CAPITAL FLOWS, INSTITUTIONS, AND FINANCIAL FRAGILITY

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Abstract

This paper studies how international capital flows are transmitted from the banking sector to the real sector in a bank-based open economy. The analysis centers on the role of institutions and domestic policies in reducing moral hazard problems and on determining the net benefit of international capital flows to a country. We develop a general equilibrium model that incorporates moral hazard problems at the bank, corporate and international levels. In this unifying model, the three layers of moral hazard problems and international capital flows reinforce one another to amplify the boom-bust cycle. The model predicts that an economy will never reach a steady state when banks can accumulate losses and finance those losses through foreign borrowing. We estimate the model using data from Thailand because Thailand experienced a financial crisis in 1997-1998 and subsequently undertook major policy reforms specifically designed to strengthen its financial institutions and system. The results from the estimation suggest that there have been structural changes in the quality of institutions and domestic policies that helped alleviate the moral hazard problems at all levels. Scenario analysis indicates that the improvement in banking supervision and foreign investors’ risk estimation substantially reduces bailout costs and the output losses. In contrast, the reduction in government subsidies or tax incentives hurts, rather than helps, the economy since the cost from the overall output decline outweighs the benefit from the lower bailout costs. These findings provide specific recommendations to policy makers considering financial reforms in the wake of the recent global financial crisis.

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This paper studies how international capital flows are transmitted from the banking sector to the real sector in a bank-based open economy. The analysis centers on the role of institutions and domestic policies in reducing moral hazard problems and on determining the net benefit of international capital flows to a country. We develop a general equilibrium model that incorporates moral hazard problems at the bank, corporate and international levels. In this unifying model, the three layers of moral hazard problems and international capital flows reinforce one another to amplify the boom-bust cycle. The model predicts that an economy will never reach a steady state when banks can accumulate losses and finance those losses through foreign borrowing. We estimate the model using data from Thailand because Thailand experienced a financial crisis in 1997-1998 and subsequently undertook major policy reforms specifically designed to strengthen its financial institutions and system. The results from the estimation suggest that there have been structural changes in the quality of institutions and domestic policies that helped alleviate the moral hazard problems at all levels. Scenario analysis indicates that the improvement in banking supervision and foreign investors’ risk estimation substantially reduces bailout costs and the output losses. In contrast, the reduction in government subsidies or tax incentives hurts, rather than helps, the economy since the cost from the overall output decline outweighs the benefit from the lower bailout costs. These findings provide specific recommendations to policy makers considering financial reforms in the wake of the recent global financial crisis.
1. INTRODUCTION

While the recent global financial crisis was the most severe since the great depression, the last half century has experienced a surprisingly large number of crises resulting from high debt levels of banks and governments. Financial crises are often associated with excessive borrowing in foreign currency and/or a rigid exchange rate regime which can lead to sudden and destabilizing capital flow reversals. Examples include the Latin American debt crisis in the early 1980s, Norway 1987, Finland and Sweden in 1991, Mexico in 1994, the Asian financial crisis in 1997, Russia in 1998, Brazil in 1998-1999, Argentina in 2001, and Iceland in 2008. In fact, foreign capital flows and levels of external debt appear to be highly correlated with the incidence of international banking crises over the last two centuries (see Reinhart and Rogoff, 2008e). 

Furthermore, as can be seen from the recent problems in Eurocurrency countries (e.g., Greece), the mix of a fixed exchange rate and excessive debt can be associated with major dislocations in the real economy as policy makers attempt to undertake fiscal reforms.

The recent financial crisis, while starting in the U.S., highlights the potential major adverse consequences for banks and financial markets around the world from international capital flows. Ample anecdotal evidence from the current episode, as well as past crises, suggests that moral hazard problems in the capital markets can lead to excessive debt levels. While international capital flows are an important source of capital for real investment, financial risks induced by large international capital flows, can potentially have an adverse effect on financial system stability. Furthermore, in countries where moral hazard problems are severe, more available capital as a result of financial liberalization may be utilized for bad investments or excess (unsustainable) consumption. Even in a country like the U.S. with well-developed markets and strong governmental institutions, regulatory and institutional capacity to deal with such moral hazard problems may not be able to keep pace with rapid innovation in financial markets.

Currently, policy makers around the world are struggling with the question of how to manage large debt loads and mitigate the risk of future financial crises. Proposed remedies include additional regulation of financial markets, closer supervision of financial institutions, and fiscal policy reforms, among others. However, policymakers have little research to guide them in making trade-offs between the costs and benefits of different policy remedies. What research does exist typically considers a specific policy in isolation and not economy-wide effects or joint effects of multiple policy actions.

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1 Reinhart and Rogoff (2008b) present a long history of financial crisis related to debt. Reinhart and Rogoff (2008a) conduct a post-mortem of the recent financial crisis and a comparison to previous financial crises.  
2 Nonetheless, growth in domestic debt (often financed with foreign capital) is also a common indicator of a financial crisis (see Reinhart and Rogoff, 2008c and 2008d).
Given the potentially far-reaching nature of proposed reforms, it is important to understand both the costs and benefits of possible remedies in as general an economic setting as is feasible.

From a policy perspective, more available foreign capital may pose a significant risk for a country which liberalizes financial markets without adequate preparation in terms of regulations and institutions (Stiglitz, 1999, 2002; Rodrik, 1998). To the contrary, excessively slow financial market liberalization could lead to low and inefficient investment, suboptimal risk-sharing (e.g., exacerbated home-bias), and relatively slow economic growth as implied by Bekaert, Harvey and Lundblad (2005). All these debates motivate three important research questions: (i) What is the net effect of international capital flows on an open economy, (ii) is the institutional environment as important as suggested by other research or is it a proxy for other factors, and (iii) can institutions change in a meaningful and timely enough way to make policy reforms worthwhile?

Given the importance of these issues, substantial research has examined the determinants, costs, and benefits of international capital flows. Many studies focus only on the costs (e.g., Hutchison and Noy, 2006; Boyer, Kumagai, and Yuan, 2006) or the benefits of financial liberalization (e.g., Bekaert et al., 2005; Henry, 2000a, 2000b). Empirical results regarding the benefits of capital flows are mixed. In addition, most studies are cross-country and thus suffer from the empirical challenge of accounting for all types of heterogeneities across countries. Hence, the issue of whether international capital flows are on net detrimental (e.g., destabilizing) remains largely unresolved.

This paper aims to (1) study the transmission mechanism of international capital flows via the banking sector to the real sector of an open economy when moral hazard problems are present and (2) empirically examine the role of the quality of institutions and domestic policies in reducing moral hazard problems and determine the net benefit of international capital flows. To address the first objective, we develop a general equilibrium model that incorporates several important facets of the real and financial economy by allowing shocks to the banking sector to be transmitted to the real sector, and vice versa, via the interest rate mechanism. It also addresses several aspects of moral hazard problems, rather than focusing on only one or two as most other models have done (e.g., Corsetti, Pesenti, and Roubini, 1999b; Dekle and Kletzer, 2005). The unifying property of this model allows interactions between different aspects of moral hazard problems which could be reinforcing or offsetting to one another. This property also makes the model more consistent with what has been observed historically, as there appears to be multiple types of moral hazard problems in many crisis countries.

