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CENTRAL BANKS' INFORMATION TRANSPARENCY, FOREIGN EXCHANGE REGIMES, AND ECONOMIC CRISES: THEORETICAL AND EMPIRICAL STUDIES

By

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ABSTRACT

CENTRAL BANKS' INFORMATION TRANSPARENCY, FOREIGN EXCHANGE REGIMES, AND ECONOMIC CRISES: THEORETICAL AND EMPIRICAL STUDIES

By

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The relationship between central banks' information transparency and the onset of economic crises has been a long discussed topic in economics. It has attracted more attention as a result of the Southeast Asian crises. Stiglitz (1998a, b and 1999) suggests that to investigate the true role of transparency in the economic crises, one has to find other factors that jointly cause a crises, and to combine these factors with transparency so that one can see how transparency performs in a crisis. Taking this suggestion, we use foreign exchange regimes and inflation targets as the factors to see the relationship between the policy combinations of transparency and regimes in stable economic environments and the chance of experiencing crises in succeeding periods.

Our theoretical model is in the structure of a monetary policy game. Since we do not discuss rules vs. discretion, we simply assume that the central bank adopts the discretionary monetary policy to affect the public's expectations of inflation and to accommodate money market disturbances. Moreover, we introduce the private information problem into our model to distinguish between transparent and opaque

central banks. The theoretical model suggests that depending on the relative size of the central bank's inflation target and the public's inflation expectations, the central bank has different choices of its type, transparent or opaque. If the inflation target is greater than the public's expectations, then given a more flexible regime, the central bank should choose to be opaque, otherwise, transparent. However, if the target is less than the expectations, given a more flexible regime, the central bank ought to be transparent, otherwise, opaque.

Conducting empirical study to examine the relationship between the policy suggestions from the theoretical model and the following economic crises, we found that three of the policy combinations are supported by the data; the only one left is the combination of a more flexible regime with an opaque type. This indicates that greater transparency does play an important role in the onset of economic crises in succeeding periods. In addition, applying the suggested policies to investigate the possible reasons that cause the Asian crises, we found that the cause of the Malaysia crisis cannot be explained well. This may be because we did not put the onset of a crisis into our theoretical model. This is a shortcoming of this paper; on the other hand, this is one of the directions that we can extend this model.

To my mother, Lu-Ing Ding

my father Geng-Shi Lu

my brother Chao-Jui Lu

And our little dog Bo-Bo

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Jing-I Lu
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CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

I. INTRODUCTION

Banking and currency crises have been highly discussed topics in economics for years. Models like the first- (for example, Krugman 1979) and the second-generation (for example, Obstfeld 1994) ones have attracted the attention of economists in the past thirty years. The 1997 Southeast Asian banking and currency crises made economic crises an even more popular topic in the economics literature. There are many studies discussing feasible policies to prevent crises, such as reducing the government budget imbalance, improving the competitiveness of the country, etc. In the present paper, we do not perform the same task but would like to investigate the relation between the central bank's policy combination and the onset of an economic crisis. We want to see which policy combinations if adopted in stable economic times can make the country more vulnerable to economic crises later. The policy combinations that we focus on are central banks' exchange rate regimes, inflation targets, and the central banks' choices of being transparent or opaque. The question that we ask is: will a country that conducts the policy combination suggested in this paper in the stable time be susceptible to experiencing crises later?

The importance of transparency was raised by the Southeast Asian economic crisis. Some economists argue that government policy in the crisis countries (Indonesia, Korea, Malaysia, the Philippines and Thailand, referred to as the Asian-5 after Radelet and Sachs, 1998a) was transparent. For example, in Furman and Stiglitz (1998), the authors believe that the reason that the Southeast Asian governments of these crisis countries became the

targets of public criticism is that by blaming them for lack of transparency, the blame was shifted away from foreign investors and their governments. In addition, another advantage of doing this is that if lack of transparency is the cause of the crisis, then there is no need for any changes in international architecture — "an important consideration in an era of financial stringency, when national legislatures are loath to provide money for international assistance." (Furman and Stiglitz, 1998). However, other economists think that the crisis countries did not perform well in terms of transparency. For example, treating corruption and crony capitalism as good indicators of lack of transparency, Frankel (1998) states that "I think many Asians may have concluded recently ... that there are *financial* advantages to the rule of law, transparency, freedom of expression, and clearly-established procedures for government succession." Krugman (1998) says that "Corruption and nepotism are nasty things, and in much of Asia they have flourished on an epic scale .... The *specific* sin that pushed Asia to the brink was the problem of moral hazard in lending – mainly domestic lending." Summers (1998) remarks that "The emphasis of these programs (IMF programs) has been at least as much on improving the quality of government intervention – to make it more transparent, less open to corruption, and more focused on the things that sustainable market-led growth depends on, ..." Florini (1999), like Furman and Stiglitz (1998), thinks that although the call for greater transparency may just reflect the need of investors to shift blame:

> "it also reflects an increase in investors' desire to identify investment opportunities across national borders, ... Demands for transparency are arising because of the growth in the number of investors wanting the means to assess the quality and risks of portfolio investments across a broad range of countries." (p. 168)

In Stiglitz (1998a and b, and 1999), the author emphasizes that lack of transparency may contribute to the onset of crises, but not be responsible to the crisis itself. The reason is that when market participants sense that something is wrong in the target countries, they panic. Without enough information to differentiate between good and bad firms or to ensure that the target countries have enough foreign reserves to defend themselves, the safest thing for the investors to do is to withdraw all their capital from the markets, which may lead to crises. This opinion is shared by Yellen (1998), and by the Bank for International Settlements (BIS) Working Group on Transparency and Accountability. Moreover, Stiglitz stresses that countries in Scandinavia experienced similar economic crises in the beginning of 1990's and those are countries with greater transparency levels. Therefore, Stiglitz concludes that "there are several factors that might jointly "cause" a crisis, and that is precisely why one needs to use more sophisticated econometric techniques that can take into account multiple attributes." (Stiglitz 1999, p.316)

Let us see how transparent some crisis countries were before the onset of crisis. Figure 1 is the comparison between the Asian-5 and Taiwan, the country that escaped the crisis. Here we use the data from *The World Competitiveness Yearbook*, a data set indicating the transparency level of a government; a larger number indicates greater transparency.[1] Generally speaking, among the Asian-5, the transparency levels of Indonesia, Korea and Thailand were decreasing to a relatively low level from 1992 to 1997; the transparency level of the Philippines was fixed at 1, a relatively low level; only Malaysia kept on being transparent throughout the period. Taiwan's level was also decreasing, but its level was relatively high, except in 1997. Figure 2 shows the same comparison among South American countries. We compare the countries that were

affected most by the 1994 Mexican crisis (Argentina, Brazil, Colombia, Mexico and Venezuela) with Chile, the one that was affected least by that crisis. Argentina, Colombia and Venezuela had relatively low transparency levels before and after the 1994 crises; Brazil's level was increasing, but was relatively low before the crises; Mexico's level was decreasing before the crises and remained low until 1997. For Chile, its level fluctuated in these six years and was relatively high until 1997. From these analyses we can conclude that there is a pattern that most crisis countries had relatively low or decreasing transparency levels before the crisis.

As Stiglitz suggests, now we need to find other factors that jointly contribute to crises. The two we choose are the exchange rate regime and the central bank's inflation target. The role of exchange rate regimes in crises has been highly discussed since the 1970s. Some studies, for example, Goldfajn and Valdés (1996), and Dornbusch, Goldfajn and Valdés (1995), find that before the occurrences of currency crises, most crisis countries have the so-called "real currency overvaluation" phenomena, which increases the chance of currency crashes. Goldfajn and Valdés (1996) have conducted empirical research on this phenomenon. Since these phenomena tend to occur in countries that adopt fixed exchange rate regimes, those authors believe that the crisis countries chose the wrong regime. The same arguments apply to the Southeast Asian crisis. However, in this crisis, there are two different opinions in regard to the overvaluation phenomena. Some studies, like Radelet and Sachs (1998a and b), Corsetti *et al* (1998a), find that the Asian-5's currencies were over-valued before the crisis, so the authors blame the Asian-5 governments' regime adoption. On the other hand, Furman and Stiglitz (1998) do not think overvaluation occurred in the Asian-5. They use several different estimates to assess

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[1] For detail description of this data set, please refer to Chapter 3 of the present paper.

real exchange rate misalignments in several countries and find that the degree of real misalignment is very sensitive to the measures used. We duplicate and present the calculated real exchange rate appreciation in Radelet and Sachs (1998a) and in Furman and Stiglitz (1998) in Tables A.1 and A.2, respectively.[2]

No matter whether there is real currency overvaluation or not, our interest is on the performance of exchange rate regimes. So let us examine the evidence from the crisis countries' choices of regimes first. Figure 3 shows the exchange regimes adopted by the Asian-5 and Taiwan from 1992 to 1997. The data come from the IMF's *Annual Report on Exchange Rate Arrangements and Exchange Restrictions*; 0 indicates a pegged regime, 1 limited flexible one, 2 managed float, and 3 free float.[3] For the Asian-5, the Philippines adopted a free float regime and Thailand a pegged one; the rest of them adopted a managed float regime. Taiwan also adopted managed float regime throughout this period. In 1997, both Indonesia and Korea freed their regimes, and Thailand switched from a peg to a managed float regime. Figure 4 is the comparison of South American countries. Chile, like Taiwan, adopted managed float for the whole period. Mexico freed its regime before the crisis in 1995. Brazil fixed its regime a little before the crisis; the regime transition of Venezuela has a U-shape transition with the bottom in 1994 and 1995; Argentina adopted a pegged regime during the whole period. From this analysis we can see that there is mild evidence that some of the major crisis countries, like the Asian-5 (except for Malaysia with a managed float regime and the Philippines with free float one through out the whole sample period) and Mexico, freed their regimes before the crises; others, like

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[2] Taiwan's results in Table 1 were calculated by the author of this paper with the method suggested by Radelet and Sachs (1998a). For details of the methods employed in this study, please refer to the original paper.

[3] For detail discussion about the regime data, please refer to section II of chapter 3.

Brazil and Venezuela, fixed theirs.

The comparison of Figures 3 and 4 with Figures 1 and 2 are listed in Tables 1 and 2. The results suggest that the combination of transparency and managed float exchange rate regime in Taiwan and Chile, the two countries that did not suffer a crisis, enabled these countries to avoid crisis. However, Malaysia also adopted the same combination; why did it experience a crisis? As to other crisis countries, the results are mixed; however, recall that a common pattern among those countries is that they all had lower transparency; does this suggest that poor transparency, contrary to Stiglitz's argument, is really the main cause of crises? This raw data comparison suggests that it is meaningful to find whether certain policy combinations can help a country reduce the chance of having crises.

To put transparency level into a theoretical model to conduct the analysis, we adopt the monetary policy game style model and use the central bank's inflation target, another factor that we look at in addition to the exchange rate regime, as one of the central bank's goals. In our model, the inflation target is the private information of the central bank. With this setting, we can not only distinguish between central banks' types, transparent or opaque, but also can have asymmetric information between central banks and the public. Using an inflation target as one of central banks' objectives is very common in the literature on monetary policy games; articles include Kydland and Prescott (1977), Barro and Gordon (1983) (to be discussed later). In the field of private information, some authors, for example, Canzoneri (1985), Garfinkel and Oh (1995), use the central bank's knowledge of the disturbances of money demand as private information in the economy, which is related to the realized inflation rate. In our model, we simplify the setting of those two papers, and simply assume that the private information comes from the central

Table 1. Comparison of exchange rate regimes and transparency levels between the Asian-5 and Taiwan

exchange rate regime	transparency level			
	0	1	2	3
pegged	• Thailand (1996)	• Thailand (1993-1995)	• Thailand (1992)	
limited flexible				
managed float	• Korea (1994, 1996), • Thailand (1997)	• Indonesia (1992, 1994-1996), • Korea (1993, 1995), • Taiwan (1997)	• Korea (1992), • Indonesia (1993), • Taiwan (1993-1996)	• Malaysia (1992-1997), • Taiwan (1992)
independent float	• Korea (1997)	• the Philippines (1992-1996), • Indonesia (1997)	• the Philippines (1997)	

Table 2. Comparison of exchange rate regimes and transparency levels among South American countries

exchange rate regime	transparency level			
	0	1	2	3
pegged	• Venezuela (1994-1995)	• Argentina (1992-1997)		
limited flexible				
managed float	• Venezuela (1993, 1996-1997), • Brazil (1994) • Colombia (1996-1997)	• Colombia (1992-1995), • Brazil (1995), • Chile (1997)	• Chile (1995), • Brazil (1996),	• Mexico (1992-1993), • Chile (1992-1994, 1996) • Brazil (1997)
independent float	• Brazil (1992-1993), • Venezuela (1992), • Mexico (1995-1997)		• Mexico (1994)	

bank's knowledge of the inflation target. Another advantage of using inflation target as one of the central bank's goals is that it is applicable to the countries in our sample in the empirical study. According to the IMF's Supporting Document to the *Code of Good Practice on Transparency in Monetary and Financial Policies* Part 2 — Good Transparency Practices for Monetary Policy by Central Banks, "in recent years some countries list price stability as the primary objective." This includes OECD countries, countries in the Eurosystem, Japan, Mexico, New Zealand, etc, which are mostly contained in our sample.

In the literature on transparency, most studies have only theoretical discussions without empirical support. One of the reasons for not conducting an empirical study is that it is very difficult to find data evaluating transparency. In addition, when transparency is used as a factor to account for the onset of crises, a majority of the papers have only verbal descriptions, but not empirical or theoretical justifications. This paper makes up for these shortcomings. We have both a theoretical model and empirical studies. We build our model on Geraats (2000a) in the structure of a monetary policy game to investigate the relationship between the central banks' economic transparency, the foreign exchange rate regime, and the inflation target. Since our focus is on the central bank's choice of transparency level, we take the exchange rate regime and the inflation target as exogenously given to the central bank and pre-determined at the beginning. Transparency is introduced into the model by its affect on the public's inflation expectations: if the public faces a transparent central bank, then the public can obtain the central bank's private information about the central bank's inflation target; otherwise, the public cannot. The central bank chooses its transparency level after it observes the given exchange rate regime and the inflation target, its private information, and the disturbances to the

economy. The public observes the central bank's choice and then forms their expectations of the inflation rate. With this setting, we can examine the appropriate combinations of transparency, the regime, and the inflation target that by pursuing them, the central bank can enhance its well-being in stable economic times. In the empirical study, we do not directly test our theoretical model but investigate the relation of policy combinations in stable economic times and the onset of crises. That is, we ask which policy combinations make the country vulnerable to economic crises later. Doing this, we use one-period lagged transparency and regime variables to explain the occurrences of crises; in addition, we include other macroeconomic variables on the right-hand-side of our regressions to control for other possibilities that may contribute to crises. The inflation target is the variable that we consider in addition to the regime. It serves as the central bank's private information to distinguish between central bank's types and to cause asymmetric information between the central bank and the public. Its affect in the theoretical model is realized once the central bank chooses its own type; therefore, we need not put this variable into our regressions. Moreover, central banks' inflation targets are not observable; because of these reasons, we do not include this variable in our regression.

There are several definitions of economic transparency in the literature. Faust and Svesson (2001), interpret transparency as how easily the public can deduce the central-bank goals and intentions from observables. Geraats (2000a) has a more concrete definition: "the disclosure of economic data, models and central bank forecasts." In this paper, we combine both the Faust and Svesson (2001) and Geraats (2000a) definitions that if the public can infer the central bank's private information through the central bank's policy instrument, then we refer to this central bank as a transparent one; if the public cannot, then they face an opaque central bank. When we conduct an empirical

study to investigate the relation between policies and crises, we use the information from both banking and currency crises. This is because in the literature on crises, there are three kinds of crises: banking crises, currency crises, and twin crises. Twin crises are defined as an occasion in which banking and currency crises tend to appear sequentially or at the same time, examples include the crises in the Asian-5 in 1997 and 1998, in Scandinavia in the early 1990s, and in Latin American countries in the early and mid-1980s. Sometimes it is the banking crisis that leads to a currency crisis; sometimes the causality is reversed; and in other times, there are some common factors that cause both crises to occur at the same time. There are several reasons that banking crises lead to currency crises. For example, as the central bank finances the bail-out of troubled financial institutions in a banking crisis, its ability to maintain the prevailing exchange rate commitment erodes. This ability can be further undermined by its inability to raise interest rates once the currency has come under attack, and if this happens, a currency crisis is unavoidable if the exchange rate regime is fixed or managed. An example of currency crises triggering banking crises is as follows. In a currency crisis, if loss of reserves from defending the currency is not sterilized by the central bank, and the speculative attack on the currency is followed by bank runs or by a period of abnormally high interest rates as the central bank attempts to defend parity, then a banking crisis could follow. In addition, the position of banks could be weakened further if much of their outstanding debt is denominated in a foreign currency. With regard to common-factor-caused twin crises, possible factors include the exchange rate-based inflation stabilization plans, financial liberalization, large swings in international interest rates and capital outflows. No matter what the reason for a twin crisis, if it is what happened in the sample period, then one must take into account this phenomenon; that is,

one must consider the information from both banking and currency crises; otherwise, some important information may be missed, which may bias the estimation. Because of this, when conducting the empirical study, we will use the information in these two crises if we can prove the twin crisis phenomena in our sample.

The theoretical analysis of our model indicates that depending on both the inflation target and the public's inflation expectations, there are four policy combinations that can be adopted in a stable period to enhance the central bank's well-being; the results from our empirical study suggest that three of these four combinations really can make the country less vulnerable to economic crises later. The best policy combinations less susceptible to banking crises are a more flexible regime coupled with greater transparency, a more fixed regime with opaqueness, or a peg regime with transparency; for currency crises, transparency is the only choice despite the flexibility of regimes. So for the onset of twin crises, transparency is the choice when given a more flexible regime, or a peg regime. Applying these results to the Asian-5, we find that the policy combinations of Indonesia, Korea, the Philippines and Thailand before the crises were just those that are susceptible to crises — opaqueness with managed float for both Indonesia and Korea, with free float for the Philippines, and with a peg for Thailand; this may explain why they experienced crises. As to Malaysia, it conducted the safer combination, a managed float regime combined with greater transparency, but still had crises. This result gives us an idea that in our future research, we should put the onset of a crisis in the model and see what policies can prevent it.

This paper is organized as follows. Chapter 1 is the introduction and the literature reviews of related topics, such as private information, transparency, and twin crises. Chapter 2 is the theoretical model. We set up a model in which the central bank cannot

choose its own type in the beginning; later on, we relax this assumption to see what type the central bank should choose given the exchange rate regime. Chapter 3 is the empirical study. Since the conclusion from the theoretical model depends on the inflation target and the public's inflation expectation, we cannot test it. Hence, we use another strategy: we let the data speak for themselves. Chapter 4 is the conclusion.

II. LITERATURE REVIEW

Our theoretical model is in the structure of a monetary policy game with a private information problem. Hence, in sub-sections (1) and (2) of Section 1 in the following, we review the theories in the literature regarding these two topics. In sub-section (3), we introduce the literature on the field of central banks' transparency. Section 2 reviews the empirical literature about transparency and twin crises; this includes the discussions on data sources, econometric methods and empirical findings.

1. Theoretical literature

In this section, we briefly review several articles in the fields of monetary policy game, private information of the central banks, and transparency.

(1) Monetary policy games

The debate on the effects of monetary policies was instigated by the facts of post-World War II — "rises in the unemployment rate appear to generate subsequent expansions in monetary growth." (Barro and Gordon, 1983) It is not possible to use the traditional natural-rate-with-rational-expectations model to explain this phenomenon, and this leads to discussion of whether monetary policy should be discretionary or follow a

rule. That is, should the central bank adopt a time-consistent or a time-inconsistent policy?[4] Kydland and Prescott (1977) advocate the time-inconsistent policy. Their arguments come from the belief that for dynamic economic planning, the results from the optimal control method are sub-optimal because in this case, decisions of economic agents are based on current and past information only; in reality, however, current decisions of economic agents depend in part on their expectations of future policy actions: "Only if these expectations were invariant to the future policy plan selected would optimal control theory be appropriate." The best way to remedy this informational problem is to let economic agents "have some knowledge of how policymakers' decision will change as a result of changing economic condition." Therefore, Kydland and Prescott (1977) support policy rules. In that paper, they give a famous example in which time-consistent policy results in an excessive inflation rate without any reduction in unemployment. Therefore, they suggest that policymakers should follow rules rather than have discretion. The reason is that discretion implies selecting the decision that is best, given the current situation, but as discussed, this results in consistent but sub-optimal planning.

Barro and Gordon (1983) formalize Kydland's and Prescott's (1977) inflation vs. unemployment example to support the arguments favoring rules. They believe that although a discretionary policymaker can create surprise inflation like the natural-rate-rational-expectation model suggested, when people understand the policymaker's objectives, these surprises cannot occur systematically. In their model, when monetary policy follows a rule, there is a chance that the realized outcome is the

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[4] According to Barro and Gordon (1983), "[t]he rules-type equilibrium ... is often referred to as the optimal, but time-inconsistent, solution (see, e.g., Kydland and Prescott 1997, p. 480). ... On the other hand,

target inflation rate; if the policy is discretionary, the outcome is excessive inflation with the same unemployment rate as in the rules case. This proves that rules are better than discretion in their case. Moreover, if the policymaker sacrifices short-term gain for the sake of maintaining a long-term reputation, this can lead to the rules equilibrium if the foregone short-term gain is less than the gains from maintaining a long-term reputation.

Our model is in the format of a monetary policy game. Since our focus is not on the choice of monetary policies, we do not consider the outcomes under eithers rule or discretion, but assume that our central banks form their decisions in discretionary style; that is, the central banks make decisions over time, not once and for all. In Barro and Gordon (1983), the authors assume that when conducting discretionary policies, central banks set up their policy instruments given the public's inflation expectations that is conditioned on previous information, not on the policy instruments; namely, there is no relation between the central banks' tools and the public's expectations. Therefore, a multi-period problem is reduced to a one-period one of selecting the policy instrument to minimize the policymaker's loss. This independence is broken when the central banks commit to rules. In this paper, we use a two-period model so we could assume that central banks' decisions can affect the public's inflation expectations, even when central banks use discretionary monetary policies. The purpose of this connection is to reveal the effects of different central bank types, transparent or opaque, on the public's expectations, and we find that under different central bank types, the public does have different expectations of next period's variables.

(2) Private information

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the discretionary equilibrium ... is often call the suboptimal, but time-consistent, solution."

To deal with the credibility problem of central banks, Canzoneri (1985) adds a stabilization role for the monetary policy and private information into Kyland's and Prescott's (1977) model. The results of the Kyland-Prescott model imply that the inefficient outcome from conflicting output and inflation goals can be eliminated by tying the hands of central banks. However, as pointed out by Canzoneri, in Kyland-Prescott's setting, there can be some benefits from the central banks maintaining some degree of flexibility if they can perform stabilization roles. In Canzoneri (1985), the central bank needs to forecast the money market disturbance. The central bank's stabilization role comes from its ability to accommodate this disturbance, and the central bank's forecast is private information if the public cannot observe it. The appearance of private information gives the central bank incentives to misrepresent its forecasts. In the author's words, central banks have the chance to make the "cheating policy" look like the "ideal policy". However, if the public does not buy it, then this will lead to a breakdown of the central bank's credibility.

Also dealing with the private information problem, in contrast to Canzoneri (1985), Garfinkel and Oh (1995) allow the central banks' forecasts to be made before the public forms its expectation. The purpose of this change is to permit a role of noisy announcement to influence the public's expectation. The result shows that even under a monetary rule, the authority can stabilize the economy by influencing expectations.

In our paper, we include the private information problem in our model to distinguish between two types of central banks, transparent or opaque. However, to avoid the unnecessary complication, we directly introduce private information into the economy by the following method, rather than allow the central bank to make forecasts as in Canzoneri (1985), and Garfinkel and Oh (1995) did. We assume that there is a

random inflation rate target realized at the beginning of the period. This rate is only known to the central bank. However, if the central bank is a transparent one, then the public can infer this rate after the central bank sets its monetary policy; if the central bank is an opaque one, then the public cannot. In addition, we also let the central bank perform a stabilization role in the economy. We borrow the idea in Canzoneri (1985) to allow the central bank to have the ability to accommodate price level fluctuations in the economy. However, throughout our paper, we do not discuss the credibility problem of the central banks — the public believes what the central banks tell them, and central banks commit to whatever they announce.

(3) Transparency

In the literature on the transparency of central banks' policies, there is seemingly unanimous agreement that countries should adopt a more transparent policy such as inflation target or some economic rules. However, the articles of Faust and Svensson (1999 and 2001) suggest other possible outcomes. Faust and Svensson (2001) build their model on Cukierman and Meltzer (1986), with only a difference in the objective function to discuss the central bank's role of credibility, transparency, and reputation in the context of a stationary, low-inflation equilibrium. Using numerical analysis the authors find that increases in the central bank's transparency are good for the public, but may worsen the central bank whose target is moderately persistent. This is because for society, increased transparency increases the costs of the central bank deviating from the announced inflation policy and hence deters the bank from using inflation surprises to achieve its employment target. As a result, variability of both inflation and employment falls, and any average inflation bias is reduced. These changes generally increase social welfare.

For the central bank itself, however, increasing transparency causes it to be less activist. Therefore, the central bank has less ability to use inflation surprises to make employment move in a favorable direction.

In a companion paper, Faust and Svesson (1999) investigate the endogenous choice of transparency under the structure of Faust and Svesson (2001). The numerical analysis shows that under a commitment regime, central banks with a zero unemployment target and a high discount rate (≈ 1, indicating more patient central banks) will prefer minimum transparency.[5] While under a discretion regime, minimum transparency is the only outcome consistent with equilibrium.[6]

Geraats (2000 a and b) supports higher revelation of the central bank's private information. In Geraats (2000a), the author proves that transparency is utility enhancing to the central bank, no matter whether the central bank can choose its type (transparent or opaque) or not. In Geraats (2000b), the author switches the action order between the public and the central bank: the central bank announces its policy first, and then the public forms its expectations. In this way, the author proves that even though the central bank can precommit, there is still inflationary bias in the economy. This is because there is asymmetric information, the information of the disturbances in the economy, between the public and the central bank; with no way to identify the disturbances, the public suspects that the central bank may use inflation surprises to stimulate output, which increases the public's inflation expectation. Therefore, enhancing transparency can reduce the "misunderstanding" between the public and the central bank, and remove the inflation

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[5] For most of the parameter space in Faust and Svesson (1999), maximum transparency is preferred by central banks.

[6] When the central bank can commit to its announcement but not the correlation between the announcement and the disturbance, both the minimum and the maximum transparency are consistent with equilibrium.

bias further.

Tarkka and Mayes (1999) emphasize the importance of publishing the central bank's forecasts, a way toward higher transparency. The authors prove that higher transparency can reduce the variability of output in the economy, and this can be achieved by revealing the central bank's output forecasts and the setting of its monetary policy instrument.

Our model is built on Geraats (2000a) but goes beyond what Geraats (2000a and b) discussed. In our model, the central bank's best choice of types depends on what kind of exchange rate regime it is given. Even though we do not let the central banks choose their own regimes, we believe this is a reasonable consideration, because when adopting the type, the central should take into account its 'ability' to endure fluctuations in the foreign exchange market. The result of our theoretical model does support our consideration, which implies the choice of a transparency level is not the answer to all the central bank's disclosure problems.

2. Empirical literature

In this sub-section, we briefly survey the empirical literature on central bank transparency and the twin crises.

(1) Transparency

Mehrez and Kaufmann (2000) investigate how lack of transparency combined with financial liberalization can lead to banking crises. In their model, financial institutions (banks) cannot distinguish among borrowers (firms) in the beginning, so they lend equally to all firms. As time passes, banks update their information about firms through

their realized productivities. However, productivity depends on aggregate shocks and the government's policies, on the one hand, and the firms' qualities, on the other; and banks cannot distinguish among the policies, shocks and qualities. If the economy is transparent in the sense that the new information is certain, banks' learning processes are fast and efficient, and the banking system will be sound. Otherwise, the learning process may lead to inefficient and unsustainable allocations of credit. Once banks discover their large exposure and vulnerability, they are prone to rollover bad loans rather than declare their losses. This delays the crisis, but increases its magnitude. To test their findings, the authors construct a data set of 56 countries from 1977 to 1997. With probit analysis, the empirical results suggest that financial liberalization increases the probability of a crisis during the five years following the liberalization. In addition, the probability of a crisis following liberalization is higher in countries with poor transparency than in countries that are transparent.

Fons (1999) argues that lack of transparency increases funding costs in banking systems, and this is proved by the yield spread data of East Asian countries from January 1997 to June 1998. However, the author emphasizes that transparency can only prevent crises, but not cure them. This argument is proved by a simple regression. The results show that transparency is positively related to a country's financial strength rating and negatively to a country's foreign currency default risk. What is worth mentioning is the adoption of corruption data to proxy transparency. Since there is no entirely accepted data set for transparency, the author uses the corruption data to proxy it. He claims that the lack of transparency in banking systems gives a good chance to government officials, the military or interest groups to be corrupt, because outside parties do not have the means, nor do they have the abilities to supervise them. On the other hand, those insiders will

exert themselves to keep transparency low, because they benefit from it. Therefore, the lack of transparency and corruption have a very solid relationship. Based on this argument, in the empirical study part of the present paper, we will use a corruption index as one of the data sets to proxy for transparency.

(2) Twin Crises

In the literature about twin crises, the focus is on the causality between banking and currency crises: banking crises leading to currency crises, currency crises causing banking crises, or these two crises occurring simultaneously. In the following, we introduce several empirical articles that try to find the possible transmission channels for twin crises.[7]

Glick and Hutchison (1999) investigate the causality between banking and currency crises. The sample employed is ninety industrial and developing countries from 1975 to 1997. Using a multivariate probit model to analyze the causality separately and simultaneously, the authors find that the twin crisis phenomenon tends to happen in financially liberalized emerging markets, but this twin crisis phenomenon is not a general characteristic in all sample countries or developing countries. In addition, the linkage between these two kinds of crisis in emerging markets is strong and robust to model specification and estimation methods. However, only in emerging markets are banking crises a significant leading indicator of future currency crises. Currency crises do not appear to be a particularly good signal of future banking distress. With these findings, the authors conclude that "the openness of emerging markets to international capital flows,

[7] For brief review of the twin crisis literature, please refer section two of Glick and Hutchison (1999), Kaminsky and Reinhart (1999).

combined with a liberalized financial structure, make them particularly vulnerable to twin crises."

Kaminsky and Reinhart (1999) investigate the link between currency and banking crises. Their sample contains twenty industrial and developing countries from 1970 to mid-1995. A chronological list of all the banking and currency crises shows that during the 1970s, when banking regulations were tight, there were only three banking crises but twenty-five currency crises; while during the 1980s and 1990s, the number of currency crises does not change a lot, but banking crises quadruple. In addition, more than half of the banking crises were followed by currency crises within three years; twenty-four percent of the banking crises happened a year before the currency crises. The authors therefore argue that "banking crises appear to have something to say about which countries were able to withstand the speculative attack during the ERM crises, and which eventually succumbed."[8] Bivariate probit analysis shows that lagged banking crisis index is significant in explaining the occurrence of currency crises, while the currency crisis index is not. However, the financial liberalization dummy is significant in both regressions. Macroeconomic "stylized facts" analysis indicates that these two crises do have common macroeconomic background.

