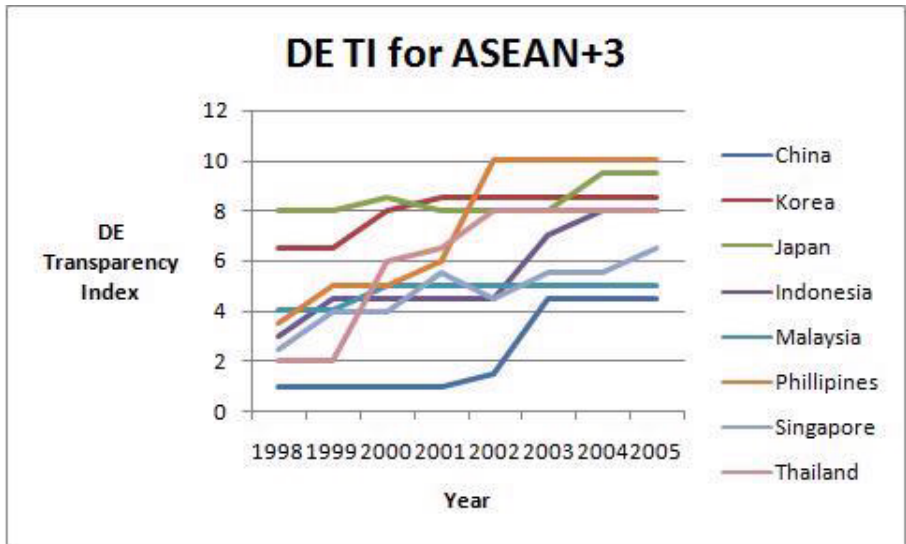
Figure 3.17: DE TI, 1998-2005, for eight ASEAN+3 countries
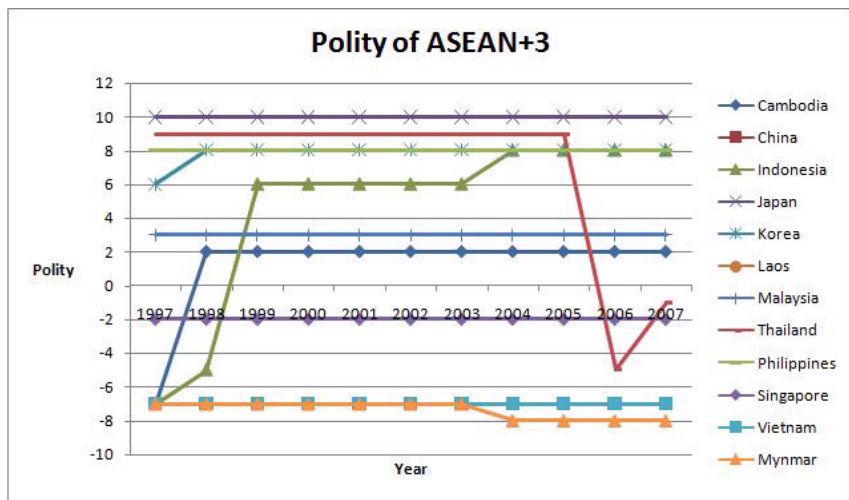
Figure 3.18: Polity of ASEAN+3 (exc.Brunei) (Source: Systemic Peace, Polity IV)

Social and Cultural Factors: Integration and Collectivist Countries

Social and cultural factors cannot be neglected in explaining the incentives of countries to seek to regional integration. The fact that most of East Asian countries can be considered as collectivist rather than individualistic countries can impede regional integration. This argument relies on historical, social, cultural, and theo-

retical analysis by Greif (2006). He argues that in collectivist countries, the social structure is segregated, while in individualistic countries, the social structure is integrated. In a segregated social structure, members of a group interact socially and economically only with members of their own group. In an individualistic social structure, members of a group interact socially and economically with members from different groups. Informal institutions are more likely to arise in a collectivist society while formal institutions are more likely to arise in an individualistic society. This difference affects agency relationship, and eventually, the likelihood of a social and economic integration because of the different cultural beliefs institutionalized in these types of societies. The cultural beliefs in a collectivist society mobilize collective punishments, in which an agent is re-hired if he does not cheat and is not hired by any other member in the society if he does cheat. Members of the group are more likely to be honest in an intra-agency relationship. Collective punishment may not extend to inter-agency relationships, and hence, in order to keep agents from other groups honest, wages must be higher. Hiring a member from the same group is therefore cheaper than hiring a member from a different group. As a result of this, the joint economy among collectivist societies is segregated. The cultural beliefs in an individualistic society do not mobilize collective punishments, while the joint economy among individualistic societies is integrated. In this case, hiring a member from the same group costs the same as hiring a member from a different group. Among collectivist societies, the joint economy is integrated only if collective punishments essentially extend to inter-agency relationships. Moreover, a collectivist society never initiates an inter-agency relationship with an individualistic society.

Different types of societies can therefore affect the likelihood of an integration. The Genoese and Maghribis are constrained by the same technology, environment,

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and organizational problems, but the Maghribis' collectivist society leads to social and economic segregation while Genoese individualistic society leads to social and economic integration. With this evidence, we argue that it is easier for an individualistic society of the European countries to integrate than it is for a collectivist society of the East Asian countries. Furthermore, Greif argues that collectivist societies might be inefficient in the long-run because a collectivist system creates a gap between profitability and efficiency of an inter-agency relationship while an individualistic system does not. Formal institutions, which may spur growth, are also more likely to be established under an individualistic system than under a collectivist system. This is supported by the fact that most under-developed countries are collectivist while most developed countries are individualistic. However, this argument may not take into account the fact that the level of development of a country might change the type of society, as people tend to be more individualistic as they move from low-technology to high-technology societies. Video games, for example, could replace playgrounds where children play together. Hence, social institution is endogenous to the level of development. There are also cases in which a collectivist society is better than an individualistic society. This is, for example, the case in times of war. Moreover, individuals could behave differently under different circumstances. For example, some societies might be very collectivist with respect to family matters, but might be very individualistic with respect to work matters. The issue of identity is also important to consider. If individuals could consider themselves as citizens of the world rather than citizens of their home countries, global integration would be more likely to take place. Social and cultural heritages could therefore affect the tendencies to integrate.

International Pressures

Another barrier could be the oppositions from other international organizations, including the IMF, WTO, and the World Bank. The main reasons for their oppositions are the double standard that it may create and moral hazard, as countries may become more lenient towards their neighbors (Jeon, 2002).

3.5.4 Some Facts about Transparency and Development Level in ASEAN+3

There has been evidence that transparency and development level, defined by the GDP per capita, are endogenous. Geraats (2008) shows that transparency depends on the monetary regime. Moreover, transparency is positively correlated with the level of past inflation, the level of development and the GDP per capita in the same year but is negatively correlated with the level of subsequent inflation. Dincer and Eichengreen (2007) show that transparency is determined by the exchange rate regime and GDP per capita, but transparency index also affects inflation persistence, output variability, inflation variability, which might in turn affect the level of GDP per capita. Our study shows that economic fundamentals and the level of development could affect qualities of economic institutions. If transparency and the level of development are co-deterrmined, it may mean that the emerging country region of East Asia will never be successful in establishing an institutionalized regional financial arrangement. East Asian emerging countries with low GDP per capita might not choose transparency, though it also depends on other economic and non-economic factors, such as polity. While a country is trapped under no regional economic cooperation, development could become worse,

creating a vicious cycle between non-transparency and low level of development.
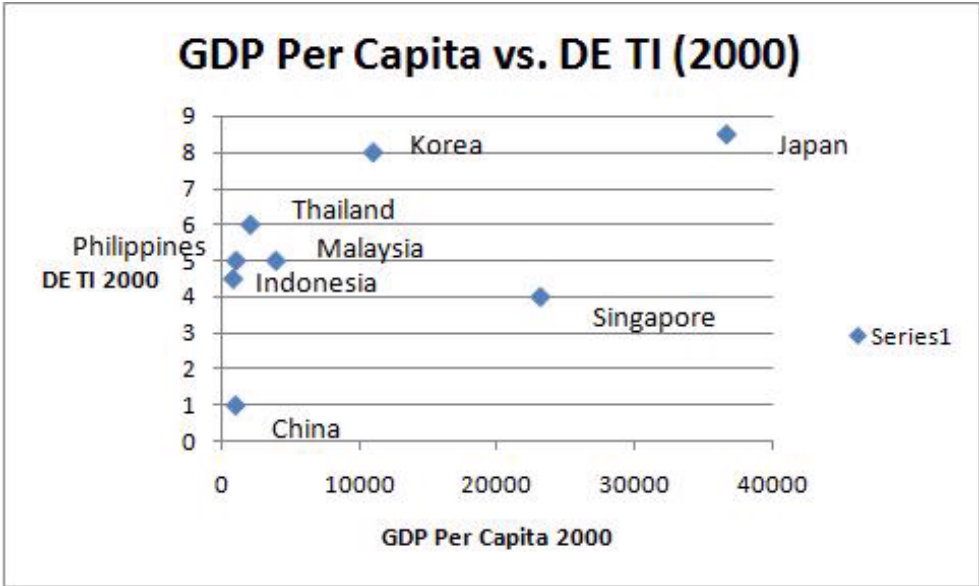
Figure 3.19: GDP Per Capita vs. DE TI (2000) for eight ASEAN+3 countries
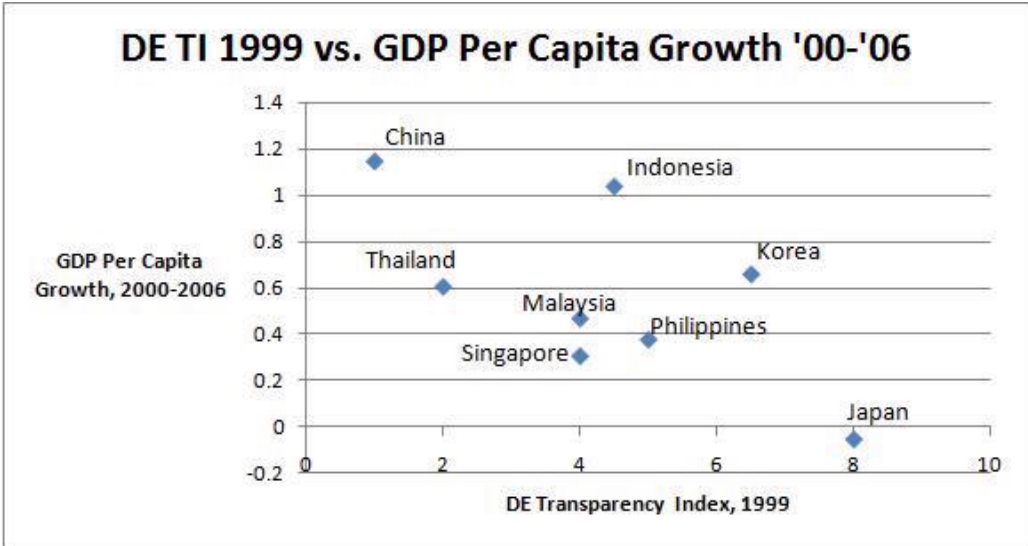

Figure 3.20: DE TI 1999 vs. GDP Per Capita Growth '00-'06 for eight ASEAN+3 countries

In order to test the relationship between transparency and the level of development, we take Dincer and Eichengreen's Transparency Index that includes eight

ASEAN+3 countries. To test for the endogeneity, we plot the relationship in both directions. We show a strong positive correlation between GDP per capita in 2000 and DE Transparency Index in 2000, although this correlation disappears as we forward the dependent variables, which means that GDP per capita in some specific year does not affect the level of transparency a few years later (see Figure 19). This suggests that the level of development does tend to increase transparency, which is consistent with our empirical study. We are also interested to know whether transparency has a positive impact on real GDP per capita growth in these countries. The data suggests that transparency is negatively correlated with GDP per capita growth from 2000 to 2006 (see Figure 20). This is counterfactual to what might have been predicted. One possible explanation is the convergence argument, that high-GDP-per-capita countries tend to grow less rapidly than low-GDP-per-capita countries. Hence, this observation might just signal that high levels of transparency are associated with more developed countries. Another explanation could be that the time lag is longer for transparency to bring positive impact. A more comprehensive study on this could explain the phenomenon.

3.6   Policy Issues

This paper has shown both theoretically and empirically that fundamentals could affect the level of transparency of partially informed agents including, the ASEAN+3 countries. Countries with higher levels of fundamentals are more closely associated with higher levels of transparency than countries with lower or intermediate levels of fundamentals. The evidence is, however, weak in the eight-RFA-country study, which includes China, Singapore, Malaysia, Japan, South Korea, Philippines, and Indonesia. We compare the DE transparency index of these countries

and their economic fundamentals, and find many anomalies. China, Brunei Darussalam, Malaysia and Singapore, which have relatively high fundamentals have relatively low levels of transparency with respect to their ASEAN+3 neighbors. Neither the exogenous nor the endogenous transparency model could explain this. A more convincing explanation is the level of democracy of these countries. China is considered to be one of the least democratic countries among its ASEAN+3 neighbors along with Myanmar. Malaysia and Singapore are semi-democratic. Korea and Japan, democratic countries, have high levels of transparency. Hence, economic fundamentals do not always explain variations in the quality of economic institutions. In the case of ASEAN+3, political biases, such as the level of democracy, seem to explain a lot of the variation in the level of transparency. The empirical study of this paper has also shown that regional bias, worldwide time bias and occurence-of-crisis bias play significant roles in determining the qualities of economic institutions. The policy implication of this is that non-economic fundamentals could affect the quality of economic institutions. Politics, for example, influence economic outcomes because economic policy decisions are made not only by economists (if at all), but also by politicians. Regional integration requires not only compatible economic fundamentals, but political fundamentals. Social and cultural heritages could also play a role.