The main assumptions of the model are based on key observations of countries experiencing crises over the past two decades. First, an economy is largely reliant on the banking sector which has access to international funds. Second, due to poor quality institutions and domestic policies, there are
three layers of moral hazard problems in the country before a crisis (i.e., moral hazard problems at the corporate, bank, and international levels). Third, a sudden stop of international capital flows is triggered when the expected level of contingent government liabilities (e.g., the amount of banks’ cumulative losses) exceeds the perceived country’s ability to cover its debts (e.g., with international reserves).

In this model, the three layers of moral hazard problems, together with international capital flows, reinforce one another to amplify the boom-bust cycle of the economy. At the corporate level, expected government subsidies or tax incentives increase firms’ expected profits, inducing firms to invest more and borrow more from banks than they should without the government subsidies or tax incentives. In the model, a firm’s optimal level of capital stock increases with the level of government subsidies or tax incentives. At the bank level, when a future government bailout is expected and banking supervision is inadequate, banks are willing to lend excessively to the corporate sector as long as they can obtain enough funding from depositors and foreign creditors. In addition, banks have an incentive to pay out their profits from performing loans (PLs) as dividends to their shareholders, rather than maintaining such profits as provisions against their losses from non-performing loans (NPLs). Hence, NPL losses are accumulated on the banks’ accounts, and banks have to finance those losses through additional foreign borrowing. In this model, the level of NPL losses that banks can accumulate in each period is determined by their loan loss provisioning ratio.

At the international level, with a presumption that government guarantees exist and the government is committed to a stable exchange (FX) rate, foreign creditors are willing to lend excessively to the domestic banking sector as long as the expected level of the government’s contingent liabilities is below the level of the country’s international reserves. They also underestimate the risks from their lending to the domestic banking sector and do not charge interest rates high enough to compensate for their risks. As a result, the banks’ cost of foreign borrowing may not increase as much with the aggregate level of banks’ net foreign borrowing as it should. The sensitivity of the banks’ foreign borrowing rate to the aggregate level of banks’ net foreign borrowing therefore reflects the level of risks that foreign investors perceive and factor into their required rate of return. In addition, if foreign investors believe that the government will attempt to maintain a stable FX rate, they will expect exchange rates to be steady and not responsive to changes in interest rate differentials, leading to greater expected deviation of the FX rate from the uncovered interest rate parity (UIP) relation.

As mentioned in Corsetti et al. (1999a), the role of moral hazard at the onset of the Asian crisis has been stressed by a number of authors, e.g., Krugman (1998a), Greenspan (1998), and Fischer (1998b).
The analysis of the model suggests that, although moral hazard problems at all levels play a role in magnifying the boom-bust cycle of an economy, the moral hazard problems at the bank and international levels are primarily the factors causing an economy to move away from its equilibrium and triggering a sudden stop and a crisis. When banks can accumulate NPL losses (the moral hazard problem at the bank level) and can obtain additional foreign borrowing to finance those losses (the moral hazard problem at the international level), the economy will never be at a steady state, as NPL losses and foreign debt continue to increase. Once the level of banks’ cumulative NPL losses exceeds the level of the country’s international reserves, a sudden stop will surely occur.

To address the second objective of analyzing the role of the quality of institutions and domestic policies in reducing moral hazard problems and determining the net benefit of capital flows, the model parameters measuring the severity of moral hazard problems are used as proxies for the quality of institutions and domestic policies. These parameters can be estimated using the data of a specific country. Consequently, we estimate the model using data from Thailand to see if the quality of institutions and domestic policies has been significantly changed as a result of policy changes after the Asian crisis. Thailand provides a good case study for several reasons. First, it is a bank-based open economy that experienced a financial crisis much like the one we study in our theoretical model. Second, in the period immediately following the Asian crisis, the country undertook nearly simultaneous and major regulatory reforms that affected almost all aspects of the financial system. Third, enough time has elapsed since these reforms took place that we should be able to evaluate their efficacy. Fourth, considering its rankings among other countries in terms of its degree of openness, economic performance, and quality of institutions, Thailand is a very typical country.

If moral hazard problems have been reduced, as a result of the reforms in Thailand, the parameters measuring moral hazard problems should indicate a lower degree of moral hazard problems in the post-crisis period. In addition, since international capital flows, together with the moral hazard problems, amplify the boom-bust cycle and could either benefit or harm a country, the estimated change in the degree of moral hazard problems allows us to assess its impact on the net benefit (or cost) of international capital flows to Thailand. To examine the above hypotheses, the parameters determining moral hazard problems at all levels are estimated for the pre-crisis, crisis, and post-crisis periods using the equilibrium conditions from the model and generalized method of moments (GMM). Hypothesis tests for the differences in parameter values before and after the crisis are conducted, and the results suggest that the moral hazard problems at all levels are less severe after the crisis. We also conduct a detailed scenario analysis to assess the impact of changes in the quality of institutions and domestic policies on the net benefit of international capital flows. Both direct costs (bailout costs) and indirect
costs (output losses) of a crisis with a sudden stop of capital flows are estimated under different moral hazard scenarios. The results indicate that the changes in the quality of institutions and domestic policies with regard to banking supervision and foreign investors’ perceptions of risks help significantly reduce the bailout costs and the output losses. In contrast, the reduction in the government subsidies or tax incentives to the corporate sector hurts, rather than benefits, the country, as the cost from the lower output outweighs the benefit from the lower bailout costs.

Overall, our analysis provides the most comprehensive examination of how moral hazard problems lead to a financial crisis in an open economy as well as how various policy remedies can mitigate direct and indirect costs arising from moral hazard problems. Our results speak directly to current policy debates about the form of financial regulatory reform and policies designed to stabilize ailing economies (e.g., Portugal, Ireland, Italy, Greece, and Spain, or the so-called ‘PIIGS’). Specifically, recent fiscal austerity proposals are unlikely to be beneficial for crisis economies in the near-to-intermediate term (though they are likely to be necessary in the longer-run once the economies regain solid footing). Instead, policies should focus on increased supervision of bank lending policies, regulatory capital requirements, and reassurance of the global investor base that must continue to finance high levels of external debt for the foreseeable future.

The rest of this paper is organized as follows. Section 2 discusses the related literature, and Section 3 presents empirical evidence supporting the key assumptions of the model. Section 4 develops the theoretical model. Section 5 discusses the application of the model. Section 6 describes the data and summary statistics. The empirical methodology and estimation results are explained in Section 7 and Section 8, respectively. Section 9 presents the scenario results. Section 10 concludes. Several appendices provide technical details and supplementary information.