Kaminsky (1999) argues that currency crises tend to occur in fragile economies, and this gives the chance to utilize the vulnerability of an economy as an indicator of currency crises. In addition, banking and currency crises have common roots and a tendency to co-occur as twin crises; thus one can use these characteristics to predict the occurrence of currency crises. With these findings, the author tries to establish a warning system that can monitor the vulnerability of an economy. The sample contains twenty

countries from 1970 to 1995. The individual indicator is obtained from theoretical literature on twin crises, and these indicators are tested based on the noise-to-signal rule. If an indicator passes the test, then it will be used with other indicators to construct composite indicators.[9] In the prediction of currency crises, the banking crisis index performs very well; however, the reverse is not so. The currency crisis index does not pass the noise-to-signal test. This early warning system is tested out-of-sample for the Asian financial crisis, and the result is very good. This system reveals that these Asian economies were very fragile and the signs of distress surfacing as early as eighteen months before the currency collapse.

Rossi (1999) tests the roles of several quality variables, such as capital account controls, prudential regulation and supervision, and the degree of depositor safety, to the occurrence of both currency and banking crises. The sample contains fifteen developing countries from 1990 to 1997. To estimate banking crises, the author uses a logit model with country fixed effects to "allow for the likelihood of a banking crisis to vary across sample countries independently of the explanatory variables." Similarly, in estimating currency crises, the author uses a logit model with time-specific effects to "account for the fact that currency crises tend to be clustered in time." In both equations, the author puts lagged currency and banking crisis indices as control variables for banking and currency crisis estimations. The results show that the lagged currency crisis index is not significant in explaining the banking crisis, while the lagged banking crisis index is. Therefore, this is evidence of the twin crisis phenomenon where banking crises occur before currency crises.

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[8] ERM stands for Exchange Rate Mechanism in the European .Monetary Union.

[9] Since the construction of early warning systems is not the focus of this paper, we do not discuss this in

In our empirical study, in addition to getting an actual count of the number of twin crises in our sample, we use several econometric methods to prove that the twin crisis phenomenon occur in our sample. Once we prove this, we then estimate both banking and currency crisis equations simultaneously so that we can include all available information to establish the appropriate policy implications.

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detail. For more thorough information, please refer to Kaminsky (1999).

CHAPTER 2

THE THEORETICAL MODEL

I. THE MODEL (AN EXOGENOUS TYPE CENTRAL BANK)

In this section, we set up the theoretical model, investigate the outcomes under each type of central bank, and discuss the appropriate combination of central bank type and exchange rate regime. Here we assume that both types (transparent or opaque), exchange rate regimes, and inflation targets are exogenous to the central banks. With this assumption, we can calculate and compare the central banks' welfare under different types. Doing this gives us an idea of what central banks will do if they can choose their types. After the discussion, we pursue the endogenous case (in Section II of this chapter) where central banks can choose their own type but still cannot choose regimes and inflation targets. Following the discussion of this case, we offer a proof of our conclusion. Throughout the analysis of both Section I and II, we assume that both the exchange rate regime and the inflation target are given to the central bank at the beginning of the first period. The purpose of this assumption is to simplify the model, because our focus is on the choice of the central bank's type.

1. The timing of the model

Assume that there is a small open economy. For simplicity, the central bank's type, transparent or opaque, is exogenous; this assumption will be relaxed later. There are two periods. The timing of the model is similar to that of Geraats (2000a). In period zero, the economy is endowed with some amount of initial foreign reserves, FR_0, and output, y_0, and there is an initial exchange rate, e_0. In this period, the central bank's type is

exogenously announced and the central bank perfectly commits to it; furthermore, once the type is revealed, it lasts two periods. The source of the difference in central bank type will be explained in the next paragraph. The effect of different types on the public is that under transparency the public will know what the central bank knows about shocks in the goods, money, and foreign exchange markets at the end of period one, while under opaqueness, the public will not learn these pieces of information. All the shocks are assumed to be normally distributed; the distributions of all the shocks are known to the public. The assumption of normally distributed shocks is crucial to the rational expectations discussion in the following sections. With the information about central bank type, the public forms its expectations of next period's inflation rate. Expectations are formed rationally.

The source of the different types comes from the private information problem of the central bank. To express this, we use Canzoneri's (1985) idea but have simplified it as follows.[10] Assuming that there is an implicit inflation rate target π^* realized after the public forms their expectations of the first-period inflation rates. π^* is drawn from the (non-degenerate) normal distribution, $\pi^* \sim N(\pi, \sigma^2_{\pi^*})$, and only the central bank knows it, but the distribution of π^* is common knowledge to the public. π^* is independent of all the disturbances of the economy. As before, the assumptions on the distribution and the independence of π^* and all disturbances are important in the analysis of rational expectations in sub-section 4 of this chapter. π^* here stands for the private information of the central bank. The purpose of including private information in our model is to distinguish between the two central bank types, and to make the information sets of the

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[10] For a more detail discuss about Canzoneri (1985), please refer to sub-section (2) of section II of chapter 1 of this paper.

central bank and the public asymmetric.

In period one, after observing the public's expectation and the shocks, the central bank announces the way it will intervene in the money and foreign exchange markets by revealing the growth rate of the money supply (g_1), the monetary policy. Like the setting of Canzoneri (1985), monetary policy is the way the central bank interacts with the public and, moreover, accommodates price level fluctuations in the economy. Through the central bank's monetary policy, the public can determine the central bank's private information, the inflation target, under transparency. On the other hand, using monetary policy, the central bank can fool the public about its inflation target under opaqueness, because the public cannot infer the economy's disturbances and the central bank's inflation target from the central bank's monetary policy. Monetary policy here is assumed to be discretionary. At the end of period one, the public forms its expectation of the period two inflation rate with its knowledge of g_1 and of the central bank's type. If the central bank is transparent, the public will also know the realizations of all the shocks and be able to infer the central bank's private information, the inflation target. At the beginning of the second period, the first period inflation rate, output, and foreign reserves are observed. The central bank perceives the public's expectations and the shocks, and determines g_2. At the end of period 2, all the second-period's variables are known.

The information is not symmetric in this model because the public knows neither the central bank's inflation rate target π^* nor the shocks when it forms its expectations at the beginning of the first period. But under transparency, the public can get all the information that is available to the central bank, when setting the expectation of second period inflation; while under opaqueness, this information, the disturbances and the inflation target, remain unknown to the public.

To make things clearer, we use the following figure to briefly show the timing of this model:

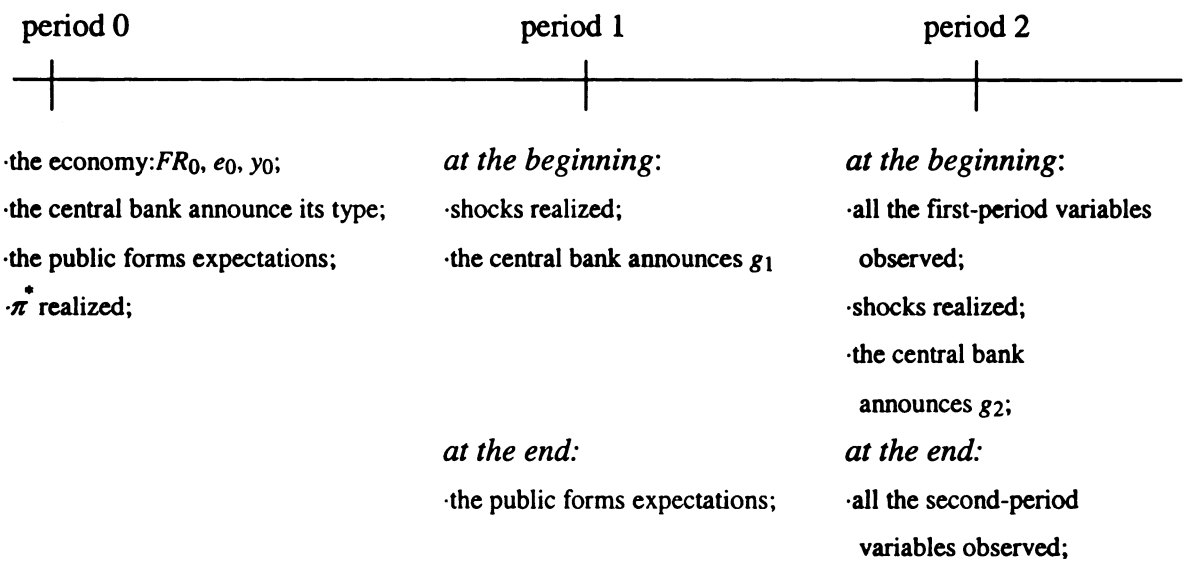

Figure 5. The timing of the model

2. The structure of the model

This model is set in the structure of a monetary policy game by combining the ideas in Garfinkel and Oh (1995), in Canzoneri (1985), and in Geraats (2000a). Since we do not discuss the "rules vs. discretion" monetary policy, we simply assume that the central bank sets monetary policy. In addition, we borrow the objective function from Geraats (2000a) and the constraints from Garfinkel and Oh (1995) and from Canzoneri (1985), and modify them to serve our purposes in the present paper. The central bank's objective function is:

$$U = W_1 + \delta W_2, \tag{1}$$

where δ is the subjective discount factor ($0 < \delta \leq 1$), and

$$W_t = (y_t - y^n) - \frac{s}{2}(\pi_t - \pi^*)^2 + q(FR_t - FR_0), \qquad (2)$$

where y_t is the aggregate real output in period t; y^n is the natural rate output; π_t denotes the inflation rate realized at the end of period t; FR_t is the foreign reserves in period t; $s > 0$ is the weight the central bank attaches to its objective of stabilizing inflation around its target rate, π^*; $q > 0$ is the importance of foreign reserves; and the subscript t is the time period, $t \in \{1, 2\}$.

Equation (2) says that the central bank is prone to stimulate output, to resist inflation fluctuations, and to accumulate foreign reserves. The structure of equation (2) is not commonly used in the literature on monetary policy games. In that literature, most studies use loss functions as the objective functions of central banks. That is, central banks minimize the loss from output and inflation fluctuations. Our objective function here can be viewed as a variant of the traditional loss functions. As Guitián (1994) points out, expressing the central bank's objective function in this way, we express the policy objectives of monetary policies as "aims relevant to economic welfare and include growth, employment, price stability, and balance of payments viability."[11] As expressed in equation (2), the central bank's objective is to encourage output increases. Although this may cause inflation, it is controlled in the second term of the objective function — fluctuations in inflation reduce welfare, so the second term suggests that the central bank likes to maintain domestic price stability, which can be achieved by maintaining the internal value of money. The third term implies that the central bank cares about the exchange rate stability, which concerns the protection and maintenance of the external

[11] As Guitián (1994) states, "there are a variety of levels at which that fundamental objective of monetary policy can be formulated." For detail discussions, please refer to footnote 2 of Guitián (1994).

value of money. To achieve this purpose, the central bank would like to hold some foreign reserves. Hence, the parameter of the third term (q here) can be viewed as an indicator of the flexibility of regimes. A larger parameter value means that the central bank puts more weight on the holding of foreign reserves, which indicates that the value of its currency is more important to the central bank, and this can be viewed as preferring a more fixed regime.[12]

In the discussion in the literature on appropriate amounts of foreign reserves, there are two different costs related to the optimal level of foreign reserves: the potential cost of external adjustments and the opportunity cost of reserve holdings. The former refers to insufficient holdings of official reserves and the consequent risk of reserve depletion that would force the central bank to undertake adjustments of the domestic economy in order to maintain the desired exchange rate. The latter is associated with excessive holdings of official reserves. This implies a less productive use of a country's capital resources which are embodied in official reserves to the extent that the opportunity cost of reserve holdings exceeds the return on reserve assets. Here we implicitly assume that the latter cost has been taken into account in the goods market, since the central bank prefers an output higher than the natural-rate output, it will guide available and appropriate amounts of foreign reserves into production in the goods market.[13] Hence, the third term in

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[12] The purpose of using a variant of the regular loss function is to reduce the complexity of the model. In addition, using a quadratic functional form, we can no longer be certain about the effect of the central bank's behavior on the public's expectations which is the key point not only in the derivation of our model, but in explaining the economics behind it. Although equation (2) is not commonly used in the literature, it is still a reasonable way viewing central bank's well being as we explained in the above paragraph.

[13] In the literature on demand for foreign reserves, some studies use long-run returns on domestic investment as a measure of this opportunity cost, for example Ben-Bassat and Gottlieb (1992). In this way,

equation (2) only refers to the consideration of the external adjustment cost that the central bank must have enough foreign reserves to offset the external disturbance.

The constraints facing the central bank are:

aggregate supply: $$y_t = y^n + \theta(\pi_t - \pi_t^e) + \varepsilon_t^S ; \quad (3)$$

money market: $$g_t - \pi_t = -\pi_t^e - \varepsilon_t^M - \varepsilon_t^{FX} - \varepsilon_t^S ; \quad (4)$$

foreign exchange market: $$FR_t - FR_{t-1} = -\lambda g_t + \varepsilon_t^{FX} ; \quad (5)$$

$$e_t - e_{t-1} = \frac{1}{\lambda}\left[\beta(BOP_t - BOP_{t-1}) + \gamma g_t - \mu(y_t^* - y_{t-1}^*) + \tau(r_t^* - r_{t-1}^*)\right] - \varepsilon_t^{FX} ; \quad (6)$$

where π_t^e is the public's expected inflation rate conditional on information available to the public at the begging of period t; e_t is the exchange rate of period t, which is expressed as the domestic currency evaluated in terms of US dollars; BOP_t is the balance of payments of period t; y_t^* denotes foreign output; r_t^* is foreign interest rate; ε_t^S is the shock in the goods market, where $\varepsilon_t^S \sim N(0, \sigma^2_S)$; ε^M_t denotes the shock in the money market, where $\varepsilon^M_t \sim N(0, \sigma^2_M)$; ε^{FX}_t denotes the shock in the foreign exchange market, where $\varepsilon^{FX}_t \sim N(0, \sigma^2_{FX})$. Here we assume that ε^S_t, ε^M_t and ε^{FX}_t are independent, but a disturbance in one market can affect other markets. All the coefficients (θ, λ, β, γ) in the above equations are positive.

Equation (3) is borrowed from Canzoneri's (1985) and from Garfinkel and Oh's (1995). It represents the output and price relationship of the standard rational-expectations aggregate supply curve.

Equation (4) defines the central bank's monetary policy in the money market;

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we can say that in the goods market, the foreign reserves have been utilized to the point that the opportunity cost of holding reserves equals to the social marginal product of capital.

equations (5) describes the relation between foreign reserves and monetary policy; and (6) is simply a description of the fluctuations of the exchange rate. The combination of equations (4) and (5) forms the aggregate demand side of the economy. The setting of equations (4), (5), and (6) is based on the ideas of Fleming (1962).[14]

There are two key assumptions in Fleming (1962): first, under a fixed exchange rate regime, the central bank sterilizes in the money market; second, capital mobility is not perfect internationally. With respect to sterilization, it means that the money supply will not be affected by the changes of foreign reserves. Expressing this idea mathematically, we have

$$dDR = d\overline{DR} - dFR,$$

where dDR is the change of domestic bonds or Treasury bills that are held by the central bank; $d\overline{DR}$ is the change of the central bank's domestic assets that is not associated with sterilization; and dFR is the change in foreign reserves. The above equation says that changes in the central bank's holdings of domestic assets can be decomposed into two parts: the autonomous change and sterilization caused change. Therefore, in the money market,

$$\begin{aligned} dM &= dDR + dFR \\ &= d\overline{DR} - dFR + dFR \\ &= d\overline{DR}, \end{aligned}$$

where dM is the change in the money supply. That is, in the money market, because of

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[14] Both Fleming (1962) and Mundell (1963) models are cornerstones in the traditional international finance field. The reason that we do not choose the Mundell (1963) model is that because Mundell assumes that capital can move freely among countries and the central bank does not sterilize in the money market. Under the setting of that model, monetary policy cannot function. This is against the purpose of this paper.

sterilization, the total change in the money supply equals the autonomous change of the central bank's domestic assets. Changes of foreign reserves play no role in the money market.

The assumption of capital mobility is crucial for sterilization to hold. This is because if capital mobility is perfect, then an expansionary monetary policy will lead to infinite balance-of-payment deficits. Under this situation, the central bank cannot adopt sterilization, since it cannot buy or sell infinite domestic bonds or Treasury bills.[15] Since we borrow Fleming's (1962) idea to set up our monetary and foreign exchange markets, the assumptions in Fleming's model apply here.

Equation (4) in our model is a description of the money market, in which Fleming's two assumptions are embedded. The structure of equation (4) is a variant of Canzoneri's (1985) and Garfinkel and Oh's (1995) quantity equation. In these two papers, the quantity equation is expressed in the following relation:

$$m_t - p_t = y^n - \rho_t , \tag{7}$$

where m_t is the logarithm of the money supply; p_t denotes the logarithm of the price level; and ρ_t is a money demand innovation, assumed to follow a random walk. First differencing equation (7) gets

$$g_t - \pi_t = \eta_t , \tag{8}$$

where $g_t = m_t - m_{t-1}$; and $\eta_t = \rho_t - \rho_{t-1}$ is an i.i.d random variable with zero mean and a finite variance. η_t can be further decomposed into two parts:

$$\eta_t = f_t + \varepsilon_t ,$$

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[15] We recognize that even with limited capital mobility, continued sterilizing would eventually deplete reserve entirely. Since we have restricted the size of the shocks in the economy (to be discussed on page 36), we need not worry about this problem.

where f_t is the central bank's forecast of η_t, and ε_t is its forecast error. In the present paper, we tailor equation (8) to fit our story. In our model, the central bank observes the disturbance in all markets (ε^S_t, ε^M_t, ε^{FX}_t) and the public's expectation of the inflation rate (π^e_t), and then, uses the growth rate of money supply (g_t) as an instrument to affect the public's expectation of the inflation rate next period (π^e_{t+1}). To suit our story about the central bank in the money market, we make the central bank set g_t to accommodate possible expectation bias ($\pi^e_t > \pi_t$) from the public and the market shocks. One can view our modification of equation (8) as switching η_t from the central bank's forecast of (first differenced) money demand innovation to the public's expectation. This is a reasonable change because generally speaking, the public's demand for money is negatively related to the expected price level (or the expected inflation rate). Since in our model, the central bank knows precisely the public's expected inflation rate, it knows the public's demand for money. Therefore, straightforward derivation yields the following equation:

$$g_t = (\pi_t - \pi^e_t) - \varepsilon^M_t - \varepsilon^{FX}_t - \varepsilon^S_t .$$

Rearranging terms, then we have equation (4). Hence, it is proper to use $-\pi^e_t$ of equation (4) to substitute for f_t in equation (8). Note that neither the changes of foreign reserves nor the disturbances in the foreign exchange market play a role in equation (4); this is because of the sterilization assumption from Fleming (1962).

Equation (5) describes the relation between the monetary policy and foreign reserves (and the disturbance in the foreign exchange market) in Fleming (1962). In that model, despite capital mobility, an expansionary monetary policy always causes a decrease of foreign reserves under a fixed regime; therefore, we have a negative sign on the right hand side of equation (5). In addition, λ can be viewed as an indicator of foreign

exchange policy. $\lambda = 0$ refers to a float regime because foreign reserves do not change.[16, 17] Under a float regime, when a money market disturbance causes fluctuations in the balance of payments, the exchange rate will appreciate or depreciate to restore the equilibrium. Hence, foreign reserves need not change. Under a fixed regime, the central bank has to buy or sell foreign reserves to keep the exchange rate constant; therefore, the magnitude of λ can indicate the intensity at which the monetary authority intervenes in the foreign exchange market. A larger λ means that the authority uses more reserves to intervene, so this suggests a more fixed regime; on the other hand, a smaller λ indicates a more flexible regime. Therefore, equation (5) expresses that when there is an expansionary (contractionary) monetary policy g_t, the foreign reserves will decrease (increase) by λg_t. When $\lambda = 0$, the central bank does not intervene in the foreign exchange market; otherwise, the central bank intervenes with λg_t foreign reserves. In addition, since λ is a parameter in our model, the setting of equation (5) implies that central banks cannot choose λ. As we point out earlier, the parameter q in equation (2) can also be seen as a regime indicator. So basically, one can use $f(\lambda)$ as an indicator of importance of foreign reserves in the objective function. However, since λ is a parameter, not what the

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[16] λ could be interpreted in another way. For example, in the case that the government bans all the capital flows so λ in equation (5) is zero and this could be viewed as a fixed regime. Since this is an extreme case and we do not consider capital flows in our theoretical model, we just point our this possible explanation here.

[17] In equation (5), it seems inconsistent that the left-hand side is the changes of foreign reserves levels and the right-hand side is the money growth rate. However, one can view λ in equation (5) as containing an unit conversion that

$$FR_t - FR_{t-1} = \tau M_{t-1} \frac{M_t - M_{t-1}}{M_{t-1}} + \varepsilon_t^{FX} = \lambda g_t + \varepsilon_t^{FX},$$

where M_t is the money supply and τ evaluates the relation between the changes of foreign reserves and the changes of money supply.

central bank can choose, we can simply use a parameter (q here) to indicate the importance of foreign reserves to the central bank. The setting of equation (5) also indicates that in addition to the policy purposes, changes of foreign reserves could come from the disturbances (ε^{FX}_t) in the foreign exchange market. There is one more thing that needs to be addressed. Since we only look at stable economic times, any large disturbance to the foreign exchange market, such as a speculative attack, is irrelevant here, which means that we have implicitly restricted the size of the disturbance. Moreover, a related assumption to this restriction is that the central bank always has enough foreign reserves to defend the currency if it wants to.

Equation (6) describes the fluctuations of the exchange rate. In Fleming (1962), if the central bank operates under a fixed or a managed float exchange rate regime, then changes of the exchange rate come from changes in the balance of payments, the government expenditure, foreign outputs, foreign interest rates, and domestic money supply; if the central bank conducts a free float regime, then the effect from the balance of payments disappears. In our model, we consider a small open economy, so we could treat the effects from changes of foreign output and of interest rates as exogenous variables, because a small open economy cannot control these two factors. In addition, we do not explicitly put the government sector into our model; for simplicity, we ignore the effects from this factor.[18] Therefore, in the case of fixed or managed float regimes, we have four factors to deal with: changes of the balance of payments, of the money supply, of foreign output and of interest rate; while in the case of a free float regime, we need care about three factors: changes of the balance of payments, of foreign output and

[18] Actually, the effect of government expenditure on fluctuations of exchange rate cannot be determined in Fleming's model.

of the interest rate. Defining the exchange rate as domestic currency in terms of US dollar, we can find that in Fleming's model, the surplus of the balance of payments has a positive effect on the exchange rate. β in equation (6) measures the effect of changes of the balance of payments on the fluctuations of the exchange rate. As to the effect from money supply, we can simply use g_t to stand for it, because g_t here is the money growth rate. Increases in domestic money supply decrease the value of domestic currency, which in turn, cause a depreciation of domestic currency. μ and τ measure the effects from changes of foreign output and interest rate, respectively. In Fleming's model, increases in foreign output have a negative effect on the exchange rate, because this raises domestic exports, which in turn, would appreciate the exchange rate. Increases in foreign interest rate have a positive effect on the exchange rate, because this increases capital outflows in home country. γ of equation (6) represents the effect of the money growth rate on changes in the exchange rate. As we explained in equation (5), λ is an indicator of the given regime, and a smaller λ indicates a more flexible regime. The effects from $BOP_t - BOP_{t-1}$ and g_t on the changes of the exchange rate should be positively related to the flexibility of the regime. That is, the more flexible the regime is, the more $BOP_t - BOP_{t-1}$ and g_t can affect the exchange rate. This is why we put a $1 / \lambda$ in equation (6). However, in the case of a perfect float regime, the effect from BOP_t disappears, so there should be no $BOP_t - BOP_{t-1}$ in equation (6). Here we still use equation (6) to represent the fluctuations of the exchange rate; when facing a perfect float regime case, we will derive the equation in a footnote.

In this model, the central bank has three goals: stimulating output, resisting inflation fluctuations, and accumulating foreign reserves. Meanwhile, the central bank has only one instrument, g_t. This setting seems to be inconsistent with the regular monetary policy

game models that have two conflicting goals and one policy tool. In our model, the goals of output and inflation rate are conflicting, which can be seen in equation (3): increases in output could come from the increases in inflation. Plugging equation (4) into (3) and (3) into (5) gives the relationship between output and foreign reserves:

$$FR_t - FR_{t-1} = -\frac{\lambda}{\theta}(y_t - y^n) + \lambda(1+\frac{1}{\theta})\varepsilon_t^S + \lambda\varepsilon_t^M + (1+\lambda)\varepsilon_t^{FX},$$

which indicates that these two goal are conflicting, too. How about the objectives of inflation rate and foreign reserves? Plugging equation (4) into equation (5) we can get equation (14) in the following section. Equation (14) can be read that if the inflation rate is too high, which worsens the central bank's well-being, then foreign reserves decrease, which also reduces the central bank's utility; however, if the inflation rate is too low, which worsens the central bank's welfare, then foreign reserves accumulate, which enhances the central bank's utility. Therefore, in our model, when the central bank wants to resist inflation, the goals of reducing fluctuations of the inflation rate and accumulating foreign reserves are consistent to the central bank. This is the case that the two targets of maintaining the internal and external value of the currency are consistent because right now, the internal value of the currency is too low so the central bank has to do something to raise it. In this case, we have the similar structure as the regular monetary policy game models: two conflicting goals and one policy tool. On the other hand, when the realized inflation rate is too low, the central bank's goal of resisting inflation fluctuations and accumulating foreign reserves are conflicting. This is because now the internal value of the currency is too high and the central bank wants to lower it. However, in this case, the central bank's goals of stimulating output and resisting inflation fluctuation are not conflicting anymore. The central bank now wants to raise the inflation rate; from

equation (3), this will increase output. So under this circumstance, there are still two conflicting objectives: inflation and foreign reserves, and one policy instrument. Therefore, even though we add one more objective to the central bank's objective function, we still have a structure similar to the standard monetary policy game model.

3. Solving the model

The model can be solved by backward induction. In period two, the central bank maximizes W_2 with respect to g_2, subject to equation (3), (4), (5), and (6) and given π^e_2, FR_1, e_1, y_2^*, y_1^*, r_2^*, r_1^*, ε^S_2, ε^M_2, and ε^{FX}_2. The first order condition implies

$$g_2 = \pi^* - \pi^e_2 - \varepsilon^M_2 - \varepsilon^{FX}_2 - \varepsilon^S_2 + \frac{\theta - \lambda q}{s}. \tag{9}$$

The money supply growth rate decreases in the public's inflation expectation and in all shocks in the markets, which means that when the central bank is aware that the public expects there will be inflation in the economy, the central bank will use a contractionary monetary policy to resist this. In addition, monetary policy is used to offset positive shocks in the economy. Substituting (9) back into (3), (4), (5), and (6) yields

$$\pi_2 = \pi^* + \frac{\theta - \lambda q}{s}; \tag{10}$$

$$y_2 = y^n + \theta(\pi^* - \pi^e_2) + \varepsilon^S_2 + \frac{\theta(\theta - \lambda q)}{s}; \tag{11}$$

$$FR_2 = FR_1 - \lambda(\pi^* - \pi^e_2) + \lambda\varepsilon^M_2 - \frac{\lambda(\theta - \lambda q)}{s} + (1+\lambda)\varepsilon^{FX}_2 + \lambda\varepsilon^S_2; \tag{12}$$

$$e_2 - e_1 = \frac{\gamma}{\lambda}(\pi^* - \pi^e_2) + \frac{1}{\lambda}C_2 - \frac{\gamma}{\lambda}(\varepsilon^S_2 + \varepsilon^M_2) - (1+\frac{\gamma}{\lambda})\varepsilon^{FX}_2 + \frac{\gamma(\theta - \lambda q)}{\lambda s}; \tag{13}$$[19]

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[19] In the case of free float, the exchange rate fluctuations are

$$e_2 - e_1 = \frac{\gamma}{\lambda}(\pi^* - \pi^e_2) + \frac{1}{\lambda}C^{free}_2 - \frac{\gamma}{\lambda}(\varepsilon^M_2 + \varepsilon^S_2) - (1+\frac{\gamma}{\lambda})\varepsilon^{FX}_2 + \frac{\gamma(\theta - \lambda q)}{\lambda s}.$$

where $C_t = [\beta(BOP_t - BOP_{t-1}) - \mu(y_t^* - y_{t-1}^*) + \tau(r_t^* - r_{t-1}^*)]$. It can be seen that in equation (10), unlike the results of the standard discretionary monetary policy game, π_2 may or may not have the inflationary bias ($\pi_2 > \pi^*$). Only when $\theta > \lambda q$, there is an inflationary bias.[20] The idea behind this needs to be explained in detail. Recall that equations (4) and (5) are the aggregate demand side of the economy. Substitute equation (4) into (5) we can get the aggregate demand equation:

$$FR_t - FR_{t-1} = -\lambda(\pi_t - \pi^e_t) + \lambda\varepsilon^M_t + \lambda\varepsilon^S_t + (1 + \lambda)\varepsilon^{FX}_t. \qquad (14)$$

Plugging the aggregate demand equation into equation (3), the aggregate supply equation, we get the equilibrium relation:

$$y_t = y^n - (\theta/\lambda)(FR_t - FR_{t-1}) + (1 + \theta)\varepsilon^S_t + \theta\varepsilon^M_t + (\theta/\lambda)(1 + \lambda)\varepsilon^{FX}_t. \qquad (15)$$

The effects from an expansionary monetary policy on the equilibrium output is

$$\partial y_t / \partial g_t = [\partial(FR_t - FR_{t-1}) / \partial g_t][\partial y_t / \partial(FR_t - FR_{t-1})] = -\lambda(-\theta/\lambda) = \theta, \qquad (16)$$

indicating that a one unit increase of money growth rate will increase the equilibrium output by θ units. Evaluated in utility units, this θ units of output equals $\theta \times 1 = \theta$ units of utility. That is, a one unit increase in money growth rate will raise the central bank's utility by θ units. However, an increased money growth rate will reduce foreign reserves by λ units, which is equal to $\lambda \times q = \lambda q$ units loss of utility. Therefore, equation (10) tells us that when the increased utility from an expansionary monetary policy (θ) is greater than the decreased utility (λq), there will be an inflationary bias in the economy. This explanation is quite reasonable because when the central bank can gain from an

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where $C_2^{free} = -\mu(y_t^* - y_{t-1}^*) + \rho(r_t^* - r_{t-1}^*)$.

[20] Recall that θ is the effect of the expectation bias ($\pi^e_t > \pi_t$) on the output; λ is the indicator of foreign exchange policy; and q is the weight of foreign reserves in the objective function.

expansionary monetary policy, it will tend to stimulate the economy by more expansionary monetary policy. However, this is expected by the public and they will update their inflation expectations with this information, which leads to an inflationary bias in the economy. Recall that λ is an indicator of the exchange rate regime, and the flexibility of regimes is decreasing in λ. When $\lambda = 0$, there is a free float regime and from equation (10), there is definitely an inflationary bias in the economy. Hence, the chance of inflationary bias is decreasing as λ increases. From this, we can infer a critical value for λ, call it $\hat{\lambda}$, that solves $\theta - \lambda q = 0$, which implies that $\hat{\lambda} = \theta/q$. Moreover, since the magnitude of λ indicates the flexibility of regimes, we can also view $\hat{\lambda}$ as the critical value of regimes. When $\hat{\lambda} < \theta/q$, there is an inflationary bias and correspondent to a more flexible regime. If $\hat{\lambda} > \theta/q$, then there is no inflationary bias indicating a more fixed regime.

In addition to the inflationary bias, there is a counter-intuitive phenomenon in equation (10): the supply shock does not affect π_2. Technically, this outcome comes from the linear-form assumption of the objective function.[21] The economic rationale behind this is quite simple. In our setting, the central bank sets its policy after observing the public's expectation and all the shocks to the economy. Therefore, when there is a supply shock that affects the inflation rate in the economy, the central bank will use its monetary policy to accommodate this; hence, no disturbances to the economy will affect inflation rates.