What we are called to do now is determine how to resolve the non-economic factors that impede regional financial integration while strengthening the economic factors, and recognize the need for greater integration in the midst of the 2007 global financial crisis and the recovery from the 1997-1998 Asian financial crisis. Immediate calls for action include changing how the Sino-Japan war is portrayed in textbooks in Japan, to hold dialogues to discuss issues on China's nuclear weapons, and to have open discussions regarding the U.S. military presence in Japan when-

ever it is appropriate. In December 2008, 32 Asian countries, including Australia, held the Bali Democracy Forum, at the initiative of Indonesia, which recently underwent a political reform towards democracy, to discuss issues on democracy in Asia (Soesastro, 2008). As our eight-RFA-country study suggests, the level of democracy seems to be very much connected to the level of transparency of their central banks. Hence, open discussions on democracy are ways to increase openness and could encourage regional integration among Asian countries. Making different political systems of the ASEAN+3 countries more compatible with each other could also be important for regional integration. For example, how democratic countries of the ASEAN+3 could work with a military-regime country of Myanmar must be well-understood, otherwise dialogues with Myanmar might not work.

Another explanation for the slow progress towards institutionalizing the regional financial arrangement is asymmetric bargaining power, in particular the gigantic and disproportionately large power of China. China's population, geography, natural resources, international reserves and trade surplus have made it enormously powerful compared to its neighbors. Decision-making processes and the bargaining process must be resolved before we can expect China and other powerful countries, as well as less dominant countries to seek to institutionalize regional financial arrangement and other regional integration measures. One policy action to resolve asymmetric bargaining power is to decrease the payoff for China at the threat point by acting more antagonistically in the bargaining stage, thus making cooperation with China more beneficial for other less powerful ASEAN+2 countries. Higher levels of GDP per capita of the less powerful countries could have increased their payoffs at the threat point, thus increasing their payoffs from bargaining. However, none of these threats seem to be rational. The power of

China is so omnipresent that none of the smaller countries will rationally commit to end their relationship with China. Increasing the levels of GDP per capita of the smaller countries cannot take place in an instant. In other words, changing the threat points is not a simple solution. Financial crisis, however, could decrease the payoffs at the threat point of all of the ASEAN+3 countries, which could make a game feasible for a set of lower feasible payoffs. A more compelling solution is a coalitional analysis. Currently, ASEAN+3 is being expanded to ASEAN+6 to include Australia, New Zealand and India, which some speculate is an effort to reduce the power of China. Some economists argue that including India in the ASEAN+3 is salient. Consensus-based decision-making rather than population- or size-based voting rights could also help to avoid China's domination of the process. A more representative voice from the smaller countries, and not only Japan and China, should be considered in the case of a disagreement or no consensus.

On a more positive note, positive shocks such as the financial crisis should bring East Asian countries towards greater regional cooperation, ending the period of reservation among some of the East Asian countries. This is evident in the growing bilateral and multilateral swap agreements among ASEAN+3 countries even beyond the Chiang Mai's Initiatives. China and Indonesia made an agreement on three-year bilateral currency swap amounting to CNY100 billion - IDR175 trillion at the end of March, 2009, which allows Indonesia to import Yuan-denominated Chinese goods and avoid a bilateral trade transacted in U.S. dollar. Other countries that made a bilateral currency swap agreement with China include South Korea, Malaysia, Hongkong, Belarus and Argentina. The lack of international support for an institutionalized regional financial arrangement or even an Asian Monetary Fund because of the moral hazard and double standard arguments is not really well-founded. The issue of moral hazard is less likely to arise. In

fact, because reputation effects are more salient in a smaller community, which could be referred to as the localization of information (Dixit, 2004) or diminishing anonymity (Greif, 2006), countries have more incentives to behave well. Also, trust-based or reputation- or relation-based institution with collective punishment system that is better sustained in a small community might be cheaper than formal, rule-based institution without collective punishment system that is more likely to erect in a large community.

An institution is needed to resolve asymmetric informational issues by providing ways to write contracts between borrowing and lending countries, to initiate concerted efforts for better economic outcomes, and to provide checks and balances for more healthy economies. A regional institution could better resolve the issue of asymmetric information because countries are closer together. A regional institution could also be more prompt in helping countries in trouble. Some studies also suggest that a punishment system is more effective in a smaller group because of localization of information and diminishing anonymity.

One of the prominent issues of institutions is that often, an institution defined more broadly as a set of rules, organizations, beliefs, norms, and implied behaviors, has multiple equilibria (Greif, 2006) or is indeterminate. In the case of a weak financial and economic institution, one of the multiple outcomes is crisis. This highlights the importance of a good financial and economic institution, which can be achieved by establishing a strong regional financial arrangement. A regional institution is also needed to enable the East Asian region to come out strongly as a rising star in a new global financial system. Moreover, we can expect that greater financial integration among ASEAN+3 countries in the midst of the recovery from the Asian financial crisis and the 2007 global financial crisis, which would be likely

improve the fundamentals of these countries, will lead to greater transparency. Greater transparency might arise not because of reputation effects, but because of improved fundamentals.

Because of the endogeneity of economic institutions, political institutions, social institutions, and other non-economic factors, the issue of establishing an institution such as an Asian regional financial arrangement must be approached from many angles. A lot of times, policies can not be generalized across countries or cases. It might be, for example, that in response to external threats or troubled times, people behave more adversely towards one another, instead of behaving cooperatively. Hence, each case may be unique. The case of the 2007 global financial crisis that could be explained by the absence of proper regulation on data disclosure is a special case of the endogenous transparency model with reputation effects, in which pressures to be transparent may make investment banks and credit rating agencies disclose information, but at poor quality.

This study also highlights the importance of a two-way academic study: how economic incentives could help to break the entrenched reservation and introduce new ways to establish a political relationship among East Asian countries and how political factors influence economic decisions.

3.7 Conclusion

This paper seeks an explanation for the slow progress of institutionalizing the regional financial arrangement that started right after the Asian Financial Crisis in order to safeguard countries against another crisis. We start with a theoretical analysis on information and coordination. We have shown that for strategic

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complementary investments, given asymmetric common knowledge in which each country knows its own fundamental but not the others and the precision of public information is exogenous, high transparency about a country's fundamental can be detrimental to the level of investment of that country if the fundamental is intermediate and if there is a high probability that the low-level investment equilibrium is played in the case of multiple equilibria. Low precision of public information may therefore be preferable in order to avoid a multiplicity of equilibria, in which the low-level investment equilibrium is played. Hence, not only might countries with low fundamental be averse to transparency, but also countries with intermediate fundamentals.

We also present a model as an extension to this paper, namely a model with endogenous precision of public information. The difficulty of endogenizing the precision of public information lays in the fact that agents often do not reveal the precision of public information, thus making it difficult to derive expectations of the fundamentals given private and public information. In a simple model of endogenous transparency, in which there are two possible levels, transparent and non-transparent, the only countries that adopt non-transparency are those countries with the lowest fundamentals or the *lemon cars*. The endogenous transparency model is hence more powerful than the exogenous transparency model because without any regulation on the adoption of transparency, countries will choose transparency because of the reputation effects and adverse selection biases.

We conduct an empirical study to test the theoretical hypothesis above that economic fundamentals could affect the level of transparency of central banks controlling for non-economic fundamentals. We show that higher inflation, higher ratio of broad money to foreign exchange reserves, and higher ratio of current account

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balance to nominal GDP could decrease the level of transparency of central banks. Structural fundamentals rather than macroeconomic fundamentals could explain more variation in transparency of central banks. Moreover, higher GDP per capita (or higher level of development), more flexible exchange rate arrangement and full democracy relative to full autocracy could increase the level of transparency. Countries located in Southern Africa, North America, Australia and New Zealand, and Northern Europe tend to have significantly higher levels of transparency than Eastern Africa to different degrees. Countries affected by the Asian, Mexican and Russian crises in the late 1990s and early 2000s have relatively higher levels of transparency, most probably because of international pressures. In general, all countries experience an upward trend in transparency over time. This empirical study shows us that transparency of central banks and economic fundamental are co-determined, and thus, fundamentals and institutions are endogenous.

We apply our theoretical analysis to determine whether aversion to transparency because of low fundamentals could cause failures to integrate. What we find is that the level of democracy seems to explain more variations of transparency among ASEAN+3 countries than do the economic fundamentals. An interesting observation is that in the case of worldwide study, polity is not the main factor in explaining variations in the transparency of central banks, while in the ASEAN+3 study, it is. This shows that after controlling for regional-specific biases, the political factor becomes prevalent, at least in the case of ASEAN+3. Singapore, Malaysia, and China, who have relatively strong fundamentals, have low transparency, which can be explained by their semi-democratic or non-democratic governments. Hence, we argue that economic factors only play a small role in the non-cooperation among East Asian countries. Rather it is the non-economic factors, including political issues of democracy, security issues surrounding China's

nuclear weapons, military issues, including US presence in Japan, and the reluctance of the Japanese government in educating its citizens about the Sino-Japan war that are more dominant in explaining the non-cooperation among East Asian countries. In fact, we argue that economic incentives should bring countries towards greater integration and offset non-economic disincentives towards integration.

Appendix 1: Proof Lemma 1

Proof. $\mathrm{E}(\theta_j|x_j^i, z_j) = \int_0^1 \theta_j \mathrm{f}(\theta_j|x_j^i, z_j)\mathrm{d}\theta_j = \int_0^1 \theta_j \frac{f(\theta_j, x_j^i, z_j)}{f(x_j^i, z_j)}d\theta_j.$

$$f(\theta_j, x_j^i, z_j) = f(x_j^i, z_j|\theta_j)f(\theta_j) = f(x_j^i|\theta_j)f(z_j|\theta_j)f(\theta_j) =$$

$$\frac{1}{\sigma_x\sqrt{2\pi}}\exp.(-\frac{(x_j^i-\theta_j)^2}{2\sigma_x^2})\frac{1}{\sqrt{2\pi\frac{1}{P_j}}}\exp.(-\frac{(z_j-\theta_j)^2}{2\frac{1}{P_j}})(1)$$

$\mathrm{f}(x_j^i, z_j) =$

$$\int_0^1 f(\theta_j, x_j^i, z_j)d\theta = \int_0^1 \frac{1}{\sigma_x\sqrt{2\pi}}\exp.(-\frac{(x_j^i-\theta_j)^2}{2\sigma_x^2})\frac{1}{\sqrt{2\pi\frac{1}{P_j}}}\exp.(-\frac{(z_j-\theta_j)^2}{2\frac{1}{P_j}})d\theta_j$$

$$=\frac{1}{(2\pi)\sigma_x\sqrt{\frac{1}{P_j}}}\int_0^1 \exp.(-\frac{1}{2}(\frac{(x_j^i-\theta_j)^2}{\sigma_x^2}+P(z_j-\theta_j)^2))d\theta_j$$

$$=\frac{1}{(2\pi)\sigma_x\sqrt{\frac{1}{P_j}}}\int_0^1 \exp.(-\frac{1}{2}(\frac{1}{\sigma_x^2}(x_j^{i2}-2x_j^i\theta+\theta_j^2)+P(z_j^2-2\theta_j z_j+\theta_j^2)))d\theta_j$$

$$=\frac{1}{(2\pi)\sigma_x\sqrt{\frac{1}{P_j}}}\int_0^1 \exp.(-\frac{1}{2}(\theta_j^2(\frac{1}{\sigma_x^2}+P_j)-2\theta_j(\frac{x_j^i}{\sigma_x^2}+z_jP_j)+\frac{x_j^{i2}}{\sigma_x^2}+P_jz_j^2))d\theta_j$$

$$=\frac{1}{(2\pi)\sigma_x\sqrt{\frac{1}{P_j}}}\int_0^1 \exp.(-\frac{1}{2}(\frac{1}{\sigma_x^2}+P_j)(\theta_j^2-\frac{2(\frac{x_j^i}{\sigma_x^2}+zP_j)\theta_j}{(\frac{1}{\sigma_x^2}+P_j)}+\frac{\frac{x_j^{i2}}{\sigma_x^2}+P_jz_j^2}{(\frac{1}{\sigma_x^2}+P_j)})d\theta_j$$

$$=\frac{1}{(2\pi)\sigma_x\sqrt{\frac{1}{P_j}}}\int_0^1 \exp.(-\frac{1}{2}(\frac{1}{\sigma_x^2}+P_j)$$

$$((\theta_j-\frac{(\frac{x_j^i}{\sigma_x^2}+z_jP_j)}{(\frac{1}{\sigma_x^2}+P_j)})^2-(\frac{(\frac{x_j^i}{\sigma_x^2}+z_jP_j)}{(\frac{1}{\sigma_x^2}+P_j)})^2+\frac{\frac{x_j^{i2}}{\sigma_x^2}+P_jz_j^2}{(\frac{1}{\sigma_x^2}+P_j)}))d\theta_j$$

$$=(\sqrt{2\pi}(\frac{1}{(\frac{1}{\sigma_x^2}+P_j)}))\frac{1}{(2\pi)\sigma_x\sqrt{\frac{1}{P_j}}}\exp.(-\frac{1}{2}(\frac{1}{\sigma_x^2}+P_j)$$

$$(-(\frac{(\frac{x_j^i}{\sigma_x^2}+z_jP_j)}{(\frac{1}{\sigma_x^2}+P_j)})^2+\frac{\frac{x_j^{i2}}{\sigma_x^2}+P_jz_j^2}{(\frac{1}{\sigma_x^2}+P_j)}))$$