2. RELATED LITERATURE

The relationships between international capital flows and macroeconomic conditions have been widely studied in the international economics literature. Early literature examined the relationships between capital flows and the saving-investment gap. Fleming-Mundell and Obstfeld-Rogoff models provide basic theoretical frameworks for analyzing such relationships. Kraay and Ventura (2000, 2002) and Ventura (2003) incorporate investment risk into consumers’ portfolio composition decisions, which determine the domestic capital stock and the net foreign asset position of a country. Motivated by concerns over financial instability caused by international capital flows, a number of researchers examine the mechanisms through which international capital flows create sudden stops and crises (e.g., Calvo, 1998; Rodrik and Velasco, 1999). Chari and Kehoe (2003) develop a model of herd behavior where informational frictions together with weak fundamentals lead to volatile capital flows and in turn
cause a financial crisis. Inspired by the market microstructure literature on the relationships between foreign exchange (FX) order flows and FX rates, more recent work (e.g., Hau and Rey, 2006, 2004; Froot, O’Connell, and Seasholes, 2001; Froot and Ramadorai, 2001, 2005) examines the two-way causal relationships between international capital flows and financial market indicators. Similar to this line of literature, this paper examines the relationships between international capital flows and each sector of an economy and emphasizes the role of the banking sector and moral hazard problems in determining the net benefit of international capital flows to a country.

This paper is also related to the literature on currency and financial crises, particularly those based on a moral hazard mechanism. The basic feature of moral hazard models (as seen in many papers, e.g., Dooley, 2000; McKinnon and Pill, 1996) is the role of expected government guarantees in causing international investors to lend a large amount of money to another country, leading to excessive risk-taking behavior of agents in that country (or a so-called ‘moral hazard problem at the international level’). There exist other possible moral hazard problems. Corsetti, Pesenti, and Roubini (1999b) develop a model in which there are expectations that the government will provide financial support to firms when they are in a bad state. Such expectations increase firms’ expected profits and cause firms to overinvest (or a so-called ‘moral hazard problem at the corporate level’). Firms can obtain funds from overly optimistic consumers, who have access to international funds and expect a government bailout when borrowing firms are in distress. Since firms do not receive transfers from the government right away, consumers have to finance their losses through foreign borrowing. Once cumulative losses exceed the level of the country’s international reserves, a sudden stop of capital flows occurs.

Dekle and Kletzer (2005) develop a model in which banking supervision is inadequate and there is a widely held perception that government guarantees exist. Hence, banks have an incentive to pay dividends from their PL profits, rather than retain profits as provisions against their NPL losses (or a so-called ‘moral hazard problem at the bank level’). Banks therefore accumulate NPL losses which later become contingent government liabilities. Once the level of banks’ cumulative NPL losses exceeds a certain threshold, the government intervenes, and banks can no longer accumulate losses. However, in their model, banks receive funds only from domestic depositors; hence, there is no role for international capital flows.

In reality, these various problems are likely to occur together. Thus, we aim to address several aspects of these moral hazard problems. The model developed in this paper incorporates (i) expected

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4Vitale (2007) surveys the market microstructure approach to exchange rate determination.

5Burnside, Eichenbaum, and Rebelo (2008), Krugman (2001), and Tinnakorn (2006) provide a review of crisis models.
government subsidies or tax incentives to the corporate sector which lead to overinvestment, similar to what we have seen in the paper by Corsetti et al. (1999b), (ii) lax banking supervision which leads to an accumulation of banks’ NPL losses, as seen in the paper by Dekle and Kletzer (2005), and (iii) expected government guarantees and the government’s commitment to a stable FX rate which cause foreign investors not only to lend a large amount of money to domestic banks, but also to underestimate their risks associated with lending to banks in another country. Unlike many theoretical papers, we attempt to estimate, rather than calibrate, the important model parameters characterizing these moral hazard problems.

Existing research also explores the fundamental issue of whether foreign capital flows are destabilizing or benefiting a country or both. Quinn (1997) and Bekaert et al. (2005) find that countries with greater openness to capital mobility experience higher growth than countries with restrictions on capital mobility while Rodrik (1998) finds no such association. To the contrary, Hutchison and Noy (2006) find that sudden-stop crises (balance of payment crises with reversals in capital flows) have a large negative, but short-lived, impact on output growth (over that found in other crises without reversals in capital flows). In addition, the benefits of financial liberalization might not be as strong as expected due to agency problems arising when rulers of sovereign states and corporate insiders pursue their own interests at the expense of outside investors (Stulz, 2005) and inadequacy of laws and supporting institutions (Henry and Lorentzen, 2003). However, this issue has not been thoroughly explored at the detailed country level. This paper adds to this line of research by further examining the role of the quality of institutions and domestic policies in reducing moral hazard problems and in determining the net benefit of international capital flows to a country. Particularly, the parameter values associated with the severity of moral hazard problems are estimated and used to assess the effect of changes in the quality of institutions and domestic policies on the costs and benefits of international capital flows in the scenario analysis.

3. EVIDENCE SUPPORTING THE KEY MODEL ASSUMPTIONS

Recent financial crises often share several characteristics. First, international capital flows typically play a key role in fueling a boom, and in many countries the banking sector provides an important role in channeling funds to the real sector. Considering the Asian crisis as an example, in 1997 bank loans accounted for 77% of the total external financing for Thailand, 68% for Indonesia, 52% for the Philippines, and 65% for South Korea while in the U.S. bank loans represented only 23% of total
external financing. It was also common for a large fraction of foreign borrowing to be intermediated by the domestic banking system. Based on Bank for International Settlements (BIS) data on foreign liabilities of domestic banks and non-banks towards BIS reporting banks, in mid-1997, the ratio of foreign borrowing intermediated by the domestic banking sector was 77% for Malaysia and Korea, 69% for the Philippines, 86% for Thailand, and 78% for China (Corsetti et al., 1999a).

Second, it is common to observe structural and policy distortions before each crisis which cause the private sector (or the public sector in the case of Mexico, Russia and Argentina) of a crisis country to accumulate high levels of debt. Widely held perceptions of (explicit and/or implicit) government guarantees or subsidies for corporate and financial investment cause firms to overinvest, banks to lend excessively to risky borrowers, and foreign capital to flow into a country. Furthermore, crisis countries frequently exhibit rigid FX regimes, for example, pegged FX rates in Thailand, Argentina, and Mexico and managed floating rate regimes in Korea, Indonesia, and Russia. Worsening the situation, banking supervision is typically quite lax before a crisis. For example, commercial banks in many Asian countries and Iceland (as well as investment banks and insurance companies in the U.S.) apparently had an incentive to take excessive risks to enhance returns.

Third, a sudden stop of capital flows and a run on a currency (and/or financial institutions), often occurs when the expected level of a country’s debt (either public or private debt) is so high that investors do not believe that the government will be able to fulfill its financial obligations. In fact, there are several signs of a country’s vulnerability to a crisis and a sudden reversal of capital flows. Many countries exhibited large current account imbalances before a crisis and thus were susceptible to a sudden reversal of capital flows, especially when such imbalances were financed by short-term flows or by instruments indexed to other currencies. For example, Thailand experienced a current account deficit for over a decade, and by 1996, only 16% of its current account deficit was financed by foreign direct investment (Corsetti et al., 1999a) while Mexico financed its current account deficit of 7% of GDP by debt instruments denominated in pesos but indexed to dollars. Furthermore, lending booms commonly precede a crisis. In countries experiencing the Asian financial crisis, the ratio of private sector lending to GDP exhibited a rapid upward trend before the crisis. For example, the growth rate during 1990-1996 of private sector lending to GDP increased dramatically in the Philippines (151%), Thailand (58%), and Malaysia (31%) (Corsetti et al., 1999a). In the U.S., the home ownership rate increased from 64% in 1994 to 69.2% in 2004 fueled largely by subprime lending. In crisis countries, asset quality is often impaired. The non-performing loans to total loans ratio in 1996 was estimated to be 13% for Thailand.