In equation (11), y_2 decreases in the inflation expectation and increases in the supply

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[21] Since the objective function is linear in output where θ shows up, differentiating the first term of the objective function with respect to g_2 leave us with only θ.

shocks. There is a seemingly counter-intuitive outcome that the money market disturbance does not affect output. This can be clearly explained by equations (15) and (16). From equation (15) one can see that when there is a positive money market disturbance, output will increase by θ units, because $\partial y_t / \partial \varepsilon^M_t = \theta$. However, the central bank will use a contractionary monetary policy to resist a positive money market shock; from equation (16), this leads to a decrease in output by θ units.[22] The change of output cancelled out, so output will not fluctuate with money market disturbances. The same idea can be applied to foreign exchange market shocks.

Equations (12) and (13) are the results in the foreign exchange market. One can see that good disturbances in markets ($\varepsilon^M_2 > 0$, $\varepsilon^{FX}_2 > 0$, and $\varepsilon^S_2 > 0$) can lead foreign reserves to accumulate and cause pressure on the currency to appreciate. If there are very big negative shocks to the markets, then there could be severe pressure on the currency to depreciate; in the meantime, foreign reserves would be depleted so that the central bank would not have sufficient foreign reserves to defend the currency. As we have mentioned before, since we only consider two stable periods in our model, we implicitly assume that the disturbances cannot be too large and the central bank always has enough foreign reserves to defend the currency if it chooses to.

The welfare of the central bank in the second period is

$$W_2 = (\theta - \lambda q)(\pi^* - \pi^e_2) + q(FR_1 - FR_0) + \frac{1}{2s}(\theta - \lambda q)^2 + (1 + \lambda q)\varepsilon^S_2$$
$$+ \lambda q \varepsilon^M_2 + q(1 + \lambda)\varepsilon^{FX}_2 . \qquad (17)$$

This shows that in the second period, the central bank benefits from lower second-period

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[22] In this case, the change of equilibrium is $\lambda (-\theta / \lambda) = -\theta$, because the monetary policy is contractionary now.

inflation expectations if $\theta > \lambda q$. Therefore, the central bank has an incentive to reduce this expectation through its action in period one in this case ($\theta > \lambda q$).

In the first period, the central bank maximizes (1), subject to (3), (4), (5), (6) and given π^e_1, FR_0, e_0, y_0, y_1^*, y_0^*, r_1^*, r_0^* ε^S_1, ε^M_1, and ε^{FX}_1. Assume the public uses the following rule to update its expectation and to form π^e_2 based on g_1:

$$\pi_2^e = u + v g_1 . \tag{18}$$

Since the public observes g_1 before forming its second-period expectation, v can be viewed as the effect of the central bank's action (g_1) on the public's expectations (π^e_2). We will show in sub-section 5 below that the rule of equation (18) is consistent with a rational-expectations equilibrium. u is what the public's second-period expected inflation will be if the central bank does not change the money growth rate. The first order condition implies

$$g_1 = \pi^* - \pi_1^e + \frac{\theta - (1+\delta)\lambda q}{s} - \frac{\delta(\theta - \lambda q)}{s} v - \varepsilon_1^M - \varepsilon_1^{FX} - \varepsilon_1^S . \tag{19}$$

Equation (19) is similar to the one of the second period (equation (9)), except that there is an action effect of the central bank (v) in this expression. This is because the central bank takes into account the effect of its action on the public's expectations when setting g_1; while it does not need to when setting g_2.

4. Rational expectations

To prove that equation (18) and rational expectations both lead to the same result, and to get the values of u and v, we should make clear the notation under different central bank types. Let the information set available to the public when it forms first-period expectations be $\boldsymbol{T} \equiv \{T, \Omega\}$ under transparency, and $\boldsymbol{O} \equiv \{O, \Omega\}$ under opaqueness, where

$\Omega \equiv \{s, q, \beta, \mu, \tau, \delta, \theta, \lambda, y^n, FR_0, e_0, y_0, y_2^*, y_1^*, y_0^*, r_2^*, r_1^*, r_0^*, \sigma^2_S, \sigma^2_M, \sigma^2_{FX}, \sigma^2_\pi\}$, and T and O are indicators of central bank type of transparency and opaqueness, respectively. When the public forms expectations for the second period at the end of period one, according to the setting of the model, the available information set is $\{g_1, \varepsilon^S_1, \varepsilon^M_1, \varepsilon^{FX}_1, T\}$ under transparency, and $\{g_1, O\}$ under opaqueness. This means that in addition to what the public has already known at the beginning of period one, under transparency, the public also knows the disturbances in all markets and the central bank's monetary policy in period one; while under opaqueness, the public's information set does not include the disturbances, so it is just $\{g_1, O\}$. Let $T_1 \equiv \{\varepsilon^S_1, \varepsilon^M_1, \varepsilon^{FX}_1, T\}$, so $O_1 \equiv O$; the difference between T_1 and T, and O_1 and O is only the monetary policy (g_1). Furthermore, define R $\in$ {T, O} and $R_1 \in \{T_1, O_1\}$; R and R_1 are indicators of the central bank's type and information set, respectively, when we do not especially specify any type of central bank. Note that the italic and bold form of T, O and R refers to information sets, while the non-italic non-bold form indicates the central bank's type.

Since the information set is very important in our analysis, we use Table 3 to make the information under different central bank types easily understood.

Rational expectations imply that

$$\left(\pi_2^e\right)^R = E\left(\pi_2 | g_1, R_1\right).$$

This means that the inflation expectation under type R is the expected value of π_2, given the information of g_1 and information set R_1. Using (10) and the fact that g_1 in (19) is normally distributed because it depends on π^* and ε^M_1, we have

Table 3. The public's information set under transparency and opaqueness

	known when setting π_2^e?				
	central bank's type: T or O	set Ω^*	ε^S_1	ε^M_1	ε^{FX}_1
transparency	yes	yes	yes	yes	yes
opaqueness	yes	yes	no	no	no

*$\Omega \equiv \{s, \beta, \mu, \tau, q, \beta, \delta, \gamma, \theta, \lambda, y^n, FR_0, e_0, y_0, y_2^*, y_1^*, y_0^*, r_2^*, r_1^*, r_0^*, \sigma^2_S, \sigma^2_M, \sigma^2_{FX}, \sigma^2_\pi\}$ is all the parameters in the model.

$$\left(\pi_2^e\right)^R = E\left(\pi^* \middle| \boldsymbol{R}_1\right) + \frac{\mathrm{cov}\left(\pi^*, g_1 \middle| \boldsymbol{R}_1\right)}{\mathrm{var}\left(g_1 \middle| \boldsymbol{R}_1\right)}\left[g_1^R - E(g_1 \middle| \boldsymbol{R}_1)\right] + \frac{\theta - \lambda q}{s}, \tag{20}$$

where cov(·) is the covariance function, and var(·) denotes the variance function. Equation (20) will be used to prove that equation (18) leads to the same result as the rational expectations assumption does.

5. Transparency

Under transparency, the public can infer π^* from g_1, because the public knows every element in equation (19), except for π^*. This implies

$$E\left(\pi^* \middle| g_1, \boldsymbol{T}_1\right) = \pi^*.$$

Taking expectations of equation (10) and applying the above finding yields

$$\begin{aligned}\left(\pi_2^e\right)^T &= E\left(\pi_2 \middle| g_1, \boldsymbol{T}_1\right) \\ &= E\left(\pi^* \middle| g_1, \boldsymbol{T}_1\right) + \frac{\theta - \lambda q}{s} \\ &= \pi^* + \frac{\theta - \lambda q}{s}.\end{aligned} \tag{21}$$

Using equations (19) and (20), we can get the same result as (21). Taking expectations of equation (19), we have $E(g_1|T_1) = g_1^T$, because $E(\varepsilon^M_1|T_1) = \varepsilon^M_1$. Therefore, the second term of equation (20) cancels out. Hence, under transparency, equation (20) becomes

$$\left(\pi_2^e\right)^T = \pi^* + \frac{\theta - \lambda q}{s}; \tag{22}$$

This proves that the result coming from the assumption of equation (18) is truly a rational equilibrium outcome.

To derive u and v under transparency, we need to use equations (18), (19), and (21). Using (21) to rearrange (19) and matching coefficients with (18) gets

$$v^T = 1;$$

$$u^T = E\left(\pi^* \middle| T\right) + \frac{\delta\theta}{s} + \varepsilon_1^M + \varepsilon_1^{FX} + \varepsilon_1^S,$$

where $E(\pi^*|T) = \pi_1^e$. The positive value of v^T implies that the central bank's behavior has a positive effect on the public's inflation expectation. From the analysis of equation (17) we know that the central bank's welfare in the second period is decreasing in the public's expectation if $\theta > \lambda q$. In this case, to benefit itself, the central bank should set a smaller or even a negative g_1 in the first period to lower the public's expectation of the second period inflation rate. However, if $\theta < \lambda q$, then the central bank can be made better-off by conducting an expansionary monetary policy.

With v^T, one can get the outcomes of both the first and the second periods under transparency. To conduct the comparison between the first and the second periods, we must list the results. In period two,

$$g_2^T = -\varepsilon_2^M - \varepsilon_2^{FX} - \varepsilon_2^S;$$

$$\pi_2^T = \pi^* + \frac{\theta - \lambda q}{s};$$

$$y_2^{\mathrm{T}} = y^n + \varepsilon_2^S;$$

$$FR_2^{\mathrm{T}} = FR_1^{\mathrm{T}} + \lambda\varepsilon_2^M + (1+\lambda)\varepsilon_2^{FX} + \lambda\varepsilon_2^S;$$

$$e_2^{\mathrm{T}} - e_1^{\mathrm{T}} = \frac{1}{\lambda}C_2 - \frac{\gamma}{\lambda}(\varepsilon_1^S + \varepsilon_2^M) - (1+\frac{\gamma}{\lambda})\varepsilon_2^{FX}.$$ [23]

The second period is the last one in our model, so when setting g_2, the central bank does not need to worry about the effect of its action (that is, g_2) in this period, because the public's expectations have already been formed. Therefore, the purpose of the central bank's action in this period is only to use g_2 to deal with the money market shocks. In the goods market, since the money market shocks are totally offset by the monetary policy, they do not affect y_2. The effect of the money market shocks affect foreign reserves through monetary policy, so there is an $\varepsilon^M{}_2$ in $FR_2{}^{\mathrm{T}}$. In addition to the effects from monetary policy actions, $FR_2{}^{\mathrm{T}}$ is also affected by the disturbance in the foreign exchange market $\varepsilon^{FX}{}_2$. The fluctuations of the exchange rate come from the second-period disturbances in all markets. However, depending on the given regime (λ), the effects from the shocks in the goods and money markets have been discounted. Note that all the second-period disturbances have negative effects on the fluctuations of the second-period exchange rate.

In the first period,

$$g_1^{\mathrm{T}} = \left[\pi^* - E\left(\pi^* \middle| T\right)\right] + \frac{\theta(1-\delta) - \lambda q}{s} - \varepsilon_1^M - \varepsilon_1^{FX} - \varepsilon_1^S;$$

$$\pi_1^{\mathrm{T}} = \pi^* + \frac{\theta(1-\delta) - \lambda q}{s};$$

$$y_1^{\mathrm{T}} = y^n + \theta\left[\pi^* - E\left(\pi^* \middle| T\right)\right] + \varepsilon_1^S + \frac{\theta}{s}[\theta(1-\delta) - \lambda q];$$

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[23] If the regime is free float, fluctuations of the exchange rates are

$$e_2^{\mathrm{T}} - e_1^{\mathrm{T}} = \frac{1}{\lambda}C_2^{free} - \frac{\gamma}{\lambda}(\varepsilon_2^M + \varepsilon_2^S) - \varepsilon_2^{FX}(1+\frac{\gamma}{\lambda}).$$

$$FR_1^T = FR_0 - \lambda[\pi^* - E(\pi^*|T)] - \frac{\lambda}{s}[\theta(1-\delta) - \lambda q] + \lambda\varepsilon_1^M + (1+\lambda)\varepsilon_1^{FX} + \lambda\varepsilon_1^S;$$

$$e_1^T - e_0 = \frac{1}{\lambda}C_1 + \frac{\gamma}{\lambda}[\pi^* - E(\pi^*|T)] - \frac{\gamma}{\lambda}(\varepsilon_1^S + \varepsilon_1^M) - (1+\frac{\gamma}{\lambda})\varepsilon_1^{FX} + \frac{\gamma[\theta(1-\delta) - \lambda q]}{\lambda s}.$$ [24]

Note that the first period has two differences from the second. First, the central bank can affect the public's period-two expectation in period one; second, transparency makes $E(\pi^*|T_1) = \pi^*$ in period two. In the first period, the central bank has a chance to manipulate the public's expectation of inflation through equation (18); so when setting g_1, it takes into account the possible outcomes of the public's expectation bias. Therefore, the term $[\pi^* - E(\pi^*|T)]$ enters into g_1^T. As to π_1^T, the inflation bias depends on whether $\theta(1-\delta) > \lambda q$.[25] In the goods market, in the first period, the public knows nothing about π^*, which causes output in period one to depend on the central bank's type. In addition, since the central bank resists inflation fluctuations, a higher π^* increases g_1^T, which in turn, increases output. With regard to the foreign exchange market, the worry about the public's expectation bias comes into FR_1^T and e_1^T through monetary policy. A comparison of π_1^T and π_2^T yields that $\pi_1^T < \pi_2^T$. The reason is as follows. From equation (17) one can see that when $\theta > \lambda q$, the central bank is made worse off by a higher $(\pi_2^T)^e$, so, from equation (18), the central bank will use a lower g_1 to prevent this from happening. The

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[24] If the regime is free float, changes of the exchange rate are

$$e_1^T - e_0 = \frac{1}{\lambda}C_1^{free} + \frac{\gamma}{\lambda}\left[\pi^* - E\left(\pi^*|T\right)\right] - \frac{\gamma}{\lambda}(\varepsilon_1^S + \varepsilon_1^M) - (1+\frac{\gamma}{\lambda})\varepsilon_1^{FX} + \frac{\gamma[\theta(1-\delta) - \lambda q]}{\lambda s}.$$

[25] Recall that the condition of inflationary bias in the second period is $\theta > \lambda q$. This condition will be hold if $\theta(1-\delta) > \lambda q$. The reason that the condition of inflationary bias changes in the first period is that in the first period, the central bank's utility is $U = (y_1 - y^n) - \frac{s}{2}(\pi_1 - \pi^*)^2 + q(FR_1 - FR_0) + \delta(\theta - \lambda q) \times (\pi^* - u - vg_1) + q\delta(FR_1 - FR_0)$. Therefore, changes of utility coming from one unit change of the monetary policy are $\theta \times 1 - \lambda q\,(1+\delta) - \delta(\theta - \lambda q) = \theta(1-\delta) > \lambda q$.

central bank's behavior is anticipated by the public, which reduces the public's expectations of the first-period inflation rate, and this reduces the realized first-period inflation rate. In the case that $\theta < \lambda q$, the central bank is made better off by higher $(\pi_2^T)^e$, so it will use an expansionary monetary policy. This is also anticipated by the public, they revise their expectations accordingly, which makes the realized inflation rate of the first period higher. However, since g_1 is higher, this makes the public's second-period inflation rate expectations higher (equation (18)), which affects the realized inflation rate, so we have $\pi_1^T < \pi_2^T$. From this analysis one can see that the reason that inflation rising over the two periods is because the central bank's behavior can always be anticipated by the public and the public adjust their behavior basing on their anticipations. If the public does not predict the central bank's behavior, then the story ends at the point that the central bank adjusts the monetary policy.

The expected welfare of the central bank under transparency is

$$E(U|\pi^*, T) = [\theta - (1+\delta)\lambda q][\pi^* - E(\pi^*|T)]$$

$$+\frac{1}{2s}[\theta(1-\delta) - \lambda q][\theta(1+\delta) - \lambda q(1+2\delta)] - \frac{\delta}{2s}(\theta - \lambda q)^2.$$[26]

In the following, we will investigate the outcome of opaque central banks, and then we will compare the results of different types to find the possible conclusion when types are endogenous to central banks.

6. Opaqueness

Using the same method as in the previous sub-section, we can get both v^O and u^O. Under opaqueness, the public cannot infer π^* from equation (19) anymore, because it

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[26] Please note that $E(\pi^*|T) = \pi_1^e$.

does not know ε^M_1. Therefore,

$$E(\pi^* | O_1) \neq \pi^*.$$

In addition, $E(g_1|O_1)$ no longer equals to g_1^O, because $E(\varepsilon^M_1|O_1) = 0$. Since $\text{cov}(\pi^*, g_1|O_1)$ $= \sigma^2_\pi$ and $\text{var}(g_1|O_1) = \sigma^2_\pi + \sigma^2_M + \sigma^2_{FX} + \sigma^2_S$, under opaqueness, equation (20) becomes

$$(\pi^e_2)^O = E(\pi^* | O) + \frac{\sigma^2_\pi}{\sigma^2_\pi + \sigma^2_M + \sigma^2_{FX} + \sigma^2_S}\left\{-\varepsilon^M_1 + [\pi^* - E(\pi^* | O)]\right\} + \frac{\theta - \lambda q}{s}. \qquad (23)^{27}$$

Rearranging (15) with the above equation and matching coefficient with (18) yields

$$v^O = \frac{\sigma^2_\pi}{\sigma^2_\pi + \sigma^2_M + \sigma^2_{FX} + \sigma^2_S} \equiv \alpha;$$

$$u^O = E(\pi^* | O) + \frac{(\theta - \lambda q)(1 + \alpha^2\delta)}{s} - \frac{\alpha[\theta - \lambda q(1+\delta)]}{s} - \varepsilon^{FX}_1 - \varepsilon^S_1.$$

Since $0 < \alpha < 1$, $v^O < v^T$. This means that with the same monetary policy, the central bank has less affect on the public's expectations. That is, a lower money growth rate reduces the public's expectation less under opaqueness than under transparency. This is because under opaqueness, when the central bank announces its action (g_1), the public cannot tell whether it reflects the central bank's policy to deal with a money market shock, or it is a policy to account for a higher inflation rate target (π^*). In other words, the central bank's signal is noisier under opaqueness. This noisy signal phenomenon, however, will not happen to a transparent central bank, because the public has information about economic shocks in all markets, so it will not mix up the central bank's inflation target with market disturbances. In the limiting case where $\sigma^2_M \to 0$, $v^O = v^T$. This implies that only when uncertainty about the money market disappears, the opaque central bank can have the same *power* to manipulate the public's expectation as a transparent central bank.

Plugging α back into equation (23) yields

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[27] Note, $O_1 = O$.

$$(\pi_2^e)^O = E(\pi^* | O) + \alpha[\pi^* - E(\pi^* | O)] + \frac{\theta - \lambda q}{s} - \alpha\varepsilon_1^M - \alpha\varepsilon_1^{FX} - \alpha\varepsilon_1^S .$$

The public's expectation of the second-period inflation is decreasing in $\varepsilon^M{}_1$, $\varepsilon^{FX}{}_1$, and $\varepsilon^S{}_1$, and increasing in π^*, which means that the central bank benefits from positive shocks in the markets and suffers from a higher inflation target if $\theta > \lambda q$ (equation (17)). However, unlike the transparent case of equation (21), the harm from all the shocks and π^* here is discounted by α. The rationale behind this is that the public cannot obtain enough information about the economy after the central bank sets g_1 under opaqueness, so for example, if there is a money market shock ($\varepsilon^M{}_1 > 0$), the public may attribute part of the decrease in g_1 to a lower π^*, not totally to the rise in $\varepsilon^M{}_1$. The same situation happens in the case when the central bank is given a higher π^*. The public will think that the rise in g_1 may be due to a shock in the money market. So the effects of $\varepsilon^M{}_1$ and π^* on the public's expectation are abated. From this analysis, we can imply that when $\theta > \lambda q$, a central bank with a higher inflation target will like to choose (if it could) an opaque type, because the punishment for this high inflation is less (α, relative to one in the transparency case). This is because an opaque central bank has the chance to fool the public to protect itself, if it does not reveal its target. Comparing with the case under transparency (equation (21)) in which the public's expectation will change perfectly with π^* (the coefficient on π^* is one), when $\theta > \lambda q$, a central bank given a lower inflation target will prefer a transparent type, while the one given a higher target prefers to be opaque if it can choose its own type.

Substituting v^O back into all the first and the second period variables, one can get the outcome under opaqueness. In the second period,

$$g_2^O = (1-\alpha)[\pi^* - E(\pi^* | O)] + (\alpha\varepsilon_1^M - \varepsilon_2^M) + (\alpha\varepsilon_1^{FX} - \varepsilon_2^{FX}) + (\alpha\varepsilon_1^S - \varepsilon_2^S);$$

$$\pi_2^O = \pi^* + \frac{\theta - \lambda q}{s} = \pi_2^T;$$

$$y_2^O = y^n + \theta(1-\alpha)[\pi^* - E(\pi^*|O)] + \alpha\theta\varepsilon_1^M + \varepsilon_2^S;$$

$$FR_2^O = FR_1^O - \lambda(1-\alpha)[\pi^* - E(\pi^*|O)] - \alpha\lambda\varepsilon_1^M + \lambda\varepsilon_2^M + (1+\lambda)\varepsilon_2^{FX} + \lambda\varepsilon_2^S;$$

$$e_2^O - e_1^O = \frac{\gamma(1-\alpha)}{\lambda}[\pi^* - E(\pi^*|O)] + \frac{1}{\lambda}C_2 + \frac{\gamma}{\lambda}[\alpha\varepsilon_1^S - \varepsilon_2^S] + \frac{\gamma}{\lambda}[\alpha\varepsilon_1^M - \varepsilon_2^M]$$
$$+\left[\frac{\alpha\gamma}{\lambda}\varepsilon_1^{FX} - (1+\frac{\gamma}{\lambda})\varepsilon_2^{FX}\right].^{28}$$

One can find that unlike the transparent case, now the expectation term enters into the second-period variables, g_2^O, y_2^O, FR_2^O, and $e_2^O - e_1^O$. This is because the public is uncertain about π^* when making decisions at the end of the first period. Note that all the second-period disturbances have negative effects on the fluctuations of the second-period exchange rates, but the disturbances in the first period have positive effects. This does not happen in the transparency case, in which the first-period disturbances do not affect the second-period exchange rate fluctuations. This is because under opaqueness, the public cannot infer, from the central bank's behavior, the knowledge of the disturbances; therefore, the effect of the first-period disturbances could last for two periods.

In the first period,

$$g_1^O = [\pi^* - E(\pi^*|O)] + \frac{1}{s}\{\theta(1-\alpha\delta) - \lambda q[1+(1-\alpha)\delta]\} - \varepsilon_1^M - \varepsilon_1^{FX} - \varepsilon_1^S;$$

$$\pi_1^O = \pi^* + \frac{1}{s}\{\theta(1-\alpha\delta) - \lambda q[1+(1-\alpha)\delta]\};$$

$$y_1^O = y^n + \theta[\pi^* - E(\pi^*|O)] + \varepsilon_1^S + \frac{\theta}{s}\{\theta(1-\alpha\delta) - \lambda q[1+(1-\alpha)\delta]\};$$

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[28] If the regime is free float, then the fluctuations of the exchange rate are

$$e_2^O - e_1^O = \frac{\gamma(1-\alpha)}{\lambda}[\pi^* - E(\pi^*|O)] + \frac{1}{\lambda}C_2^{free} + \frac{\gamma}{\lambda}[\alpha\varepsilon_1^S - \varepsilon_2^S] + \frac{\gamma}{\lambda}[\alpha\varepsilon_1^M - \varepsilon_2^M]$$
$$+\left[\frac{\alpha\gamma}{\lambda}\varepsilon_1^{FX} - (1+\frac{\gamma}{\lambda})\varepsilon_2^{FX}\right].$$

$$FR_1^O = FR_0 - \lambda[\pi^* - E(\pi^*|O)] - \frac{\lambda}{s}\{\theta(1-\alpha\delta) - \lambda q[1+(1-\alpha)\delta]\}$$
$$+ \lambda\varepsilon_1^M + (1+\lambda)\varepsilon_1^{FX} + \lambda\varepsilon_1^S;$$
$$e_1^O - e_0 = -\frac{\gamma}{\lambda}[\pi^* - E(\pi^*|O)] + \frac{1}{\lambda}C_1 - \frac{\gamma}{\lambda}(\varepsilon_1^S + \varepsilon_1^M) - (1+\frac{\gamma}{\lambda})\varepsilon_1^{FX}$$
$$+ \frac{\gamma\{\theta(1-\alpha\delta) - \lambda q[1+\delta(1-\alpha)]\}}{\lambda s}.$$ [29]

Now, δ is discounted by α, and if $\alpha \to 1$, the last terms in all the above equations are the same as those of the transparent case. To facilitate the comparison between the money growth rates of transparency and opaqueness, we can utilize the fact that $E(\pi^*|T) = E(\pi^*|O) = \bar{\pi}^*$ because the central bank's type is exogenous to it, so its announcement of the type in the beginning does not reveal any information about the inflation target; therefore, the announcement does not affect the public's expectations. Subtracting g_1^O from g_1^T yields

$$g_1^O - g_1^T = -(\delta/s)(1-\alpha)(\theta - \lambda q),$$

which implies that $g_1^T > g_1^O$ if $\theta > \lambda q$. This result comes from the fact that when $\theta > \lambda q$, the second-period welfare will decrease in π_2^e despite the central bank's type; therefore, the central bank has to use a contractionary monetary policy to reduce π_2^e (equation (4)). However, the monetary policies will be less contractionary for opaque central banks, because they have less power to manipulate the public's expectations. Hence, opaque central banks would rather choose not to reduce the money growth rate too much so that output would be reduced a lot; instead, they would like to use a more expansionary

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[29] If the regime is free float, then changes of the exchange rate are

$$e_1^O - e_0 = -\frac{\gamma}{\lambda}[\pi^* - E(\pi^*|O)] + \frac{1}{\lambda}C_1^{free} - \frac{\gamma}{\lambda}(\varepsilon_1^S + \varepsilon_1^M) - (1+\frac{\gamma}{\lambda})\varepsilon_1^{FX}$$
$$+ \frac{\gamma\{\theta(1-\alpha\delta) - \lambda q[1+\delta(1-\alpha)]\}}{\lambda s}.$$

monetary policy to affect the public's inflation expectations, because the public may think that the expansionary monetary policy is due to the shocks in the markets.

Finally, the expected welfare of the central bank is

$$E(U|\pi^*, O) = \{(\theta - \lambda q)[1 + \delta(1-\alpha)] - \delta\lambda q\}[\pi^* - E(\pi^*|O)]$$

$$+ \frac{1}{2s}[(1-\alpha\delta)(\theta - \lambda q) - \delta\lambda q][(1+\alpha\delta)(\theta - \lambda q) - \delta\lambda q] - \frac{\delta}{2s}(\theta + \lambda q)^2 .$$

In the following section, we will investigate what the exogenous model implies if the central bank can choose its own type.

7. Comparison between the welfare functions of transparent and opaque central banks

Until now, we have assumed that the central bank's type is exogenous. However, in practice, it is not. So we would like to know what will happen if the central bank can choose its own type. In this section, we compare the central bank's welfare of each type when the type is exogenously given. Doing this gives us an idea of what type the central bank will choose if it can. With the results of the comparison, we can then set up an endogenous type model in section II and conduct the empirical analysis.

Using the same condition of the last section that $E(\pi^*|T) = E(\pi^*|O) = \bar{\pi}^*$, we can compare central banks' welfare under different types:

$$E(U|\pi^*, T) - E(U|\pi^*, O) = -\delta(\theta - \lambda q)(1-\alpha)(\pi^* - \bar{\pi}^*) - \frac{\delta^2}{2s}(\theta - \lambda q)^2(1-\alpha^2) . \qquad (24)$$

The second term on the right hand side of equation (24) is negative; therefore, the sign of the above equation depends on the first term. However, we can only be sure that if $\pi^* > \bar{\pi}^*$ and $\theta > \lambda q$, or $\pi^* < \bar{\pi}^*$ and $\theta < \lambda q$, then equation (24) is negative, because in these cases, the first term is also negative; otherwise, the first term is positive, and we

still cannot determine what sign equation (24) is. The results of the analysis of the sign of equation (24) are summarized in Table 4.

Table 4. Analysis of equation (24)

sign of equation (24):	negative	positive
choice of types:	opaqueness	transparency
conditions:	$\pi^* > \overline{\pi}^*$ and $\theta > \lambda q$ $\pi^* < \overline{\pi}^*$ and $\theta < \lambda q$	$\pi^* > \overline{\pi}^*$ and $\theta < \lambda q$[†] $\pi^* < \overline{\pi}^*$ and $\theta > \lambda q$[†]

[†] This condition cannot guarantee that the central bank will definitely choose transparency, because under this condition, the sum of the two terms of equation (24) may still be negative. However, if this condition does not held, equation (24) cannot be positive. So this condition is a necessary condition.

Table 4 says, take the second column as an example, that if the sign of equation (24) is negative, then the central bank will choose to be opaque if it can. The two conditions that lead to this choice is that either $\pi^* > \overline{\pi}^*$ and $\theta > \lambda q$, or $\pi^* < \overline{\pi}^*$ and $\theta < \lambda q$. Note that the sign of equation (24) cannot be determined, if $\pi^* > \overline{\pi}^*$ and $\theta < \lambda q$, or $\pi^* < \overline{\pi}^*$ and $\theta > \lambda q$ (in the third column). However, if these two conditions do not hold, then equation (24) cannot be positive, so these two conditions are the necessary condition for equation (24) to be positive. Recall that λ is an indicator of the exchange rate regime and $\theta > \lambda q$ ($\Rightarrow \lambda < \theta / q$) corresponds to a more flexible regime. Table 4 shows that, for example, when there is an expectationary bias ($\pi^* < \overline{\pi}^*$) and a central bank is given a more flexible regime ($\theta > \lambda q$), then the welfare of a transparent central bank is greater than that of an opaque central bank and the central bank should choose to be transparent if it can. This is the case of the very lower-right cell of Table 4.

Do the results of Table 4 make any sense? Recall that $\theta > \lambda q$ means that the central bank is given a more flexible regime and that there is an inflationary bias in the second period.[30] Table 4 tells us that when there will be an inflationary (deflationary) bias in the second period, a central bank endowed with a higher (lower) inflation target should choose an opaque type; if there will be an inflationary (deflationary) bias in the second period, then a central bank with a lower (higher) inflation target should choose transparency. The reason is that in our model the central bank resists fluctuations in inflation; hence, when a central bank gets a lower inflation target and knows that there will be an inflationary bias in the second period (the case of the lower-right cell in Table 4), it may be a good strategy for the central bank to choose transparency, because the central bank can reveal its target through the monetary policy. Once the public knows the true target, they will update their information set, which in turn, will affect the outcome of the second period.[31] The same argument could be applied to the case where the central bank obtains a higher inflation target, but there will be a deflationary bias in the second period. As to the opaque case, when endowed with a higher target, the central bank can take advantage of the opaque type to conceal its true target, which may reduce the public's inflation expectations and lower inflation rate fluctuations.

The results in Table 4 gives an idea of how the central bank will do if it can choose its own type. In the following, we will apply the results here to the endogenous type

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[30] For the roles of the regime indicator and the inflationary bias indicator of λ, please refer to sub-section 3 of section I of this chapter.

[31] One may feel confused because the second period inflation rates are the same in the transparent and opaque cases. However, this is the outcome when the central bank's type is exogenous. If the central bank can choose its own type, the outcome will not be the same. Please refer to the discussion about the endogenous type.

model.