$$\int_0^1 \frac{1}{\sqrt{2\pi(\frac{1}{\sigma_x^2}+P_j)}} \exp.\left(-\frac{1}{2}\left(\frac{(\theta_j - \frac{(\frac{x_j^i}{\sigma_x^2}+zP_j)}{(\frac{1}{\sigma_x^2}+P_j)})^2}{\frac{1}{(\frac{1}{\sigma_x^2}+P_j)}}\right)\right)d\theta_j$$

$$f(\theta_j|x_j^i, z_j) =$$

$$\cfrac{\frac{1}{(2\pi)\sigma_x\sqrt{\frac{1}{P_j}}} \exp.\left(-\frac{(x_j^i-\theta_j)^2}{2\sigma_x^2}\right)\exp.\left(-\frac{(z_j-\theta_j)^2}{2\frac{1}{P_j}}\right)}{\left(\sqrt{2\pi(\frac{1}{(\frac{1}{\sigma_x^2}+P_j)})}\right)\frac{1}{(2\pi)\sigma_x\sqrt{\frac{1}{P_j}}} \exp.\left(-\frac{1}{2}(\frac{1}{\sigma_x^2}+P_j)\right)}$$

$$\left(-\left(\frac{\frac{x_j^i}{\sigma_x^2}+z_j P_j}{(\frac{1}{\sigma_x^2}+P_j)}\right)^2 + \frac{\frac{x_j^{i2}}{\sigma_x^2}+P_j z_j^2}{(\frac{1}{\sigma_x^2}+P_j)}\right) \int_0^1 \frac{1}{\sqrt{2\pi(\frac{1}{\sigma_x^2}+P_j)}} \exp.\left(-\frac{1}{2}\left(\frac{(\theta_j - \frac{(\frac{x_j^i}{\sigma_x^2}+z_j P_j)}{(\frac{1}{\sigma_x^2}+P_j)})^2}{\frac{1}{(\frac{1}{\sigma_x^2}+P_j)}}\right)\right)d\theta_j$$

$$\int_0^1 \frac{1}{\sqrt{2\pi(\frac{1}{\sigma_x^2}+P_j)}} \exp.\left(-\frac{1}{2}\left(\frac{(\theta_j - \frac{(\frac{x_j^i}{\sigma_x^2}+z_j P_j)}{(\frac{1}{\sigma_x^2}+P_j)})^2}{\frac{1}{(\frac{1}{\sigma_x^2}+P)}}\right)\right)d\theta_j = 1$$

$$E(\theta_j|x_j^i, z_j) =$$

$$\int_0^1 \theta_j \cfrac{\frac{1}{(2\pi)\sigma_x\sqrt{\frac{1}{P_j}}} \exp.\left(-\frac{(x_j^i-\theta_j)^2}{2\sigma_x^2}\right)\exp.\left(-\frac{(z_j-\theta_j)^2}{2\frac{1}{P_j}}\right)}{\left(\sqrt{2\pi(\frac{1}{(\frac{1}{\sigma_x^2}+P_j)})}\right)\frac{1}{(2\pi)\sigma_x\sqrt{\frac{1}{P_j}}} \exp.\left(-\frac{1}{2}(\frac{1}{\sigma_x^2}+P_j)\right)} d\theta_j$$

$$\left(-\left(\frac{\frac{x_j^i}{\sigma_x^2}+z_j P_j}{(\frac{1}{\sigma_x^2}+P_j)}\right)^2 + \frac{\frac{x_j^{i2}}{\sigma_x^2}+P_j z_j^2}{(\frac{1}{\sigma_x^2}+P_j)}\right) \int_0^1 \frac{1}{\sqrt{2\pi(\frac{1}{\sigma_x^2}+P_j)}} \exp.\left(-\frac{1}{2}\left(\frac{(\theta_j - \frac{(\frac{x_j^i}{\sigma_x^2}+zP_j)}{(\frac{1}{\sigma_x^2}+P_j)})^2}{\frac{1}{(\frac{1}{\sigma_x^2}+P_j)}}\right)\right)d\theta_j$$

$$= \int_0^1 \theta_j \frac{1}{\sqrt{2\pi(\frac{1}{\sigma_x^2}+P_j)}} \exp.\left(-\frac{1}{2}\left(\frac{(\theta_j - \frac{(\frac{x_j^i}{\sigma_x^2}+z_j P_j)}{(\frac{1}{\sigma_x^2}+P_j)})^2}{\frac{1}{(\frac{1}{\sigma_x^2}+P_j)}}\right)\right)d\theta_j$$

$$(\theta_j|x_j^i, z_j) \sim N\left(\frac{(\frac{x_j^i}{\sigma_x^2}+z_j P_j)}{(\frac{1}{\sigma_x^2}+P_j)}, \frac{1}{(\frac{1}{\sigma_x^2}+P_j)}\right) \quad \blacksquare$$

Appendix 2: Proof of Corollary 1

Proof. A uniform distribution in $\Re$ is proxied by a normal distribution with mean 0 and precision σ_θ^2 as $\sigma_\theta^2 \to \infty$.

$$\mathrm{E}(\theta_j|x_j^i, z_j) = \int_{-\infty}^{\infty} \theta_j \mathrm{f}(\theta_j|x_j^i, z_j) = \int_{-\infty}^{\infty} \theta_j \frac{f(\theta_j, x_j^i, z_j)}{f(x_j^i, z_j)} d\theta_j.$$

$$f(\theta_j, x_j^i, z_j) = f(x_j^i, z_j|\theta_j)f(\theta_j) = f(x_j^i|\theta_j)f(z_j|\theta_j)f(\theta_j) =$$

$$\frac{1}{\sigma_\theta \sqrt{2\pi}} \exp.(\frac{-\theta_j^2}{2\sigma_\theta^2})\frac{1}{\sigma_x \sqrt{2\pi}} \exp.(-\frac{(x^i-\theta_j)^2}{2\sigma_x^2})\frac{1}{\frac{1}{P}\sqrt{2\pi}} \exp.(-\frac{(z_j-\theta_j)^2}{2\frac{1}{P}})$$

$$\mathrm{f}(x_j^i, z_j) = \int_{-\infty}^{\infty} f(\theta_j, x_j^i, z_j)d\theta_j =$$

$$\int_{-\infty}^{\infty} \frac{1}{\sigma_\theta \sqrt{2\pi}} \exp.(\frac{-\theta_j^2}{2\sigma_\theta^2})j\frac{1}{\sigma_x \sqrt{2\pi}} \exp.(-\frac{(x_j^i-\theta_j)^2}{2\sigma_x^2})\frac{1}{\sqrt{2\pi\frac{1}{P}}} \exp.(-\frac{(z_j-\theta_j)^2}{2\frac{1}{P}})d\theta_j$$

$$= \frac{P_j^{1/2}}{(2\pi)^{\frac{3}{2}}\sigma_x\sigma_\theta} \int \exp.(-\frac{1}{2}(\frac{(x_j^i-\theta_j)^2}{\sigma_x^2} + P_j(z_j-\theta_j)^2 + \frac{\theta_j^2}{\sigma_\theta^2}))d\theta_j$$

$$= \frac{P_j^{1/2}}{(2\pi)^{\frac{3}{2}}\sigma_x\sigma_\theta} \int \exp.(-\frac{1}{2}(\frac{1}{\sigma_x^2}(x_j^{i2} - 2x_j^i\theta_j + \theta_j^2) + P(z_j^2 - 2\theta_j z_j + \theta_j^2) + \frac{\theta_j^2}{\sigma_\theta^2}))d\theta_j$$

$$= \frac{P_j^{1/2}}{(2\pi)^{\frac{3}{2}}\sigma_x\sigma_\theta} \int \exp.(-\frac{1}{2}(\theta_j^2(\frac{1}{\sigma_x^2} + P_j + \frac{1}{\sigma_\theta^2}) - 2\theta_j(\frac{x_j^i}{\sigma_x^2} + z_j P_j) + \frac{x_j^{i2}}{\sigma_x^2} + P_j z_j^2))d\theta_j$$

$$= \frac{P_j^{1/2}}{(2\pi)^{\frac{3}{2}}\sigma_x\sigma_\theta} \int \exp.(-\frac{1}{2}(\frac{1}{\sigma_x^2} + P_j + \frac{1}{\sigma_\theta^2})(\theta_j^2 - \frac{2(\frac{x_j^i}{\sigma_x^2}+z_j P_j)\theta_j}{(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})} + \frac{\frac{x_j^{i2}}{\sigma_x^2}+P_j z_j^2}{(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})})d\theta_j$$

$$= \frac{P_j^{1/2}}{(2\pi)^{\frac{3}{2}}\sigma_x\sigma_\theta} \int \exp.(-\frac{1}{2}(\frac{1}{\sigma_x^2} + P_j + \frac{1}{\sigma_\theta^2})$$

$$((\theta_j - \frac{(\frac{x_j^i}{\sigma_x^2}+z_j P_j)}{(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})})^2 - (\frac{(\frac{x_j^i}{\sigma_x^2}+z_j P_j)}{(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})})^2 + \frac{\frac{x_j^{i2}}{\sigma_x^2}+P_j z_j^2}{(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})}))d\theta_j$$

$$= \frac{P_j^{1/2}}{(2\pi)^{\frac{3}{2}}\sigma_x\sigma_\theta} \exp.(-\frac{1}{2}(\frac{1}{\sigma_x^2} + P_j + \frac{1}{\sigma_\theta^2})$$

$$(-(\frac{(\frac{x_j^i}{\sigma_x^2}+z_j P_j)}{(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})})^2 + \frac{\frac{x_j^{i2}}{\sigma j_x^2}+P_j z_j^2}{(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})})) \int \exp.(-\frac{1}{2}(\frac{(\theta_j-\frac{(\frac{x_j^i}{\sigma_x^2}+z_j P_j)}{(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})})^2}{\frac{1}{(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})}}))d\theta_j$$

$$f(\theta_j|x_j^i, z_j) = \frac{\frac{P_j^{1/2}}{(2\pi)^{\frac{3}{2}}\sigma_x\sigma_\theta}\exp.(\frac{-\theta_j^2}{2\sigma_\theta^2})\exp.(-\frac{(x_j^i-\theta_j)^2}{2\sigma_x^2})\exp.(-\frac{(z_j-\theta_j)^2}{2\frac{1}{P_j}})}{\frac{P_j^{1/2}}{(2\pi)^{\frac{3}{2}}\sigma_x\sigma_\theta}\exp.(-\frac{1}{2}(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})(-(\frac{(\frac{x_j^i}{\sigma_x^2}+z_jP_j)}{(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})})^2+}j$$

$$\frac{\frac{x_j^{i2}}{\sigma_x^2}+P_jz_j^2}{(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})}))\int_{-\infty}^{\infty}\exp.(-\frac{1}{2}(\frac{(\theta_j-\frac{(\frac{x_j^i}{\sigma_x^2}+z_jP_j)}{(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})})^2}{\frac{1}{(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})}}))d\theta_j$$

$$\int_{-\infty}^{\infty}\exp.(-\frac{1}{2}(\frac{(\theta_j-\frac{(\frac{x_j^i}{\sigma_x^2}+z_jP_j)}{(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})})^2}{\frac{1}{(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})}}))d\theta_j = 1$$

$$E(\theta_j|x_j^i, z_j) = \int_{-\infty}^{\infty}\theta_j\frac{\frac{P_j^{1/2}}{(2\pi)^{\frac{3}{2}}\sigma_x\sigma_\theta}\exp.(\frac{-\theta^2}{2\sigma_\theta^2})\exp.(-\frac{(x_j^i-\theta_j)^2}{2\sigma_x^2})\exp.(-\frac{(z_j-\theta_j)^2}{2\frac{1}{P_j}})}{\frac{P_j^{1/2}}{(2\pi)^{\frac{3}{2}}\sigma_x\sigma_\theta}\exp.(-\frac{1}{2}(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})(-(\frac{(\frac{x_j^i}{\sigma_x^2}+zP_j)}{(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})})^2+\frac{\frac{x_j^{i2}}{\sigma_x^2}+P_jz_j^2}{(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})}))}d\theta$$

$$=\int_{-\infty}^{\infty}\theta_j\exp.(-\frac{1}{2}(\frac{(\theta_j-\frac{(\frac{x_j^i}{\sigma_x^2}+zP_j)}{(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})})^2}{\frac{1}{(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})}}))d\theta_j$$

$$(\theta_j|x_j^i, z_j) \sim N(\frac{(\frac{x_j^i}{\sigma_x^2}+z_jP_j)}{(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})}, \frac{1}{(\frac{1}{\sigma_x^2}+P_j+\frac{1}{\sigma_\theta^2})})$$

As $\sigma_\theta^2 \to \infty, (\theta_j|x_j^i, z_j) \sim N(\frac{(\frac{x_j^i}{\sigma_x^2}+z_jP_j)}{(\frac{1}{\sigma_x^2}+P_j)}, \frac{1}{(\frac{1}{\sigma_x^2}+P_j)})$. ■

Appendix 3: Proof of Proposition 1

Proof. Denote:

$F_1(x^*(z_i), \theta^*(z_i); z_i) =$

$\theta_i + (1 - \int_{-\infty}^{x(z_i^*)-\theta_i}\frac{1}{\sigma_x\sqrt{2\pi}}\exp.(\frac{-u^2}{2\sigma_x^2})du)(1 + \int_{-\infty}^{x(z_i^*)-\theta_i}\frac{1}{\sigma_x\sqrt{2\pi}}\exp.(\frac{-u^2}{2\sigma_x^2})du) - 1 = 0$

$F_2(x^*(z_i), \theta^*(z_i); z_i) =$

$(\mathrm{w}_{x_i}\mathrm{x}_i + \mathrm{w}_{z_i}\mathrm{z}_i) + (1 - \int_{-\infty}^{\theta(z_i^*)} \frac{1}{\sigma_\theta\sqrt{2\pi}} \exp.(-\frac{(u - E(\theta_{-i}|x_i, z_i)^2}{2\sigma_\theta^2} \mathrm{du}) +$

$(\int_{-\infty}^{\theta(z_i^*)} \frac{1}{\sigma_\theta\sqrt{2\pi}} \exp.(-\frac{(u - E(\theta_i|x_i, z_i)^2}{2\sigma_\theta^2} \mathrm{du})(1 - \int_{-\infty}^{x^*(z_i)} \frac{1}{\sigma_{\bar{x}}\sqrt{2\pi}} \exp.(-\frac{(u - E(x_i^{-i}|x_i z_i))^2}{2\sigma_{\bar{x}}^2}) \mathrm{du}) - 1 = 0$

$\mathrm{F}(\mathrm{x}(\mathrm{z}_i), \mathrm{z}_i) = [\mathrm{F}_1(\mathrm{x}(\mathrm{z}_i), \mathrm{z}_i), \mathrm{F}_2(\mathrm{x}(\mathrm{z}_i), \mathrm{z}_i)]'$

Transform the distributions of θ_i and x_i^{-i} into standard normal distributions:

$(\frac{\theta_i - (w_{x_i}x_i + w_{z_i}z_i)}{\sigma_\theta} | \mathrm{x}_i.\mathrm{z}_i)$ is normally distributed with mean 0 and variance 1,

$(\frac{\theta_i + \varepsilon_i^{-i} - (w_{x_i}x_i + w_{z_i}z_i)}{\sigma_{\bar{x}}} | \mathrm{x}_i.\mathrm{z}_i)$ is normally distributed with mean 0 and variance 1.