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These ratios are calculated using the figures from Expert Group on the Challenges of the Asian Economy and Financial Markets (2001), which are based on International Financial Statistics data of the International Monetary Fund (IMF-IFS).
and Indonesia, 8% for Korea, 10% for Malaysia, and 14% for the Philippines (Corsetti et al., 1999a). Moreover, there was a serious mismatch between foreign liabilities and foreign assets in many crisis countries. The ratio of foreign liabilities to foreign assets relative to BIS reporting banks exceeded 100% in countries experiencing the Asian financial crisis during 1993-1997 (Corsetti et al., 1999a).

Based on the above key observations, the model is developed using the following assumptions: (i) the banking sector plays a key role in channeling international capital flows to the corporate sector, (ii) moral hazard problems at the corporate, bank, and international levels are present in an economy, and (iii) a sudden stop of capital flows occurs when the expected level of the country’s debt is greater than the level of the country’s liquid assets.

4. MODEL

This section presents a general equilibrium model of a bank-based, open economy with moral hazard problems. The focus of this model is primarily on smaller open economies since those countries experienced an influx of international capital flows after their financial liberalizations and many of them underwent financial crises with sudden reversals of capital flows. Hence, they are good subjects for examining both the costs and benefits of international capital flows. So while some of the stylized facts of our model match what has happened in recent crises to the U.S., U.K., Germany, and Japan, it is better to consider of our model as applying more directly to countries whose economies are unlikely to have a significant impact on world interest rates (Greece, Mexico, Thailand, etc.). Nonetheless, the model could be extended for a large open economy by endogenizing the world interest rate.

Our overall aim is to explain the relationship between international capital flows via the banking sector and the real economy, how moral hazard problems amplify the impact of international capital flows on a country, and the occurrence of a financial crisis. Consequently, the model incorporates several important aspects of the real and financial economy, allowing shocks to one sector to be transmitted to the others through interest rates.

Second, and as already mentioned, our model simultaneously address the three levels of moral hazard problems (i.e., the corporate, bank and international levels). This unifying property allows interactions between different levels of moral hazard problems as they could be reinforcing or offsetting one another. Following the idea of Corsetti et al. (1999b), this model addresses the moral hazard problem at the corporate level, which results from expected government subsidies or tax incentives and can induce firms to overinvest. Unlike Corsetti et al. (1999b), subsidies or tax incentives from the government to the corporate sector in this model are contemporaneously provided to all firms in each period, rather than provided only to low-type firms and accumulated as the government’s expected
contingent liabilities. Similar to Dekle and Kletzer (2005), this model incorporates the moral hazard problem at the bank level, because banks have an incentive to accumulate losses from NPLs given an expected government bailout and inadequate bank monitoring. Unlike Dekle and Kletzer (2005), banks in this model can borrow from abroad and will finance their losses or cash shortfalls through additional foreign borrowing. The moral hazard problems at the international level are explicitly modeled here through the determination of an interest rate for banks’ foreign borrowing and an FX rate. Presumptions by foreign investors that government guarantees exist cause them to underestimate the risks associated with their lending to the domestic banking sector. Foreign investors therefore do not charge an interest rate high enough to compensate for their risks. Moreover, an FX rate is expected to deviate more from the conventional UIP when a country adopts a pegged FX regime since investors anticipate that the government will try to maintain a constant FX rate, regardless of the level of an interest rate differential.

Third, a sudden stop of capital flows and a financial crisis can occur in this model when the level of the country’s international reserves (a proxy for liquid assets) is below the level of cumulative losses in the banking sector (the expected level of contingent government liabilities).\textsuperscript{7} Altogether, the model considers a bank-based, small open economy with four major sectors: (i) a corporate sector, (ii) a banking sector, (iii) a household sector, and (iv) a public sector (government), which combines fiscal and monetary authorities.

4.1 Structure of the Model

4.1.1 Corporate Sector

There are N firms in each period, t. Each firm, j, is owned by households in a well-diversified portfolio and pays out all its net profits as dividends to its existing shareholders. Each firm specializes in the production of traded goods \( y \) and has the following production function.

\[
y_{t+1} = A_{t+1} k_{t+1}^{\alpha t_1^{1-\alpha}}
\]  

(F1)

Where \( y_{t+1} \) = Firm j’s output for period t+1, 
\( k_t \) = Firm j’s capital stock at the end of period t, 
\( A_{t+1} \) = Production technology factor for period t+1, which is assumed to be random and subject to firm type, 
\( l_t \) = Firm j’s employed labor at the end of period t, 
\( \alpha \) = Income share of capital (0 \( \leq \alpha \leq 1 \)).

\textsuperscript{7}Similar to Burnside, Eichenbaum, and Rebelo (2000, 2001b), this emphasizes the role of a prospective government deficit in causing a crisis.
At the beginning of period $t+1$ (at the end of period $t$), each firm invests $I_t^j = k_t - k_{t-1} + d k_{t-1}$. The amount $k_t - k_{t-1}$ (‘new investment’) is used to produce traded goods $y_{t+1}$ and the amount $d k_{t-1}$ is used to finance its capital depreciation. The fraction, $1 - \text{cap}$ ($0 \leq \text{cap} \leq 1$), of its new investment is financed through bank debt while the remaining portion is financed through newly-issued preferred stocks or bonds, which are sold to the household sector. Each firm uses its own profits to finance capital depreciation ($d k_{t-1}$), where $d$ is the capital depreciation rate and $0 \leq d \leq 1$. Banks, new bondholders, and new shareholders demand the same rate of return, $r_t^j$, from a firm. It is assumed that labor is inelastically supplied, and each firm $j$ pays wages at a rate $W_t$ per one unit of labor.

There are 2 types of firms in each period $t+1$. Ex ante each firm does not know its type, $A_{t+1}$). The fraction, $1 - \text{NPL}_t$, of the firms is high-type with production technology $A + u_{t+1}$, and the remaining fraction $\text{NPL}_t$ is low-type with production technology $A - w_{t+1}$. These low-type firms are not able to pay interest on debt. Assuming that $(1 - \text{NPL}_t)u_{t+1} - \text{NPL}_tw_{t+1} = 0$, $A > u_{t+1} > w_{t+1} > 0$ and $0 \leq \text{NPL}_t \leq 1$, $E_t(A_{t+1}) = A$, and $E_t[y_{t+1}] = Ak_t^{1-a}$. Firms may also have to pay taxes to the government. To promote investment, the government may provide subsidies or tax incentives to firms. The expected value of net transfers to/from the government is $E_t(s_{t+1}) = nk_t^{1-a}$, where $n$ could be positive (subsidies) or negative (taxes).