II. THE MODEL (AN ENDOGENOUS TYPE CENTRAL BANK)

In section I of this chapter, we maintain the assumption that the central bank cannot determine its own type. In this section, we will relax this presumption, because it is not real in practice. From the analysis of sub-section 7 of section I we know that the choice of the central bank's type depends on the relative size of θ and λq, and π^* and $E(\pi^*|R)$; in this section and the next one, we make the assumption that $\theta > \lambda q$ so that we can conduct the analysis without too many complications; the same logic can be applied to the case where $\theta < \lambda q$. The finding in sub-section 7 in this chapter indicates that when $\theta > \lambda q$, the central bank endowed with a higher inflation target will benefit from opaqueness, while the one with a lower target will benefit from transparency.

1. The model

Before conducting the analysis, we need to adjust the timing of the exogenous model to fit the endogenous story. In the exogenous case, the central bank announces its type before the realization of the inflation target. Here in the endogenous case, since the realized inflation target will affect the central bank's choice of type, we have to switch the sequence of the realization of inflation target and the announcement of the central bank's type. In period zero, the inflation rate target π^* is drawn from a non-degenerate normal distribution $\pi^* \sim N(\pi, \sigma^2_\pi)$; the realization of π^* is only observed by the central bank, but its distribution is common knowledge to the public. Next, the central bank announces its type. After knowing the type, the public forms its expectations $E(\pi^*|R)$ depending on the central bank's type $R \in \{T, O\}$. This in turn affects the central bank's

expected payoff, which is assumed to equal

$$E(U|\pi^*, \boldsymbol{R}) = A^{\mathrm{R}}\left|\pi^* - E(\pi^*|\boldsymbol{R})\right| + B^{\mathrm{R}}, \tag{25}$$

where $A^{\mathrm{O}} > A^{\mathrm{T}} > 0$ and $B^{\mathrm{O}} \geq B^{\mathrm{T}}$.[32] The formation of equation (25) comes from the analogy of the exogenous case, and the rationale of the sequence is the following. When the inflation target is higher than the expectation ($\pi^* > E(\pi^*|\boldsymbol{R})$), the central bank faces a favorable trade-off among output, inflation, and foreign reserves, which increase its expected payoff. Hence, both A^{O} and A^{T} are positive. In addition, since the central bank's signal is noisier under opaqueness, the deviation between π^* and the expectation persists longer than the transparency case. Therefore, A^{O} is greater than A^{T}. In the present paper, to make things consistent with the results of our exogenous case, we assume that $B^{\mathrm{O}} \geq B^{\mathrm{T}}$.[33]

In the next sub-section, we will offer a proof of our discussion here that transparency is not the only choice in our model.[34] But here, let us discuss the central bank's choice intuitively. From the result of the comparison between the welfare of transparent and opaque central banks in the exogenous case, we obtain the conclusion that the central bank's inflation target will affect its choice of type, and most importantly, the public knows this. Hence, when the central bank announces its own type at the beginning of period one, the one who adopts transparency (opaqueness) sends out a message that it has

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[32] Actually, the sequence of A^{O} and A^{T} can be justified with the condition that $\theta > \lambda q$, but we may need more than this to make sure that both A^{T} and A^{O} ($\theta > \lambda q(1+\delta)$) are positive. For simplicity, we ignore this for a while.

[33] As to B^{R}'s, Geraats (2000a) makes an assumption without any explanation that the public cannot be worse off under transparency, so $B^{\mathrm{T}} \geq B^{\mathrm{O}}$ in her paper; and she emphasized that this is consistent with the findings in the exogenous case.

[34] In Geraats (2000a), transparency is the unique, pure strategy sub-game perfect equilibrium.

a lower (higher) inflation target. This will affect the public's inflation expectation, which in turn will affect the central bank's expected payoff. Furthermore, the central bank's welfare is decreasing in the public's inflation expectation, under both transparency and opaqueness.[35] So when it has the ability to choose its type, the central bank will take advantage of the effects from the announcements of its type to reduce the public's inflation expectation. When the condition $\theta > \lambda q$ holds, the result of the exogenous type indicates that $\pi_1^T < \pi_1^O$; this relationship will be reinforced when the type is endogenous because the central bank's announcement of type can now affect the public's expectation of first period inflation. Therefore, choosing to be transparent can reduce the public's inflation expectation further. In other words, endogenous choice of type gives central banks more incentive to be transparent. However, unlike what happens in Geraats (2000a) that this incentive would make transparency the only choice of the central bank when the type is endogenous, in our specific model, this incentive may not be large enough so that transparency is not the only choice despite given exchange rate regimes; this is because the exogenous determined regimes affect the effect of the public's inflation expectation on the expected welfare of the central bank.

Here we can conclude that when the central bank can choose its own type and is given a more flexible regime ($\theta > \lambda q$), the one with a higher inflation target will choose to be opaque; otherwise, transparent. With the same logic we can deduce that when given a more fixed regime ($\theta < \lambda q$), the central bank with a higher inflation target will choose to be transparent; otherwise, opaque.[36]

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[35] This happens when the condition $\theta > \lambda q(1+\delta)$ holds.

[36] When the central bank is given a more fixed regime ($\theta < \lambda q$), the sequence and signs of A^O and A^T change, so the central bank's welfare is increasing in the public's inflation expectation, and we have $\pi_1^T >$

2. The proof

In this section, we apply the regular proof procedure to show that unlike Geraats (2000a), transparency is not central bank's only choice in our model. The proof procedure that we employ here is the standard one in traditional game theory. First, we assume that transparency is the equilibrium so all central banks should choose it. Then we prove that this assumption cannot be sustained because there exists a threshold so that some central banks would deviate. Second, we investigate whether there is a threshold equilibrium in which some central banks can deviate. The result shows that this kind of threshold could exist. Finally, we assume that opaqueness is the equilibrium so all central banks should choose it. The analysis indicates that this assumption cannot be hold in equilibrium because there may be no solution to it.[37] Therefore in our model, some central banks will choose to be transparent, and others opaque.

In the first step, we would like to show that there could exist a threshold such that in certain circumstances, some central banks would want to deviate. Suppose transparency is the equilibrium, so $E(\pi^*|T) = \pi$. The central banks would deviate from transparency if

$$E(U|\pi^*, O) > E(U|\pi^*, T).$$

Using equation (23), we can rewrite the condition as

π_1^O from the exogenous model. In this case, a central bank with a relatively low inflation target should choose to be opaque, because with this choice, the central bank may have a chance to fool the public, which would raise the public's inflation expectation, and which in turn, will affect the realized outcome in the economy and benefit the central bank.

[37] With the same procedure, Geraats (2000a) finds that first, there exists a threshold for opaque central banks to deviate; second, there is no equilibrium in which some central banks adopt transparency, while others opaqueness; finally, transparency is the perfect equilibrium because no central banks will deviate. Therefore, she concludes that transparency is the unique, pure strategy sub-game perfect equilibrium in her model.

$$\pi^* > \frac{1}{A^O - A^T}\left[A^O E(\pi^* | O) - A^T \pi + (B^O - B^T)\right] \tag{26}$$

Let the central bank that would be indifferent between types, whose threshold inflation rate target is denoted by $\tilde{\pi}$, satisfy the above equation with equality. Further, since the distribution of π^* is assumed to be normal, and previous analysis implies that $E(\pi^* | O) = E(\pi^* | \pi^* > \tilde{\pi})$,

$$E(\pi^* | O) = E(\pi^* | \pi^* > \tilde{\pi}) = \pi + \sigma_\pi \frac{\varphi\left(\frac{\tilde{\pi} - \pi}{\sigma_\pi}\right)}{1 - \Phi\left(\frac{\tilde{\pi} - \pi}{\sigma_\pi}\right)}, \tag{27}$$

where $\varphi(\cdot)$ denote the probability density function of the standard normal distribution and $\Phi(\cdot)$ the corresponding cumulative density function.

If no central banks deviate, then equation (26) should hold with equality. Combining this condition with equation (27), we can define the threshold $\tilde{\pi}$ as

$$\frac{\tilde{\pi} - \pi}{\sigma_\pi} = \frac{A^O}{A^O - A^T} \frac{\varphi\left(\frac{\tilde{\pi} - \pi}{\sigma_\pi}\right)}{1 - \Phi\left(\frac{\tilde{\pi} - \pi}{\sigma_\pi}\right)} - \frac{B^O - B^T}{A^O - A^T} \frac{1}{\sigma_\pi}.$$

The right-hand-side of the above equation is increasing and convex in $(\tilde{\pi} - \pi)/\sigma_\pi$ ($\equiv \tilde{z}$) and could be positive or negative. In addition, the limit of the first term of the above equation is $[A^O/(A^O - A^T)] \cdot \tilde{z}$ as $\tilde{z} \to \infty$, and 0 as $\tilde{z} \to -\infty$.[38] So there is no solution to the above equation if the right-hand side is positive, and there is a solution if the right-hand side is negative, which means that there could exist a threshold $\tilde{\pi}$ for the

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[38] Applying l'Hôpital's rule,

$$\lim_{z \to \infty} \frac{A^O}{A^O - A^T} \frac{\varphi(\tilde{z})}{1 - \Phi(\tilde{z})} = \frac{A^O}{A^O - A^T} \lim_{z \to \infty} \frac{-z \cdot \varphi(\tilde{z})}{-\varphi(\tilde{z})} = \frac{A^O}{A^O - A^T} \cdot \tilde{z}.$$

With the same idea,

$$\lim_{z \to -\infty} \frac{A^O}{A^O - A^T} \frac{\varphi(\tilde{z})}{1 - \Phi(\tilde{z})} = \frac{A^O}{A^O - A^T} \frac{0}{1} = 0.$$

transparent central banks to deviate. Therefore, transparency can not be a sub-game perfect equilibrium.

The second step is to show that there may exist a threshold equilibrium in which some central banks will choose transparency, while others opaqueness. From the analysis in previous section we know that both $E(U|\pi^*, O)$ and $E(U|\pi^*, T)$ are increasing in π^* with slope A^O and A^T, respectively. So $E(\pi^*|O) = E(\pi^*|\pi^* > \tilde{\pi})$ and $E(\pi^*|T) = E(\pi^*|\pi^* < \tilde{\pi})$. In addition,

$$E(\pi^*|T) = E(\pi^*|\pi^* < \tilde{\pi}) = \pi - \sigma_\pi \frac{\varphi\left(\frac{\tilde{\pi}-\pi}{\sigma_\pi}\right)}{\Phi\left(\frac{\tilde{\pi}-\pi}{\sigma_\pi}\right)}. \tag{28}$$

Suppose that $\tilde{\pi}$ is the threshold such that $E(U|\tilde{\pi}, O) = E(U|\tilde{\pi}, T)$. Using equation (25), (27) and (28), this relationship can be written as

$$\frac{\tilde{\pi}-\pi}{\sigma_\pi} = \frac{A^T}{A^O - A^T}\frac{\varphi\left(\frac{\tilde{\pi}-\pi}{\sigma_\pi}\right)}{\Phi\left(\frac{\tilde{\pi}-\pi}{\sigma_\pi}\right)} + \frac{A^T}{A^O - A^T}\frac{\varphi\left(\frac{\tilde{\pi}-\pi}{\sigma_\pi}\right)}{1-\Phi\left(\frac{\tilde{\pi}-\pi}{\sigma_\pi}\right)} - \frac{B^O - B^T}{A^O - A^T}\frac{1}{\sigma_\pi}.$$

The right-hand side of the above equation can be either positive or negative, and it is convex in $\tilde{z}$. The limit of the first two terms of the right-hand-side is $[A^O/(A^O - A^T)]\cdot\tilde{z}$ as $\tilde{z} \to \infty$, and $[-A^T/(A^O - A^T)]\cdot\tilde{z}$ as $\tilde{z} \to -\infty$, and both are greater than $\tilde{z}$. Therefore, if the right-hand side is positive, there is no solution to the above equation, which means that the threshold does not exist. However, if the right-hand-side is negative, there does exist a threshold in which some central banks will choose to be transparent, while others opaque.

The final step is to prove that opaqueness is not a sub-game perfect equilibrium. Assume that opaqueness is the perfect equilibrium; hence $E(\pi^*|O) = \pi$. Central banks will deviate, if $E(U|\pi^*, O) < E(U|\pi^*, T)$, which implies

$$\pi^* < -\frac{A^T}{A^O - A^T} E(\pi^* | T) + \frac{A^O}{A^O - A^T}\pi - \frac{B^O - B^T}{A^O - A^T}.$$

As before, $E(\pi^*|T) = E(\pi^* | \pi^* < \tilde{\pi})$. Applying equation (28), we get

$$\frac{\tilde{\pi} - \pi}{\sigma_\pi} = \frac{A^T}{A^O - A^T} \frac{\varphi\left(\frac{\tilde{\pi}-\pi}{\sigma_\pi}\right)}{\Phi\left(\frac{\tilde{\pi}-\pi}{\sigma_\pi}\right)} - \frac{B^O - B^T}{A^O - A^T} \frac{1}{\sigma_\pi}.$$

The right-hand side of the above equation can be positive or negative. If it is positive, then there is a solution to the above equation, which means that there exists a threshold that some central banks will deviate. On the other hand, if the right-hand-side of the above equation is negative, then there may be no solution, one solution, or multiple solutions to the above equation. In this case, we can not be certain whether opaqueness is the sub-game perfect equilibrium.

Following the same procedure, we can prove that in the case of $\theta > \lambda q$, some central banks would like to be transparent, while others opaqueness. The intuitive discussion is in footnote 36.

3. Discussion

The result of the endogenous model is different from that of Geraats (2000a) in two aspects. First, depending on the given parameters (θ, λ, q), the public's inflation expectations have different affect on central banks' well-being in our model; while in Geraats (2000a), the public's expectations have negative affects on central banks' welfare. Second, transparency is not the only choice of central banks in our model, but in Geraats (2000a), transparency is. In the following, we would like to discuss these two points in detail.

As we have explained in the beginning of section II of this chapter, the sequence of

θ and λq affects the result of the public's inflation expectations on the central bank's well-being: if $\theta > \lambda q$, then the former has negative affect on the latter, which is a similar case to Geraats (2000a). From this one can see that parameters, especially θ, λ, q, play a very important role in our model; however, this does not happen in Geraats (2000a). The reason that we have this result is that our model focuses on a small open economy so that we have a foreign exchange market; moreover, in that market, we use the parameter λ as an indicator of given regimes to differentiate among central banks. Given different levels of λ, the effect of a monetary policy varies (please refer to the discussion of equation (10)); since this is known to the public, it will affect the public's expectations of the inflation rate, which in turn, will affect the central bank's welfare. The model of Geraats (2000a) concentrates on a closed economy so it does not have all these complications. In her model, the public's inflation expectations always have negative effect on the central bank.

The proof in the previous section shows that in our model (when $\theta > \lambda q$), unlike the result of Geraats (2000a), transparency is not the only choice of central banks: some will choose to be transparent, while others opaque. Technically, the difference of the present paper and Geraats (2000a) comes from the sequence of B^R's of equation (25): in Geraats (2000a), $B^O \leq B^T$; while in this paper, $B^O \geq B^T$. This is because we consider a small open economy in which the central bank cares not only the goods and money markets, but also the foreign exchange market. Why does adding an external sector change the result so much? The answer can be seen from equation (14) of section I. The public's inflation expectations have a positive effect on the accumulation of foreign reserves. If we only consider the effect of accumulation of foreign reserves, when the central bank is given a higher inflation target, it has more incentive to reveal it because *by* doing this, the central

bank gives the public more accurate information to adjust their expectations, and from which, the central bank benefits more. On the other hand, when the central bank gets a lower inflation target, it may want to conceal the information so that it would have a chance to fool the public to reduce the harm from a lower inflation expectation on the accumulation of foreign reserves. Therefore, comparing our model with Geraats's (2000a), we find that setting the external sector in this way reduces the central bank's incentive to be transparent when it is given a lower inflation target, which contributes to the change of the relationship of B^R's in our model.

In the next chapter, we would like to examine the relationship between the central bank's policies in stable economic times, the policies suggested in our endogenous theoretical model, and the onset of economic crises in succeeding period.

CHAPTER 3

EMPIRICAL STUDY

In this chapter, we conduct an empirical study to see the relationship between policy combinations suggested in the previous chapter and economic crises. In section I, we establish and explain the linkage between our theoretical model and empirical study. In sections II to V, we introduce the variables in our regressions, our data sources, and the econometric methods that we employ. Section VI contains the explanations of empirical results.

I. THE THEORETICAL MODEL AND THE EMPIRICAL STUDY

The discussion of section II of the previous chapter justifies the analysis of Table 4 that, for example, given a higher (lower) inflation target and a more flexible regime, that is, $\theta > \lambda q$, the central bank should choose an opaque (transparent) type. This gives an indication of what type the central bank should choose to be, given the exchange rate regimes and the inflation targets, to improve its welfare in stable economic times. Given these combinations of regimes, inflation targets, and the choices of types, we want to see which one of the combinations would make the country more susceptible to economic crises in succeeding periods. The reason we do this is that from the data of some crisis countries, certain transparency and regime combinations seem to make a country more vulnerable to economic crises. So we would like to examine whether certain kind of policy combinations, if adopted by central banks in stable economic periods, will expose the country to economic crises later. Now the question is: why do we look at policies in stable times? Generally speaking, if a central bank knows that a crisis is coming, then it

will do its best to prevent it. The problem is: could a central bank really predict and prevent a coming economic crisis? For the prediction of a crisis, there are many studies in this field, for example, the studies of the so-called alarm systems, but it seems that none of them can predict the onset of crises very well. Therefore, it is not appropriate to assume that central banks can observe in advance the onsets of crises. As to prevent a crisis, to reduce the chance of having a currency crisis, the central bank can simply adopt a free float regime, but this may not be able to prevent a banking crisis, and most importantly, some central banks may not be able to use a free float regime, because, for example, it has to prevent its external sector from unstable exchange rates. To prevent banking crises, the central bank can strengthen the banking system, monitor the banking system carefully, etc., but sometimes a banking crisis will still happens. So it seems that the central bank has limited ability to prevent any kind of economic crises. With this rationale, we think that a reasonable way to describe a central bank's behavior is just to use the traditional setting in the stable time that the central bank maximizes its well-being, subject to the conditions the economy faces. Since the derived policies are only for stable economic times, these policies have nothing to do in preventing the central banks from succeeding economic crises; moreover, those policies may make the country even more susceptible to crises later. Our purpose here is to investigate whether certain policies that can enhance the central bank's welfare in stable times make the country vulnerable to economic crises afterward.

Here we would like to emphasize more on the relationship between stable-time policy combinations and the onset of economic crises in succeeding periods. A central bank with a fixed regime has a greater chance to suffer from a currency crisis, because, for example, speculators know that the central bank will use foreign reserves to defend

the currency, so speculators can gain a lot from arbitrage. Therefore, a country with a fixed regime could easily become the target of speculative attacks. Connecting this rationale to our theoretical and empirical studies, we would like to see that given a more fixed regime, what type the central bank should choose to be to maximize its well-being in a stable economic time. This part is done through the theoretical model. With the relationship of the given regime and the chosen type that we got from the theoretical model, we then want to ask: is this central bank susceptible to either a currency or a banking crisis later? The answer could be obtained in an empirical study in which we use lagged exchange rate regime, the central bank's type, and other macroeconomic variables to find the probability of having either a banking or a currency crisis in the next period. Comparing the probability of each policy combination gives us an idea of what combination makes a country vulnerable to economic crisis later. On the other hand, although flexible regime countries may escape from currency crises, fluctuations in exchange rates may lead to banking crises in the domestic banking system. This is because, for example, if domestic banks borrow in foreign currencies without hedging, then a large depreciation of the domestic currency will weaken the banks. To investigate the linkage between policy combinations and the onset of a crisis for countries with more flexible regimes, we use the same method as that described in the previous paragraph, but look at banking crises only when the given regime is free float.

In addition to the exchange rate regime, our policy combination suggestions of the theoretical model also depend on the inflation target. In the empirical study, we do not put the inflation target in our regressions. The reason is that the inflation target is private information of the central bank in our model. With this private information, we can distinguish between transparent and opaque central banks, and make the information sets

of the central banks and of the public asymmetric. From the theoretical analysis of the endogenous model, one can find that the inflation target has the nature of an endogenous variable in our model, because it affects the central bank's behavior and in turn, the public's expectations. Therefore we can say that the effect of the inflation target is totally revealed through the central bank's choice of type. Moreover, it is almost impossible to find data on every central bank's inflation target, so we choose not to put this variable into our regressions.

In addition, as we mentioned in Chapter 1, in the literature there are three kinds of crises: banking crises, currency crises and twin crises. In the case of twin crises, sometimes it is a banking crisis that leads to a currency crisis; sometimes it is the reverse; and at other times, banking and currency crises are triggered by common factors. If the twin crisis phenomenon is what happened, then investigating only one kind of crisis may miss some important information, which may bias our estimates. Therefore, before estimating the regressions, we will examine whether the twin crisis phenomenon is what happened in our sample. If it is, then we will estimate both banking and currency crises simultaneously.

II. THE VARIABLES AND DATA SOURCES

In this section, we introduce the dependent and independent variables in our regressions, the reasons we choose those variables, and the data sources for each variable.

1. The dependent variables

The dependent variables in our regression are the onset of currency and banking crises. In the literature, there are several propositions about identifying crises. In the

following sub-sections, we will introduce the methods to define crises that are most commonly adopted in the literature, and then we will explain the methods that we use and the reasons for choosing them.

(1) *Currency Crisis*

In the literature, there are several different but similar ways to identify currency crises. For example, based on the arguments in Girton and Roper (1977), Eichengreen *et al* (1996) construct the currency crisis index as a weighted average index of changes in the exchange rate, foreign reserves, and the interest rate. The idea is that if a speculative attack is successful, then currency depreciation will happen. In this situation, the monetary authority may use foreign reserves to offset the attack or raise interest rate to defer it. If this index is greater than its mean plus one and a half its standard deviation, then the crisis dummy variable is one; otherwise, the dummy takes the value of zero.[39] In addition, weights are chosen to prevent any one of the components (exchange rate changes, foreign reserve changes, and interest rate changes) from dominating the index. Basically, this method is the same as that of Eichengreen *et al* (1995), except that in that paper, the authors identify a crisis as at least two standard deviations above the mean.

Following the spirit of Eichengreen *et al* (1995), Kaminsky and Reinhart (1999) construct their index as a weighted average of exchange rate changes and reserve changes with weights such that the two components of the index have equal conditional volatilities. Since the data on interest rates do not span the entire sample of developing countries, the authors drop the interest rate component of the index in Eichengreen *et al*

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[39] In sensitivity analysis, the authors use the two standard deviation threshold, but the results are not statistically significantly changed.

(1995). Moreover, indices that are at least three standard deviations or more above the mean are cataloged as crises.

The identification method that we employ is the one adopted in Glick and Hutchison (1999). Basically it is similar to the classification in Kaminsky and Reinhart (1999), therefore, to Eichengreen *et al* (1995 and 1996). The index is defined as a weighted average of monthly real exchange rate changes and monthly percentage nominal reserve losses, with the weights inversely related to the variance of the changes in each component over the sample for each country.[40] The assumption behind this is that exchange rate pressure coming from large nominal exchange rate changes should affect the purchasing power of the domestic currency. That is, the real exchange rate should be affected by large changes in the nominal exchange rate. Countries that have large changes in exchange rate pressure are defined by the authors as those whose indices are in excess of the mean plus two times the country-specific standard deviation.[41] The advantages of this identification method is that we can "exclude some large depreciations that occur during high inflation episodes" without "screening out sizable depreciation events in more moderate inflation periods for countries that have occasionally experienced periods of hyperinflation and extreme devaluation."[42] With this method, we define a binary dummy variable (*Currency Crisis*) that takes the value 1 for a country with large

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[40] When calculating the real exchange rate, we use the formula

$$\text{real exchange rate} = (ep^*/p),$$

where e is the value of domestic currency in terms of one unit of foreign currency; p^* is the foreign price level, and p is the domestic price level. With respect to ep^*, we use the exchange rate against US dollar, Deutch mark, and Japanese yen, and the CPI's of each country; and then, we employ the geometric average of the products of the exchange rates and the price levels as the value of ep^*.

[41] According to Glick and Hutchison (1999), the choice of cut-off point is arbitrary. In addition, the results in Frankel and Rose (1996) suggest that regression results are not very sensitive to the cut off choices.

[42] Please refer to footnote 4 in Glick and Hutchison (1999) about the difference between this method and the approach in Kaminsky and Reinhart (1999).

exchange rate pressure and 0 otherwise. That is, a country that experienced a currency crisis during the sample period has a currency crisis dummy variable with the value 1.

The definition of currency crises is not consistent with our theoretical model. As we mentioned above, the rationale behind the definition of currency crises, which comes from Girton and Roper (1997), is that the central bank would use foreign reserves or raise the interest rate to offset the speculative attack pressures, so the fluctuations of the exchange rate, foreign reserves, and the interest rate are used to construct the index of currency crises. However, in our theoretical model, for simplicity, we do not allow the central bank to use foreign reserves or the interest rate as instruments to directly intervene in the foreign exchange market. So there seems to be a conflicting here between the definition of *Currency Crisis* and our theoretical model. As we describe in equation (6) of Chapter 2, one of the factors contributing to the fluctuations of the exchange rate in our model is the balance of payments that determines the fluctuations of foreign reserves. So it is reasonable for us to use the same index as Glick and Hutchison's (1999) that employs changes in the exchange rate and foreign reserves to construct the index. In addition, our purpose here is to test our policy implications from the theoretical model, not the theoretical model itself, so using ex post data to examine the policy implications should not cause any problems.

The result of the currency crisis identification procedure is shown in the second column of Appendix 3 of the present paper. The sample size in Glick and Hutchison (1999) is ninety countries, but in our paper, because of the restriction imposed by the lack of transparency data (to be discussed in sub-section (1) of section 2), we have only fifty countries; forty-two of them overlapped with those of Glick and Hutchison (1999). For the overlapping countries, we duplicate the results in Glick and Hutchison (1999), while

for the other eight countries, we construct their indices ourselves.[43] However, due to the data availability, we can only identify China's currency crises since 1987, the Czech Republic's since 1993, Poland's since 1988, Russia's since 1996, and Taiwan's since 1980.

The data needed to construct this index are real exchange rate changes and percentage changes in foreign reserves; both of them come from line rf and line 1l.d of the IMF's *International Financial Statistics* (IFS), except for the exchange rate of the US dollar, and both data series for Taiwan. We use line sa data, the end-of-period national currency value of the SDR, to represent the US's exchange rate, because this is the only data set in the IFS, except for the ECU (European Currency Unit) rate, that we can use to proxy the fluctuation of US dollar. Taiwan's data are obtained from line rf and line 1l.d of the *Financial Statistics, Taiwan District, The Republic of China*; it is published by the Economic Research Department of the Central Bank of China, and is compiled in IFS's format and methodology.

(2) *Banking Crisis*

In the literature, when dealing with the identification of banking crises, most of the studies follow the criteria of Caprio and Klingebiel (1996), or Demirgüc-Kunt and Detragiache (1998a and b). Examples include Mehrez and Kaufmann (2000), Hutchison

[43] The overlapping countries identified as industrial countries are Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom; those identified as emerging markets are Argentina, Brazil, Chile, Colombia, Egypt, Hong Kong, India, Indonesia, Jordan, Korea, Malaysia, Mexico, Pakistan, Peru, Philippines, Singapore, South Africa, Thailand, Turkey, Venezuela; and one country belongs to developing countries: Hungary. Countries not in Glick's and Hutchison's (1999) sample are US, Australia, China, Czech, Israel, Poland, Russia, and Taiwan.

and McDill (1999), Hardy and Pazarbasioğlu (1999), Eichengreen and Rose (1998), etc.[44] Therefore, in this section, we will discuss these two studies and introduce the way we identify banking crises.

Caprio and Klingebiel (1996) identify banking crises of various degrees of intensity in sixty-nine countries. The authors form their judgement of the extent of the problem and the impact on net bank capital on the basis of both official published data and the opinion of country experts. They identify a banking crisis with the criteria that the ratio of nonperforming loans to total loans is above 5-10 percent.

In Demirgüc-Kunt and Detragiache (1998a and b), the authors construct the crisis variable basically following Caprio and Klingebiel (1996), Lindgren *et al* (1996), Drees and Pazarbasioğlu (1995), Kaminsky and Reinhart (1999), and Sheng (1995). According to the authors, for an episode of distress to be classified as a crisis, the following four conditions have to hold:

(a) The ratio of nonperforming assets to total assets in the banking system exceeded 10 percent.

(b) The cost of the rescue operation was at least 2 percent of GDP.

(c) Banking sector problems resulted in a large scale nationalization of banks.

(d) Extensive bank runs took place or emergency measures such as deposit freezes, prolonged bank holidays, or generalized deposit guarantees were enacted by the government in response to the crisis. (1998a, p.90-91)

In constructing the currency crisis index, we also follow Glick and Hutchison (1999)

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[44] Of course, there are some exceptions. One example is Kaminsky and Reinhart (1999). The authors identify banking crises based on two criteria; if either one is satisfied, then the certain event is classified as a banking crisis: i) bank runs that lead to the closure, merging, or takeover by the public sector of financial institutions; ii) there are no runs, but the closure, merging, takeover, or large-scale government assistance of an important financial institution.

to establish the banking crisis index. Basically, Glick and Hutchison (1999) identify and date episodes of banking sector distress using the criteria of Caprio and Klingebiel (1996), and Demirgüc-Kunt and Detragiache (1998a and b). If an episode of banking distress is identified in either study, it is included in the sample. If there is ambiguity over the timing of the episode, the authors use the dating scheme of Demirgüc-Kunt and Detragiache (1998a and b), because they think those two papers are more specific about the precise start and end of each episode. One advantage of identifying banking crises this way is, as Eichengreen and Rose (1998) say that: "one can avoid the danger of picking crises consistent with their own priors of how they are correlated with macroeconomic and structural variables." After identifying the banking crisis episodes, we define a binary dummy variable (*Banking Crisis*) that takes the value 1 if there is banking sector distress in a certain year, and 0, otherwise.

The identification results are presented in the third column of Appendix 1. We duplicate the identification for the countries found in data sets from Appendix B of Glick and Hutchison (1999); for those that are not included in their sample, we identify with the information in other studies. Data on Australia, Israel, Poland, Russia, Taiwan, and United States are from Box 1 of Caprio and Klingebiel (1996); on China and the Czech Republic from Table 2 of Lindgren *et al* (1996). Lindgren *et al* (1996) define a banking crisis when one of the following happens: runs, substantial portfolio shifts, collapses of financial firms, or massive government interventions. When data appear in both Caprio and Klingebiel (1996) and Lindgren *et al* (1996), we use the former, because their identification procedure is more specific.

2. The explanatory variables

The major variables in our theoretical model are the central bank's transparency level and the exchange rate regimes, so these two variables are included on the right-hand side of our regressions.[45] In addition to these two variables, we also include several other control variables that have been shown to provide consistent and significant information about banking fragility and currency vulnerability. In the following sub-sections, we will discuss all the variables employed, and the construction of them.

(1) The transparency level

In our theoretical model, the definition of transparency is whether the public can get the exact information the central bank has through the central bank's behavior. Since it is almost impossible to get a measure that evaluates central bank's transparency in this way, we use several proxies to stand for the central bank's transparency. Mehrez and Kaufmann (2000) suggest using the transparency data from *The World Competitiveness Yearbook* (WCY), the corruption index, and the corruption index combined with the public sector size as proxies.[46] As will be explained in detail in the following sub-sections, these proxies do not quite match the definition of economic transparency in our theoretical model. However, since these are the only data sets available, we still employ them here but keep in mind the imperfection of these data sets.