We can re-write $\mathrm{F}_2(\mathrm{x}^*(\mathrm{z}_i), \theta^*(\mathrm{z}_i); z_i)$ as:

$\mathrm{F}_2(\mathrm{x}^*(\mathrm{z}_i), \theta^*(\mathrm{z}_i); z_i) = (\mathrm{w}_{x_i}\mathrm{x}_i + \mathrm{w}_{z_i}\mathrm{z}_i) + (1 - \int_{-\infty}^{\frac{\theta(z_i^*) - (w_{x_i}x_i + w_{z_i}z_i)}{\sigma_\theta}} \frac{1}{\sqrt{2\pi}} \exp.(-\frac{u^2}{2}) \mathrm{du}) +$

$(\int_{-\infty}^{\frac{\theta(z_i^*) - (w_{x_i}x_i + w_{z_i}z_i)}{\sigma_\theta}} \frac{1}{\sqrt{2\pi}} \exp.(-\frac{u^2)}{2} \mathrm{du})(1 - \int_{-\infty}^{\frac{(x^*(z_i) - z_i)w_{z_i}}{\sigma_{\bar{x}}}} \frac{1}{\sqrt{2\pi}} \exp.(-\frac{u^2}{2}) \mathrm{du}) - 1 = 0$

$\mathrm{F}_1(\mathrm{x}^*(\mathrm{z}_i), \theta^*(\mathrm{z}_i); z_i)$ and $\mathrm{F}_2(\mathrm{x}^*(\mathrm{z}_i), \theta^*(\mathrm{z}_i); z_i)$ are continuously differentiable with respect to $\mathrm{x}(\mathrm{z}_i)$, $\theta(z_i)$, and z_i.

Using the Implicit Function Theorem, the determinant of the Jacobian of

$\mathrm{F}(\mathrm{x}(\mathrm{z}_i), \theta(z_i); z_i) \neq 0.$

$|\mathrm{D}_{x,\theta}\mathrm{F}(\mathrm{x}(\mathrm{z}_i), \theta(z_i); z_i)| =$

$[2\frac{1}{\sigma_\theta}\frac{1}{\sigma_x}\Phi(\frac{x^*(z_i) - \theta(z_i)}{\sigma_x})\Phi(\frac{(x^*(z_i) - z_i)w_{z_i}}{\sigma_{\bar{x}}})\phi(\frac{x^*(z_i) - \theta(z_i)}{\sigma_x})\phi(\frac{\theta(z_i^*) - (w_{x_i}x_i + w_{z_i}z_i)}{\sigma_\theta})]$

$-[1 + 2\frac{1}{\sigma_x}\Phi(\frac{x^*(z_i) - \theta(z_i)}{\sigma_x})\phi(\frac{x^*(z_i) - \theta(z_i)}{\sigma_x})][w_{x_i}(1 + \frac{1}{\sigma_\theta}\phi(\frac{\theta(z_i^*) - (w_{x_i}x_i + w_{z_i}z_i)}{\sigma_\theta})$

$\Phi(\frac{(x^*(z_i) - z_i)w_{z_i}}{\sigma_{\bar{x}}})) - w_{z_i}(\frac{1}{\sigma_{\bar{x}}}\Phi(\frac{\theta(z_i^*) - (w_{x_i}x_i + w_{z_i}z_i)}{\sigma_\theta})\phi(\frac{(x^*(z_i) - z_i)w_{z_i}}{\sigma_{\bar{x}}})],$

where $\sigma_\theta = \frac{1}{\frac{1}{\sigma_{\bar{x}}^2} + P}$, $\sigma_{\bar{x}} = \frac{1}{\frac{1}{\sigma_{\bar{x}}^2} + P} + \sigma_x^2.$

$|\mathrm{D}_{x,\theta}\mathrm{F}(\mathrm{x}(\mathrm{z}_i),\theta(z_i);z_i)| \neq 0.$

$$\begin{pmatrix} \frac{dx(z_i)}{dz_i} \\[2mm] \frac{d\theta(z_i)}{dz_i} \end{pmatrix} =$$

$$\begin{pmatrix} -\frac{1}{|D_{x,\theta}F(x(z_i),\theta(z_i);z_i)|}(-)(1 + 2\frac{1}{\sigma_x}\Phi(\frac{x^*(z_i)-\theta(z_i)}{\sigma_x})\phi(\frac{x^*(z_i)-\theta(z_i)}{\sigma_x})) \\[2mm] (w_{z_i}(\frac{1}{\sigma_{\bar{x}}}\phi(\frac{(x^*(z_i)-z_i)w_{z_i}}{\sigma_{\bar{x}}})\Phi(\frac{\theta(z_i^*)-(w_{x_i}x_i+w_{z_i}z_i)}{\sigma_\theta})+ \\[2mm] 1 + \frac{1}{\sigma_\theta}\phi(\frac{\theta(z_i^*)-(w_{x_i}x_i+w_{z_i}z_i)}{\sigma_\theta})\Phi(\frac{(x^*(z_i)-z_i)w_{z_i}}{\sigma_{\bar{x}}}))) \\[2mm] -\frac{1}{|D_{x,\theta}F(x(z_i),\theta(z_i);z_i)|}\{[-2\frac{1}{\sigma_x}\Phi(\frac{x^*(z_i)-\theta(z_i)}{\sigma_x})\phi(\frac{x^*(z_i)-\theta(z_i)}{\sigma_x})] \\[2mm] [(w_{z_i}(\frac{1}{\sigma_{\bar{x}}}\phi(\frac{(x^*(z_i)-z_i)w_{z_i}}{\sigma_{\bar{x}}})\Phi(\frac{\theta(z_i^*)-(w_{x_i}x_i+w_{z_i}z_i)}{\sigma_\theta}) + 1 \\[2mm] +\frac{1}{\sigma_\theta}\phi(\frac{\theta(z_i^*)-(w_{x_i}x_i+w_{z_i}z_i)}{\sigma_\theta})\Phi(\frac{(x^*(z_i)-z_i)w_{z_i}}{\sigma_{\bar{x}}}))]\} \end{pmatrix} \blacksquare$$

Appendix 4: Proof of Proposition 2

Proof. Denote:

$$\mathrm{F}_1(\mathrm{x}^*(\mathrm{z}_i),\theta^*(z_i);z_i) = \theta_i + \sum_{j=1}^{K-1}\frac{(K-1)!}{(K-1-j)!j!}(1 - \int_{-\infty}^{x(z_i^*)-\theta_i}\frac{1}{\sigma_x\sqrt{2\pi}}\exp.(\frac{-u^2}{2\sigma_x^2})du)^j$$

$$(1 + \int_{-\infty}^{x(z_i^*)-\theta_i}\frac{1}{\sigma_x\sqrt{2\pi}}\exp.(\frac{-u^2}{2\sigma_x^2})du)^{K-1-j} - 1 = 0$$

$$\mathrm{F}_2(\mathrm{x}^*(\mathrm{z}_i),\theta^*(z_i);z_i) = (\mathrm{w}_{x_i^i}\mathrm{x}_i+\mathrm{w}_{z_i}\mathrm{z}_i)+(1-\int_{-\infty}^{\frac{\theta(z_i^*)-(w_{x_i}x_i+w_{z_i}z_i)}{\sigma_\theta}}\frac{1}{\sqrt{2\pi}}\exp.(-\frac{u^2}{2})du)$$

$$\sum_{j=0}^{K-2}\frac{(K-2)!}{(K-2-j)!j!}(1 - \int_{-\infty}^{\frac{(x^*(z_i)-z_i)w_{z_i}}{\sigma_{\bar{x}}}}\frac{1}{\sqrt{2\pi}}\exp.(-\frac{u^2}{2})du)^j$$

$$(\int_{-\infty}^{\frac{(x^*(z_i)-z_i)w_{z_i}}{\sigma_{\bar{x}}}}\frac{1}{\sqrt{2\pi}}\exp.(-\frac{u^2}{2})du)^{K-2-j} + (\int_{-\infty}^{\frac{\theta(z_i^*)-(w_{x_i}x_i+w_{z_i}z_i)}{\sigma_\theta}}\frac{1}{\sqrt{2\pi}}\exp.(-\frac{u^2}{2})du)$$

$$\sum_{j=1}^{K-2}\frac{(K-2)!}{(K-2-j)!j!}(1 - \int_{-\infty}^{\frac{(x^*(z_i)-z_i)w_{z_i}}{\sigma_{\bar{x}}}}\frac{1}{\sqrt{2\pi}}\exp.(-\frac{u^2}{2})du)^j$$

$$(\int_{-\infty}^{\frac{(x^*(z_i)-z_i)w_{z_i}}{\sigma_{\bar{x}}}}\frac{1}{\sqrt{2\pi}}\exp.(-\frac{u^2}{2})du)^{K-2-j} - 1 = 0$$

$\mathrm{F}_1(\mathrm{x}^*(\mathrm{z}_i),\theta^*(z_i);z_i)$ and $\mathrm{F}_2(\mathrm{x}^*(\mathrm{z}_i),\theta^*(z_i);z_i)$ are continuously differentiable with respect to $\mathrm{x}(z_i)$, $\theta(z_i)$, and z_i.

Using the Implicit Function Theorem, the determinant of the Jacobian of

$F(x(z_i),\theta(z_i); z_i) \neq 0$.

$|D_{x,\theta}F(x(z_i),\theta(z_i); z_i)| =$

$[(K\text{-}1)\frac{1}{\sigma_\theta}\frac{1}{\sigma_x}\Phi(\frac{x^*(z_i)-\theta(z_i)}{\sigma_x})^{K-2}\Phi(\frac{(x^*(z_i)-z_i)w_{z_i}}{\sigma_{\bar{x}}})^{K-2}\phi(\frac{x^*(z_i)-\theta(z_i)}{\sigma_x})\phi(\frac{\theta(z_i^*)-(w_{x_i}x_i+w_{z_i}z_i)}{\sigma_\theta})] -$

$[1 + (K-1)\frac{1}{\sigma_x}\Phi(\frac{x^*(z_i)-\theta(z_i)}{\sigma_x})^{K-2}\phi(\frac{x^*(z_i)-\theta(z_i)}{\sigma_x})][w_{x_i}(1 + \frac{1}{\sigma_\theta}\phi(\frac{\theta(z_i^*)-(w_{x_i}x_i+w_{z_i}z_i)}{\sigma_\theta})$

$\Phi(\frac{(x^*(z_i)-z_i)w_{z_i}}{\sigma_{\bar{x}}})^{K-2}) - w_{z_i}(K-2)(\frac{1}{\sigma_{\bar{x}}}\Phi(\frac{\theta(z_i^*)-(w_{x_i}x_i+w_{z_i}z_i)}{\sigma_\theta})$

$\Phi(\frac{(x^*(z_i)-z_i)w_{z_i}}{\sigma_{\bar{x}}})\phi(\frac{(x^*(z_i)-z_i)w_{z_i}}{\sigma_{\bar{x}}})]$,

where $\sigma_\theta = \frac{1}{\frac{1}{\sigma_x^2}+P}$, $\sigma_{\bar{x}} = \frac{1}{\frac{1}{\sigma_x^2}+P} + \sigma_x^2$.

$|D_{x,\theta}F(x(z_i),\theta(z_i); z_i)| \neq 0$.