Assuming that firm $j$’s expected profits are based on its long-run average amount of employed labor, $\bar{l}$, at the beginning of period $t+1$ (at the end of period $t$), each firm chooses the level of capital stock, $k_t$, to maximize its expected profits for period $t+1$, $\pi^F_{t+1}$.

$$\pi^F_{t+1} = E[\text{Output} + \text{Subsidies}\cdot (\text{Taxes}) - \text{Wages} - \text{Interest payments} - \text{Capital depreciation}]$$

$$= Ak_t^{1-a} + nk_t^{1-a} - W_t\bar{l} - (1 - \text{NPL}_t) \cdot r_t^j k_t - d \cdot k_t$$

subject to

$$I_t^j = (k_t - k_{t-1}) + d \cdot k_{t-1} \quad \text{(Total investment = New investment + Capital depreciation)}$$

$$k_t = c_t^j + \text{cap} \cdot k_t \quad \text{(Uses of capital = Bank debt + Newly-issued bonds or stocks)}$$

Based on the above setup, the optimal level of capital stock (by rearranging the first order condition with respect to $k_t$) of each firm equals

$$k_t = \bar{l} \left( \frac{\alpha(A + n)}{(1 - \text{NPL}_t) r_t^j + d} \right)^{1-a}$$

The optimal level of capital stock increases with parameter $n$, which measures the level of government subsidies (or taxes if negative). The higher the level of government subsidies or tax incentives (or lower taxes), the higher the firm’s expected profits and the greater the incentive for the firm to overinvest. Hence, the parameter $n$ can be used as a measure of the degree of overinvestment or the moral hazard.
problem at the corporate level. However, since the output increases with the level of capital stock, \( y_{t+1} = A_{t+1} k_t^{1-a} \), the higher degree of overinvestment, as a result of the higher level of government subsidies or tax incentives, also brings about higher output. It can also be seen that the optimal level of capital stock decreases with the rate of return demanded by banks and bond/shareholders, \( r^i_t \). Hence, the interest rate plays a key role in influencing the firm’s investment decision in this model.

### 4.1.2 Banking Sector

Suppose that there are M identical banks. Each bank, \( i \), receives deposits, \( a^i_t \), in local currency (LC) real terms from households and borrows \( b^i_t \) in foreign currency (FC) nominal terms from foreign creditors. It pays a real deposit rate of \( r_t \) to depositors and a nominal foreign borrowing rate of \( i^b_t \) to foreign creditors.\(^8\) Each bank lends its money in LC real terms, \( e^i_t \), to the corporate sector and charges a lending rate of \( r^l_t \). Only high-type firms (the fraction \( 1-NPL_t \) of the firms) can pay interest on bank debt in each period \( t \). In addition, each bank has operating expenses of \( o_t \), which are assumed to be mainly employee salaries. Assume that \( o_t = \xi e^i_t \), where \( \xi \) is the operating expense factor and \( \xi \geq 0 \).

In this model, the bank’s nominal foreign borrowing rate, \( i^b_t \), is a function of the world nominal interest rate and the aggregate level of banks’ net foreign borrowing, i.e.,

\[
i^b_t = \psi_0 i^w_t + \psi_1 (b_t - \hat{b}) \tag{B1}
\]

Where \( i^w_t = \text{World nominal interest rate for period } t+1 \),

- \( b_t = \text{Aggregate level of banks’ net foreign borrowing at the end of period } t \),
- \( \psi_0 = \text{Interest rate sensitivity to the world interest rate} \),
- \( \psi_1 = \text{Interest rate sensitivity to the aggregate level of banks’ net foreign borrowing} \),
- \( \hat{b} = \text{Perceived optimal level of aggregate banks’ net foreign borrowing} \).

The benefits of modeling the foreign borrowing rate in this way are twofold. First, parameter \( \psi_1 \), which is expected to be greater than or equal to zero, reflects how much higher the rate of return foreign creditors need to compensate for their higher risks from a greater amount of lending to the banking sector in another country. Hence, \( \psi_1 \) can be used as a measure of the degree of a moral hazard problem at the international level. When this moral hazard problem is severe, foreign creditors underestimate the risks from their lending to the banking sector and do not fully incorporate those risks into their required rate of return, and thus the value of parameter \( \psi_1 \) is low. As mentioned earlier, this could happen when

---

\(^8\) The weighted average cost of funds for each bank \( r^i_t = \left( r_t a^i_t + i^b_t \frac{b^i_t}{p^i_t} \right) \times \left( a^i_t + \frac{r^l_t}{p^i_t} b^i_t \right) \).
foreign creditors believe that government guarantees exist. Second, this is one way to induce stationarity to a small open economy model according to Schmitt-Grohe and Uribe (2003). Particularly, when $\psi_1$ is greater than zero, domestic interest rates serve as an adjustment and transmission mechanism through which any shock affecting the level of banks’ net foreign borrowing will have an impact on firms’ investment decision and households’ saving decision.

Each bank is owned by households in a well-diversified portfolio and may choose to pay dividends to its shareholders in each period. When banks are not adequately monitored and when there is a widely held perception that government guarantees exist, it is optimal for banks to maintain minimal loan loss reserves and to pay out their profits from performing loans as dividends, $X^i_t$ to their shareholders. This creates another layer of moral hazard at the bank level. Assume that each bank maintains the fraction $\upsilon$ ($0 \leq \upsilon \leq 1$) of its profits from PLs as provisions against its losses from NPLs. Dividends paid by each bank are thus equal to the fraction $1-\upsilon$ of its profits from PLs, i.e.,

$$X^i_t = (1 - \upsilon) (\text{Profits from PLs}) = (1 - \upsilon) (1 - NPL^i_{t-1}) e^i_{t-1} [r^i_{t-1} - (r^c_{t-1} + \xi)] \quad (B2)$$

Since the losses from NPLs are not contemporaneously offset by government transfers, each bank may not have sufficient cash to both finance its NPL losses and pay dividends. It therefore has to cover its losses or cash shortfalls through additional foreign borrowing. Let $F^i_t$ be the level of bank $i$’s cumulative NPL losses or cash shortfalls, which evolves as

$$F^i_t = (1 + r^c_{t-1}) F^i_{t-1} + X^i_t \quad (B3)$$

Given the fact that several emerging countries adopted rigid exchange rate regimes before their crises, it is reasonable to first assume that each bank $i$ expects the government to maintain a stable exchange rate and thus does not hedge the FX risk associated with its foreign borrowing.10 Thus, in each period $t$, bank $i$ will incur FX profits or losses from its net foreign borrowing of the amount

$$FX^i_t = \left( \frac{e^i_t - e^i_{t-1}}{P^i_t - P^i_{t-1}} \right) (1 + r^b_{t-1}) b^i_{t-1} \quad (B4)$$

Let $AFX^i_t$ be the level of bank $i$’s cumulative FX profits or losses, which evolves as

$$AFX^i_t = (1 + r^c_{t-1}) AFX^i_{t-1} + FX^i_t \quad (B5)$$

---

9An alternative story as proposed by Giannetti (2007) could be an information asymmetry problem. In this model, foreign creditors do not know the quality of bank assets. Hence, they initially lend to banks at a low interest rate. This enables insolvent banks to accumulate bad loans. In equilibrium, when a substantial amount of losses have been accumulated, solvent banks do not find it any longer optimal to issue debt at the interest rates that would compensate investors for risks. Foreign investors anticipate this and stop lending to banks.