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[45] For the reason that we do not put the inflation target in the regression, please refer to section I of this chapter.

[46] *The World Competitiveness Yearbook* was named the *World Competitiveness Report* before 1995.

(a) Data from the WCY[47]

The first proxy we use is the criterion Transparency of the WCY. The question asked in the survey is: whether the government does or does not communicate its policy intentions clearly. The respondents of the survey are executives in top-and-middle management in all the countries covered by the WCY. The score of each country is the average value (transformation from 1-6 scale to a 1-10 scale) of respondents' rating for their respective countries.[48]

One of the imperfections of this data set is that the data are available from the WCY since 1996, and from *The World Competitiveness Report* from 1992 to 1995. Therefore, we follow the same assumption in Mehrez and Kaufmann (2000) that all the data before 1992 have the same value as 1992's.[49, 50] Among the fifty countries of our sample, not every one of them has the transparency data available since 1992: Argentina since 1994, Chile 1993, China 1994, Colombia 1994, Czech Republic 1994, Egypt 1995, Iceland 1995, Israel 1995, Jordan 1995, Peru 1995, the Philippines 1994, Poland 1994, and Russia 1994. In addition, in 1992 and 1993, the surveyed countries were divided into two groups, the OECD country group and the developing country group, and as emphasized in the yearbooks, the two groups should not be directly compared.[51] Therefore, to

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[47] One of the measures in Mehrez and Kaufmann (2000) comes from this yearbook, too. Mehrez and Kaufmann (2000) argue that the data are available only for 1998, so they made an assumption that "the level of transparency across countries has not changed significantly during our sample". However, to our knowledge, the data are available from the WCY since 1996, and from *The World Competitiveness Report* from 1992 to 1995.

[48] In 1992, the average value was transformed from 1-6 scale to a 0-100 scale.

[49] The starting year of each country's data is not the same. Therefore, for a country that starts in 1994, the data before 1994 have the same value as those of 1994. For details about the starting year of each country, please refer to the next two paragraphs.

[50] With this method, we have some fluctuations in the data of recent years, but before 1992, there is no change due to the assumption. Whether doing this can improve our estimates should be evaluated by running the regressions with the assumption of Mehrez and Kaufmann (2000).

[51] According to *The World Competitiveness Yearbook 1992*, the choice of the second group countries or economies is based on their impact on world trade and the availability of internationally comparable

combine the available data into one data set, we must find some method to make them comparable. The way we do this is to get the first, second, and third quartiles of each year's data, and within each group in 1992 and 1993. Then, we construct a dummy variable (*Transparency*) using the following criteria:

Transparency =	3	if a single datum is greater than the third quartile;
	2	if a single datum is greater than the second quartile but less than or equal to the third quartile;
	1	if a single datum is greater than the first quartile but less than or equal to the second quartile;
	0	otherwise (less than or equal to the first quartile).

For a datum of the OECD group that is greater than the third quartile of the group in 1992, its dummy variable has a value 3, the same for the datum of the developing-country group with a value greater than the third quartile of the group in the same year. Hence, with this method, we can utilize all the data that are available.

Another imperfection of this proxy is that it evaluates the transparency of the 'government', not only the central bank. Therefore, when the manager responds to the survey questions, she may be referring the central, or the local government, and not to the central bank. So this proxy may not be able to capture our definition of transparency. The third imperfection of this proxy is that it is based on survey data, so it is highly subjective. However, the advantage of this proxy, compared to the other two proxies that we will use (e.g., corruption index, size of the public sector combined with corruption index), is that it directly evaluates transparency. In explaining the regression results and making conclusions, we have to keep in mind the above mentioned drawbacks of the transparency proxy.

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statistics.

(b) The corruption index

The corruption index is employed in both Mehrez and Kaufmann (2000), and Fons (1998) to represent transparency. Mehrez and Kaufmann (2000) use the corruption index from Political Risk Service, Syracuse, New York (ICRG indices) as one measure of transparency. There is no explanation in that article why the authors use this data. However, our guess is that in highly transparent economic and political environments, it is not easy for government officials to interfere with policies for their own interests, or for the public to bribe government officials; therefore, corruption is often combined with poor transparency. This is also the argument in Fons (1998). In this article, the author uses corruption data from Transparency International (TI), a non-governmental organization founded in 1993 and headquartered in Berlin. However, there is a risk of using the corruption data: corruption itself may be one of the factors that cause crises. To address this issue, Mehrez and Kaufmann (2000) suggest that one should use the data that directly evaluated transparency, such as the ones in the WCY.

In the present paper, the data on corruption indices come from both the index of TI and the criterion Improper Practice of the WCY. The indices from Transparency International are based on survey data conducted by Göttingen University and TI itself. A "10" indicates a perfectly clean country whereas a "0" refers to a country where business transactions are entirely penetrated by corruption. However, TI's annual data is only available in 1995-1997; for other years, it reports an average value of 1988-1992 and of 1980-1985. To add to these empty data cells, we use the criterion Improper Practices of the WCY in 1990-1994.[52] A country that has a good reputation in this criterion, that is,

[52] Improper practices are defined as bribing or corruption behaviors in the WCY, and this criterion is also surveyed and has the same properties as the criterion Transparency.

less bribery or corruption, has a higher score. Hence, for 1988-1989, we use TI's average value, the same for 1980-1985. Before 1980, we assume that the corruption situation did not change a lot in each country, so we can still use the average value for 1980-1985 for this period. For 1986-1987, we use the 1988-1992's average value. For countries that are not included in TI's survey in 1995-1997, we use the data in the Improper Practices criterion of WCY; those countries are Iceland 1995-1997, Luxembourg 1996, the Czech Republic 1995, Poland 1995, Russia 1995, Egypt 1995, Israel 1995, Jordan 1995, Peru 1995.

Following Mehrez and Kaufmann (2000), we create a dummy variable (*Corruption I*) for transparency that takes the value of 1 if the corruption index (or the improper practice criterion) is greater (less) than the median of the whole sample in a certain year, and the value 0, otherwise.

There are some problems with this proxy. The major one concerns the relation of the proxy with our definition of transparency. Given the way this proxy is calculated, it measures the corruption of the general government, not just of the central bank. So the link of this proxy to our definition is even weaker than that of the proxy from the WCY. This is another reason why we base our conclusions on the WCY proxy.

(c) The public-sector size combined with the corruption index

Our second measure follows the method mentioned in Mehrez and Kaufmann (2000). This variable is made through combining the size of the public sector and the corruption index. This idea comes from Kopits and Craig (1998) that "transparency in government behavior is reflected mostly in the structure and functions of the public sector, such as financing operations." With this idea, Mehrez and Kaufmann (2000) create a

measure of public sector size as the ratio of credits directed to the government and the public sectors relative to total domestic products. The data comes from the IFS, and the ratio is constructed as the percentage of the sum of the net claims on the central government (line 32an of the IFS), claims on state and local governments (or on the rest of the general government, line 32b), claims of official entities (line 32bx), and claims on non-financial public enterprises (line 32c) on domestic credits (line 32).

As to the method of classifying each level of transparency, we duplicate what is done in Mehrez and Kaufmann (2000):

> "We define country with large (small) public sector if the share is greater (smaller) than the median. We combined this measure with our measure of corruption and define three levels of transparency. Poor transparency if a country is corrupt and has large public sector; medium transparency if a country is corrupt but has a small public sector or is not corrupt but has a large public sector; good transparency is a country, which is not corrupt and has a small public sector." (p.19)

With this method, we construct the third dummy variable (*Corruption II*) for transparency by the following rule:

Corruption II =	2	if a country is not corrupt and has a small public sector size;
	1	if a country is not corrupt but has a large public sector size, or a country is corrupt but has a small public sector size;
	0	otherwise (for a country that is corrupt and has a large public sector size).

For countries that have missing values during a year, we assume that they did not change too much in this aspect, so we can substitute the missing values with the last observed data. Those countries are South Africa 1990-1991 (substituted with 1992's datum), Iceland 1975-1994, China 1990-1993, Pakistan 1990-1991, the Philippines

1990-1993, Czech Republic 1990-1993, Poland 1990-1993, Egypt 1990-1994, Israel 1990-1994, Jordan 1990-1994, Argentina 1990-1993, Chile 1990-1992, Colombia 1990-1993, Peru 1975-1994, and Venezuela 1990-1991.

This proxy suffers from the same problem as the corruption index. Therefore, we use this proxy just as a reference.

(2) Exchange rate regime

Another key right-hand-side variable from our theoretical model is the exchange rate regime. This is also a quality variable, so it is not easy to evaluate. As mentioned in Poirson (2001), "Measuring the degree of exchange rate regime flexibility is probably the main challenge confronting the empirical analysis of exchange rate regime choice."

To conquer this problem, some authors use the IMF's classification published both in the *International Financial Statistics* and in detail in the *Annual Report on Exchange Rate Arrangements and Exchange Restrictions* (ERAER), for example, Melvin (1985). The advantage of IMF's data is that they are from governments' official reports so they are objective. However, according to Poirson (2001), before 1999's edition, the IMF's classification does not take into account the difference between the *de jure* and the *de facto* regime. nor does it distinguish between standard and hard pegs; these are the shortcomings of the IMF data.[53] In the literature, there are other suggestions for identifying the exchange rate regime, such as the index in Holden *et al* (1979), and the *FLT* index in Poirson (2001).[54] The advantage of these measures is that they directly

[53] The 1999's issue of ERAER covered the year of 1998.

[54] For example. the *FLT* index in Poirson (2001) is the following

calculate the weighted fluctuations of exchange rates and use them as an indicator of the regime, so the index can be viewed as continuous. Nevertheless, the drawback of this method is that foreign reserves are a component of the indicator variable. In practice, the monetary authorities do not necessarily intervene in the foreign exchange market through direct purchases and sales of reserves. Even if the authorities do so, they can intervene through several dimensions, and it is very hard to identify each of them. Besides, it is not easy to classify the sources of changes of reserves between interventions and external shocks.

Despite the drawbacks of the IMF's data, we will still use them in our empirical study. The reason is that we can transform IMF data into a dummy variable with different values, and this makes explaining our results easier. If we use other measures like the *FLT* index in Poirson (2001), although they may not suffer from the shortcomings of IMF data, they are continuous and this makes our explanations harder. Of course we can transform the *FLT* index into a dummy variable, but this loses the spirit of the *FLT* index and this index still has the problem with foreign reserves.

Before the 1983 issue, the appendix table of the ERAER only distinguished between "exchange rate maintained within relatively narrow margins" and "exchange rate not maintained within relatively narrow margins ..... or otherwise determined." From the

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$$FLT^i = \frac{\sum_{k=0}^{11}\left[\frac{|\xi_{t-k}-\xi_{t-k-1}|}{\xi_{t-k-1}}\right]}{\sum_{k=0}^{11}\left[\frac{|FR_{t-k}-FR_{t-k-1}|}{\sum_{j=0}^{11} H_{t-k-j}}\right]},$$

where ξ_t is the nominal exchange rate of country i in month t; H_t denotes the monetary base of country i in month t.

1984 to the 1996 issues, the exchange rate determinations were classified into peg, limited flexibility, and more flexible arrangements. There are three more categories in the third classification: "adjusted according to a set of indicators", "other managed floating", and "independently floating". In the 1997 and 1998 issues, exchange rate arrangements were identified into pegged, flexibility limited, and more flexible arrangements, and the last category had two sub ones: "managed floating" and "independent floating". To avoid inconsistency, we use the data from 1982 to 1997 and treat the ones before 1982 as missing values. We construct four dummy variables (*Peg*, *Limited Flexible*, *Managed Float*, and *Free Float*) with the following rules:

Peg = 1	if a country adopts a pegged regime, 0 otherwise;
Limited Flexible = 1	if a country adopts a limited flexibility regime, 0 otherwise;
Managed Float = 1	if a country adopts a regime that is classified as "adjusted according to a set of indicators" or as "other managed floating" before 1997's issue, or as "managed floating" in 1997's and 1998's issues, 0 otherwise;
Free Float = 1	if a country adopts an independent floating regime, 0 otherwise.

Since Taiwan has not been a member of IMF since 1978, there is no information about Taiwan in the ERAER. Therefore, we search in various issues of the *Annual Report of the Central Bank of China* to evaluate the way the Central Bank of China deals with exchange rates. According to the reports, the Central Bank of China switched from a fixed exchange rate regime to a managed float one on July 11th, 1978. On February 1st, 1979, the bank abolished the regulations on the base exchange rate and established a local foreign exchange market; so the spot and forward exchange rates were basically determined by supply and demand in the market. However, in fact, the bank still played

an important role in the determination of the exchange rate.[55] On December 29th, 1990, each authorized foreign exchange bank in Taiwan was allowed to set its own exchange rates, and according to the Central Bank of China, the exchange rate has been totally deregulated since then. Nevertheless, as emphasized in various issues of the annual reports (1995, 1996, and 1997 issues of Chinese version), the Central Bank of China will intervene in the foreign exchange market if the exchange rate fluctuates too much due to the public's "abnormal" expectations, seasonal adjustments, or unexpected disturbances in the market. Hence, the announced free float regime still looks like a managed one. We conclude that the exchange rate regime's transition in Taiwan is the following: fixed regime from 1975 to 1978 (so *Peg* = 1, *Limited Flexible* = 0, *Managed Float* = 0, *Free Float* = 0); limited flexibility regime from 1979 to 1990 (*Peg* = 0, *Limited Flexible* = 1, *Managed Float* = 0, *Free Float* = 0); managed float from 1991 to 1997 (*Peg* = 0, *Limited Flexible* = 0, *Managed Float* = 1, *Free Float* = 0).

(3) The interaction variables

In addition to *Transparency* (or *Corruption I* and *Corruption II*) and several regime variables, in our regressions, we want to add some variables that are constructed by multiplying *Transparency* (or *Corruption I* or *Corruption II*) by other regime variables, namely *Interaction* (*Peg*), *Interaction* (*Limited Flexible*), *Interaction* (*Managed Float*),

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[55] There are two transition systems of the managed float period: the negotiated exchange rate system and the central exchange rate system. Between February 1st, 1979 and August 31st, 1982, the exchange was determined through negotiation. Within this period, from February 1st, 1979 to March 2nd, 1980, the exchange rate was determined by the representatives from the Central Bank of China and from five major authorized foreign exchange banks. From March 3rd, 1980 to August 31st, 1982, the Central Bank withdrew itself from the negotiation process; only the five major foreign exchange bank representatives determined the rate. The central exchange rate system was adopted from September 1st, 1982 to April 3rd, 1989. During this period, although the central bank did not participate in determining the exchange rate, the band of exchange rate fluctuations was determined by it.

and *Interaction* (*Free Float*). The advantage of doing this is that we can make the effect of say *Peg* (*Transparency*, or *Corruption I* or *Corruption II*) on the onset of a crisis depend on the magnitude of *Transparency*, *Corruption I* or *Corruption II* (*Peg*). Using the currency crisis equation as an example, for the following regression,

. *Currency Crisis* = constant + a×*Transparency* + b×*Peg* + c×*Managed Float* + d×(other variables) + e×*Interaction* (*Peg*) + error term,

The effect of *Peg* on *Currency Crisis* is (b + e×*Transparency*), and the effect of *Transparency* on *Currency Crisis* is (a + e×*Peg*), holding all other variables fixed. If d is positive, then *Peg* goes from 0 to 1 has a larger effect on *Currency Crisis* for a more transparent country. Without this setting, the effects of *Transparency* and *Peg* are unchanged, a and b, respectively, across different levels of transparency and exchange rate regimes. Another advantage of the Interaction variable will be illustrated in section VI of this chapter.

The conclusion of our theoretical model implies that given different exchange rate regimes, the central bank should adopt different types. To evaluate this argument, we can compare the probabilities of each crisis from different combinations of *Transparency* and *Regime*. Using the same example to illustrate this idea, we can show that an opaque central bank (*Transparency* = 0) with a more fixed regime (say *Peg* = 1) contributes to the onset of a currency crisis the probability (constant + b + d×(other variables)), with (other variables) evaluated at their means. For a transparent central bank (*Transparency* = 3) with a more flexible regime (say *Managed Float* = 1), the probability is (constant + 3a + c + d×(other variables) + 3e). Hence, the probability difference between the opaque-fixed central bank and the transparent-managed-float central bank is 3a + c +3e – b. Without *Interaction*, the difference is only (3a + c – b). Therefore, adding an

interaction variable can reveal the difference that one wants to investigate — in this case, the probability difference. In addition, the inter-dependence characteristic between *Transparency* and the regime variables from the interaction variable is consistent with the argument of our theoretical analysis.[56]

(4) Other right-hand-side variables

Since our empirical analysis follows Glick and Hutchison (1999), the explanatory variables that are significant in their regressions will all be included in our estimates. In addition, we add several other variables that we think necessary and reasonable.

(a) Variables in Glick and Hutchison (1999)

The choice of variables in Glick and Hutchison (1999) is determined by the purpose of their paper, the data availability, and the results in other studies. In the following, we discuss the variables that are reported in that paper.

a. Variables in the banking crisis equation

The explanatory variables of banking crises are real GDP growth rates (*Real GDP Growth*), inflation rates (*Inflation*), and financial liberalization (*Liberalization*).[57, 58]

According to Demirgüc-Kunt and Detragiache (1998a and b), GDP growth rates and inflation rates can capture the adverse effects of macroeconomic variables on banks' nonperforming loans:

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[56] There is a chance that the predicted probability of crisis is greater than 1 or less than 0. For the discussion about this, please refer to sub-section 1 of section V of this chapter.

[57] Other variables that are used but not reported are real credit growth rates, nominal and real interest rate changes, the budget position of the general government and the explicit deposit insurance.

"inflation is introduced as an explanatory variable because it is likely to be associated with high nominal interest rates and because it may proxy macroeconomic mismanagement, which adversely affects the economy and the banking system through various channels." (Demirgüc-Kunt and Detragiache 1998a, p.93)

The GDP growth rate and its variants are also used in Hardy and Pazarbasioğlu (1999), Kaminsky and Reinhart (1999), Eichengreen and Rose (1998), Mehrez and Kaufmann (2000), Rossi (1999), and Hutchison and McDill (1999), and have good explanatory abilities.

The inflation rate is used in Mehrez and Kaufmann (2000), but its explanatory power is not very robust to the model's setting. In Hardy and Pazarbasioğlu (1999), the inflation rate is included in the group including shocks that may directly or indirectly (through the real sector) affect the health of the banking sector, or which may indicate the advent of such a shock.

In some articles, financial liberalization is often proxied by the real interest rate. As mentioned in Demirgüc-Kunt and Detragiache (1998b), proxying financial liberalization this way will include too much noise in the variables because

"Real interest rates, ..., especially when measured *ex post*, are likely to be affected by a variety of factors that have little to do with changes in the regulatory framework of financial markets. This problem may be limited in a cross-country study, in which interest rates are averaged over long periods of time, but in a panel study like ours with an important time-series dimension proxying financial liberalization with the real interest rate would be potentially misleading. For instance, a positive correlation between real interest rates and the probability of a banking

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[58] We thank professor Michael Hutchison for his generousity of lending us the financial liberalization data.

crisis may simply reflect the fact that both variables tend to be high during cyclical economic downturns, while financial liberalization plays no role." (Demirgüc-Kunt and Detragiache 1998b, p.10)

Therefore, a better way to identify this variable is to date observed policy changes. Although several other papers date financial liberalization differently than Demirgüc-Kunt and Detragiache (1998b), for example Mehrez and Kaufmann (2000), and Kaminsky (1999), basically, they accept this argument. In our regressions, we build a dummy variable (*Liberalization*) to identify whether a country has already liberalized its interest rates. It equals 1 if a country has liberalized, 0 otherwise.

The variables *Real GDP Growth* and *Inflation* are constructed with the data in IFS (lines 99b, 99b.c, 99b.p, 64, and 64..xx). As before, Taiwan's data are obtained from *Financial Statistics, Taiwan District, The Republic of China.* These two variables are calculated with the following two formulas, respectively

$$\textit{Real GDP Growth}_t = \frac{\text{real GDP}_{t+1} - \text{real GDP}_t}{\text{real GDP}_t};$$

$$\textit{Inflation}_t = \frac{\text{CPI}_{t+1} - \text{CPI}_t}{\text{CPI}_t};$$

where real GDP_t is the real GDP of year t; CPI_t is the consumer price index of year t; and real GDP is the nominal GDP divided by CPI.[59]

Most of our financial liberalization data are lent to us by Professor Michael Hutchison.[60] For Hong Kong, Pakistan, Singapore, South Africa, and Taiwan, data come from Table 1 and 5 of Williamson and Mahar (1998); for Hungary, Pakistan, Poland, and Russia, the indices are from Table 13 of Lindgren *et al* (1996); for Israel, the data come

[59] We reconstruct China's and Russia's CPI with the data of line 64..xx, changes in consumer price, in IFS.

[60] The data on financial liberalization in Glick and Hutchison (1999) come from Demirgüc-Kunt and Detragiache (1998b) and were supplemented by national and international sources.

from Table 1 of Demirgüc-Kunt and Detragiache (1998); for Czech Republic, data from the description of Table 2.1 of Transition Report 1996; for Iceland, data from Guðmundsson and Kristinsson (1997);[61] for China, data from Mehran and Quintyn (1996). [62]For these countries, we identify the starting date of financial liberalization as the time that the authority deregulated interest rate controls. The results of this identification are available in the forth column of Appendix 3.

b. Variables in the currency crisis equation

The variables employed to explain currency crises in Glick and Hutchison (1999) are the degree of real currency over-valuation (*Overvaluation*), export revenue growth (*Export Growth*), and the M2 to foreign reserves ratio (*M2/Reserves Ratio*).[63]

Over-valuation is defined as deviations from the fitted trend in the real trade weighted exchange rate. The latter is created by taking the trade-weighted sum of the bilateral real exchange rates (defined in terms of CPI indices) against the U.S. dollar, the Deutschemark, and the yen, where the trade-weights are based on the average bilateral trade with the U.S., Europe, and Japan in 1980. In the literature, some authors argue that

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[61] According to Guðmundsson and Kristinsson (1997),

> "The major steps in the internal liberalization of interests is the widespread permission to use price indexation of financial obligations in 1979, the freedom of the banks to decide their own deposit and lending rates that was established in two steps during the years 1984-86 and the replacement of the former Usury Act with a new Interest Rate Act in 1987, establishing almost complete negotiating freedom for interest rates." (p.66)

Since we take the authority's deregulation of interest rates as the start of financial liberalization, we identify the starting date of Iceland's liberalization as 1984.

[62] According to this article, China attempted to liberalize interest rates during 1986 to 1988; however. it was stopped by a following inflation in the economy. As a part of a development of a nationally integrated interbank market, the liberalization of interest rates was re-introduced in 1996. Therefore, we identify 1986 to 1988 and 1996 to 1997 as the financial liberalization periods for China.

[63] Several other variables are used but are not reported because they are not significant in the regressions. They are the current account to GDP ratio, nominal and real M2 growth rates, nominal and real domestic credits (net of claims on the public sector), M2 to reserve money multiplier, and the budget surplus to GDP ratio.

real exchange rates tend to be overvalued before the onset of a currency crisis. For example, Radelet and Sachs (1998a) argue that real exchange rate appreciation could signal the likelihood of a currency crisis, but this variable is not significant in their estimation. Frankel and Rose (1996) use this variable as a measure of vulnerability to external shocks, and it is significant at 5% level when the lagged variable is used.

Export growth rates are prone to decline before a currency crisis, and this retardation will cause expectations that foreign exchange earnings will plunge. This variable is used in Kaminsky (1999) as a single indicator of currency crises, and it turns out to be a good one.

The M2 to foreign reserves ratio indicates the international liquidity of the domestic banking system. This variable generally increases prior to a currency crisis. This variable is used in Kaminsky (1999) and in Rossi (1999), but is not significant in the latter study.

The data needed to construct *Real Currency Overvaluation*, *Export Growth*, and *M2/Reserves Ratio* come from IFS (lines rf, 70..d, 34, 34a.n, 34b.n, 35, 35l, 39mb, 39mbc, 39m, and 11.d), and for Taiwan, the data are from *Financial Statistics, Taiwan District, The Republic of China*. In addition, as mentioned in the previous section, *Real Currency Overvaluation* is defined as the deviation from the fitted trend in the real trade weighted exchange. The trade weights are based on the average bilateral trade with the U.S., Europe and Japan in 1990 and the data come from *Direction of Trade Statistics Yearbook*; for Taiwan, they are from the *Monthly Statistics of Exports and Imports, Taiwan Area, the Republic of China* by the Department of Statistics, Ministry of Finance, R.O.C.[64] The

[64] Trade weights in Glick and Hutchison (1999) are based on the average bilateral trade with those three countries in 1980. Since some of our sample countries do not have data in 1980, we use the data in 1990 instead. However, we admit that this could make our estimation results differ from that of Glick and Hutchison (1990).

Export Growth is calculated with the formula similar to that of the real GDP growth rate. For *M2/Reserves Ratio*, M2 is obtained with line 34 + line 35 for most of the sample countries.

(b) Other variables

In this section, we discuss the reason that we add other variables to explain both banking and currency crises, and the data sources of those variables.

a. Variables in the banking crisis equation

In the banking crisis regression, we add a repeated banking crisis dummy, regional variables, a explicit deposit insurance dummy, and a moral hazard dummy. The argument is as follows. Hardy and Pazarbasioğlu (1999) propose the importance of regional factor and repeated crises on banking crises. They argue that economic behavior will be permanently affected by a banking crisis and economic agents may behave differently when faced with such events a second time. Furthermore, repeated crises may indicate that inherent weaknesses in the banking sector were not adequately resolved. Therefore, the authors use a dummy variable to capture the effect of previous banking crises; it equals one in a repeat crisis and its lead-up, and zero otherwise. Moreover, a number of regional variables are used, because the authors believe that the causes of banking system distress differ across economies with different structural characteristics. An obvious example is the Southeast Asian financial crisis; it is shown to differ in several regards from episodes elsewhere. The regional variables were constructed by multiplying the macroeconomic explanatory variables with dummy variables that identified the region to which a country belongs. Both the repeated crisis dummy variable and the regional

variables have good explanatory powers in the estimation. In our regressions, we also construct a repeated crisis dummy (*Repeated Banking Crisis*) and several regional dummies (*Regional Variable 1* to *12*) with the methods suggested in Hardy and Pazarbasioğlu (1999). The regional variables are constructed by multiplying the macroeconomic explanatory variables, *Real GDP Growth* and *Inflation*, with dummy variables that identified the region to which a country belongs. We use six dummy variables to identify the region to which a country belongs: Asia, Africa, Europe, Middle East, Oceania, and South America. With this method, *Regional Variable 1* and *7* are Africa dummy multiplied by *Real GDP growth* and *Inflation*, so they both represent Africa; *Regional Variable 2* and *8* represent Asia; *Regional Variable 3* and *9* Europe; *Regional Variable 4* and *10* Middle East; *Regional Variable 5* and *11* Oceania; and *Regional Variable 6* and *12* South America.

The explicit deposit insurance and moral hazard variables are included in Hutchison and McDill (1999). The authors argue that explicit deposit insurance may lead to a greater incentive for the bank managers to take on risk and make the banking system more vulnerable to adverse economic conditions; Demirgüc-Kunt and Detragiache (1998a) find some support of this hypothesis. An alternative view is that a system of explicit deposit insurance may limit the liability of the government to support depositors and banks; while a country with an implicit system may actually take on greater responsibility for the protection of depositors by not making clear government policy on the issue. Moral hazard is an indicator measuring the coincidence of both financial liberalization and explicit deposit insurance. so it is constructed by multiplying explicit insurance with financial liberalization. The idea is to capture the potentially more potent effect on moral hazard when both of these institutional factors are combined. In our

regressions, we construct a dummy variable (*Insurance*) to identify whether a country has adopted explicit deposit insurance for the banking sector. It takes the value 1 if the country has, and 0 otherwise. In addition, we have another dummy variable (*Moral Hazard*) that is made up by multiplying *Liberalization* and *Insurance* together. Data of *Insurance* come from Table 3 of Garcia (1999), and Table 1 of Kyei (1995).[65] The results are available in the fifth column of Appendix 3. Moral hazard data are constructed by multiplying the financial liberalization dummy with the explicit deposit insurance dummy.

b. Variables in the currency crisis equation

With respect to currency crises, we take into account the possibility of currency crisis contagion and the influence of capital inflows, but do not control for the effect of foreign debt structures on currency crises such as Frankel and Rose (1996). Eichengreen *et al* (1996) investigate the contagion phenomena of currency crises from 1959 to 1993 in twenty industrial countries. They find that it is trade, rather than speculators' expectations based on macroeconomic factors, that transmits currency crises around the world. Therefore, we employ the variables that are significant in evaluating contagion through the trade channel: crisis elsewhere in the world (*Currency Crisis Elsewhere*), inflation rates (*Inflation*), unemployment rates, and the government budget position (*Budget*). However, since we cannot find appropriate data on India's unemployment rate, we do not

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[65] According to Kyei (1995), explicit deposit insurance means that the protection arrangements are normally explicitly stated in a stature.
"First, some kind of legislation, whether the constitution, central bank law or banking law would require the establishment of a guarantee system. Typically the statute would specify the types of institutions and deposits covered, coverage limits, management and membership, funding arrangements, and procedures for the resolution of bank failures." (p. 4)

put this variable in our regression. To investigate the significance of capital inflows on currency crises, we consider the capital control variable. As emphasized in Radelet and Sachs (1998a), capital inflows played a key role in the currency crisis in Southeast Asia. This variable is employed in Eichengreen *et al* (1996), and Rossi (1999), and it is significant in the latter study not in the former. In our regressions, we build a dummy variable (*Currency Crises Elsewhere*) that equals 1 if there is currency crisis elsewhere in the world, 0 otherwise; and another dummy variable (*Capital Control*) to indicate whether there are capital controls in a certain country. It equals 1 if there are, and 0 otherwise. Since including *Currency Crisis Elsewhere* often causes multicollinearity problems in the regressions, it is dropped by the software automatically if the problem appears. However, we still put this variable in our regression every time we run the regression. We do not report it in the outcome tables, but indicate its coefficient in the footnote if this variable is not dropped.

The data that are needed to construct *Inflation*, and *Government Budget* come from IFS (lines 64, 64..xx, 80, 99b. and 99b.p), and for Taiwan, the data are from *Financial Statistics, Taiwan District, The Republic of China. Government Budget* is the percentage of government budget surplus or deficit/GDP. The data for the *Currency Crisis Elsewhere* dummy use the currency crisis index to identify currency crises around the world. The data for *Capital Control* come from IMF's *Exchange Arrangements and Exchange Restrictions*. This report changes its capital control related classification in 1997, which covers the year 1996. Therefore, before 1996, we use the idea of Milesi-Ferretti (1998) to construct this dummy variable; after 1996, we adopt the method in Bai and Wei (2001). In Milesi-Ferretti (1998), the author uses three criteria in the summary table of *Exchange Arrangements and Exchange Restrictions* to identify the appearances of capital controls:

restriction on payments for capital transactions, separate exchange rate(s) for some or all capital transactions and/or some or all invisibles, and restriction on payments for current transactions. If a certain country has any of these restrictions, then we identify it as having some kind of capital controls. As mentioned in Milesi-Ferretti (1998), this identifying method provides information on neither the intensity nor the effectiveness of controls. However, since our focus is only on the relation between the appearance of capital controls and the currency crises, we still use data from *Exchange Arrangements and Exchange Restrictions*. In 1996, there are ten items in the category of controls on capital transactions in *Exchange Arrangements and Exchange Restrictions*, and eleven in 1997's edition. We use the idea in Bai and Wei (2001) that if a certain country has three or more controls on the ten or eleven items, then we assign 1 to the capital control dummy variable, 0 otherwise. With this method, the variable for some countries changes from 0 to 1 in 1996: Belgium, France, Sweden, Finland, Portugal, Spain, Australia, Argentina, Peru, Indonesia, Malaysia. Since the classification method has been changed, we cannot tell whether the change of the values taken by this dummy variable is due to a change of national policies or to the change of our identifying method.