$\begin{pmatrix} \frac{dx(z_i)}{dz_i} \\ \\ \frac{d\theta(z_i)}{dz_i} \end{pmatrix} =$

$\begin{pmatrix} -\frac{1}{|D_{x,\theta}F(x(z_i),\theta(z_i);z_i)|}(-)(1 + (K-1)\frac{1}{\sigma_x}\Phi(\frac{x^*(z_i)-\theta(z_i)}{\sigma_x})^{K-2}\phi(\frac{x^*(z_i)-\theta(z_i)}{\sigma_x})) \\ (w_{z_i}((K-2)\frac{1}{\sigma_{\bar{x}}}\phi(\frac{(x^*(z_i)-z_i)w_{z_i}}{\sigma_{\bar{x}}}) \\ \Phi(\frac{\theta(z_i^*)-(w_{x_i}x_i+w_{z_i}z_i)}{\sigma_\theta})\Phi(\frac{(x^*(z_i)-z_i)w_{z_i}}{\sigma_{\bar{x}}})^{K-3} + \\ 1 + \frac{1}{\sigma_\theta}\phi(\frac{\theta(z_i^*)-(w_{x_i}x_i+w_{z_i}z_i)}{\sigma_\theta})\Phi(\frac{(x^*(z_i)-z_i)w_{z_i}}{\sigma_{\bar{x}}})^{K-2})) \\ -\frac{1}{|D_{x,\theta}F(x(z_i),\theta(z_i);z_i)|}\{[-(K-1)\frac{1}{\sigma_x}\Phi(\frac{x^*(z_i)-\theta(z_i)}{\sigma_x})^{K-2}\phi(\frac{x^*(z_i)-\theta(z_i)}{\sigma_x})] \\ [w_{z_i}((K-2)\frac{1}{\sigma_{\bar{x}}}\phi(\frac{(x^*(z_i)-z_i)w_{z_i}}{\sigma_{\bar{x}}}) \\ \Phi(\frac{\theta(z_i^*)-(w_{x_i}x_i+w_{z_i}z_i)}{\sigma_\theta})\Phi(\frac{(x^*(z_i)-z_i)w_{z_i}}{\sigma_{\bar{x}}})^{K-3} + \\ 1 + \frac{1}{\sigma_\theta}\phi(\frac{\theta(z_i^*)-(w_{x_i}x_i+w_{z_i}z_i)}{\sigma_\theta})\Phi(\frac{(x^*(z_i)-z_i)w_{z_i}}{\sigma_{\bar{x}}})^{K-2})]\} \end{pmatrix} \blacksquare$

Appendix 5: Strategic Complements. Numerical Example.

We use *Excel* as first approximations that give us critical values at three-decimal working precision. Then, we use *Mathematica* to compute these critical values using the results we have from the first approximations to at least six-decimal working precision. The function used in *Mathematica* is "FindRoot" to solve simultaneous non-linear equations:$F(x(z_i),\theta(z_i); z_i) = 0$. (Proofs are omitted).

Example of *Mathematica* Programming: z=-1, P=.0001, $\frac{1}{\sigma_x}$=1

F1 = theta - (CDF[NormalDistribution[], (xstar - theta)/((1/1)^(1/2))])^(2)

F2 = ((1/(.0001 + 1))*xstar + (.0001/(.0001 + 1))*-1) +

(1 - CDF[NormalDistribution[], (theta - ((1/(.0001 + 1))*

xstar + (.0001/(.0001 + 1))*-1))/((1/(.0001 + 1))^(1/2))]) +

(CDF[NormalDistribution[], (theta - ((1/(.0001 + 1))*

xstar + (.0001/(.0001 + 1))*-1))/((1/(.0001 + 1))^(1/2))])*

(1 - CDF[NormalDistribution[], ((xstar + 1)*

(.0001/(.0001 + 1)))/(((1/(.0001 + 1)) + (1/1))^(1/ 2))]) - 1

FindRoot[{F1 == 0, F2 == 0}, {{theta, .25}, {xstar, .25}}]

{theta -> 0.250042, xstar -> 0.250147}

Appendix 6: Consistency of Numerical Examples with Proposition 1

For K=3, we evaluate the derivatives of the critical values with respect to the public signal, $(\frac{d}{dz_i}\theta^*(z_i), \frac{d}{dz_i}x^*(z_i))$, using the formulae we derive in Proposition 1 to prove the local existence of $x^*(z_i)$ and $\theta^*(z_i)$ at the simulated critical values x^* and θ^*. We show that these derivatives are negative and at these simulated critical values, these derivatives are consistent with the graphs we plot on the simulated critical values against public signals. (Proofs are omitted).

Appendix 7: Proof of Lemma 3

Proof. Note: $x \sim N(\mu, \sigma^2)$, $\frac{f(x, x=[a,b])}{f(x=[a,b])} = \left[\begin{array}{c} \frac{\frac{1}{\sigma}\phi(\frac{x-\mu}{\sigma})}{\Phi(\frac{b-\mu}{\sigma}) - \Phi(\frac{a-\mu}{\sigma})}, \text{ for } x=[a,b]. \\ \\ 0, \text{ everywhere else.} \end{array} \right]$

We can write the conditional distribution $\frac{f(\theta_j, x_j^i, z_j, \theta_j=[a,b])}{f(x_j^i, z_j, \theta_j=[a,b])}$ as $\frac{f(\theta_j, \theta=[a,b]|x_j^i, z_j)f(x_j^i, z_j)}{f(x_j^i, z_j, \theta_j=[a,b])}$.

From Lemma 1:

$\frac{f(\theta_j, \theta_j=[a,b]|x_j^i, z_j)f(x_j^i, z_j)}{f(x_j^i, z_j, \theta_j=[a,b])} =$

$$
\left[\cfrac{\cfrac{1}{\sqrt{2\pi\frac{1}{\frac{1}{\sigma_x^2}+P_j}}} \exp.\left(-\frac{1}{2}\left(\cfrac{(\theta_j - \frac{\frac{x_j^i}{\sigma_x^2}+P_j z_j}{\frac{1}{\sigma_x^2}+P_j})^2}{\frac{1}{\frac{1}{\sigma_x^2}+P_j}}\right)\right) \int_0^1 \frac{1}{\sigma_x\sqrt{2\pi}} \exp.\left(-\frac{(x_j^i-\theta_j)^2}{2\sigma_x^2}\right)\frac{1}{\sqrt{2\pi(\frac{1}{P_j})}} \exp.\left(-\frac{(z_j-\theta_j)^2}{2\frac{1}{P_j}}\right)d\theta_j}{\int_a^b \frac{1}{\sigma_x\sqrt{2\pi}} \exp.\left(-\frac{(x_j^i-\theta_j)^2}{2\sigma_x^2}\right)\frac{1}{\sqrt{2\pi(\frac{1}{P_j})}} \exp.\left(-\frac{(z_j-\theta_j)^2}{2\frac{1}{P_j}}\right)d\theta_j} \right] =
$$

$$
\left[\cfrac{\dfrac{1}{\sqrt{2\pi\frac{1}{\frac{1}{\sigma_x^2}+P_j}}}\exp.\left(-\frac{1}{2}\left(\dfrac{(\theta_j-\frac{\frac{x_j^i}{\sigma_x^2}+P_jz_j}{\frac{1}{\sigma_x^2}+P_j})^2}{\frac{1}{\frac{1}{\sigma_x^2}+P_j}}\right)\right)}{\displaystyle\int_0^1\frac{1}{\sigma_x\sqrt{2\pi}}\exp.\left(-\frac{(x_j^i-\theta_j)^2}{2\sigma_x^2}\right)\frac{1}{\sqrt{2\pi(\frac{1}{P_j})}}\exp.\left(-\frac{(z_j-\theta_j)^2}{2\frac{1}{P_j}}\right)d\theta_j}{\displaystyle(\sqrt{2\pi(\frac{1}{(\frac{1}{\sigma_x^2}+P_j)})})\frac{1}{(2\pi)\sigma_x\sqrt{\frac{1}{P_j}}}\exp.\left(-\frac{1}{2}(\frac{1}{\sigma_x^2}+P_j)\left(-(\frac{\frac{x_j^i}{\sigma_x^2}+z_jP_j}{(\frac{1}{\sigma_x^2}+P_j)})^2+\frac{\frac{x_j^{i2}}{\sigma_x^2}+P_jz_j^2}{(\frac{1}{\sigma_x^2}+P_j)}\right)\right)}{\displaystyle\int_a^b\frac{1}{\sqrt{2\pi(\frac{1}{(\frac{1}{\sigma_x^2}+P_j)})}}\exp.\left(-\frac{1}{2}\left(\frac{(\theta_j-\frac{\frac{x_j^i}{\sigma_x^2}+z_jP_j}{(\frac{1}{\sigma_x^2}+P_j)})^2}{\frac{1}{(\frac{1}{\sigma_x^2}+P_j)}}\right)\right)d\theta_j}}\right]=
$$

$$
\left[\cfrac{\frac{1}{\sqrt{2\pi\frac{1}{\frac{1}{\sigma_x^2}+P_j}}}\exp.\left(-\frac{1}{2}\left(\frac{(\theta_j-\frac{\frac{x_j^i}{\sigma_x^2}+P_jz_j}{\frac{1}{\sigma_x^2}+P_j})^2}{\frac{1}{\frac{1}{\sigma_x^2}+P_j}}\right)\right)(\sqrt{2\pi(\frac{1}{(\frac{1}{\sigma_x^2}+P_j)})})\frac{1}{(2\pi)\sigma_x\sqrt{\frac{1}{P_j}}}}{\exp.\left(-\frac{1}{2}(\frac{1}{\sigma_x^2}+P_j)\left(-(\frac{\frac{x_j^i}{\sigma_x^2}+zP_j}{(\frac{1}{\sigma_x^2}+P_j)})^2+\frac{\frac{x_j^{i2}}{\sigma_x^2}+P_jz_j^2}{(\frac{1}{\sigma_x^2}+P_j)}\right)\right)}\cdot\cfrac{\int_0^1\frac{1}{\sqrt{2\pi(\frac{1}{(\frac{1}{\sigma_x^2}+P_j)})}}\exp.\left(-\frac{1}{2}\left(\frac{(\theta_j-\frac{\frac{x_j^i}{\sigma_x^2}+zP_j}{(\frac{1}{\sigma_x^2}+P_j)})^2}{\frac{1}{(\frac{1}{\sigma_x^2}+P_j)}}\right)\right)d\theta_j}{\displaystyle(\sqrt{2\pi(\frac{1}{(\frac{1}{\sigma_x^2}+P_j)})})\frac{1}{(2\pi)\sigma_x\sqrt{\frac{1}{P_j}}}\exp.\left(-\frac{1}{2}(\frac{1}{\sigma_x^2}+P_j)\left(-(\frac{\frac{x_j^i}{\sigma_x^2}+z_jP_j}{(\frac{1}{\sigma_x^2}+P_j)})^2+\frac{\frac{x_j^{i2}}{\sigma_x^2}+P_jz_j^2}{(\frac{1}{\sigma_x^2}+P_j)}\right)\right)}}{\displaystyle\int_a^b\frac{1}{\sqrt{2\pi(\frac{1}{(\frac{1}{\sigma_x^2}+P_j)})}}\exp.\left(-\frac{1}{2}\left(\frac{(\theta_j-\frac{\frac{x_j^i}{\sigma_x^2}+zP_j}{(\frac{1}{\sigma_x^2}+P_j)})^2}{\frac{1}{(\frac{1}{\sigma_x^2}+P_j)}}\right)\right)d\theta_j}}\right]=
$$

$$
\left[\cfrac{\frac{1}{\sqrt{2\pi\frac{1}{\frac{1}{\sigma_x^2}+P_j}}}\exp.\left(-\frac{1}{2}\left(\frac{(\theta_j-\frac{\frac{x_j^i}{\sigma_x^2}+P_jz_j}{\frac{1}{\sigma_x^2}+Pj})^2}{\frac{1}{\frac{1}{\sigma_x^2}+P_j}}\right)\right)}{\displaystyle\int_a^b\frac{1}{\sqrt{2\pi(\frac{1}{(\frac{1}{\sigma_x^2}+P_j)})}}\exp.\left(-\frac{1}{2}\left(\frac{(\theta_j-\frac{\frac{x_j^i}{\sigma_x^2}+zP_j}{(\frac{1}{\sigma_x^2}+P_j)})^2}{\frac{1}{(\frac{1}{\sigma_x^2}+P_j)}}\right)\right)d\theta_j}}\right].
$$

This random variable $(\theta_j|x_j^i, z_j, \theta_j = [a,b])$ has a doubly truncated normal

distribution with the probability density function taking the form of:

$$\frac{\frac{1}{\sqrt{2\pi\sigma_x^2}}\exp.(-\frac{1}{2}(\frac{(\theta_j-\mu)^2}{\sigma_x^2}))}{\int_a^b \frac{1}{\sqrt{2\pi\sigma_x^2}}\exp.(-\frac{1}{2}(\frac{(\theta_j-\mu)^2}{\sigma_x^2}))d\theta_j} \text{ and a} \leq x \leq \text{b (Johnson, Kotz, and Balakrishan, 1994),}$$

and with the expected conditional value of:

$$\mathrm{E}(\theta_j|x_j^i, z_j, \theta_j=[a,b]) = \int_a^b \theta_j \frac{f(\theta_j, \theta_j=[a,b]|x_j^i, z_j)f(x_j^i, z_j)}{f(x_j^i, z_j, \theta_j=[a,b])}d\theta_j$$

$$= \int_a^b \theta_j \frac{\frac{1}{\sqrt{2\pi\frac{1}{\frac{1}{\sigma_x^2}+P_j}}}\exp.(-\frac{1}{2}(\frac{(\theta-\frac{\frac{x_j^i}{\sigma_x^2}+P_j z_j}{\frac{1}{\sigma_x^2}+P_j})^2}{\frac{1}{\frac{1}{\sigma_x^2}+P_j}}))}{\int_a^b \frac{1}{\sqrt{2\pi(\frac{1}{\frac{1}{\sigma_x^2}+P_j})}}\exp.(-\frac{1}{2}(\frac{(\theta_j-\frac{(\frac{x_j^i}{\sigma_x^2}+zP_j)}{(\frac{1}{\sigma_x^2}+P_j)})^2}{(\frac{1}{\frac{1}{\sigma_x^2}+P_j})}))d\theta_j}d\theta_j$$