10The model can be extended by relaxing this assumption. By doing so, a bank’s FX hedging will influence the bank’s decision on interest rates and this will affect the level of the bank’s cumulative FX profits or losses.
Since there is a widely held perception that government guarantees exist and that the government is committed to a stable exchange rate, principal and interest of banks’ foreign debt are assumed to be rolled over by foreign creditors every period as long as the level of the country’s international reserves is higher than the expected level of contingent government liabilities.

Based on information at the end of period \( t \), each bank \( i \) chooses the deposit amount \( a^i_t \), the foreign borrowing amount \( b^i_t \), and the lending amount \( e^i_t \) to maximize its expected profits for period \( t+1 \), \( \pi^B_{t+1} \).

\[
\pi^B_{t+1} = \text{Interest received from PLs} - \text{Interest paid to depositors} \quad - \text{Interest paid to foreign creditors} - \text{Operating expenses}
\]

\[
= (1 - \text{NPL}_i) r^i_t e^i_t - r^i_t a^i_t - i^B_t b^i_t - (\varepsilon - \xi) e^i_t
\]

subject to

\[
e^i_t - e^i_{t-1} = a^i_t - a^i_{t-1} + \frac{\ell^i_t}{P^i_t} b^i_t - \frac{\ell^i_{t-1}}{P^i_{t-1}} b^i_{t-1} + (1 - \text{NPL}_i) r^i_t e^i_{t-1} - r^i_{t-1} a^i_{t-1} - i^B_t b^i_{t-1} - \xi e^i_{t-1} - X^i_t
\]

(\( \Delta \) Lending from the end of \( t-1 \) to the end of \( t = \Delta \) Deposits + \( \Delta \) Net foreign borrowing

+ Actual net income for period \( t \) – Dividends paid to shareholders)

\[
e^i_t = a^i_t + \left( \frac{\ell^i_t}{P^i_t} \right) b^i_t - AFX^i_t - F^i_t
\]

(Lending at the end of \( t = \) Deposits + Net foreign borrowing

– Cumulative FX profits or losses – Cumulative NPL losses or cash shortfalls)

By rearranging the first order conditions with respect to \( a^i_t \) and \( b^i_t \), the optimal lending rate equals

\[
r^i_t = \left( \frac{1}{1 - \text{NPL}_i} \right) (r^i_t + \xi)
\]

(B9),

and the optimal deposit rate is equal to the optimal foreign borrowing rate, i.e.,

\[
r^i_t = i^B_t = r^e_t = \psi^0 r^w_t + \psi^l (b - \hat{b})
\]

(B10).

Equations (B9) and (B10) suggest that in equilibrium each bank determines the deposit rate to be equal to the foreign borrowing rate required by foreign creditors and sets the lending rate just high enough to make profits from PLs cover losses from NPLs. Also, the domestic interest rates, both the lending and deposit rates, increase with the aggregate level of banks’ net foreign borrowing and thus serve as an adjustment mechanism in this model. Hence, if \( \psi^l \) is sufficiently high, the domestic interest rates will significantly increase during a boom, when the level of investment and banks’ foreign borrowing is high, causing firms to lower their investment and inducing households to deposit more money in banks. By
paying dividends to its shareholders when its expected profits are zero in each period, each bank accumulates NPL losses on its account of the amount equal to the dividends paid to its shareholders, i.e.,

\[ X^i_t = (1 - \upsilon) (\text{Profits from PLs}) = (1 - \upsilon) (\text{Losses from NPLs}) = (1 - \upsilon) (\text{NPL}_t (1 + \xi)) \]

(B11).

According to equation (B11), the loan loss provisioning ratio, \( \upsilon \), determines the level of dividends each bank pays to its shareholders and the amount of NPL losses each bank accumulates in each period. Thus, parameter \( \upsilon \) can be used as a measure of the degree of the moral hazard at the bank level. The lower the value of \( \upsilon \), the higher the dividends each bank pays to its shareholders, the higher the level of the bank’s cumulative NPL losses, and the more severe the moral hazard problem at the bank level.

4.1.3 Household Sector

We assume that all households are identical. They work in corporations or banks and have preferences over consumption and money holdings. They hold the entire stock of domestic money balances and own both firms and banks in a well-diversified portfolio. Other than using their money for consumption and money holdings, households invest part of their savings, \( \text{cap}(K_t - K_{t-1}) \) where \( 0 \leq \text{cap} \leq 1 \), in newly-issued corporate bonds or stocks, which give them a rate of return of \( r^i_t \), and deposit the rest in banks which give them a rate of return of \( r_t \) (\( \leq r^i_t \)). Hence, in each period households receive income from the corporate sector in the form of wages, bond or stock returns from previous period’s investment, and dividends. They also receive income from the banking sector in the form of salaries, interest on deposits, and dividends. All household income, except interest on deposits, is taxable. Using the most updated information they receive in each period, households decide on how to spend their income. In particular, they choose the paths of consumption (\( C_s \)), money holdings (\( M_s \)), and deposits (\( a_s \)) to maximize their expected utility,

\[
E_t \left\{ \sum_{s=t}^{\infty} \frac{1}{(1 + \delta)^{s-t}} \left[ \ln(C_s) + \chi \ln(M_s/P_s) \right] \right\} (H1),
\]

subject to

\[
a_s - a_{s-1} = r_s a_{s-1} + (1 - \eta) \left[ Y_s + S_s - d \cdot K_{s-1} - r_s (1 - \text{cap}) K_{s-1} + X_s - C_s - \frac{M_s - M_{s-1}}{P_s} - \text{cap} \cdot (K_s - K_{s-1}) \right], \quad \forall s
\]

(D Deposit balances = Non-taxable income + Taxable income – Consumption

–Δ Money balances in real terms – Investment in newly-issued corporate bonds or stocks) (H2),

\[
\lim_{s \to \infty} \left\{ \prod_{t=1}^{s-1} \frac{1}{1 + r_t} \right\} a_s = 0 \quad \text{(Transversality condition)} \quad (H3),
\]

where \( \eta = \text{Personal income tax rate}, \)
Ps = Domestic price level at the end of period s,
\( \chi \) = Preference for money holdings relative to consumption,
\( \delta \) = Time preference factor.

According to the first order conditions with respect to \( a_s \) and \( M_s \),

\[
C_{s+1} = \left( \frac{1+r_s}{1+\delta} \right) C_s \quad \text{(H4)},
\]

\[
\frac{M_s}{P_s} = \chi C_s (1 + i_s) \quad \text{where} \quad (1+i_s) = (1+\pi_s)(1+r_s) \quad \text{(H5)},
\]

the growth rate of consumption, \( C_{s+1}/C_s \), increases with the domestic real deposit rate, \( r_s \). In addition, real money balances, \( M_s/P_s \), increase with consumption, \( C_s \), but decrease with the domestic nominal deposit rate, \( i_s \). This implies that when the domestic real deposit rate increases, households consume less today relative to the next period and maintain lower money balances. They instead deposit more money in banks to earn the higher rate of return. Hence, the domestic deposit rate plays a key role in influencing households’ decisions on consumption, money holdings, as well as the amount of their deposits with banks.