For Taiwan, we search in various issues of the *Annual Report of the Central Bank of China* to evaluate the way it deals with capital controls. According to the reports, the Central Bank of China mainly loosened controls on capital inflows and outflows that were related to the capital and current accounts in 1987. After that year, firms and individuals could trade and hold foreign exchange freely without reporting it to the Bank. Although there were still limits on the amounts that individuals could remit inward and outward (US$ 50,000 and US$ 5 million, respectively) in 1987, these amounts were expanded year by year. For example, in 1989, the inward and outward remittances

allowed were US$ 500,000 and US$1 million, respectively; in 1990 they were US$ 2 million. Moreover, other restrictions such as those in offshore investment are abandoned gradually after 1987. Therefore, we take 1987 as the year that Taiwan gave up capital controls. The results of identifying capital controls for all the sample countries are available in the sixth column of Appendix 3.

(5) Summary

A brief definition of each variable discussed in this section is available in Appendix 4. As explained in section I, what we would like to investigate in the empirical study is the relationship between the policy combinations in stable economic times and the onset of economic crises in 'succeeding periods', in the regression equations, we put one-period lags of all the explanatory variables on the right-hand side. Putting all the variables together, we can illustrate our regression as follows:

Banking Crisis = f(lag of Transparency, lag of Peg, lag of Limited Flexible, lag of Managed Float, lag of Free Float, lag of Real GDP Growth, lag of Inflation, lag of Liberalization, lag of Repeated Banking Crisis, lag of Regional Variables 1 to *12, lag of Insurance, lag of Moral Hazard, lag of Interaction (Peg), lag of Interaction (Limited Flexible), lag of Interaction (Managed Float), lag of Interaction (Free Float), Currency Crisis) + error term*;

Currency Crisis = f(lag of Transparency, lag of Peg, lag of Limited Flexible, lag of Managed Float, lag of Free Float, lag of Overvaluation, lag of Export Growth, lag of M2/Reserves Ratio, lag of Currency Crisis Elsewhere, lag of Inflation, lag of Budget, lag of Capital Control,

lag of Interaction (*Peg*), *lag of Interaction* (*Limited Flexible*), *lag of Interaction* (*Managed Float*), *lag of Interaction* (*Free Float*), *Banking Crisis*) + *error term.*

III. DATA SAMPLE AND MISCELLANY

As stated in section II-1-(1) of this chapter, the sample size of the present paper is restricted by the availability of the transparency data from the WCY, so we have only fifty countries ranging from 1975 to 1997. Choosing the sample this way, we admit that there might be the self-selection problem that countries in this sample are those that are more transparent or more developed compared to the out of sample countries.

In addition, this sample contains not only countries experiencing banking or currency crises, but those who did not. This is commonly used in the study of crises, and this method is referred to as "program evaluation" in econometrics. Countries without either banking or currency crises are the "control group", while those with crises are the "experimental group" or the "treatment group". As mentioned in Glick and Hutchison (1999), this way enables us to make conclusion about the conditions distinguishing between crisis and non-crisis countries.

There are minimum data requirements to be included in the study of Glick and Hutchison (1999) that GDP are available for a minimum of 10 consecutive years over the sample period. However, since our sample is not as large as theirs, we do not include this requirement in our paper, but utilize all the data that we can get. In addition, to predict the occurrence of banking and currency crises, Glick and Hutchison (1999) also impose a "24-month window" to reduce the chances of capturing the continuation of the same banking or currency episodes. Since we are not interested in predicting, we do not follow

them in this way.

The last thing to mention is about the frequency of the data. Like Glick and Hutchison (1999), we use annual crisis observations with monthly data to identify them.[66] The disadvantage with annual data is that it "limit(s) some insights about the relative timing of the onset of currency and banking crises." Our defense is that the main concern is the relation between the central bank's policies and the onset of crisis. The exact timing of the crises is not that important to us. Moreover, as mentioned in Glick and Hutchison (1999), using annual data allows us to have more countries in our sample.[67]

IV. THE ECONOMETRIC METHOD

In this section, we briefly introduce the econometric tests and models that we will employ in estimating our regressions. Since most of the econometric tests and models are just routine procedures, we will not explain them specifically.[68]

1. Econometrics method and test results

In this section, we introduce the econometric methods we will use, justify their application, and show test results that support our choices.

(1) Econometric methods

No matter how careful we are in the process of specifying our model, there is still some chance that we may neglect some explanatory variables. This would lead to the

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[66] Kaminsky and Reinhart (1999) date banking crises by month.

[67] Glick and Hutchison (1999) have one more defense: they "do not believe that it is possible to date banking crises with such precision as monthly data presumes."

[68] We refer the reader to Wooldridge (2000) for a detail discussion of the econometric methodology.

so-called omitted variable problem, yet we could take advantage of the panel data structure to solve this problem. Therefore, in the single equation estimation, we first investigate whether the omitted variable problem occurs. We do this by performing the Breusch and Pagan test for the presence of unobserved effects (Breusch and Pagan, 1980). If the test results show that there are unobservables, the next step is to determine whether those unobservables are correlated with the explanatory variables, in order to determine whether a fixed or a random effects model is appropriate. We employ the Hausman test to make our choice (Hausman, 1978).

In the simultaneous equation estimation, our regressions are specified as follows:

$$Banking\ Crisis_{i,t} = \alpha_1 \cdot Currency\ Crisis_{i,t} + z_{i,t-1,1} \cdot \beta_1 + u_{i,t,1};$$

$$Currency\ Crisis_{i,t} = \alpha_2 \cdot Banking\ Crisis_{i,t} + z_{i,t-1,2} \cdot \beta_2 + u_{i,t,2}, \qquad (29)$$

where $z_{i,t}$'s are vectors of all the macroeconomic control variables, and β's are coefficient vectors. After solving these two equations, one can find that

$$Currency\ Crisis_{i,t} = \frac{1}{1-\alpha_1\alpha_2}\left[\alpha_2 z_{i,t-1,1}\beta_1 + z_{i,t-2,2}\beta_2 + \alpha_2 u_{i,t,1} + u_{i,t,2}\right];$$

$$Banking\ Crisis_{i,t} = \cdot\frac{\alpha_1}{1-\alpha_1\alpha_2}\left[\alpha_2 z_{i,t-1,1}\beta_1 + z_{i,t-2,2}\beta_2 + \alpha_2 u_{i,t,1} + u_{i,t,2}\right] + z_{i,t-1,1}\beta_1 + u_{i,t,1}.$$

Therefore, in equations (29), both *Banking Crisis* and *Currency Crisis* are related with u_{it1} and u_{it2}, which makes these two variables endogenous variables. To conquer this problem, we use instrumental variables combined in a fixed effects model to estimate equations (29).[69]

Since the dependent variables in our empirical model are binary variables, the usual econometric methods cannot be applied here. In econometrics, there are two models

[69] See Chapter 16 in Wooldridge (2000).

associated with binary dependent variables: the linear probability model (LPM) and the binary response model. The former refers to the situation where the binary dependent variable is linear in all the parameters; the latter uses a normal cumulative distribution function (the probit model) or a logistic function (the logit model) to transform the LPM into a non-linear formulation. The advantage of doing these transformations is that, contrary to the LPM, the predicted probabilities can be guaranteed to be within the 0-1 interval. However, given the difficulties involved in estimating probit or logit models with endogenous depend variables we still restrict ourselves to the LPM if this is the case.

(2) Test results

The Breusch-Pagan unobserved effect test results are in Table 5. The results show that there are unobserved effects in banking crisis equations, no matter which transparency measure we use. In the currency crisis equation, the unobserved effect does not exist. One of the problems with the Breusch-Pagan test is the assumption that the residuals, $u_{i,t}$'s in equations (29), are normally distributed. Therefore, if the $u_{i,t}$'s in our sample do not follow a normal distribution, the test results are not valid. We reconfirm the result of the Breusch-Pagan test in the currency crisis equation with an AR(1) test suggested in Wooldridge (2002).[70] The results of the AR(1) test reported in Table 6 show that the null hypothesis is rejected, which implies that the unobserved effects could exist. Although the test results from the Breusch-Pagan and the AR(1) tests are contradictory, we choose to adhere to the AR(1) results because the Breusch-Pagan has the strong normal distribution assumption that may or may not suit our sample. Having concluded

[70] For detail discuss about the AR(1) test, please refer to sections 7.8.5 and 10.4.4 of Chapters 7 and 10 of Wooldridge (2002).

that there exist the unobserved effects, the next question is: whether these effects are correlated with the explanatory variables.

To answer this question, we perform the Hausman test (see Table 7). In both the banking and currency crisis equations, no matter what transparency data sets we use, the null hypothesis is rejected. This indicates that, if the specifications of our regressions are correct, then the assumption behind the null hypothesis that $u_{i,t}$'s and the explanatory variables are not correlated is incorrect. Therefore, we will employ the fixed effects model when conducting the single equation estimation.

Table 5. The Breusch-Pagan test results

H_0: There is no unobserved effect		
	test statistics:	result:
banking crisis equation:		
with *Transparency*	$\chi^2(1) = 30.07$	reject H_0
with *Corruption I*	$\chi^2(1) = 10.59$	reject H_0
with *Corruption II*	$\chi^2(1) = 28.39$	reject H_0
currency crisis equation:		
with *Transparency*	$\chi^2(1) = 0.16$	cannot reject H_0
with *Corruption I*	$\chi^2(1) = 0.17$	cannot reject H_0
with *Corruption II*	$\chi^2(1) = 1.34$	cannot reject H_0

Table 6. The AR(1) test results

H_0: $u_{i,t}$ is serially uncorrelated			
	coefficient	t statistics:	result:
currency crisis equation:			
with *Transparency*	0.7114938	t = 25.87	reject H_0
with *Corruption I*	0.6415531	t = 21.28	reject H_0
with *Corruption II*	0.6411199	t = 19.70	reject H_0

Table 7. The Hausman test results

H_0: There is difference in coefficients of fixed and random effects models		
	test statistics:	result:
banking crisis:		
with *Transparency*	$\chi^2(1) = 57.81$	reject H_0
with *Corruption I*	$\chi^2(1) = 69.75$	reject H_0
with *Corruption II*	$\chi^2(1) = 31.75$	reject H_0
currency crisis		
with *Transparency*	$\chi^2(1) = 68.26$	reject H_0
with *Corruption I*	$\chi^2(1) = 35.27$	reject H_0
with *Corruption II*	$\chi^2(1) = 26.22$	reject H_0

2. Discussion on Glick and Hutchison (1999)

Glick and Hutchison (1999) employ the two-stage method for cross section data in Maddala (1983) to estimate banking and currency crises simultaneously. The model they look at is the so-called structural model:

$$y_{i,t,1} = \alpha_1 y_{i,t,2} + z_{i,t,1}\beta_1 + u_{i,t,1},$$

$$y_{i,t,2} = \alpha_2 y_{i,t,1} + z_{i,t,2}\beta_2 + u_{i,t,2},$$

where $y_{i,t,1}$ and $y_{i,t,2}$ can be viewed as *Banking Crisis* and *Currency Crisis*, and $z_{i,t,1}$ and $z_{i,t,2}$ the explanatory variables that we have discussed in previous sections. Solving the above equations, one can get the following equations

$$y_{i,t,1} = \beta_{01} + z_{i,t,1}\beta_{11} + z_{i,t,2}\beta_{12} + u_{i,t,2}\beta_{13} + u_{it1},$$

$$y_{i,t,2} = \beta_{02} + z_{i,t,1}\beta_{21} + z_{i,t,2}\beta_{21} + u_{i,t,1}\beta_{23} + u_{it2}. \qquad (30)$$

This is the reduced form model — endogenous variables all expressed in exogenous variables. Maddala's (1983) two-stage method involves two steps. First, estimate the reduced forms with probit. Second, substitute the predicted values of $y_{i,t,1}$ and $y_{i,t,2}$ from the reduced form estimation into the structural model and estimate it by probit. Maddala (1983) also offer the formulas that are needed to adjust the variance-covariance matrix.

This is a convenient and clear method to deal with simultaneous equations with dependent variables on both sides; however. in our estimations, we do not perform the same tasks as Glick and Hutchison (1999) do to extend this method to panel data. The reason is that to use Maddala's method, Glick and Hutchison (1999) assume that all the variables in vectors $z_{i,t,1}$ and $z_{i,t,2}$ of equations (30) are exogenous, so there is no omitted-variable style endogenous variable problem. However, this assumption only

brings us back to the random effects model case in which, the composite error is still correlated over time. Because of this, in conducting simultaneous-equation estimation, we do not follow Glick and Hutchison (1999), but use the methods we mentioned before: fixed effects or random effects models combined with instrumental variables. Using these methods, we do not need to make the exogenity assumption.

3. Discussion

Before illustrating how we will employ the econometric models discussed in previous sub-sections, let us review what our data set looks like and what we want to do with this data set.

Our sample has fifty countries ranging from 1975 to 1997, so it is a balanced panel data set. What we want to do is to examine the relation of our policy implications in stable times and the later onset of a crisis. The way that we do this is to use both banking and currency crises related variables as dependent variables to run the regressions, because we believe twin crisis phenomena is what should be considered.

Given the discussion in the above paragraph, we want to conduct a two-step method to examine our model. In the first step, we use several methods to prove that the twin crisis phenomena do occur in our sample. We not only count the proportion of twin crises on both banking and currency crises, but use single equation regressions to prove that it is necessary to consider twin crisis phenomena because banking (currency) crises can be explained very well by currency (banking) crises. In this stage, we show the results from LPM and fixed effects with LPM to prove our arguments. For the first step regression, we estimate the following two equations separately:

$$P\,(Banking\ Crisis) = \beta_0 + \beta_1 \cdot lag\ of\ Transparency + \beta_2 \cdot lag\ of\ Peg + \beta_3 \cdot lag\ of$$

$$\textit{Limited Flexible} + \beta_4\ \textit{lag of Managed Float} + \beta_5\ \textit{lag of Free Float} + \beta_6 \cdot \textit{lag of Real GDP Growth} + \beta_7 \cdot \textit{lag of Inflation} + \beta_8 \cdot \textit{lag of Liberalization} + \beta_9 \cdot \textit{lag of Repeated Banking Crisis} + \beta_{10} \cdot \textit{lag of Regional Variable 1} + \beta_{11} \cdot \textit{lag of Regional Variable 2} + \ldots + \beta_{21} \cdot \textit{lag of Regional Variable 12} + \beta_{22} \cdot \textit{lag of Insurance} + \beta_{23} \cdot \textit{lag of Moral Hazard} + \beta_{24}\ \textit{lag of Interaction (Peg)} + \beta_{25}\ \textit{lag of Interaction (Limited Flexible)} + \beta_{26}\ \textit{lag of Interaction (Managed Float)} + \beta_{27}\ \textit{lag of Interaction (Free Float)} + \beta_{28} \cdot \textit{Currency Crisis} + \textit{error term},$$

$$P(\textit{Currency Crisis}) = \beta_0 + \beta_1 \cdot \textit{lag of Transparency} + \beta_2 \cdot \textit{lag of Peg} + \beta_3 \cdot \textit{lag of Limited Flexible} + \beta_4\ \textit{lag of Managed Float} + \beta_5\ \textit{lag of Free Float} + \beta_6 \cdot \textit{lag of Overvaluation} + \beta_7 \cdot \textit{lag of Export Growth} + \beta_8 \cdot \textit{lag of M2/Reserves ratio} + \beta_9 \cdot \textit{lag of Currency Crisis Elsewhere} + \beta_{10} \cdot \textit{lag of Inflation} + \beta_{11} \cdot \textit{lag of Budget} + \beta_{12} \cdot \textit{lag of Capital Control} + \beta_{13}\ \textit{lag of Interaction (Peg)} + \beta_{14}\ \textit{lag of Interaction (Limited Flexible)} + \beta_{15}\ \textit{lag of Interaction (Managed Float)} + \beta_{16}\ \textit{lag of Interaction (Free Float)} + \beta_{17} \cdot \textit{Banking Crisis} + \textit{error term}. \quad (31)$$

There are several things to be noted here. First, some of the predicted probabilities of success from LPM related models may not be within unit interval. Although there are some methods that can adjust the predicted probabilities, for example, weighted least squares, as mentioned in Wooldridge (2000), if the proportion that is needed to be

adjusted is too large, then the adjustments can affect the results. Since we do find that the proportion of outside 0-1 interval predicted probabilities in our estimations is quite large (about 15%), we take Wooldridge's (2000) suggestion that we do not adjust the predicted values, but simply use Ordinary Least Squares (OLS) estimation and compute the robust standard errors in test statistics.

The second issue relates to the choice of the transparency variable. As what we have mentioned, since data on transparency, as we have defined it, does not exist, we use three proxies for it: *Transparency*, *Corruption I* and *Corruption II*. Doing this we may face the problem that there may be measurement errors in the proxies. The idea is illustrated very clearly in Chapter 9 of Wooldridge (2000), so we do not repeat here. Since we use proxies, when interpreting the empirical results, we must keep in mind that our proxies may suffer from the measurement error problem. In addition, as what we have discussed, our proxies can only 'partly' stand for the central bank's transparency level.

The third issue is about the interaction variables; recall that those variables are the product of *Transparency* (or *Corruption I* and *Corruption II*) and the regime variables. As we noted in sub-section (3) of section I of this chapter, one of the advantages of including the interaction variable is that it makes the effects of *Transparency* (the regime variables) on the onset of crisis depend on the level of the regime variables (*Transparency*). Here we address another benefit from the adding of this interaction variable. In the discussion of the fixed effects model, we emphasize that when one conducts fixed effects estimation, any explanatory variable that is constant over time will be swept away by the time-demeaned process. Looking at the data sets of *Transparency* and the regime variables, we find that for some countries, these two data sets do not vary a lot over time; therefore, when using the fixed effects method to estimate, we might actually eliminate

these two variables. The benefit of adding the interaction variables is just to offset this problem. Although for some countries, the *Transparency* and regime variables do not change a lot, multiplying them together can add more variation so that when conducting fixed effects estimation, we can avoid the swept-away problem.

The forth issue concerns estimation of fixed effects models. When estimating fixed effects models, we use country fixed effects in both crises in which the variable *Country* is assumed to be time constant. Rossi (1999) uses country fixed effects when estimating banking crises and time fixed effects when estimating currency crises, because in the latter, the author believes that time fixed effects can capture the phenomena that currency crises tend to be clustered in time. We also performed time fixed effects in estimating currency crises and the results are not very different from those of country fixed effects.

Now we can go to the second step of our estimation. In this step, since both *Banking Crisis* and *Currency Crisis* are endogenous variables, we use the fixed effects model combined with the instrumental variable method to estimate our regressions.

V. THE EMPIRICAL RESULTS

In this section, we discuss the empirical results and relate them to the conclusions of our theoretical model.

1. Step 1: Are there twin crises in our sample?

The necessity of using both banking and currency crisis data is examined in step 1. At this stage, we first use the time distribution of both banking and currency crises to show the coincidence of these two crises, and then we use seven econometric models and three different combinations of transparency and regime data sets to prove that currency

(banking) crises can explain banking (currency) crises well.

Table 8 is the time distribution of these two crises. When counting the number of each crisis, we use Glick and Hutchison's (1999) method that for multi-year banking crises we use only the first year in a spell of banking distress; for currency crises, we treat any large change in currency pressure following twenty four months of an identified currency crisis as the same one. As to twin crises, it is defined as when a banking (currency) crisis is accompanied by a currency (banking) crisis during the crisis period. The frequency of each crisis is defined as the number of crises divided by the number of years in each time category. So frequencies can be read as how many crises in each year of each time category.

In the whole sample period (the last column of Table 8), we have 59 banking crises, 107 currency crises, and 42 twin crises; twin crises are 71 percent of banking crises and 39 percent of currency crises. We can say that the proportion of twin crises on both banking and currency crises is very high. Look at the frequency of each crisis; the frequency of banking crises is much higher now than in 1970's. In 1990-1994 and 1995-1997, it is 2.6 and 2.1 times that in 1975-1979. For currency crises, the frequency does not change as much. The frequency of twin crises fluctuates more. It is 3.3 and 2.9 time that in 1975-1979 in 1990-1994's and 1995-1997's categories. From these analyses, we can conclude that the incidence of twin crises is very high, so it is necessary to take this phenomenon into account when studying crises.

The single equation estimation results are shown in Tables 9 to 11. Table 9 uses the variables *Transparency* and *Regime* to stand for the transparency level and exchange rate regime; this is the key data combination that we will focus on. Variable combinations of Tables 10 and 11 are *Corruption I* plus *Regime*, and *Corruption II* plus *Regime*,

respectively. As we have mentioned, these two variables (*Corruption I* and *Corruption II*) may be subjected to the measurement error problem, so we expect the estimation results from them may not be as good as those from the *Transparency* and *Regime* combination. In Tables 9 to 11, the first regression is the OLS with robust standard errors of test statistics and the second applies the fixed effects model to regular LPM. In all the tables, the numbers in parentheses are the P-values, and one asterisk indicates 5% significance, two 10%. The software that we used is STATA 7.0.

In Table 9 in the banking crisis equation, no matter what kind of econometric models we use, *Currency Crisis* is significant at 5% level. The same results are found in Tables 10 and 11. In addition, the sign of *Currency Crisis* is positive, which indicates that currency crises have positive affects on the onset of banking crises. Hence, in the banking crisis equation, we can say that banking crises are highly correlated with currency crises, and this result is very robust. In Table 9 in the currency crisis equation, *Banking Crisis* is significant at 5% level and has a positive sign. The same results are found in Tables 10 and 11. Therefore, we can also conclude that currency crises and banking crises are highly correlated, and this result is also robust. Moreover, a rough comparison of the results of regression (1) with those of regression (2) of both equations in Tables 9 to 11 shows that some of the signs and significant levels of the explanatory variables have changed, which indicates that some of the regressors are endogenous.

These results are consistent with the findings in Glick and Hutchison's (1999) single equation estimates. When using only contemporaneous and lagged crisis variables as regressors in probit estimation (Tables 4a and 4b in that paper), those authors find that the contemporaneous currency crisis (banking crisis) variable helps explain banking crises (currency crises). The result is more significant in developing and emerging

country samples. When they include other macroeconomic variables in the regressions (Tables 5a and 5b in Glick and Hutchison 1999), the contemporaneous currency crisis variable is significant for the whole sample, developing and emerging countries, while the banking crisis variable can help explain currency crises in emerging countries.

Our findings in the first step suggest that twin crises do happen in our sample and banking and currency crises are highly related. Therefore, it is necessary to estimate these two crises simultaneously; otherwise, we may lose important information from another crisis, and this may bias the estimation results.

2. Step 2: What policy combinations can reduce the chances of crises?

Since the twin crisis phenomenon is very obvious in our sample, we suspect that there must be something common to these two crises. If we ignore it, then our estimation results can be biased, and so will our policy conclusion be. Therefore, in this section, we employ simultaneous equation estimation methods to capture this 'commonality' between these two crises, and we will see what the data suggest is the best policy combination.

The econometric method we use is the instrumental variable with fixed effects model. As we mentioned above, we will focus on the results using *Transparency* and *Regime* combinations, and treat the results from *Corruption I* and *Corruption II* as reference.

Simultaneous estimation results are in Table 12; Table 13 is the estimated probabilities of each crisis for each variable combination. In Table 12, the transparency level in regression (3) comes from *Transparency*, in regression (4) from *Corruption I*, and in regression (5) from *Corruption II*. In Table 12, the transparency level does not change a lot from the single equation estimation: still positive and insignificant with

Transparency and *Corruption II*, and negative and insignificant with *Corruption I*. The results of *Peg*, *Limited Flexible*, and *Managed Float* do not change, either. The significance of *Free Float* switches from insignificant to significant in Table 12 for regressions (3) and (5). Since there are interaction variables of *Transparency* and all the regime variables, the effects of the transparency level and regime variables on the onset of banking crises depend on one another, so we cannot determine the effects right now. The outcome of *Real GDP Growth* is positive and changes from insignificant to significant in all regressions of Table 12. *Inflation* has the same effects, positive and significant, as the results of Tables 9 to 11. As we have mentioned, Demirgüc-Kunt and Detragiache (1998a) think that *Real GDP Growth* and *Inflation* can capture the effects of macroeconomic variables on the banking system's non-performing loans. If this argument is true, then the results from our estimations of these two variables show that macroeconomic variables have positive effects on banks' non-performing loans. The sign and significance of *Liberalization* almost do not change, except in regression (5); the results here are consistent with Glick and Hutchison (1999), Mehres and Kaufmann (2000), and Demirgüc-Kunt and Detragiache (1998a). The result of *Repeated Banking Crisis* changes a lot. When estimating with *Transparency* and *Corruption I*, it switches from significant in Tables 9 and 10 to insignificant in Table 12; with *Corruption II*, from positive to negative. The result of *Insurance* almost does not change: negative and significant in regressions (3) and (4), and insignificant in regression (5). As we stated before, this result is consistent with that of Glick and Hutchison (1999), but contradictory to that of Demirgüc-Kunt and Detragiache (1998a). Since there is an interaction variable of these two variables (*Moral Hazard*), the actual effects of *Liberalization* and *Insurance* on the onset of banking crises depend on one another. When we use instrumental

variables to estimate simultaneously, *Currency Crisis* is still significant in almost all estimations of the three regressions, and the sign is still positive. This finding is consistent with that of Glick and Hutchison (1999) when the authors use the whole sample or only developing countries (Table 6 in Glick and Hutchison 1999). While using only emerging markets, the currency crisis variable is significant in that paper. *Moral Hazard* is still positive but switches from significant in Tables 9 to 11 to insignificant Table 12; this result is similar to the findings of Hutchison and McDill (1999). This result implies that if there is moral hazard phenomenon in an economy (both explicit deposit insurance and financial liberalization), then the economy has a greater chance of suffering from a banking crises. Note that the sign of *Liberalization* is positive and of *Insurance* is negative. This indicates that financial liberalization can really increase the chance of experiencing a banking crisis, but the effect from explicit deposit insurance is uncertain. However, if both events occur at the same time, there is a greater probability of having a banking crisis.[71] The outcomes from regional variable estimation are quite similar to those of Tables 9 to 11: except for Africa related variables (*Regional Variables 1* and *7*), the rest have negative signs. This implies that countries located in Africa have a greater chance of having banking crises. This is somewhat contrary to the general perceptions. Except in regression (4), all other interaction variables are negative and insignificant, and this is the same as the results of Tables 9 to 11.

Before we discuss the hypothesis test results of the banking crisis equation of Table12, let us look at the results of the currency crisis equation. The transparency level is negative and insignificant with *Transparency* and *Corruption II*, and positive with

[71] The estimation results of *Real GDP Growth*, *Inflation*, *Liberalization*, *Repeated Banking Crisis*, *Insurance*, *Currency*, and *Moral Hazard* in Tables 8-1 and 9-1 are very similar to those of Table 7-1, so we do not discuss about these specifically.

Corruption I, which is the same is as in Tables 9 to 11. All the regime variables are negative, insignificant and do not change from the single equation estimations in all regressions. *Overvaluation* is almost the same, except for regression (4); the outcome is significant and positive in regression (3), not in regressions (4) and (5), which suggests that real overvaluation of a currency has a positive effect on increasing the probability of currency crises. This finding is consistent with that of Glick and Hutchison (1999). *Export Growth* also stays the same, negative and significant, and this result is exactly the same with Glick and Hutchison (1999). This result implies real export revenue growth can reduce the chance of experiencing a currency crisis. *M2/Reserves Ratio* also stay the same, positive and significant; this confirms partially the popular argument that increases in this ratio make a country vulnerable to currency crises. The two variables to control for contagion, *Inflation* and *Budget*, have the same effects: negative and insignificant with *Transparency* and *Corruption II*, and significant with *Corruption I* for *Inflation*, and negative and significant in all regressions for *Budget*. In Eichengreen *et al* (1996), these two variables are positively related to the onset of currency crises. Therefore, the result of our estimation implies that if currency crises are contagious, then the countries in our sample have less chance to suffer from currency crises. Considering our sample countries, we feel that this is quite contradictory to general perceptions. The result of *Capital Control* stays the same: positive and insignificant in regressions (3) and (4), and negative in regression (5). The positive sign is contradictory to our expectations because the general idea is that capital control should be able to prevent a currency crisis. *Banking Crisis* stays the same: positive and significant. This result is consistent with that of Glick and Hutchison (1999) with their emerging market sample, although that paper does not

take advantage of fixed or random effects model.[72] All the interaction variables are the same, positive and insignificant in regressions (3) and (5), but is negative in regression (4).

To investigate which policy combination is supported by the data, we use the following method. Taking the banking equation as an example, we write the regression equation as

Probability of a Banking Crisis = $c + \alpha \times$ *lag of Transparency* $+ \beta_1 \times$ *lag of Peg* $+ \beta_2 \times$ *lag of Limited Flexible* $+ \beta_3 \times$ *lag of Manage Float* $+ \beta_4 \times$ *lag of Free Float* $+ \gamma \times X + \theta_1 \times$ *lag of Interaction* (*Peg*) $+ \theta_2 \times$ *lag of Interaction* (Limited Flexible) $+ \theta_3 \times$ *lag of Interaction* (*Managed Float*) $+ \theta_4 \times$ *lag of Interaction* (*Free Float*) +error term,

where c is the constant term; X is other lagged variables in the banking crisis equation, so X and γ are vectors. Given a certain kind of regime, then we calculate the predicted probability of a banking crisis at different transparency levels, and then test whether the probability difference is significantly large. For instance, say Managed Float = 1, and we use transparency data from WCY, so we have 4 different transparency levels, 3, 2, 1, 0. When X is evaluated at the mean, the probability difference for *Transparency* = 3 and *Transparency* = 2 is

$$\text{probability difference} = [c + 3\hat{\alpha} + \hat{\beta}_3 + \hat{\gamma}\overline{X} + 3\hat{\theta}_3] - [c + 2\hat{\alpha} + \hat{\beta}_3 + \hat{\gamma}\overline{X} + 2\hat{\theta}_3]$$

$$= \hat{\alpha} + \hat{\theta}_3,$$

where the hat indicates the estimated parameter, and the over-bar the mean of each

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[72] The results of *Overvaluation*, *Export Growth*, *M2/Reserves Ratio*, *Inflation*, *Budget*, *Capital Control*, and *Banking Crisis* in Tables 8-1 and 9-1 are similar to those of Table 7-1.

variable in vector X. Given *Managed Float* = 1, the probability difference is $\hat{\alpha}+\hat{\theta}_3$ for each level of *Transparency*. With this method, we can get all the probability differences for different levels of exchange rate regimes, and conduct the hypothesis test of parameter combinations. For *Peg* = 1, the probability difference is $\hat{\alpha}+\hat{\theta}_1$; *Limited Flexible* = 1, $\hat{\alpha}+\hat{\theta}_2$; *Free Float* = 1, $\hat{\alpha}+\hat{\theta}_4$. The null hypothesis is H_0: $\alpha+\theta_x=0$, where x = 1, 2, 3, 4, and the alternative hypothesis is H_1: $\alpha+\theta_x<0$. What we want to test is, given a regime, whether a central bank should choose to be more transparent.