Rewriting the conditional probability density function:

$$\mathrm{f}(\theta_j|x_j^i, z_j, \theta_j=[a,b]) =$$

$$\frac{\frac{1}{\sqrt{2\pi\frac{1}{\frac{1}{\sigma_x^2}+P_j}}}\exp.(-\frac{1}{2}(\frac{(\theta_j-\frac{\frac{x_j^i}{\sigma_x^2}+P_j z_j}{\frac{1}{\sigma_x^2}+P_j})^2}{\frac{1}{\sigma_x^2}+P_j}))}{\int_a^b \frac{1}{\sqrt{2\pi(\frac{1}{\frac{1}{\sigma_x^2}+P_j})}}\exp.(-\frac{1}{2}(\frac{(\theta_j-\frac{(\frac{x_j^i}{\sigma_x^2}+z_j P_j)}{(\frac{1}{\sigma_x^2}+P_j)})^2}{(\frac{1}{\frac{1}{\sigma_x^2}+P_j})}))d\theta_j}$$

$$= \frac{\frac{1}{\sqrt{\frac{1}{\frac{1}{\sigma_x^2}+P_j}}}\phi(\frac{\theta_j-\frac{\frac{x_j^i}{\sigma_x^2}+P_j z_j}{\frac{1}{\sigma_x^2}+P_j}}{\sqrt{\frac{1}{\frac{1}{\sigma_x^2}+P_j}}}))}{\Phi(\frac{(b-\frac{(\frac{x_j^i}{\sigma_x^2}+z_j P_j)}{(\frac{1}{\sigma_x^2}+P_j)})}{\sqrt{\frac{1}{\frac{1}{\sigma_x^2}+P_j}}})-\Phi(\frac{(b-\frac{(\frac{x_j^i}{\sigma_x^2}+z_j P_j)}{(\frac{1}{\sigma_x^2}+P_j)})}{\sqrt{\frac{1}{\frac{1}{\sigma_x^2}+P_j}}})}.$$

This conditional probability density function is the probability function of a truncated normal distribution of

$\theta_j | x_j^i, z_j \sim N(\mu, \sigma_x^2).$, where μ be $\frac{\frac{x_j^i}{\sigma_x^2} + P_j z_j}{\frac{1}{\sigma_x^2} + P_j}$ and $\sigma^2 = \frac{1}{(\frac{1}{\sigma_x^2} + P_j)}$.

The expectation and variance of a random variable with a truncated normal distribution is given by:

$$\mathrm{E}(\theta_j | x_j^i, z_j, \theta_j = [a, b]) = \mu + \frac{\phi(\frac{a-\mu}{\sigma}) - \phi(\frac{b-\mu}{\sigma})}{\Phi(\frac{b-\mu}{\sigma}) - \Phi(\frac{a-\mu}{\sigma})} \sigma$$

$$\mathrm{Var}(\theta_j | x_j^i, z_j, \theta_j = [a, b]) = \sigma^2 \Big[1 + \frac{(\frac{a-\mu}{\sigma})\phi(\frac{a-\mu}{\sigma}) - (\frac{b-\mu}{\sigma})\phi(\frac{b-\mu}{\sigma})}{\Phi(\frac{b-\mu}{\sigma}) - \Phi(\frac{a-\mu}{\sigma})} - \Big(\frac{\phi(\frac{a-\mu}{\sigma}) - \phi(\frac{b-\mu}{\sigma})}{\Phi(\frac{b-\mu}{\sigma}) - \Phi(\frac{a-\mu}{\sigma})}\Big)^2\Big]. \quad \blacksquare$$

Appendix 8: Eijffinger-Geraats Transparency Questionnaire (Eijffinger-Geraats, 2006)

(1) Political Transparency: refers to openness about policy objectives. This comprises a statement of the formal objectives of monetary policy, including an explicit prioritization in case of potentially conflicting goals, and quantitative targets. Political transparency is enhanced by institutional arrangements, like central bank independence and central bank contracts, because they ensure that there is no undue influence or political pressure to deviate from states objectives.

(a) Is there a formal statement of the objective(s) of monetary policy, with an explicit prioritization in case of multiple objectives?

No formal objective(s)=0.

Multiple objectives without prioritization=1/2.

One primary objective, or multiple objectives with explicit priority=1.

(b) Is there a quantification of the primary objective(s)?

No=0.

Yes=1.

(c) Are there explicit institutional arrangements or contracts between the monetary authorities and the government?

No central bank, contract or other institutional arrangements=0.

Central bank without explicit instrument independence or contract=1/2.

Central bank with explicit instrument independence of central bank contract (although possibly subject to an explicit override procedure)=1.

(2) Economic transparency: focuses on the economic information that is used for monetary policy. This includes the economic data the central bank uses, the policy models it employs to construct economic forecasts or evaluate the impact of its decisions, and the internal forecasts the central bank relies on. The latter are particularly important since monetary policy actions are known to take effect only after substantial lags. So, the central bank's action are likely to reflect anticipated developments.

(a) Is the basic economic data relevant for the conduct of monetary policy publicly available? The focus is on the release of data for the following five variables: money supply, inflation, GDP, unemployment rate and capacity utilization.

Quarterly time series for at most two out of the five variables=0.

Quarterly time series for three or four out of the five variables=1/2.

Quarterly time series for all five variables=1.

(b) Does the central bank disclose the formal macroeconomic model(s) it uses for policy analysis?

No=0.

Yes=1.

(c) Does the central bank regularly publish its own macroeconomic forecast?

No numerical central bank forecasts for inflation and output=0.

Numerical central bank forecasts for inflation and/or output published at less than quarterly frequency=1/2.

Quarterly numerical central bank forecasts for inflation and output for the medium term (one to two years ahead),specifying the assumption about the policy instrument (condition or unconditional forecasts)=1.

(3) Procedural transparency: is about the way monetary policy decisions are taken. It involves an explicit monetary policy rule or strategy that describes the monetary policy framework, and an account of the actual policy deliberations and how the policy decision was reached, which is achieved by the release of minutes and voting records.

(a) Does the central bank provide an explicit policy rule or strategy that describes its monetary policy framework?

No=0.

Yes=1.

(b) Does the central bank give a comprehensive account of policy deliberation (or explanation in case of a single central banker) within a reasonable amount of time?

No, or only after a substantial lag (more than 3 weeks)=0.

Yes, comprehensive minutes (although not necessarily verbatim or attributed) or explanation (in case of a single central banker), including a discussion of backward and forward-looking argument=1.

(c) Does central bank disclose how each decision on the level of its main oper-

ating instrument or target was reached?

No voting record, or only after substantial lag (more than eight weeks)=0.

Non-attributed voting records=1/2.

Individual voting records, or decision by single central banker=1.

(4) Policy transparency: means a prompt announcement of policy decisions. In addition, it includes an explanation of the decision and a policy inclination or indication of likely future policy actions. The latter is relevant because monetary policy actions are typically made in discrete steps; a central bank may be inclined to change the policy instrument, but decide to wait until further evidence warrants moving a full step.

(a) Are decisions about adjustments to the main operating instrument or target promptly announced?

No, or after a significant lag=0.

Yes, at the latest on the day of implementation=1.

(b) Does the central bank provide an explanation when it announces policy decision?

No=0.

Yes, when policy decisions change, or only superficially=1/2.

Yes, always and including forward-looking assessment=1.

(c) Does the central bank disclose an explicit policy inclination after every

policy meeting or an explicit indication of likely future policy actions (at least quarterly)?

No=0.

Yes=1.

(5) Operational Transparency: concerns the implementation of the central bank's policy actions. It involves a discussion of control errors in achieving the operating instrument or target set in the policy decision, and (unanticipated) macroeconomic disturbances that affect the transmission of monetary policy from instrument to outcome.

(a) Does the central bank regularly evaluate to what extent its policy operating targets (if any) have been achieved?

No, or not very often (at less than annual frequency)=0.

Yes, but without providing explanation for significant deviations=1/2.

Yes, accounting for significant deviations from target (if any); or (nearly) perfect control over main operating instrument/target=1.

(b) Does the central bank regularly provide information on (unanticipated) macroeconomic disturbances that affect the policy transmission process?

No, not very often=0.

Yes, but only through short-term forecasts or analysis of current macroeconomic development (at least quarterly)=1/2.

Yes, including a discussion of past forecast error (at least annually)=1.

(c) Does the central bank regularly provide an evaluation of the policy outcome in light of its macroeconomic objective?

No, or not very often (at less than annual frequency)=0.

Yes, but superficially=1/2.

Yes, with an explicit account of the contribution of monetary policy in meeting the objectives=1.
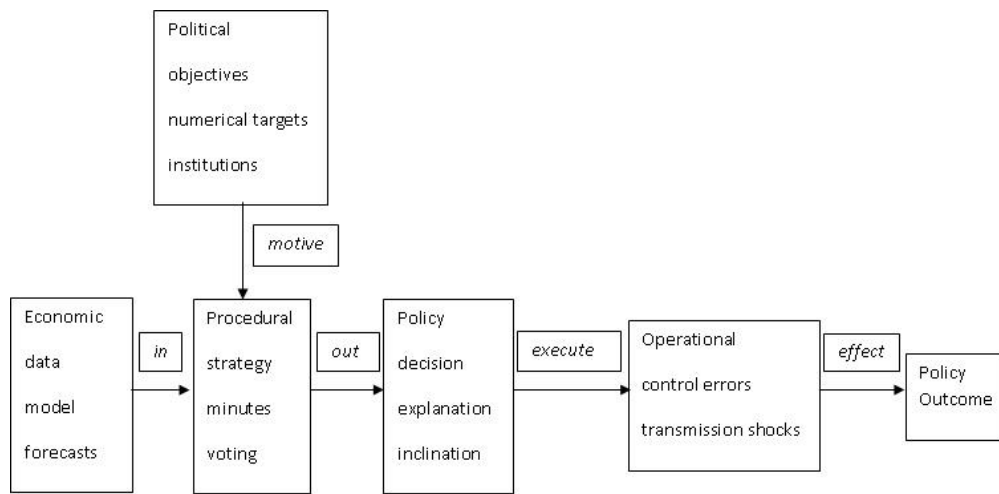
Figure 3.21: Eijffinger-Geraats Transparency Index Framework (Eijffinger, Geraats, 2006)

Appendix 9:

Regression 1: (original)

$$
\begin{aligned}
DETI_{i,t} \;=\; & \alpha + \beta_1 GDPPERCAP_{i,t-1} + \beta_2 (GDPPERCAP_{i,t-1})^2 + \\
& \beta_5 EXREGIME_{i,t-1} + \beta_6 INFLATION_{i,t-1} \\
& \beta_3 UNEMPLOYMENT_{i,t-1} + \beta_4 (UNEMPLOYMENT_{i,t-1})^2 + \\
& \beta_7 RESERVE_{i,t-1} + \beta_8 (RESERVE_{i,t-1})^2 \\
& \beta_9 RER_{i,t-1} + \beta_{10} (RER_{i,t-1})^2 \\
& \beta_{11} DCAGDP_{i,t-1} + \beta_{12} (DCAGDP_{i,t-1})^2 \\
& + I(POLITY_{i,t-1}) + I(REGION_i) + I(CRISIS) + I(YEAR_t)
\end{aligned}
$$

where:

GDPPERCAP=GDP Per Capita

UNEMPLOYMENT=unemployment rate

EXREGIME=exchange rate arrangement

INFLATION=inflation

RESERVE=the ratio of broad money to foreign exchange reserves

RER=Real Exchange Rate appreciation (-)/ depreciation (+)

DCAGDP= the ratio of current account balance to nominal GDP

I(POLITY)=indicator variable on polity (-10=most autocratic, +10=most democratic)

I(REGION)=indicator variable on region (1-19)

I(CRISIS)=1 if country is in crisis in the last 8 years (1998-2005), =0 otherwise

I(YEAR)=indicator variable on year (1998-2005)

Command in STATA

xi: xtmixed deti laggedgdppercapita laggedgdppercapitasq laggedexchanger-atearrangement laggedinflation laggedunemployment laggedunemploymentsq lagge-dreserves laggedreservessq laggeddcagdp laggeddcagdpsq laggedrealexchangerate laggedrealexchangeratesq i.laggeddemocracy i.region i.crisis i.year ||countryid:

Output

Mixed-effects REML regression Number of obs = 584

Group variable: countryid Number of groups = 75

Obs per group: min = 4

avg = 7.8 max = 8

Table 3.11: Regression 1

DETI$_t$	Coeff.	z	P>|z|
GDPPERCAPITA$_{t-1}$	.0000951	2.13	.033
GDPPERCAPITASQUARED$_{t-1}$	-1.21e-09	-1.92	.055
EXREGIME$_{t-1}$	.1472609	3.31	.001
INFLATION$_{t-1}$	-1.770036	-3.81	.000
UNEMPLOYMENT$_{t-1}$	-7.828995	-1.96	.050
UNEMPLOYMENTSQ$_{t-1}$	31.99875	2.82	.005
RESERVES	-.1904879	-3.27	.001
RESERVESSQUARED	-.0074515	3.43	.001
DCAGDP	-1.618754	-2.04	.041
DCAGDPSQUARED	-2.547012	-.87	.384
RER	-.9492929	-2.67	.008
RERSQUARED	.5864727	1.72	.085

.