4.1.4 Public Sector

The public sector comprises fiscal and monetary authorities. It manages the stock of international reserves and implements fiscal and monetary policies. The domestic public sector can borrow from and lend in domestic and international financial markets at a rate of \( r_t \) and never defaults on its domestic and foreign liabilities. We assume that fiscal policies are exogenous\(^{11} \) and the following modified uncovered interest rate parity (UIP) holds,

\[
E_t \left[ \frac{e_{t+1}}{e_t} \right] = (1+P_t) \left( \frac{e_{t+1}}{e_t} \right) = \frac{(1+i_t)}{(1+i^w_t)} \quad \text{(MU)},
\]

where \( P_t = \text{Expected exchange rate deviation from conventional UIP} \),

\( i^w_t = \text{World nominal interest rate for period } t+1 \),

\( i_t = \text{Domestic nominal deposit rate for period } t+1 = (1+\pi_t)(1+r_t) - 1 \), and

\( e_t = \text{Nominal exchange rate (domestic currency per one unit of foreign currency)} \)

at the end of period \( t \).

According to equation (MU), when \( P_t = 0 \), the exchange rate is entirely determined by the interest rate differential, i.e., the UIP relation holds exactly. Hence, parameter \( P_t \) measures the expectations of market participants on how much the exchange rate will deviate from the conventional

\(^{11}\)Personal income tax rate, \( \eta \), and government subsidies or taxes to the corporate sector, \( n \), are constant, and government spending is exogenous.
UIP which presents another moral hazard problem at the international level. When \( P_\varepsilon > 0 \) (\( P_\varepsilon < 0 \)), it is expected that the local currency will be worth more (less) than the value based on the conventional UIP. The expected exchange rate deviation from the conventional UIP (i.e., the absolute value of \( P_\varepsilon \)) should be higher in countries adopting rigid exchange rate regimes since their exchange rates will be less responsive to interest rate differentials than those in countries adopting more flexible exchange rate regimes.

The public sector can choose to target either the nominal exchange rate (\( \varepsilon \)) or the inflation rate (\( \pi \)) to maintain the consolidated public sector budget identity,

\[
\frac{\varepsilon_t}{P_t} (R_t - R_{t-1}) = T_t + \frac{M_t - M_{t-1}}{P_t} + r_{t-1} \frac{\varepsilon_t}{P_t} R_{t-1} - G_t - S_t
\]

\( \Delta \text{ International reserves} = \text{Tax revenues} + \Delta \text{Monetary aggregate in real terms} + \text{Interest on international reserves at the end of the previous period} - \text{Government spending} - \text{Government subsidies or taxes to the corporate sector} \) \hspace{1cm} (G1),

For the analyses in the following sections, we assume that the government of this economy chooses to target the inflation rate. Hence, the inflation rate is exogenous, and the exchange rate is endogenously determined by the model according to equation (MU).

### 4.1.5 National Account

By combining the budget constraints of the four sectors, the economy’s resource constraint follows

\[
Y_t = I_t + C_t + G_t + NFA_t - (1 + r_{t-1})NFA_{t-1}
\]

where

\[
NFA_t = \frac{\varepsilon_t}{P_t} [R_t - b_t] = \text{Net foreign assets of the public and private sectors}
\]

\[
NFA_t = (NFA_t - b_t) = \text{Net foreign assets of the public and private sectors}
\]

### 4.1.6 Market Clearing Conditions in Normal Times

In normal times when the level of the country’s international reserves exceeds the expected level of the government’s contingent liabilities, the markets in this model clear as follows:

**Deposits:** Banks set the deposit rate and are willing to accept deposits as supplied by the household sector.

**Money:** Monetary aggregate (\( M_t \)) is determined by the household demand for money holdings, which can be influenced by the government’s action through the exchange rate or the inflation rate.

**Foreign borrowing:** Foreign creditors set the foreign borrowing rate and are willing to supply loans as demanded by the domestic banking sector.
Bank lending to the corporate sector: Banks set the lending rate to cover their costs from granting loans to the corporate sector. As long as they can obtain enough funding from depositors and foreign creditors, banks are willing to extend credit as demanded by the corporate sector.

In good times, firms are able to obtain as much funding as they want to finance their real investments. International capital flows via the banking sector serve as an additional source of financing for firms’ investment, leading to higher investment and output during a boom. However, with moral hazard problems, more available capital facilitates excessive borrowing and risk-taking behavior of several agents in the economy. With government subsidies or tax incentives, firms overinvest. When banking supervision is lax and a future government bailout is expected, banks lend excessively to firms as long as they can obtain enough funding from depositors and foreign creditors. Banks also have an incentive to maintain minimal loan loss provisions. With expected government guarantees and stable exchange rates, foreign creditors lend excessively to the domestic banking sector. These factors not only amplify a boom, but also increase the country’s vulnerability to a sudden stop and a crisis.

4.2 A Sudden Stop Financial Crisis

4.2.1 The Occurrence of a Crisis

Two key ingredients cause a sudden stop: (i) banks’ accumulation of NPL losses (the moral hazard problem at the bank level) and (ii) banks’ ability to obtain additional foreign borrowing to meet their cash constraints (the moral hazard problem at the international level). First, banks have an incentive to maintain minimal provisions (υ <1) and accumulate NPL losses on the banks’ accounts, F_t, when a future government bailout is expected and banking supervision is inadequate. Second, since the losses from NPLs are not contemporaneously offset by government transfers, banks have to cover their cash shortfalls through additional foreign borrowing. Given a presumption that government guarantees exist and the government is committed to a stable exchange rate, foreign creditors continue to allow banks to borrow in excess of the banks’ credit net of deposits as long as foreign creditors believe that the government can fulfill the country’s future debt obligations. Thus, banks are able to obtain funds from foreign creditors as long as the level of the country’s international reserves at the beginning of period, \((ε_t/P_t)R_{t-1}\), remains above the fraction β of the banks’ cumulative NPL losses F_t.

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12 Although the moral hazard problem at the corporate level is not one of the major factors causing a sudden stop, it could amplify the effect of capital flows. Particularly, government subsidies or tax incentives increase firms’ expected profits, causing firms to overinvest and borrow excessively from banks. Overinvestment and excessive bank lending magnify a boom as well as increase crisis costs when a bust comes.
When the level of international reserves reaches the threshold $\beta F$, foreign creditors stop rolling over the outstanding stock of credit and do not further extend credit to the domestic banking sector. A sudden stop financial crisis starts the first time the following sudden stop condition holds:

$$\left(\frac{\varepsilon_{t_{c}}}{P_{t_{c}}}\right) R_{t_{c}-1} < \beta F_{t_{c}}, 0 \leq \beta \leq 1 \quad (SS1).$$

It can be seen that when banks cannot accumulate NPL losses (when $F$ equals zero), either because banking supervision is effective (no moral hazard problem at the bank level) or banks cannot borrow from abroad in excess of their credit net of deposits (no moral hazard problem at the international level), a sudden stop condition (SS1) will never hold and a crisis will never occur.