The test results are shown at the end of each crisis equation in Table 12. The critical value of $\chi^2_{0.05}$ with one degree of freedom is 3.841. In the banking crisis equation, none of the hypotheses can be rejected. As to currency crisis equation, the peg and managed float hypotheses of regression (3) can be rejected.

The predicted probabilities of different policy combinations are in Table 13. In regression (3), we use *Transparency* to stand for the central bank's transparency level; in regression (4), *Corruption I*; in regression (5), *Corruption II*. In addition, since currency crises cannot happen in a free float regime country, we need not calculate the predicted probability of this case. In regression (3), the transparency level is proxied by Transparency, so the larger the number is, the higher the transparency level. When the regime is free float, the predicted probabilities of banking crises are increasing as transparency level decreases. This implies that given a more flexible regime, the central bank should choose a more transparent type to prevent banking crises. When the given regime is managed float, the predicted probabilities of banking crises are still increasing as the transparency level decreases, so are the predicted probabilities of currency crises.

Therefore, we can say that given a median flexible regime, the central bank should adopt a transparent type to prevent both crises. Nevertheless, the probability difference is only statistically significant in the currency crisis equation. An interesting thing happens when the given regime is relatively fixed. When *Limited Flexible* = 1, the predicted probabilities of banking crises are decreasing as the transparency level decreases. This is a very interesting result. If we can say that *Limited Flexible* = 1 is a relatively more fixed regime, then the result suggests that given a more fixed regime, the central bank should choose a more opaque type to reduce the chance of experiencing banking crises. However, the probability difference is not significant. In the currency crisis equation, the predicted probabilities have the same pattern as before, and the probability differences are statistically insignificant. When the given regime is peg, in the banking crisis equation, the predicted probabilities go back to the old pattern: increases as the transparency level decreases, and the probability difference is not significant. In the currency crisis equation, the predicted probability pattern is still the same, and the probability difference is also.

In regression (4), the transparency data are proxied by corruption indices, so a transparency level of 1 indicates a less transparent level. The results in the banking crisis equation show a pattern that higher transparency decreases the probability of crisis, but the probability differences are not significant in all regimes. In currency crisis equation, when given a managed float regime, the results indicate that lower transparency can reduce the chance of experiencing a currency crisis. However, the probability differences are not significant in all crisis regressions. When the given regime is limited float, the probability increases as the transparency level decreases, and the difference is not significant. When the given regime is peg, the probability decreases as the transparency level decreases, but the probability difference is not significant. Transparency data of

regression (5) come from the combination of corruption indices and public sector sizes. A higher value of *Corruption II* indicates a higher level of transparency. In the banking crisis equation, the predicted values have a pattern that as the transparency level decreases, the probabilities of crisis increase, but the probability differences are not significant. In the currency crisis equation, when the given regime is managed float, the predicted results are decreasing as the transparency level decreases. When the regime is limited float, the outcome is decreasing. The results from the peg regime are the same as that of the limited float regime. The probability differences for all regimes are not significant in currency crisis equation.

Table 14 is the summary of all the policy suggestions in Table 13. One can see that the suggested choices for banking crises are quite consistent in all three regressions: transparency; only the choice for the limited flexible regime of regression (3) is opaqueness. On the other hand, the suggestions for currency crises are mixed, depending on which data set we use. It seems that if we use corruption-related data sets, then the outcomes tend to support opaqueness. As we mentioned before, because of the problems of using corruption to proxy for transparency, we draw our conclusions mainly on the results of regression (3) in Tables 12 and 13, although some of the probability differences are not statistically significant. We get the outcomes that when given a free float regime, central banks should choose more transparent types to prevent a banking crisis. When given relatively flexible regimes (a managed float regime), central banks can use more transparent types to reduce the chance of experiencing both banking and currency crises. If the central banks are given a relatively fixed regime (a limited flexible regime), the policy suggestions are: for banking crises, the central bank should pair this regime with an opaque type, but for currency crises, the choice is still transparency. When given a peg

regime, the central bank should use transparency to prevent both banking crises and currency crises.

3. Discussion

In this section, we compare our theoretical model with the empirical results and discuss the appropriatness of the policy suggestions.

Table 2 is the policy combinations suggested in our theoretical model. There are four combinations: when $\pi^* > \bar{\pi}^*$, if given a more flexible regime, then the central bank should choose to be opaque, otherwise, transparent; when $\pi^* < \bar{\pi}^*$, if given a more flexible regime, the central bank ought to be transparent, otherwise, opaque. The empirical study shows that if more flexible regimes, including free and managed float regimes, and the peg one are paired with transparency, then the countries are less susceptible to banking crises in the succeeding periods. As to currency crises, no matter what the regimes are, they should be coupled with transparency to make countries less vulnerable to currency crises in the following periods. Relating the empirical results to the theoretical ones we find that three of the four utility-enhancing policies in our theoretical model are consistent with the empirical studies suggested policy combination that can make a country less susceptible to crises. The one that can raise a central bank's welfare in stable times but makes it vulnerable to economic crises later is the combination of a more flexible regime with an opaque type.

Are these policy combinations reasonable? The theoretical rationale of the policy combinations has been illustrated in Chapter 2. Here we only focus on the explanation in practice. The relation of transparency and exchange rate regime is well illustrated in the

1998 report of the Euro-Currency Standing Committee Working Group of BIS (Bank for International Settlement). According to this report, the main benefits of greater transparency are to

> "improve the accountability of the authorities and the scope for markets to exercise financial discipline. This, in turn, could help to induce an earlier correction of unsustainable policies and allow market participants to form a more accurate view of the condition of individual countries, thereby also possibly limiting contagion."

Of course, there are potential costs associated with greater transparency: the reduced operational flexibility to manage reserves or to intervene covertly in order to counteract exchange market pressures, the uncertainties involved in the transition towards a more demanding disclosure standard, and the logistical burdens of implementation. The empirical results of currency crises in this paper suggested that these potential costs of greater transparency might be less than the benefits of it, so transparency is the only choice despite of the flexibility of regimes. However, the results for more fixed regimes are contradictory to general perceptions that to prevent speculative attacks, countries using more fixed regimes should be more opaque. As to banking crises, it is quite straightforward that if transparency is the only choice for currency crises, then it could be the choice to reduce the chances of currency-crisis caused banking crises. In addition, our empirical results on banking crises in the cases of free float, managed float, and fixed regimes confirm the argument of the BIS report that higher transparency gives the financial market discipline to follow, so the benefit of greater transparency outweighs the cost of it. However, our empirical results show that given a limited flexible regime, the appropriate type is opaque. Our explanation is that in this case, central banks need more operational flexibility to manage reserves or to intervene covertly in order to counteract

exchange market pressures; therefore, transparency could be harmful to central banks.

Applying the empirical results to investigate the Asian-5, we find that both Indonesia and Korea used the wrong policy combinations before crises. They coupled managed float style regimes with opaque types. If we say that managed float regimes are relatively flexible, then they adopted the wrong combination: flexible regimes with opaqueness. Malaysia was flexible and transparent. This is a correct policy combination in our theoretical model and empirical results; unfortunately, Malaysia still suffered from economic crises. This result reveals a possible shortcoming of our theoretical model. Since we did not put the onset of crises in our model, we can only say that the policy combinations suggested in our paper are the ones that can only make a country less susceptible to economic crises, not the combinations that can avoid enable countries to crises. This is one direction that we can extend the present model. The Philippines paired an independent float regime with an opaque type. This is a bad combination for the avoidance of both banking and currency crises. Thailand was peg and opaque, which is also not a combination that could make a country less vulnerable to crises.

CHPATER 4

CONCLUSIONS

The purpose of this paper is to find the relation between the choice of a central bank's transparency level, exchange rate regime, and inflation target during stable economic periods and the chance of experiencing economic crises in succeeding periods. We would like to see what combinations of these policies make the central bank more susceptible to economic crises later. Using a monetary policy game style model to investigate the policy combinations in stable economic times that can enhance the central bank's utility, we find that appropriate policy combinations depend on the relation between the central bank's inflation target and the public's expectations of it. When the former is greater than the latter, given a more flexible regime, the central bank should choose to be opaque, otherwise, transparent. On the other hand, when the inflation target is less than the expectation of it, given a more flexible regime, the central bank ought to be more transparent, otherwise, more opaque. Using the information on both banking and currency crises and appropriate econometric models to examine the policy combinations suggested by the theoretical model, we find that three of the four stable-time combinations can make the country less vulnerable to economic crises later. However, some of the support for these combinations is not statistically significant.

Applying this finding to the Asian-5, we find that Indonesia, Korea, the Philippines, and Thailand adopted the policy combinations that are showed in this paper to make countries more susceptible to crises; this could be the reason that they experienced both banking and currency crises in 1997 and 1998. However, Malaysia chose the correct combination but still had banking and currency crises in 1997. Moreover, Taiwan used

similar policy combination similar to Malaysia, and it did not experience crises in 1997 and 1998. This points out a shortcoming of our theoretical model: we did not put the onset of the crises into our model so all the policy combinations here are the ones that can only make a country less vulnerable to economic crises, not the ones that can prevent a country from experiencing crises. These facts suggest that this is one of the possible extensions of this paper.

In addition to the possible extensions of our theoretical model, there are several limitations of our empirical studies. First of all, given the imperfection of the data on transparency, we cannot get the expected empirical result that the probability differences between different policy combinations are significant. Second, as to the explanatory variables of banking crises, we focused mostly on macroeconomic and institutional variables. In some studies, structural variables that capture the characteristics of banking systems and financial markets are used that can explain the crises well. Including these variables in our future study is another aim of ours.

APPENDIX 1.
THE PROOF OF REAL CURRENCY OVERVALUATION

Table A.1. Real exchange rates, end of year data

	Indonesia	Korea	Malaysia	Philippines	Thailand	Taiwan	Argentina	Brazil	Mexico	Chile
1988	98.0	102.0	98.0	90.0	102.0	98.6	156.0	159.0	106.0	94.0
1989	93.0	95.0	94.0	85.0	98.0	90.5	692.0	175.0	107.0	99.0
1990	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1991	99.0	99.0	99.0	82.0	97.0	91.9	66.0	112.0	85.0	91.0
1992	92.0	94.0	87.0	69.0	90.0	80.7	49.0	119.0	74.0	74.0
1993	88.0	93.0	88.0	71.0	88.0	80.6	42.0	148.0	67.0	71.0
1994	92.0	91.0	86.0	62.0	89.0	83.9	44.0	53.0	111.0	66.0
1995	89.0	88.0	84.0	63.0	87.0	89.3	46.0	39.0	123.0	65.0
1996	80.0	88.0	78.0	56.0	80.0	86.3	44.0	35.0	95.0	61.0
Mar. 1997	75.0	89.0	72.0	53.0	75.0	92.7	42.0	33.0	81.0	55.0
Jun. 1997	78.0	89.0	75.0	54.0	76.0	90.8	42.0	33.0	79.0	55.0
Sep. 1997	99.0	88.0	92.0	66.0	104.0	90.7	42.0	33.0	75.0	53.0
1997	150.0	157.0	108.0	75.0	124.0	91.3	41.0	33.0	75.0	53.0

Source: Radlet and Sachs (1998a), Table 10; Taiwan's data were calculated by the authors with the method suggested in Radlet and Sachs (1998a)

The base figure (100) is the average for the year 1990.

APPENDIX 2.
THE PROOF OF NO REAL CURRENCY OVERVALUATION

Table A.2. Measures of real exchange rate misalignment, percentage from equilibrium value

	Methodology			
	PPP-1[a]	PPP-2[b]	Per capita GDP adjusted[c]	Monetary model[d]
	(Jan. – June 1997)	(May 1997)	(1996)	(May 1997)
Indonesia	6	-5	-16	0
Korea	-5	-9	1	-12
Malaysia	12	8	-41	2
Philippines	37	19	-16	-24
Thailand	11	7	-18	2
Taiwan	-2	-3	—	8
Argentina	65	—	34	—
Brazil	33	—	33	—
Mexico	3	—	-18	—
Chile	—	—	—	—

Source: Furman and Stiglitz (1998)

[a] Percentage change between real exchange rate average over 1989-1991 and average over January to June 1997.

[b] Overvaluation of the real exchange rate in May 1997 relative to Chinn's (1998) estimate of the PPP exchange rate over 1975-96.

[c] Percentage difference between actual real exchange rate in 1996 and the predicted rate for that year based on the fitted values from the regression of the real exchange rate on per capita GDP measured in PPP dollars. The actual real exchange rate is the ratio of the PPP rate to the dollar exchange rate in 1996, as calculated by the World Bank.

[d] Overvaluation of real exchange rate in May 1997 based on Chinn's sticky price monetary model of the exchange rate.

APPENDIX 3: CURRENCY AND BANKING CRISES DATES AND QUALITY EXPLANATORY VARIABLES (1975-1997)

	Currency Crises	Banking Crises	Financial Liberalization	Explicit Deposit Insurance	Capital Control
Argentina	1975-1976, 1982-1983, 1989-1991	1980-1982, 1989-1990, 1995-1997	1977-1982, 1987-1997	1971-1997	1975-1992, 1996-1997
Australia	1976, 1983, 1985-1987, 1993, 1995[6]	none[1]	1981-1997	implicit[5]	1975-1983, 1996-1997
Austria	none	none	1974-1997	1979-1997	1975-1990, 1997
Belgium	1982	none	1986-1997	1974-1997	1975-1989, 1996-1997
Brazil	1982-1983, 1987, 1990-1991, 1995	1990, 1994-1997	1975-1997	1995-1997	1975-1997
Canada	1976, 1992	1983-1985	1974-1997	1967-1997	none
Chile	1985	1976, 1981-1983	1974-1997	1986-1997	1975-1997
China	1989, 1993[6]	none[2]	1986-1988, 1996-1997[7]	implicit[5]	1980-1997
Columbia	1985	1982-1987	1980-1997	1985-1997	1975-1997
Czech, Republic	1993, 1997[6]	none[2]	1992-1997[8]	1994-1997	1990-1997
Denmark	none	1987-1992	1981-1997	1988-1997	1975-1987

(cont'd)

Egypt	1979, 1989-1991	1980-1985, 1991-1995	1991-1997	implicit[5]	1975-1997
Finland	1977-1978, 1982, 1991-1993	1991-1994	1986-1997	1969-1997	1975-1990, 1996-1997
France	1982	1994-1995	1974-1997	1980-1997	1975-1992, 1996-1997
Germany	none	1978-1979	1974-1997	1966-1997	1997
Greece	1980, 1982-1983, 1985	1991-1995	1974-1997	1993-1997	1975-1997
Hong Kong	none	1982-1986	1973-1997[3]	implicit[5]	none
Hungary	1989, 1994-1995	1991-1995	1990-1997[2]	1993-1997	1981-1997
Iceland	1983-1984, 1988, 1992-1993	1985-1986, 1993	1984-1997[9]	1985-1997	1975-1997
India	1976, 1991, 1993, 1995	1993-1997	1991-1997	1961-1997	1975-1997
Indonesia	1978, 1983, 1986, 1997	1994, 1997	1983-1997	implicit[5]	1977, 1996-1997
Ireland	none	none	1985-1997	1989-1997	1975-1991
Israel	1980-1982, 1984-1985, 1988, 1993[6]	1977-1983[1]	1990-1997[4]	implicit[5]	1975-1997

(cont'd)

Italy	1976, 1992, 1995	1990-1995	1974-1997	1987-1997	1975-1982, 1986-1992
Japan	1979, 1989-1990	1992-1997	1985-1997	1971-1997	1975-1978, 1995-1997
Jordan	1983, 1987-1989, 1992	1989-1990	1988-1997	implicit[5]	1975-1997
Korea	1980, 1997	1997	1984-1988, 1991-1997	1996-1997	1975-1997
Luxembourg	none	none	1974-1997	1989-1997	1975-1989
Malaysia	1986, 1997	1985-1988, 1997	1978-1997	implicit[5]	1996-1997
Mexico	1976, 1982, 1985, 1994-1995	1981-1991, 1995-1997	1989-1997	1986-1997	1982-1997
Netherlands	none	none	1974-1997	1979-1997	1975-1976
New Zealand	1975, 1983-1988, 1991	1987-1990	1980, 1984-1997	none	1975-1983
Norway	1978, 1986, 1992	1987-1993	1985-1997	1961-1997	1975-1994, 1997
Pakistan	none	none	1995-1997[2, 3]	implicit[5]	1975-1997
Peru	1976, 1979, 1978-1988	1983-1990	1980-1984, 1990-1997	1992-1997	1975-1992, 1996

(cont'd)

Philippines	1983-1984, 1986, 1997	1981-1987, 1997	1981-1997	1963-1997	1975-1997
Poland	1988-1989[6]	1991-1997[1]	1990-1997[2]	1995-1997	1986-1997
Portugal	1976-1978, 1982-1983, 1993, 1995	1986-1989	1984-1997	1992-1997	1975-1992, 1996-1997
Russia	none[6]	1995[1]	1992-1997[2]	implicit[5]	1992-1997
Singapore	1975	1982	1973-1997[3]	implicit[5]	1975, 1977, 1997
South Africa	1975, 1978, 1984-1986,1996	1977, 1985, 1989	1980-1997[3]	implicit[5]	1975-1997
Spain	1976-1977, 1982, 1992-1993	1977-1985	1974-1997	1977-1997	1975-1993, 1996-1997
Sweden	1977, 1981-1982, 1992-1993	1990-1993	1980-1997	1996-1997	1975-1992, 1996-1997
Switzerland	1978	none	1989-1997	1984-1997	none
Taiwan	1981[6]	none[1]	1989-1997[3]	1985-1997	1975-1986[10]
Thailand	1981, 1984, 1997	1983-1987, 1997	1989-1997	implicit[5]	1975-1997
Turkey	1978-1980, 1994	1982-1985, 1991, 1994-1995	1980-1982, 1984-1997	1983-1997	1975-1997

(cont'd)

United Kingdom	1976, 1979, 1981-1982, 1986, 1992	1975-1976, 1984	1974-1997	1982-1997	1975-1978
United States	1980, 1982, 1985-1987, 1990, 1995[6]	none[1]	1974-1997	1934-1997	none
Venezuela	1984, 1986, 1994-1996	1978-1986, 1994-1997	1981-1983, 1989-1997	1985-1997	1975-1997

[1] Source: Caprio and Klingebiel (1996)

[2] Source: Lindgren, Garcia, and Saal (1996)

[3] Source: Williamson and Mahar (1998)

[4] Source: Demirgüc-Kunt and Detragiache (1998)

[5] Source: Kyei (1995)

[6] Constructed by the authors

[7] Source: Mehran and Quintyn (1996)

[8] Source: Table 2.1 of *Transition Report* 1996

[9] Source: Guðmundsson and Kristinsson (1997)

[10] Source: *Annual Report of the Central Bank of China*, various years

APPENDIX 4. DEFINITIONS OF VARIABLES

dependent variables:

Banking Crises: A binary dummy variable equals 1 if a country experienced banking crises in the sample period, 0 otherwise.

Currency Crises: A binary dummy variable equals 1 if a country experienced currency crises in the sample period, 0 otherwise.

independent variables:

Transparency: A dummy variable with 4 values: 3, 2, 1, 0; a higher value indicate a high level of transparency. It is constructed with the data from *The World Competitiveness Yearbook.*

Corruption I: A binary dummy variable with the value 0 if a country is identified as transparent (no corrupt), 1 otherwise. It is constructed with the corruption indices in TI and supplemented by data in *The World Competitiveness Yearbook.*

Corruption II: A dummy variable with 3 values: 2, 1, 0; a higher value indicates a high level of transparency (no corrupt). It is constructed by combining corruption indices and public sector sizes.

Peg: A dummy with value 1 if a country adopts a pegged regime that is classified in the *Annual Report on Exchange Arrangements and Exchange Restrictions*, 0 otherwise.

Limited Flexible: A dummy with value 1 if a country adopts a limited flexibility regime that is classified in the *Annual Report on Exchange Arrangements and Exchange Restrictions,* 0 otherwise.

Managed Float: A dummy with value 1 if a country's regime is classified as "adjusted according to a set of indicators" or as "other managed floating" before 1997's issue, or as "managed floating" in 1997's and 1998's issues of the *Annual Report on Exchange Arrangements and Exchange Restrictions*, 0 otherwise.

Free Float: A dummy with value 1 if a country's regime is classified as independent floating in the *Annual Report on Exchange Arrangements and Exchange Restrictions*, 0 otherwise.

Real GDP Growth: indicating the real GDP growth rate

Inflation: indicating inflation rates

Liberalization: A dummy variable indicates whether interest rate liberalization appears in a country. It equals 1 if there is liberalization, 0 otherwise.

Repeated Banking Crisis: A dummy variable indicates whether a country has already had banking crises before. It equals 1 if a country has, 0 otherwise.

Regional Variables 1 to *12*: Dummy variables that are constructed by multiplying regional dummies with macro variables. Regional Variable 1 and 7 represent Africa; Regional Variable 2 and 8 Asia; Regional Variable 3 and 9 Europe; Regional Variable 4 and 10 Middle East; Regional Variable 5 and 11 Oceania; and Regional Variable 6 and 12 South America.

Insurance: A dummy variable that indicates whether a country has explicit deposit insurance in its banking sector. It equals 1 if the country does, 0 otherwise.

Moral Hazard: A dummy variable constructed by multiplying Liberalization with Insurance.

Over-Valuation: indicating the real currency over-valuation

Export Growth: indicating the real export growth rate

M2/reserves ratio: the ratio of M2 to foreign reserves

Currency Crisis Elsewhere: A dummy variable indicating whether there is currency curses elsewhere in the world. It equals 1 if there is, 0 otherwise.

Budget: the percentages of government budget surplus or deficit/GDP

Capital Control: A dummy variable indicates whether a country has restrictions on capital flows. It equals 1 if the country does, 0 otherwise.

APPENDIX 5. DATA SOURCES

variable	sources
dependent variable:	
Banking Crisis:	Glick and Hutchison (1999); Caprio and Klingebiel (1996); Lindgren, Garcia, and Saal (1996)
Currency Crisis:	Glick and Hutchison (1999); constructed by the authors with the data in IFS[1]
independent variables:	
Transparency:	*The World Competitiveness Yearbook*, 1996-1997; *The World Competitiveness Report*, 1992-1995
Corruption I:	Transparency International, 1995-1997, 1975-1989; *The World Competitiveness Report*, 1990-1994
Corruption II:	Transparency International, 1995-1997, 1975-1989; *The World Competitiveness Report*, 1990-1994; IFS[1]
Peg:	*Annual Report on Exchange Rate Arrangements and Exchange Restrictions*
Limited Flexible:	*Annual Report on Exchange Rate Arrangements and Exchange Restrictions*
Managed Float:	*Annual Report on Exchange Rate Arrangements and Exchange Restrictions*
Free Float:	*Annual Report on Exchange Rate Arrangements and Exchange Restrictions*
Real GDP Growth:	IFS[1]
Inflation:	IFS[1]
Liberalization:	Glick and Hutchison (1999); Lindgren, Garcia, and Saal (1996); Williamson and Mahar (1998); Demirgüc-Kunt and Detragiache (1998a)[2, 3]
Repeated Banking Crisis:	constructed by authors with the data in the data source of *Banking Crisis*

(cont'd)

Regional Variable 1 to *12*:	constructed by timing other macroeconomic explanatory variable with regional dummies
Insurance:	Kyei (1995); Garcia (1999)
Moral Hazard:	constructed by multiplying *Liberalization* with *Insurance*
Overvaluation:	IFS; Direction of Trade Statistic Yearbook[1, 4]
Export Growth:	IFS[1]
M2/Reserve Ratio:	IFS[1]
Budget:	IFS[1]
Capital Control:	Constructed by the authors with the method suggested in Milesi-Ferretti (1998) and Bai and Wei (2001), and the data in *Annual Report on Exchange Rate Arrangements and Exchange Restrictions*[5]

[1] Taiwan's data come from the *Financial Statistics, Taiwan District, The Republic of China (compiled in accordance with IFS format)* by the Economic Research Department, the Central Bank of China.

[2] Czech Republic's data come from the description of Table 2.1, Transition Report 1996.

[3] Iceland's data come from Guðmundsson and Kristinsson (1997).

[4] The direction of trade data of Taiwan come from the *Monthly Statistics of Exports and Imports, Taiwan Area, the Republic of China* by the Department of Statistics, Ministry of Finance, R.O.C.

[5] Taiwan's data come from the *Annual Report of the Central Bank of China*, various years.

BIBLIOGRAPHY

Annual Report of the Central Bank of China, Taiwan: Central Bank of China, various issues.

Annual Report on Exchange Rate Arrangements and Exchange Restrictions, Washington D.C.: IMF, various issues.

Barro, Robert J., and Gordon, David B., August 1983, "A Positive Theory of Monetary Policy in a Natural Rate Model." *Journal of Political Economy*, *91* (4), 589-610.

Bai, Chong-En, and Wei, Shang-Jin, March 2001, "The Quality of Bureaucracy and Capital Account Policies," Working Paper no. 2575, World Bank, Washington D.C.

Ben-Bassat, A., and Gottlieb, D., 1992, "On the Effect of Opportunity Cost on International Reserve Holdings," *Review of Economics and Statistics*, *74*, 329-32.

Breusch, T. S, and Pagan, A. R., 1980, "The LM Test and Its Applications to Model Specification in Econometrics," *Review of Economic Studies*, *47*, 239-254.

Canzoneri, Matthew B., December 1985, "Monetary Policy Games and the Role of Private Information," *American Economic Review*, *75*, 1056-1070.

Caprio, Gerard, Jr. and Klingebiel, Daniela, July 1996, "Bank Insolvencies: Bad Luck, Bad Policy, or Bad Banking," In *Annual World Bank Conference on Development Economics 1996*, edited by Bruno, Michael, and Pleskovic, Boris, Washington D.C.: World Bank.

Chinn, Menzie D., April 1998, "Before the Fall: Were East Asian Currencies Overvalued?" Working Paper no. 6491, Cambridge, Mass.: National Bureau of Economic Research.

Corsetti, Giancarlo, Pesenti, Paolo and Roubini, Nouriel, December 1998, "What caused the Asian Currency and Financial Crisis? Part I: A Macroeconomic Overview," Working Paper no. 6833, Cambridge, Mass.: National Bureau of Economic Research. (a).

Cukierman, A, and Meltzer, A. H., 1986, "A Theory of Ambiguity, Credibility, and Inflation under Discretion and Asymmetric Information," *Econometrica, 54*, 1099-1128.

Demirgüc-Kunt, Asli, and Detragiache, Enrica, March 1998, "The Determinants of Banking Crises in Developing and Developed Countries," *Staff Papers, 45* (1), Washington D.C.: IMF, (a).

_____ , June 1998, "Financial Liberalization and Financial Fragility," Working Paper WP/98/83, IMF, Washington D.C., (b).

Direction of Trade Statistics Yearbook, 1990, Washington D.C.: IMF.

Dornbusch, Rudiger, Goldfajn, Ilan, and Valdés, Rodrigo O., 1995, "Currency Crises and Collapses," *Brookings Papers on Economic Activity, 2*, 219-270.

Drees, Burkhard, and Pazarbasioğlu, Ceyla, June 1995, "The Nordic Banking Crises: Pitfalls in Financial Leberalization?" Working Paper WP/95/61, IMF Washington D.C.

Eichengreen, Barry, Rose, Andrew K. and Wyplosz, Charles, June 1995, "Exchange Market Mayhem: The Antecedents and Aftermath of Speculative Attacks," *Economic Policy, 21*, 249-312.

_____ , August 1996, "Contagious Currency Crises," Discussion Paper: 1453, Centre for Economic Policy Research.

Eichengreen, Barry, and Rose, Andrew, January 1998, "Staying Afloat When the Wind Shifts: External Factors and Emerging-Market Banking Crises," Working Paper no. 6370, Cambridge, Mass.: National Bureau of Economic Research.

Faust, Jon, and Svensson, Lars E. O., 1999, "The Equilibrium Degree of Transparency and Control in Monetary Policy," *Journal of Monetary, Credit, and Banking*,

_____ , May 2001, "Transparency and Credibility: Monetary Policy with Unobservable Goals," *International Economic Review, 42*, 369-397.

Financial Statistics, Taiwan District, The Republic of China, Taiwan: Central Bank of

China, various issues.

Fleming, J. M., 1962, "Domestic Financial Policies under Fixed and Floating Exchange Rates," *Staff Papers*, *9*, Washington D.C.: IMF.

Florini, Ann M., 1999, "Does the Invisible Hand Need a Transparency Glove? The Politics of Transparency," In *Annual World Bank Conference on Development Economics 1999*, edited by Pleskovic Boris, and Stiglitz, Joseph E., Washington D.C.: World Bank.

Fons, Jerome S, January 1999, "Improving Transparency in Asian Banking Systems," conference paper of the Internet Center for Corruption Research.

Frankel, Jeffrey, and Rose, Andrew K., 1996, "Currency Crashes in Emerging Markets," *Journal of International Economics*, *41*, 351-366.

Frankel, Jeffrey A., April 1998, "The Asian Model, the Miracle, the Crisis ant the Fund," speech delivered at The U.S. International Trade Commission.

Furman, Jason, and Stilgitz, Joseph E., 1998, "Economic Crises: Evidence and insights from East Asia," *Brookings Papers on Economic Activity*, *2*, 1-114.

Garcia, Gillian G. H., April 1999, "Deposit Insurance: A Survey of Actual and Best Practices," Working Paper WP/99/54, IMF, Washington D.C.

Garfinkel, Michelle R., and Oh, Seonghwan, 1995, "When and How Much to Talk, Credibility and Flexibility in Monetary Policy with Private Information," *Journal of Monetary Economics*, *35*, 341-357.

Geraats, Petra M., 2000, "Why Adopt Transparency? The Publication of Central Bank Forecasts," CIDER Working Paper 113, University of California, Berkeley, (a).

_____ , October 2000, "Precommitment, Transparency and Monetary Policy," paper presented for the Bundesbank/CFS conference "Transparency in Monetary Policy", Frankfurt, (b).

Girton, Lance, and Roper, Don, September 1997, "A Monetary Model of Exchange

Market Pressure Applied to Postwar Canadian Experience," *American Economic Review, 67*, 537-548.

Glick, Reuven and Hutchison, Michael, December 1999, "Banking and Currency Crises: How Common are Twins?" Working Paper PB99-07, Federal Reserve Bank of San Francisco, Center for Pacific Basin Studies.

Goldfajn, Ilan, and Valdés, Rodrigo O., February 1999, "The Aftermath of Appreciations," *Quarterly Journal of Economics, 114* (1), 229-262.

Guitián, Manuel, 1994, "Rule or Discretion in Monetary Policy: National and International Perspectives," In *Frameworks for Monetary Stability, Policy Issues and Country Experiences*, edited by Baliño , Tomás J.T. and Cottarelli, Carlo, Washington D.C.: IMF.

Guðmundsson, Már, and Kristinsson, Yngvi Örn, November 1997, "Monetary Policy in Iceland During the Ninetis," Policy Papers, Bank for International Settlements, Basle.

Hardy, Daniel C. and Pazarbasioğlu, Ceyla, September 1999, "Determinants and Leading Indicators of Banking Crises: Further Evidence," *Staff Papers, 46*, Washington D.C.: IMF.

Holden, Paul, Holden, Merle, and Suss Esther C., August 1979, "The Determinants of Exchange Rate Flexibility: An Empirical Investigation," *The Review of Economics and Statistics, 61*, 327-333.

Hausman, J. A., 1978, "Specification Tests in Econometrics," *Econometrica, 46*, 1251-1271.

Hutchison, Michael M. and McDill, Kathleen, July 1999, "Are All Banking Crisis Alike? The Japanese Experience in International Comparison," Working Paper no. 7253, Cambridge, Mass.: National Bureau of Economic Research.