Table 3.12: Regression 1, cont.

I(POLITY2)	1.81039	1.24	.213
I(POLITY3)	.6309463	.42	.673
I(POLITY4)	.5742103	.42	.672
I(POLITY5)	1.135863	.82	.412
I(POLITY6)	1.598662	1.14	.254
I(POLITY7)	2.049721	1.37	.17
I(POLITY8)	2.157456	1.35	.176
I(POLITY9)	-.8091402	-.54	.587
I(POLITY11)	-.4876156	-.33	.742
I(POLITY12)	.4857216	.34	.738
I(POLITY13)	.3988954	.16	.876
I(POLITY14)	3.008728	2.01	.044
I(POLITY15)	.90332224	.67	.503
I(POLITY16)	1.17243	.87	.382
I(POLITY17)	1.43272	1.07	.285
I(POLITY18)	1.291813	.96	.336
I(POLITY19)	1.069359	.79	.428
I(POLITY20)	1.86272	1.37	.172

.

Table 3.13: Regression 1, cont.

I(REGION2)	-.0291694	-.02	.985
I(REGION3)	1.173495	.69	.489
I(REGION4)	2.729856	1.17	.241
I(REGION5)	2.044812	1.1	.272
I(REGION6)	.1462903	.09	.931
I(REGION7)	1.582003	1.04	.297
I(REGION8)	6.991754	2.91	.004
I(REGION9)	9.479348	4.04	.000
I(REGION10)	.9970283	.54	.588
I(REGION11)	.8201153	.44	.663
I(REGION12)	2.481032	1.57	.116
I(REGION13)	.6670308	.44	.658
I(REGION14)	2.251013	1.29	.196
I(REGION15)	1.110306	.76	.445
I(REGION16)	1.50119	1.04	.297
I(REGION17)	4.024274	2.69	.007
I(REGION18)	1.660637	.99	.322
I(REGION19)	4.242221	1.77	.077

.

Table 3.14: Regression 1, cont.

I(CRISIS)	1.84758	2.67	.008
I(YEAR1999)	.1863427	1.13	.191
I(YEAR2000)	.5014312	3.49	.000
I(YEAR2001)	.8610037	5.7	.000
I(YEAR2002)	1.245093	8.03	.000
I(YEAR2003)	1.355135	8.18	.000
I(YEAR2004)	1.608896	9.25	.000
I(YEAR2005)	1.777133	9.85	.000
CONSTANT	-.4946193	-.27	.786

Note: the coefficients on unemployment become insignificant when we run the regression with orthogonalized independent variables.

Appendix 10:

Regression 2: (without unemployment)

$$
\begin{aligned}
DETI_{i,t} = {} & \alpha + \beta_1 GDPPERCAP_{i,t-1} + \beta_2 (GDPPERCAP_{i,t-1})^2 + \\
& \beta_3 EXREGIME_{i,t-1} + \beta_4 INFLATION_{i,t-1} + \\
& \beta_5 RESERVE_{i,t-1} + \beta_6 (RESERVE_{i,t-1})^2 \\
& \beta_7 RER_{i,t-1} + \beta_8 (RER_{i,t-1})^2 \\
& \beta_9 DCAGDP_{i,t-1} + \\
& + I(POLITY_{i,t-1}) + I(REGION_i) + I(CRISIS) + I(YEAR_t)
\end{aligned}
$$

where:

GDPPERCAP=GDP Per Capita

EXREGIME=exchange rate arrangement

INFLATION=inflation

RESERVE=the ratio of broad money to foreign exchange reserves

RER=Real Exchange Rate appreciation (-)/ depreciation (+)

DCAGDP= the ratio of current account balance to nominal GDP

I(POLITY)=indicator variable on polity (-10=most autocratic, +10=most democratic)

I(REGION)=indicator variable on region (1-19)

I(CRISIS)=1 if country is in crisis in the last 8 years (1998-2005), =0 otherwise

I(YEAR)=indicator variable on year (1998-2005)

Command in STATA

xi: xtmixed deti laggedgdppercapita laggedgdppercapitasq laggedexchanger-atearrangement laggedinflation laggedreserves laggedreservessq laggeddcagdp i.democracy i.region i.crisis i.year ||countryid:

Output

Mixed-effects REML regression Number of obs = 649

Group variable: countryid Number of groups = 84

Obs per group: min = 3

avg = 7.7 max = 8

Table 3.15: Regression 2

$DETI_t$	Coeff.	z	P>|z|
GDPPERCAPITA	.0000927	2.28	.022
$GDPPERCAPITASQUARED_{t-1}$	-1.13e-09	-1.89	.058
$EXREGIME_{t-1}$	.135508	3.18	.001
$INFLATION_{t-1}$	-1.109903	-2.8	.005
$RESERVES_{t-1}$	-.1280636	-2.62	.009
$RESERVESSQ_{t-1}$	.0057443	2.95	.003
RER_{t-1}	-.5990215	-2.25	.025
$RERSQ_{t-1}$	.2293227	1.81	.071
DCAGDP	-1.412857	-2.03	.043

.

Table 3.16: Regression 2, cont.

I(POLITY2)	1.746504	1.32	.188
I(POLITY3)	.6491689	.47	.636
I(POLITY4)	.6046694	.5	.620
I(POLITY5)	.7552114	.62	.536
I(POLITY6)	1.649546	1.31	.189
I(POLITY7)	.5422832	.42	.672
I(POLITY8)	-.015514	-.01	.991
I(POLITY9)	.8847709	.70	.487
I(POLITY10)	.059738	.04	.966
I(POLITY11)	.7273669	.58	.561
I(POLITY12)	.3430782	.26	.795
I(POLITY13)	.9518903	.42	.677
I(POLITY14)	1.54668	1.23	.217
I(POLITY15)	.4281239	.36	.722
I(POLITY16)	1.039057	.87	.386
I(POLITY17)	1.081071	.90	.367
I(POLITY18)	1.33227	1.11	.267
I(POLITY19)	1.374387	1.14	.253
I(POLITY20)	2.190003	1.80	.072

.

Table 3.17: Regression 2, cont.

I(REGION2)	.1182925	.1	.918
I(REGION3)	2.146925	1.71	.087
I(REGION4)	.7293044	.59	.554
I(REGION5)	.9859309	.68	.494
I(REGION6)	-.2552168	-.2	.839
I(REGION7)	1.085502	1.02	.305
I(REGION8)	5.63735	2.81	.005
I(REGION9)	8.449721	4.33	.00
I(REGION10)	.1538443	.14	.891
I(REGION11)	.7773641	.60	.546
I(REGION12)	1.678207	1.45	.147
I(REGION13)	.4677368	.44	.662
I(REGION14)	1.520336	1.18	.239
I(REGION15)	.3537219	.36	.720
I(REGION16)	.9762814	1	.318
I(REGION17)	3.135058	2.91	.004
I(REGION18)	1.100708	.88	.377
I(REGION19)	3.180414	1.58	.113

.

Table 3.18: Regression 2, cont.

I(CRISIS)	1.436086	2.42	.016
I(YEAR1999)	.1742855	1.29	.196
I(YEAR2000)	.4526542	3.32	.001
I(YEAR2001)	.8289379	5.87	.000
I(YEAR2002)	1.20015	8.26	.000
I(YEAR2003)	1.319378	8.8	.000
I(YEAR2004)	1.575402	10.09	.000
I(YEAR2005)	1.698822	10.48	.000
CONSTANT	-.2845945	-.21	.837

Note: all the results of this regression remain robust when we run the regression with orthogonalized independent variables.

Appendix 11: Chronology of Asian Regional Financial Arrangement (1997-2009) (Source: Minister of Finance, Japan; Soesastro, 2008; Jeon, 2002)

1997-1998: Asian financial crisis

August - September 1997: Asian Monetary Fund was proposed by Japan.

December 1997: The 1st ASEAN+3 Summit was held in Kuala Lumpur, Malaysia.

April 1999: The 1st ASEAN+3 Finance Ministerial meeting was held in Manila, Philippines.

November 28, 1999: The 3rd ASEAN+3 Summit was held in Manila, Philippines. Leaders agreed to enhance "self-help and support mechanism in East Asia".

May 6, 2000: The 2nd ASEAN+3 Finance Ministerial meeting was held in Chiang Mai, Thailand. Finance ministers agreed to promote the Chiang Mai Initiatives Bilateral Swap.

May 15, 2004: The 4th ASEAN+3 Finance Ministerial meeting was held in Jeju, Korea. Finance ministers agreed to explore the ways of enhancing its effectiveness of the Chiang Mai Initiatives. Sixteen BSA were already made totalling to US$36.5 billion. Asian Bond Market Initiatives were initiated. Based Capital Accord was agreed.

May 4, 2005: The 8th ASEAN+3 Finance Ministerial meeting was held in Istambul, Turkey. Finance ministers agreed to take the following measures to enhance the effectiveness of the Chiang Mai Initiatives: 1. integration and en-

hancement of ASEAN+3 economic surveillance into the Chiang Mai framework; 2. clear definition of the swap activation process and the adoption of a collective decision-making mechanism; 3. significant increase on the size of swaps from 1 to 2 billion; 4. improvement of the drawdown mechanism.

May 4, 2006: The 9th ASEAN+3 Finance Ministerial meeting was held in Hyderabad, India. A more advanced framework of regional liquidity support was envisaged (that was later called the Chiang Mai Initiatives Multilateralization).

May 5, 2007: The 10th ASEAN+3 Finance Ministerial meeting was held in Kyoto, Japan. Finance ministers unanimously agreed that a self-managed reserve pooling arrangement was an appropriate way to implement the Chiang Mai Initiative Multilateralization.

May 4, 2008: The 11th ASEAN+3 Finance Ministerial meeting was held in Madrid, Spain. Finance ministers agreed to transform Chiang Mai Initiatives into a much stronger Chiang Mai Initiatives Multilateralization. China-Japan-Korea would be responsible to 80% of the fund while the rest of the ASEAN countries would be responsible to the rest of the fund.

October 25, 2008: The 7th Asia-Europe meeting was held in Beijing. A US$80 billion regional, multilateral fund based on the Chiang Mai Initiatives Multilateralization was created and expected to become active in May 2009.

November 20, 2008: A technical-group meeting was held in Manila, Philippines, to discuss the details of the new self-managed reserve pooling arrangement.

November 28, 2008: A Deputy Finance Ministerial meeting was held in Hakone, Japan, to discuss the details of the new self-managed reserve pooling arrangement.

December 10, 2008: Bali Democracy Forum was held in Bali to discuss issues on democratization in Asia. Thirty two countries, including Australia, attended the forum.

December 13, 2008: A Trilateral Summit of China, Japan, and Korea was held in Fukuoka. The three countries reiterated their commitment to strengthening the Chiang Mai Initiatives Multilateralization. The summit was seen as a development to the long-time reservation among these countries.

December 15, 2008: ASEAN+3 may expand the reserve pool to US$120 billion from US$80 billion.

February 18, 2008: ADBI kicked off studies to expand Asian Bond Market.

February 19, 2008: ASEAN+3 Finance Ministerial meeting was held in Phuket, Thailand. Ministries of Finance advanced in expanding the reserve pool to US$120 billion from US$80 billion.

Appendix 12: Vulnerability Data 2003

Brunei	%Real GDP	DCA/GDP	M2/Reserve, IPS	Bank Lending Growth	Inflation	%RER
1997						
1998	-0.1078678				-0.004414	0.01713
1999	0.06612423		7.890		-0.004156	0.04697
2000	0.01286849		13.262	0.108984073	0.015581	0.09481
2001	-0.024246	0.439196564	11.052	0.034404957	0.00596	0.16053
2002	-0.0054092	0.347399855	10.207	0.043436498	-0.023151	-0.0461
2003	0.03922199	0.469490357	10.257	0.034153412	0.003	-0.0024
2004	0.10396216	0.510447945	12.011	0.063831582	0.008142	-0.0399
2005		0.630796496	11.193	0.034521993	0.012445	0.07255
2006			11.879	-0.008906487	0.001223	-0.0936
2007			10.378	0.086383038		
2008						
2009						

*M2="Broad Money" line 59

Source: IFS

Figure 3.22: Vulnerability Data 2003: Brunei Darusallam

Cambodia	%Real GDP	DCA/GDP	M2/Reserve, IPS	Bank Lending Growth	Inflation	%RER
1997		-0.07141975				
1998	0.05	-0.05583414		0.027978046	0.148066	-0.034
1999	0.126	-0.05286247		0.16594689	0.040077	-0.017
2000	0.084	-0.03773757		0.17717726	-0.00792	0.079
2001	0.077	-0.02191771	0.96525625	0.04190629	-0.00601	0.032
2002	0.068	-0.02514948	0.94815267	0.131183581	0.03225	-0.007
2003	0.087	-0.05017572	1.02749899	0.262260249	0.012105	0.024
2004	0.103	-0.03436136	1.12808953	0.447524352	0.039375	-0.001
2005	0.132	-0.05754868	1.26639165	0.194837683	0.056506	-0.001
2006	0.108	-0.04609108	1.48556008	0.548447936	0.047117	-0.027
2007	0.101	-0.0578459	1.56210362	0.782290957	0.058539	-0.042
2008						
2009						