International Financial Statistics, Washington D.C.: IMF, various issues.

Kaminsky, Graciela L., December 1999, "Currency and Banking Crises: The Early

Warning of Distress," Working Paper WP/99/178, IMF, Washington D.C.

Kaminsky, Graciela, and Reinhart, Carmen M., June 1999, "The Twin Crises: The Causes of Banking and Balance-of-Payments Problems," *American Economic Review, 89*, 473-500.

Kopits, L. and Craig, Jon, January 1998 "Transparency in Government Operations," Occasional Paper 158, IMF, Washington D.C.

Krugmen, Paul, 1979, "A Model of Balance of Payment Crises," *Journal of Money, Credit, and Banking, 11*, 311-325.

_____ ,March 1998, "Will Asia Bounce Back?," speech for Credit Suisse First Boston, Hong Kong, available at http://web.mit.edu/krugman/www.suisse.html.

Kydland, Finn and Prescott, Edward, June 1977, "Rules Rather than Discretion: the Inconsistency of Optimal Plans," *Journal of Political Economy, 85*, 473-492.

Kyei, Alexander, December 1995 "Deposit Protection Arrangements: A Survey," Working Paper WP/95/134, IMF, Washington D.C.

Lindgren, Carl-Joan, Garcia, Gillian, and Saal, Mattew I., September 1996, *Bank Soundness and Macroeconomic Policy*, Washington D.C.: IMF.

Maddala, G. S., 1983, *Limited-Dependent and Qualitative Variables in Econometrics*, UK: Cambridge University Press.

Mehran, Hassanali and Quintyn Marc, March 1996, "Financial Sector Reforms in China," World Bank article, available at http://www.worldbank.org/fandd/english/0396/articles/040396.htm.

Mehrez, Gil, and Kaufmann, Daniel, February 2000, "Transparency, Liberalization and Banking Crisis," Working Paper no. 2286, World Bank, Washington D.C.

Melvin, M., 1985, "The Choice of An Exchange Rate System and Macroeconomic Stability," *Journal of Money, Credit and Banking, 17*, 467-78.

Milesi-Ferretti, Gian Maria, 1998, "Why Capital Controls? Theory and Evidence," In *Positive Political Economy: Theory and Evidence*, edited by Eijffinger, Sylvester, and Huizinga, Harry, UK: Cambridge University Press.

Monthly Statistics of Exports and Imports, Taiwan Area, the Republic of China, 1990, Taiwan: Department of Statistics, Ministry of Finance,

Mundell, R. A., 1963, "Capital Mobility and Stabilization Policy under Fixed and Flexible Exchange Rates," *Canadian Journal of Economics and Political Science, 29*, 475-485.

Obstfeld, Maurice, 1994, "The Logic of Currency Crises," *Cahiers Êconomiques et Monétaires, 43*, 189-213.

Poirson, Hélène, April 2001 "How Do Countries Choose Their Exchange Rate Regime?" Working Paper, WP/01/46, IMF, Washington D.C.

Radelet, Steven and Sachs, Jeffrey, August 1998, "The Onset of the East Asian Currency Crisis," Working Paper no. 6680, Cambridge, Mass.: National Bureau of Economic Research, (a).

_____ , 1998, "The East Asian Financial Crisis: Diagnosis, Remedies, Prospects." *Brookings Papers on Economic Activity, 1*, 1-90, (b).

Report of the Working Group on Transparency and Accountability, October 1998, Bank For International Settlements, Basle.

Report of a Working Group established by the Euro-currency Standing Committee of the central banks of the Group of Ten countries, Enhancing Transparency Regarding the Authorities' Foreign Currency Liquidity Position, September 1998, Bank for International Settlements, Basle.

Rossi, Marco, May 1999, "Financial Fragility and Economic Performance in Developing Economies: Do Capital Controls, Prudential Regulation and Supervision Matter?" Working Paper WP/99/66, IMF, Washington D.C.

Sheng, A., 1995, *Bank Restructuring*, Washington D.C.: World Bank.

Stiglitz, Joseph, February 4, 1998, "Bad Private-Sector Decisions," *The Wall Street Journal*, (a).

_____ , March 12, 1998, "Sound Finance and Sustainable Development in Asia," address to the Asia Development Forum, available at http://www.worldbank.org/html/exdr/extme/jssp031298.html (b).

_____ , 1999, "Lessons From East Asia," *Journal of Policy Modeling*, *21* (3), 311-330.

Summers, Lawrence H., March 1998, "Opportunities out of Crises: Lessons From Asia," speech to the Overseas Development Council, Treasury News, PR-2309.

Supporting Document to the *Code of Good Practice on Transparency in Monetary and Financial Policies* Part 2 — Good Transparency Practices for Monetary Policy by Central Banks, available at http://www.imf.org/

Tarkka, Juha and Mayes, David, December 1999, "The Value of Publishing Official Central Bank Forecasts," Discussion Papers 22/99, Bank of Finland.

The World Competitiveness Yearbook, Switzerland: IMD International, various issues.

Williamson, John, and Mahar, Molly, November 1998, "A Survey of Financial Liberalization," In *Essays in International Finance*, *211*, New Jersey: International Financial Section, Department of Economics, Princeton University.

Wooldridge, Jeffrey M., 2000, *Introductory Econometrics: A Modern Approach*, US: South-Western.

_____ , 2002, Econometric Analysis of Cross Section and Panel Data, London: The MIT Press.

Yellen, Janet, April 1998 "Lessons From the Asian Crisis," speech to Council on Foreign

Table 8. Coincidence of banking and currency crises

	1975-1979	1980-1984	1985-1989	1990-1994	1995-1997	1975-1997
banking crises:						
number	7	15	10	18	9	59
frequency	1.4	3	2	3.6	3	2.57
currency crises:						
number	24	29	22	21	11	107
frequency	4.8	5.8	4.4	4.2	3.67	4.65
twin crises:						
number	4	9	9	13	7	42
frequency	0.8	1.8	1.8	2.6	2.33	1.83

Table 9. Single equation estimation: *Transparency*

	regression (1)[a] (LPM)	regression (2)[a] (fixed effects)
dependent variable: *Banking Crisis*		
Transparency	.3790437* (0.001)	.5327218 (0.218)
Peg	.7517602* (0.000)	.7519373** (0.064)
Limited Flexible	.4331777* (0.000)	.2219686 (0.572)
Managed Float	.6409257* (0.000)	.5965748 (0.113)
Free Float	.635531* (0.000)	.5794195 (0.127)
Real GDP Growth	.1848137 (0.905)	2.516285 (0.124)
Inflation	.9553597* (0.000)	.9018681* (0.001)
Liberalization	.0881943 (0.106)	.127048* (0.044)
Repeated Banking Crisis	.1341998* (0.000)	.108845* (0.039)
Insurance	-.1102092* (0.041)	-.3010276* (0.002)
Currency Crisis	.2114116* (0.000)	.1915717* (0.000)
Moral Hazard	.0608738 (0.348)	.2024328* (0.034)
Regional Variable 1	-.7522619 (0.804)	3.743989 (0.443)
Regional Variable 2	-.9973225 (0.538)	-4.143703* (0.020)
Regional Variable 3	-.1430913 (0.927)	-3.284771** (0.054)
Regional Variable 4	-2.051271 (0.267)	-4.008142* (0.037)
Regional Variable 5	-4.591573* (0.031)	-5.85957* (0.035)

Table 9 (cont'd).

Regional Variable 6	-.3983906 (0.801)	-2.535979 (0.132)
Regional Variable 7	-2.966533* (0.000)	3.973184 (0.264)
Regional Variable 8	-.8880875* (0.042)	-2.133659* (0.004)
Regional Variable 9	-.9808253* (0.000)	-1.107355* (0.000)
Regional Variable 10	-1.022556* (0.000)	-.8949279* (0.001)
Regional Variable 11	-1.768753 (0.181)	-1.105809 (0.526)
Regional Variable 12	-.9465404 (0.000)	-.8916289* (0.001)
Interaction (Peg)	-.4439246* (0.001)	-.6198656 (0.158)
Interaction (Limited Flexible)	-.3602285* (0.003)	-.4449834 (0.304)
Interaction (Managed Float)	-.4336029* (0.000)	-.5699699 (0.185)
Interaction (Free Float)	-.4629076* (0.000)	-.6292704 (0.145)
constant	-.4579088* (0.000)	-.3594641 (0.356)

Dependent variable: *Currency Crisis*		
Transparency	-.4080842* (0.028)	-.4662731 (0.257)
Peg	-.2805301* (0.014)	-.2109547 (0.593)
Limited Flexible	-.5105854* (0.000)	-.2932196 (0.442)
Managed Float	-.3911162* (0.000)	-.3030379 (0.405)
Free Float	-.4201957* (0.000)	-.4988038 (0.173)
Overvaluation	.001037* (0.037)	.0010615** (0.070)

Table 9 (cont'd).

Export Growth	-.4732485* (0.000)	-.4350672* (0.000)
M2/Reserves Ratio	.0008674 (0.216)	.0033248* (0.015)
Inflation	-.0024535 (0.549)	-.0045223 (0.246)
Budget	-1.024356* (0.004)	-1.077946* (0.012)
Capital Control	.0097891 (0.758)	.059461 (0.267)
Banking Crisis	.1692494* (0.000)	.1956683* (0.000)
Interaction (Peg)	.310851** (0.100)	.2631584 (0.531)
Interaction (Limited Flexible)	.395211* (0.033)	.4488541 (0.276)
Interaction (Managed Float)	.3739971* (0.040)	.3740105 (0.361)
Interaction (Free Float)	.4132653* (0.024)	.4460451 (0.278)
constant	.4669171* (0.000)	.3935784 (0.294)

Note: Numbers in the parentheses are P-values.

Significance at 5 percent level is denoted by *; at 10 percent level by **.

[a] The variable "Currency Crisis Everywhere" in currency-crisis equation was dropped in the regression because of colliearity problem.

Table 10. Single equation estimation: *Corruption I*

	regression (1)[a] (LPM)	regression (2)[a] (fixed effects)
dependent variable: *Banking Crisis*		
Corruption I	-.349216* (0.003)	-.5048298 (0.252)
Peg	.2064069* (0.036)	.1276454 (0.574)
Limited Flexible	.0625644 (0.486)	-.1340346 (0.575)
Managed Float	.0286039 (0.724)	.0246216 (0.907)
Free Float	.0811277 (0.388)	.0167317 (0.942)
Real GDP Growth	.5557119 (0.693)	2.549544 (0.122)
Inflation	.7732517* (0.000)	.8640889* (0.001)
Liberalization	.0929155** (0.064)	.1059359** (0.090)
Repeated Banking Crisis	.1462688* (0.000)	.1196934* (0.024)
Insurance	-.0792852 (0.130)	-.3031668* (0.002)
Currency Crisis	.2160296* (0.000)	.1995094* (0.000)
Moral Hazard	.043982 (0.472)	.2110152* (0.029)
Regional Variable 1	-1.768918 (0.595)	4.410213 (0.370)
Regional Variable 2	-1.579821 (0.281)	-4.177613* (0.020)
Regional Variable 3	-.6561807 (0.642)	-3.256419** (0.057)
Regional Variable 4	-2.58076 (0.127)	-4.319868* (0.026)
Regional Variable 5	-4.602042 (0.025)	-5.82842* (0.037)

Table 10 (cont'd).

Regional Variable 6	-.7114835 (0.622)	-2.542657 (0.134)
Regional Variable 7	-1.647431* (0.043)	5.440293 (0.128)
Regional Variable 8	-1.121129* (0.018)	-2.041337* (0.006)
Regional Variable 9	-.78139* (0.000)	-1.051037* (0.000)
Regional Variable 10	-.8017691* (0.000)	-.8776529* (0.002)
Regional Variable 11	-.0830775 (0.949)	.0159805 (0.993)
Regional Variable 12	-.7638674* (0.000)	-.8533208* (0.001)
Interaction (Peg)	.4540036* (0.002)	.5419788 (0.230)
Interaction (Limited Flexible)	.4046396* (0.002)	.540159 (0.230)
Interaction (Managed Float)	.5812442* (0.000)	.5662966 (0.189)
Interaction (Free Float)	.5379847* (0.000)	.5064956 (0.251)
constant	-.091224 (0.209)	.1062243 (0.627)

Dependent variable:
Currency Crisis

Corruption I	.3078695** (0.090)	.4343474 (0.299)
Peg	-.0362198 (0.836)	-.0423085 (0.837)
Limited Flexible	-.1536019 (0.368)	.2173345 (0.340)
Managed Float	.0189373 (0.914)	.0567097 (0.766)
Free Float	.0408661 (0.816)	-.0646557 (0.752)
Overvaluation	.0011638* (0.019)	.000994** (0.096)

Table 10 (cont'd).

Export Growth	-.4938716* (0.000)	-.4408101* (0.000)
M2/Reserves Ratio	.000901 (0.163)	.0029216* (0.031)
Inflation	-.001853 (0.642)	-.0047585 (0.229)
Budget	-1.026588* (0.004)	-.9819038* (0.020)
Capital Control	.0461076 (0.117)	.0513577 (0.351)
Banking Crisis	.1886188* (0.000)	.2075844* (0.000)
Interaction (Peg)	-.3029086 (0.115)	-.5192662 (0.223)
Interaction (Limited Flexible)	-.1778197 (0.346)	-.5344592 (0.213)
Interaction (Managed Float)	-.3912277* (0.037)	-.5414841 (0.186)
Interaction (Free Float)	-.4033535* (0.026)	-.5222989 (0.209)
constant	.0093533 (0.958)	-.0404194 (0.848)

Note: Numbers in the parentheses are P-values.

Significance at 5 percent level is denoted by *; at 10 percent level by **.

[a] The variable "Currency Crisis Everywhere" in currency-crisis equation was dropped in the regression because of colliearity problem.

Table 11. Single equation estimation: *Corruption II*

	regression (1)[a] (LPM)	regression (2)[a] (fixed effects)
dependent variable: *Banking Crisis*		
Corruption II	.1816158**	.2124054
	(0.094)	(0.420)
Peg	.5998496*	.5649689**
	(0.000)	(0.077)
Limited Flexible	.3232152*	.1760639
	(0.031)	(0.577)
Managed Float	.5014787*	.4349119
	(0.000)	(0.150)
Free Float	.4998065*	.3549596
	(0.000)	(0.245)
Real GDP Growth	.1362811	2.494059
	(0.925)	(0.123)
Inflation	.7794514*	.8487791*
	(0.000)	(0.001)
Liberalization	.0893896**	.0977428
	(0.100)	(0.125)
Repeated Banking Crisis	.1273797*	.078726
	(0.001)	(0.160)
Insurance	-.0679016	-.2978185*
	(0.224)	(0.006)
Currency Crisis	.2182665*	.1943998*
	(0.000)	(0.000)
Moral Hazard	.0343009	.2433916*
	(0.613)	(0.017)
Regional Variable 1	-.8549936	5.451435
	(0.805)	(0.308)
Regional Variable 2	-1.23239	-4.31943*
	(0.411)	(0.017)
Regional Variable 3	-.1649232	-3.362783*
	(0.909)	(0.045)
Regional Variable 4	-2.098921	-4.378251*
	(0.224)	(0.021)
Regional Variable 5	-4.514514*	-5.947859*
	(0.034)	(0.029)

Table 11 (cont'd).

Regional Variable 6	-.3732724 (0.804)	-2.163332 (0.202)
Regional Variable 7	-1.807976** (0.063)	5.774511 (0.102)
Regional Variable 8	-.7272288 (0.128)	-1.687049* (0.039)
Regional Variable 9	-.7851785* (0.000)	-1.062922* (0.000)
Regional Variable 10	-.8421359* (0.000)	-.8853797* (0.001)
Regional Variable 11	-.7278181 (0.583)	-.1484181 (0.932)
Regional Variable 12	-.7720656* (0.000)	-.8384443* (0.001)
Interaction (Peg)	-.2875586* (0.029)	-.3245271 (0.229)
Interaction (Limited Flexible)	-.2253556** (0.054)	-.191865 (0.479)
Interaction (Managed Float)	-.2862689* (0.006)	-.2671412 (0.305)
Interaction (Free Float)	-.2717401* (0.008)	-.2124161 (0.422)
constant	-.3107715* (0.012)	-.2108089 (0.491)
Dependent variable: *Currency Crisis*		
Corruption II	-.2684967* (0.000)	-.3436544 (0.181)
Peg	-.3173966** (0.063)	-.4294192 (0.172)
Limited Flexible	-.3901417* (0.017)	-.3320082 (0.284)
Managed Float	-.4049281* (0.008)	-.3836364 (0.193)
Free Float	-.3323719* (0.023)	-.4665446 (0.116)
Overvaluation	.0010473** (0.051)	.0001448 (0.827)

Table 11 (cont'd).

Export Growth	-.4322907*	-.3543786*
	(0.002)	(0.007)
M2/Reserves Ratio	.0014494**	.0030765*
	(0.097)	(0.039)
Inflation	-.0052701**	-.0105152*
	(0.059)	(0.017)
Budget	-1.146714*	-1.356091*
	(0.014)	(0.010)
Capital Control	.0171989	-.0084878
	(0.628)	(0.895)
Banking Crisis	.1795373*	.1994421*
	(0.000)	(0.000)
Interaction (Peg)	.2514856*	.3479597
	(0.001)	(0.186)
Interaction (Limited Flexible)	.2269059*	.4094303
	(0.000)	(0.122)
Interaction (Managed Float)	.3125994*	.3546655
	(0.000)	(0.164)
Interaction (Free Float)	.2629542*	.257041
	(0.000)	(0.320)
constant	.357687*	.4915173
	(0.036)	(0.112)

Note: Numbers in the parentheses are P-values.

Significance at 5 percent level is denoted by *; at 10 percent level by **.

[a] The variable "Currency Crisis Everywhere" in currency-crisis equation was dropped in the regression because of colliearity problem.

Table 12. Simultaneous equation estimation

	regression (3)[a] (*Transparency*)	regression (4)[a] (*Corruption I*)	regression (5)[a] (*Corruption II*)
dependent variable: *Banking Crisis*			
transparency level	.5885828 (0.179)	-.44314 (0.321)	.2546722 (0.379)
Peg	.8187317* (0.047)	.1674335 (0.458)	.6762109** (0.054)
Limited Flexible	.3488568 (0.388)	-.0966707 (0.697)	.3395819 (0.327)
Managed Float	.620797 (0.101)	.0044614 (0.983)	.495867 (0.132)
Free Float	.6890571** (0.081)	.0862627 (0.707)	.6142976** (0.077)
Real GDP Growth	2.755775** (0.093)	2.884119** (0.079)	3.031757** (0.084)
Inflation	.9690404* (0.000)	.9222898* (0.001)	.9939791* (0.001)
Liberalization	.1701519* (0.015)	.1464847* (0.045)	.1948769* (0.015)
Repeated Banking Crisis	.0547118 (0.326)	.0671335 (0.224)	-.0077362 (0.904)
Insurance	-.293125* (0.019)	-.3047911* (0.020)	-.2155155 (0.135)
Currency Crisis	.3373337** (0.095)	.3084487 (0.165)	.683501* (0.011)
Moral Hazard	.1585332 (0.224)	.1774637 (0.200)	.0766424 (0.618)
Regional Variable 1	3.815818 (0.488)	4.583773 (0.406)	3.099924 (0.597)
Regional Variable 2	-4.157952* (0.019)	-4.229189* (0.017)	-4.683002* (0.017)
Regional Variable 3	-3.052116** (0.082)	-3.144594** (0.068)	-3.001135 (0.102)
Regional Variable 4	-4.14829* (0.031)	-4.728629* (0.014)	-4.760674* (0.020)
Regional Variable 5	-4.53388 (0.120)	-4.544267 (0.116)	-4.206323 (0.171)

Table 12 (cont'd).

Regional Variable 6	-2.744299 (0.104)	-2.821841** (0.094)	-2.81109 (0.128)
Regional Variable 7	3.82228 (0.307)	5.656996 (0.125)	3.689337 (0.351)
Regional Variable 8	-2.098503* (0.007)	-1.951373* (0.012)	-1.576713** (0.078)
Regional Variable 9	-1.352636* (0.000)	-1.248379* (0.000)	-1.527578* (0.000)
Regional Variable 10	-1.001397* (0.000)	-.9703013* (0.001)	-1.167765* (0.000)
Regional Variable 11	-1.627205 (0.427)	-.3960664 (0.858)	-2.978436 (0.221)
Regional Variable 12	-.9562755* (0.000)	-.9086453* (0.001)	-.9776432* (0.001)
Interaction (Peg)	-.660473 (0.135)	.5329217 (0.253)	-.3691132 (0.211)
Interaction (Limited Flexible)	-.5128297 (0.244)	.5728552 (0.215)	-.2730124 (0.364)
Interaction (Managed Float)	-.6156083 (0.155)	.5917349 (0.174)	-.327493 (0.249)
Interaction (Free Float)	-.667668 (0.127)	.5185279 (0.256)	-.2698843 (0.351)
constant	-.4869112 (0.243)	.0040647 (0.986)	-.4324919 (0.226)
Test:			
H_0: $\alpha + \theta = 0$ H_1: $\alpha + \theta_1 < 0$	$\chi^2(1) = 1.11$	$\chi^2(1) = 0.78$	$\chi^2(1) = 3.25$
H_0: $\alpha + \theta = 0$ H_1: $\alpha + \theta_2 < 0$	$\chi^2(1) = 2.46$	$\chi^2(1) = 1.49$	$\chi^2(1) = 0.06$
H_0: $\alpha + \theta = 0$ H_1: $\alpha + \theta_3 < 0$	$\chi^2(1) = 0.30$	$\chi^2(1) = 2.59$	$\chi^2(1) = 2.09$
H_0: $\alpha + \theta = 0$ H_1: $\alpha + \theta_4 < 0$	$\chi^2(1) = 3.75$	$\chi^2(1) = 0.48$	$\chi^2(1) = 0.07$
Dependent variable: *Currency Crisis*			
Transparency	-.5015582 (0.228)	.4560116 (0.279)	-.3376119 (0.191)

Table 12 (cont'd).

Peg	-.2659578 (0.513)	-.0528608 (0.799)	-.4153457 (0.193)
Limited Flexible	-.3159678 (0.411)	.2197423 (0.336)	-.3252088 (0.296)
Managed Float	-.3424952 (0.355)	.0547712 (0.774)	-.3723159 (0.212)
Free Float	-.5461409 (0.145)	-.071708 (0.728)	-.4527141 (0.133)
Overvaluation	.0010475** (0.075)	.0009819 (0.101)	.0001689 (0.801)
Export Growth	-.4307176* (0.000)	-.4361324* (0.000)	-.3584428* (0.007)
M2/Reserves Ratio	.0033172* (0.015)	.0028887* (0.034)	.0031237* (0.037)
Inflation	-.0053269 (0.197)	-.0054869 (0.195)	-.0102211* (0.024)
Budget	-1.00437* (0.024)	-.9336565* (0.031)	-1.413399* (0.013)
Capital Control	.0587161 (0.274)	.0507293 (0.358)	-.0077979 (0.904)
Banking Crisis	.2671577* (0.032)	.2668338* (0.037)	.1657264 (0.223)
Interaction (Peg)	.3057116 (0.474)	-.5412328 (0.208)	.3395054 (0.201)
Interaction (Limited Flexible)	.4793618 (0.250)	-.5598557 (0.196)	.4040382 (0.128)
Interaction (Managed Float)	.4108008 (0.322)	-.5688309 (0.170)	.3468363 (0.177)
Interaction (Free Float)	.4879582 (0.243)	-.5470706 (0.192)	.2489079 (0.339)
constant	.4193317 (0.268)	-.0439597 (0.835)	.4841934 (0.119)
Test: (chi-square)			
H_0: $\alpha + \theta = 0$ H_0: $\alpha + \theta_1 < 0$	$\chi^2(1) = 11.39$	$\chi^2(1) = 0.93$	$\chi^2(1) = 0.00$
H_0: $\alpha + \theta = 0$ H_0: $\alpha + \theta_2 < 0$	$\chi^2(1) = 0.22$	$\chi^2(1) = 1.03$	$\chi^2(1) = 1.04$

Table 12 (cont'd).

H_0: $\alpha + \theta = 0$ H_0: $\alpha + \theta_3 < 0$	$\chi^2(1) = 4.99$	$\chi^2(1) = 1.61$	$\chi^2(1) = 0.04$
H_0: $\alpha + \theta = 0$ H_0: $\alpha + \theta_4 < 0$	—	—	—

Note: Numbers in the parentheses are P-values.

Significance at 5 percent level is denoted by *; at 10 percent level by **.

[a] The variable "Currency Crisis Everywhere" in currency-crisis equation was dropped in the regression because of colliearity problem.

Table 13. Fitted values from different combinations of transparency levels and regime variables

	regression (3) (*Transparency*)	regression (4) (*Corruption I*)	regression (5) (*Corruption II*)
banking crisis:			
Free Float = 1:			
transparency level = 3	.03446898	—	—
transparency level = 2	.11355426	—	.26593751
transparency level = 1	.19263954	.23649747	.28114964
transparency level = 0	.27172482	.16110955	.29636176
Managed Float = 1:			
transparency level = 3	.12238818	—	—
transparency level = 2	.14941372	—	.0322896
transparency level = 1	.17643926	.22790315	.10511038
transparency level = 0	.2034648	.07930826	.17793116
Limited Flexible = 1:			
transparency level = 3	.15878355	—	—
transparency level = 2	.08303052	—	-.01503422
transparency level = 1	.00727748	.10789146	.00330594
transparency level = 0	-.06847556	-.0218238	.02164611
Peg = 1:			
transparency level = 3	.18572864	—	—
transparency level = 2	.25761888	—	.12939306
transparency level = 1	.32950912	.33206215	.24383406
transparency level = 0	.40139936	.2422804	.35827507
currency crisis:			
Managed Float = 1:			
transparency level = 3	.05027389	—	—
transparency level = 2	.14103132	—	.22409443
transparency level = 1	.23178874	.12243314	.21486996
Transparency level = 0	.32254616	.23525246	.2056455

Table 13 (cont'd).

Limited Flexible = 1:			
transparency level = 3	.28248441	—	—
transparency level = 2	.30468079	—	.38560524
transparency level = 1	.32687718	.29637942	.31917894
transparency level = 0	.34907356	.40022357	.25275264
Peg = 1:			
transparency level = 3	-.18845606	—	—
transparency level = 2	.00739046	—	.16640287
transparency level = 1	.20323699	.04239925	.1645093
transparency level = 0	.39908352	.12762048	.16261574

Table 14. Comparison of the results in Table 13

Regression (3) given regime:	banking crisis equation:	currency crisis equation:
free float	transparency	—
managed float	transparency	transparency*
limited flexible	opaqueness	transparency
peg	transparency	transparency*

Regression (4) given regime:	banking crisis equation:	currency crisis equation:
free float	transparency	—
managed float	transparency	opaqueness
limited flexible	transparency	opaqueness
peg	transparency	opaqueness

Regression (5) given regime:	banking crisis equation:	currency crisis equation:
free float	transparency	—
managed float	transparency	opaqueness
limited flexible	transparency	opaqueness
peg	transparency	opaqueness

note: Asterisk (*) indicates that the probability differences are statistically significant in fixed and random effects estimations.

Figure 1. Comparison of transparency levels between the Asian-5 and Taiwan

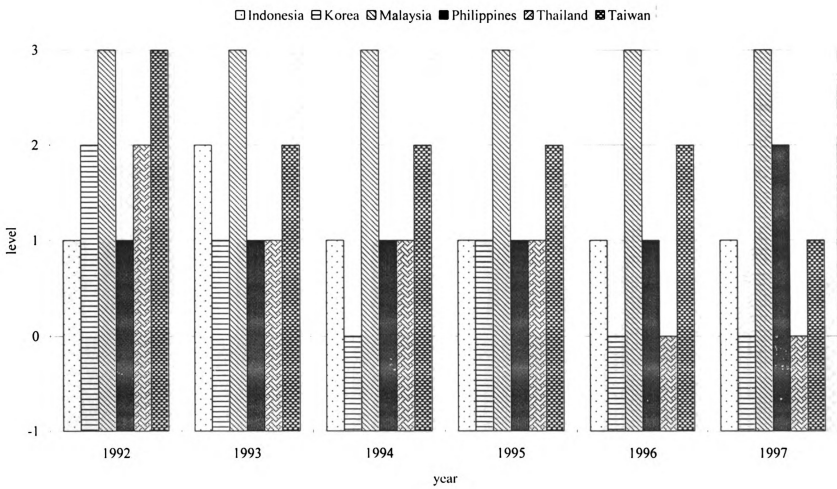

Figure 2. Comparison of transparency levels among South American countries

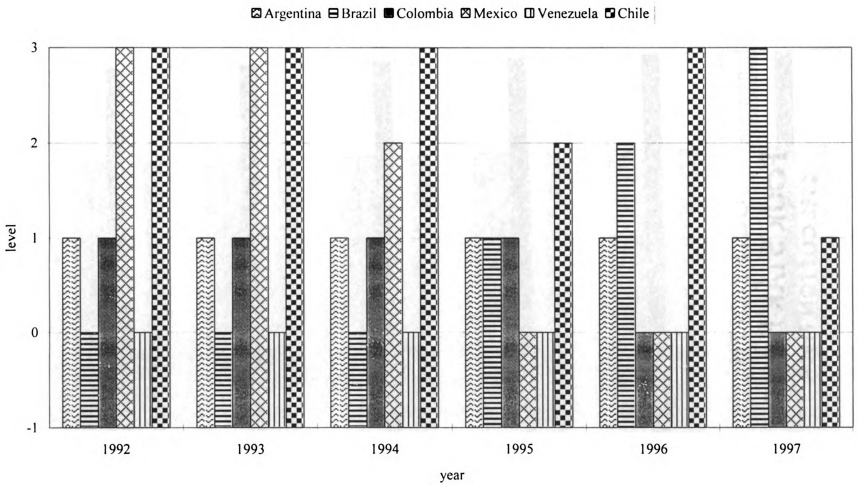

Figure 3. Comparison of exchange rate regimes Between the Asian-5 and Taiwan

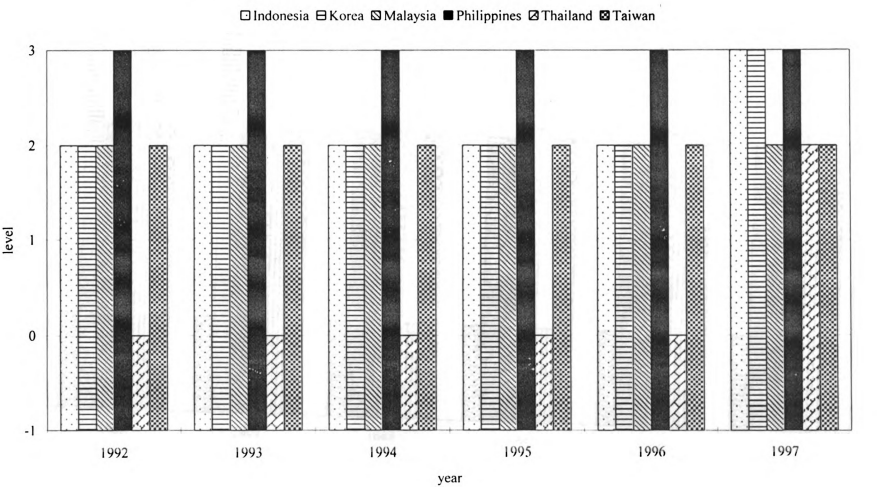

Figure 4. Comparison of exchange rate regimes among South American countries