Source: IFS

Figure 3.23: Vulnerability Data 2003: Cambodia

Indonesia	%Real GDP	DCA/GDP	M2/Reserve,	IPS Bank Lending Growth	Inflation	%RER
1997		-0.03621799	4.61101023			
1998	-0.131262	0.034400294	3.1676362	0.332185702	0.583869	0.1065
1999	0.00791007	0.037256278	3.44894992	-0.554921849	0.204891	-0.2512
2000	0.04919684	0.05517755	2.7316062	0.221741895	0.037184	0.3498
2001	0.03643	0.043593936	2.97872519	0.207327519	0.11504	-0.0005
2002	0.04500063	0.038391216	3.19240899	0.160393597	0.118785	-0.2195
2003	0.04779931	0.034079058	3.22917063	0.192213629	0.06586	-0.0915
2004	0.05031546	0.006324709	3.18402285	0.31115285	0.06243	0.0606
2005	0.05692401	0.000983446	3.69204004	0.210018699	0.104526	-0.0095
2006	0.05510442	0.029267705	3.72890126	0.12066019	0.131101	-0.1626
2007	0.06316534	0.024669478	3.18576216	0.224050659	0.064072	0.0094
2008						
2009						
Source: IFS						

Figure 3.24: Vulnerability Data 2003: Indonesia

Laos	%Real GDP	DCA/GDP	M2/Reserve,	IPS Bank Lending Growth	Inflation	%RER
1997		-0.366	1.37377708			
1998	0.04	-0.151	1.80551968	0.150071478	0.909802	-0.1373
1999	0.073	-0.089	2.00837862	-0.079705786	1.284195	-0.2045
2000	0.058	-0.005	1.97506473	0.291985264	0.250846	-0.1063
2001	0.058	-0.05	2.0643198	0.070110602	0.07812	0.1014
2002	0.059	0.002	1.72488068	-0.111547183	0.106315	0.0334
2003	0.058	-0.032	1.94106075	-0.001954166	0.154887	-0.1321
2004	0.069	-0.074	2.22525359	0.152225678	0.104626	-0.0785
2005	0.073	-0.068	2.20909608	0.231312955	0.071655	-0.0011
2006	0.083	0.014	2.2125366	0.064954639	0.068023	-0.1276
2007	0.075	0.026	1.96376289	0.336036013	0.045224	-0.0515
2008						
2009						
*M2="Money"+"Quasi Money", line 34+35						
Source: IFS						

Figure 3.25: Vulnerability Data 2003: Laos

Malaysia	%Real GDP	DCA/GDP	M2/Reserve,	PS Bank Lending Growth	Inflation	%RER
1997		-0.08197235	3.61182682			
1998	-0.0735934	0.127836769	3.05245614	0.005901582	0.053	-0.0581
1999	0.06137608	0.159241332	2.90048209	-0.00079518	0.027	-0.0054
2000	0.08858822	0.090499134	3.29485671	0.072543792	0.015	0.0181
2001	0.00518	0.078535568	3.23138423	-0.053948842	0.014	0.0139
2002	0.05391074	0.071294586	3.02547924	0.025646771	0.018	-0.0022
2003	0.05788346	0.121423888	2.55857979	0.067191737	0.01	0.0126
2004	0.06783321	0.120877464	2.13368038	0.065052677	0.015	0.0114
2005	0.05332119	0.144558799	2.33344861	0.09122038	0.03	-0.0011
2006	0.05774601	0.156887984	2.47617811	0.068399065	0.036	-0.0692
2007	0.06346611	0.149037295	2.38586795	0.092466003	0.02	-0.0561
2008						
2009						

Source: IFS

Figure 3.26: Vulnerability Data 2003: Malaysia

Myanmar	%Real GDP	DCA/GDP	M2/Reserve,	PS Bank Lending Growth	Inflation	%RER
1997		-0.00234278	205.00486			
1998	0.05773181	-0.0018737	227.81967	0.348513051	0.514876	-0.3576
1999	0.10916152	-0.00080588	341.214777	0.207941705	0.184007	-0.1146
2000	0.06234815	-0.00054168	549.535018	0.416249887	-0.00109	0.0902
2001	0.11344	-0.0002929	424.711599	0.561835281	0.21101	-0.1197
2002	0.12025794	0.000107483	527.147552	0.461883914	0.570747	-0.4022
2003	0.13839851	-1.42923E-05	499.084973	-0.438615321	0.365899	-0.315
2004		6.72969E-05	565.360141	0.255847658	0.045343	-0.0602
2005			577.8042	0.331039258	0.093685	0.0272
2006			482.666656	0.143570773	0.199966	-0.1827
2007				0.21800696	0.350245	-0.2748
2008						
2009						

*M2="Money Plus Quasi Money", line 35
Source: IFS

Figure 3.27: Vulnerability Data 2003: Myanmar

Philippines	%Real GDP	DCA/GDP	M2/Reserve, IPS	Bank Lending Growth	Inflation	%RER
1997		-0.07167279	3.61291888			
1998	-0.0057673	0.022658107	3.14278121	-0.057002687	0.092659	-0.0919
1999	0.03396352	-0.03891953	2.53841815	-0.020223678	0.059471	-0.0045
2000	0.04008271	-0.03316081	2.17452435	0.052963599	0.039501	0.2334
2001	0.034	-0.02468658	2.19572767	-0.006509106	0.068	-0.0101
2002	0.05537718	-0.0037372	2.35441494	0.003500617	0.029963	0.0188
2003	0.04915419	0.00370769	2.26876205	0.029153346	0.034545	0.0346
2004	0.05000437	0.01886135	2.55100557	0.095296574	0.059754	-0.019
2005	0.04831344	0.019339485	2.42740819	-0.000108426	0.076285	-0.094
2006		0.043546456	2.54268079	0.095599438	0.062404	-0.1004
2007		0.039238552	2.21057853	0.058902014	0.028042	-0.157
2008				-1		
2009						

*M2="Narrow Money" +"Quasi Money", line 59
Source: IFS

Figure 3.28: Vulnerability Data 2003: Philippines

Singapore	%Real GDP	DCA/GDP	M2/Reserve, IPS	Bank Lending Growth	Inflation	%RER
1997		0.175660851	1.03170245			
1998	-0.014	0.220249742	1.28933309	0.063764396	-0.00268	0.0091
1999	0.072	0.171	1.35925026	-0.033670189	0.000167	0.0251
2000	0.101	0.116	1.23076626	0.054294128	0.013616	0.06
2001	-0.024	0.129	1.29148643	0.125748756	0.00997	0.0884
2002	0.042	0.123	1.26249994	-0.087178553	-0.00391	-0.0432
2003	0.035	0.226	1.19005999	0.028265763	0.005079	-0.0034
2004	0.09	0.162	1.1251612	0.043793919	0.016625	-0.0298
2005	0.073	0.186	1.13702221	0.024044568	0.004251	0.0487
2006	0.082	0.211	1.25522168	0.047530279	0.01021	-0.0584
2007	0.077	0.232	1.26717352	0.173246976	0.02078	-0.0531
2008						
2009						

Source: IFS

Figure 3.29: Vulnerability Data 2003: Singapore

Thailand	%Real GDP	DCA/GDP	M2/Reserve, IPS	Bank Lending Growth	Inflation	%RER
1997		-0.03	3.50823838			
1998	-0.105	0.113	4.49438566	-0.080376496	0.080722	-0.2703
1999	0.044	0.1	3.80367001	-0.151823372	0.003039	0.0404
2000	0.048	0.082	3.63304516	-0.128803879	0.015673	0.1753
2001	0.022	0.044	3.66488516	-0.066503549	0.01637	0.034
2002	0.053	0.037	3.27627062	0.123395497	0.006208	-0.0148
2003	0.07	0.032	3.46920469	0.064020855	0.018002	-0.0783
2004	0.062	0.017	3.12928119	0.112639298	0.027683	-0.0142
2005	0.045	-0.044	3.09588598	0.079796149	0.045415	0.0389
2006	0.052	0.01	2.89957622	0.045368594	0.046419	-0.1334
2007	0.05	0.063		0.047858203	0.022283	-0.0588
2008					0.054726	0.0235
2009						

Figure 3.30: Vulnerability Data 2003: Thailand

Vietnam	%Real GDP	DCA/GDP	M2/Reserve, IPS	Bank Lending Growth	Inflation	%RER
1997		-0.05988756	3.34120328			
1998	0.058	-0.04132188	3.68194451	0.191	0.072662	0.0698
1999	0.048	0.041283376	3.43769052	0.458	0.04117	-0.0088
2000	0.068	0.036346948	4.49510927	0.342	-0.0171	0.0882
2001	0.069	0.021374184	5.04806178	0.232	-0.00432	0.0733
2002	0.071	-0.01736482	5.18459317	0.255	0.03831	-0.0009
2003	0.073	-0.04925058	4.22248034	0.324	0.032201	0.0064
2004	0.078	-0.02110785	4.79147608	0.394	0.077583	-0.0392
2005	0.084	-0.01062423	4.79490521	0.349	0.082815	-0.0367
2006	0.082	-0.00269815	4.29425756	0.229	0.073863	-0.0304
2007	0.085	-0.09848637		0.49794864	0.088946	-0.052
2008					0.243963	-0.1206
2009						

Figure 3.31: Vulnerability Data 2003: Vietnam

China	%Real GDP	DCA/GDP	M2/Reserve, IPS	Bank Lending Growth	Inflation	%RER
1997		0.037478799			0.028068	
1998	0.078	0.030110069	8.46089095	0.200208943	-0.00845	0.0241
1999	0.076	0.019218751	9.1811912	0.120922355	-0.01408	0.0366
2000	0.084	0.017199059	9.66398039	0.10951006	0.002553	0.0308
2001	0.083	0.013216661	8.87084749	0.135970084	0.004634	0.0235
2002	0.091	0.024362154	7.67742333	0.279879297	-0.00765	0.0237
2003	0.1	0.027836858	6.54865632	0.194983345	0.011568	0.011
2004	0.101	0.035454072	4.97861813	0.08791278	0.03885	-0.0116
2005	0.104	0.068780522	4.50627166	0.106711107	0.018206	-0.01
2006	0.117	0.089419624	4.14187404	0.162545749	0.01464	-0.0155
2007	0.119	0.110133093	3.60885663	0.176357113	0.047543	-0.0815
2008						
2009						

Source: IFS

Figure 3.32: Vulnerability Data 2003: China

Japan	%Real GDP	DCA/GDP	M2/Reserve, IPS	Bank Lending Growth	Inflation	%RER
1997		0.02441728	20.5312585			
1998	-0.021	0.027191393	24.5539188	0.020888144	0.006664	-0.103
1999	0	0.023536668	21.409	-0.014058261	-0.00332	-0.094
2000	0.028	0.027334408	15.699	-0.019312013	-0.00712	0.171
2001	0.002	0.023249571	12.698	-0.419255664	-0.00758	0.189
2002	0.003	0.027441616	12.219	-0.077654884	-0.00895	-0.068
2003	0.015	0.029755073	9.609	-0.039256361	-0.00249	-0.084
2004	0.027	0.035949782	8.017	-0.022554409	-8.4E-05	-0.002
2005	0.019	0.03897966	7.204	0.032317457	-0.00274	0.175
2006	0.02	0.03985459	6.822	-0.003283984	0.002415	0.038
2007	0.024	0.04652768	6.707	-0.001660311	0.000582	-0.015
2008			6.70740748			

*M2=M2 (Period Average)
Source: IFS

Figure 3.33: Vulnerability Data 2003: Japan

Korea	%Real GDP	DCA/GDP	M2/Reserve, IPS	Bank Lending Growth	Inflation	%RER
1997		-0.028933738	11.106			
1998	-0.069	0.100406163	7.26	0.089	0.075	-0.329
1999	0.095	0.052702403	5.82	0.162	0.008	-0.0419
2000	0.085	0.026770474	4.468	0.167	0.023	0.12324
2001	0.038	0.01695938	4.51	0.117	0.041	0.02638
2002	0.07	0.009350563	4.456	0.171	0.028	-0.1073
2003	0.031	0.019665331	3.263	0.087	0.035	-0.0067
2004	0.047	0.037417421	2.985	0.021	0.036	-0.1397
2005	0.042	0.018697569	3.359	0.077	0.028	-0.0166
2006	0.051	0.005904509	3.439		0.022	-0.0716
2007	0.05	0.006184963	3.284		0.025	0.00981
2008					0.047	0.33219
2009						

Source: IFS

Figure 3.34: Vulnerability Data 2003: Korea

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CONCLUDING REMARK

Although the three chapters do not explicitly study institutions in the context of the current global financial crisis, there are a lot of implications that could be derived from them. One such implication is how institutions could be improved in order to yield a better nature of equilibria if indeterminacy of outcomes is unavoidable. A financial crisis is not predictable because there are multiple outcomes that could have occurred from the initial conditions of the global economy, including the global imbalance and financial deregulation. An even stronger demand on economic theory is how to deal with a multiplicity of equilibria itself.

This study also warns that economic decision is never separate from political factors. Therefore, a new economic theory should be integrated with other studies as much as other studies consider economic factors. A new economic theory must eventually be brought into the context of policy decision that is made by politicians and not social planners. An enlightening economic theory must be able to inspire politicians to make favorable political decisions, such as designing economic incentives that could inspire political integration in the midst of conflicts.

Institution can be studied only by a non-traditional, social science empirical method because it highly depends on the culture, norms, beliefs, and historical accounts. Hence, a new economic theory must challenge the traditional method of empirical study and be creative in designing a new approach of conducting an empirical study. Chapters 1 and 3 use deductive methods while Chapter 2 uses both inductive and deductive methods. A new economic theory is not far from reality, necessitating the interactive use of both methods.