### 4.2.2 The Effect of a Crisis

When there is a sudden stop, foreign creditors stop rolling over the outstanding stock of credit and do not further extend credit to the domestic banking sector, causing a reduction in bank lending to the corporate sector and an economic contraction as follows:

**Foreign borrowing:** During a sudden stop, banks can borrow from abroad only up to the point where the level of the country’s international reserves can cover the fraction $\beta$ of the banks’ cumulative NPL losses (i.e., $\left(\varepsilon_{t_{c}} / P_{t_{c}}\right) R_{t_{c}-1} \geq \beta F$). A discrepancy between the demand for and the supply of foreign borrowing or a credit cut by foreign creditors is equal to $F - \left(\varepsilon_{t_{c}} / P_{t_{c}}\right) R_{t_{c}-1} / \beta$. Notice that the higher the fraction of banks’ cumulative NPL losses which are expected by foreign creditors to be covered by the country’s international reserves, $\beta$, the higher the credit cut by foreign creditors.

**Government bailouts:** When there is a sudden stop, the government will step in and rescue banks. During such a period, the government will subsidize the fraction $\varphi$ of the banks’ cash shortfalls as a result of the credit cut by foreign creditors (where $0 \leq \varphi \leq 1$). Hence, there will be transfers of banks’ cumulative NPL losses to the government of the amount $\varepsilon_{t_{c}} / P_{t_{c}} R_{t_{c}-1} / \beta$.

It is also assumed that a bailout plan by the government will start a certain number of periods after the first sudden stop. From the start to the end of the bailout plan (bailout period), there will be a series of transfers of the remaining banks’ NPL losses, $F_{t_{c}}$, to the government to clean up the banking system. Banks’ bad assets, $F_{t_{c}}$, will thus be replaced with good assets, $G_{A_{t_{c}}}$. All the transfers of bad assets to the government will be booked as government liabilities, $L_{t_{c}}$, and the government will have to find ways to gradually finance such liabilities through fiscal or monetary tools.

**Bank lending to the corporate sector:** If banks only receive partial subsidies from the government ($\varphi < 1$) during a sudden stop, banks have to call their loans and reduce their lending to the
corporate sector by the amount \( (1-\varphi)(F_t - \left(\varepsilon_t / P_t \right) (R_t / \beta)) \) to meet their cash constraints. Firms will therefore receive less credit and will have to reduce their investment, causing a reduction in the level of capital stock and output during a sudden stop period.

The costs of a crisis created by international capital flows and moral hazard problems could be substantial. Two types of costs are considered in this model: (1) direct costs (or bailout costs), which includes transfers from the government to the banking sector to subsidize banks’ cash shortfalls during sudden stops and transfers of the remaining banks’ NPL losses to the government to clean up the banking system during the bailout period, and (2) indirect costs (or output losses), as credit cuts by foreign creditors during sudden stops lead to reductions in bank lending to the corporate sector, corporate investment, and output. The analysis and the assessment of the direct and indirect costs through the scenario analysis will be discussed in section 9.

4.3 Analysis of the Model

In this model, an economy is defined to be at a steady state equilibrium point when there is no change in any of the endogenous variables. These steady state conditions can only be achieved when there are no changes in any of the exogenous variables and when banks maintain a 100% loan loss provisioning ratio, \( \nu \). The equilibrium conditions derived in sections 4.1 and 4.2 based on decentralized (not first best) decision making by each sector are summarized in Appendix A. Appendix B provides the list and descriptions of all parameters and variables. Appendix C presents the steady state solutions for all variables. If the loan loss provisioning ratio is less than 100%, there will be an accumulation of banks’ NPL losses, \( F_t \), which needs to be financed through additional foreign borrowing, \( b_t \). \( F_t \) and \( b_t \) will continue to increase, and the steady state will never be reached. As \( F_t \) continues to increase, the sudden stop condition, \( \left(\varepsilon_t / P_t \right) R_{t-1} < \beta F_t \), will eventually occur, and thus a sudden stop will certainly occur in this case.

It can be shown through the dynamic analysis that, when banks maintain a loan loss provisioning ratio of 100% at all times, there are stable paths leading to a steady state. By combining the thirteen equilibrium conditions in Appendix A, the dynamics of the economy can be analyzed using two first difference equations: the change in household consumption, \( C_t - C_{t-1} \), and the change in banks’ net foreign borrowing, \( b_t - b_{t-1} \). Appendix D presents the linear approximations around the steady state values of \( b_t \) and \( C_t \), the phase diagram, and the solutions for the linearized difference equations. The phase diagram suggests that there are stable paths leading to a steady state as well as unstable paths leading to an explosion in this economy. Thus, this equilibrium is a saddle point where it is stable in some directions, but unstable in others.
In sum, this model suggests that when banks can accumulate NPL losses (i.e., maintain a loan loss provisioning ratio of less than 100%) and borrow from abroad to finance those losses, a sudden stop will surely occur at some point, and a steady state will never be reached. In contrast, when banks maintain the loan loss provisioning ratio at 100% at all times, there are some stable paths leading to a steady state. These analyses therefore highlight the role of the moral hazard problems at the bank level (when banks can accumulate NPL losses) and at the international level (when banks can obtain funds from abroad to finance their cash shortfalls) in causing instability in an economy.

5. APPLICATION OF THE MODEL

5.1 Empirical Strategy

The model developed in section 4 demonstrates a mechanism through which international capital flows are transmitted from the banking sector to the corporate sector. It also shows how moral hazard problems at all levels, together with international capital flows, fuel a boom as well as cause instability in an economy. In fact, structural and policy distortions are the root causes of those moral hazard problems. With regard to the moral hazard problem at the bank level, banks can maintain minimal loan loss provisions and accumulate NPL losses largely due to ineffective banking supervision. Regarding the moral hazard problem at the corporate level, firms’ overinvestment is mainly driven by government policies aiming to promote investment. With regard to the moral hazard problems at the international level, foreign creditors lend excessively to the domestic banking sector without demanding rates of return high enough to compensate for their risks because they believe that government guarantees exist. In addition, foreign creditors expect exchange rates to move less with interest rate differentials since they believe that the government is committed to a stable exchange rate. Hence, changes in the quality of institutions and domestic policies can potentially help reduce moral hazard problems and increase the net benefit of international capital flows to a country.

A major benefit of our model is that it can be applied in a fairly straightforward manner to a specific country. This allows for the opportunity to examine an economy, which has experienced a financial crisis and undergone major institutional reforms, and address two of our primary research questions empirically: (i) Have changes in the quality of institutions and domestic policies led to significant reductions in moral hazard problems after a crisis, and (ii) what are the impacts of such changes on the net benefit of international capital flows?  

13Not every crisis country has gone through major institutional reforms. However, these hypotheses are still useful as they can be used to test whether there have been no significant changes in the quality of institutions and domestic policies in those crisis countries.
We chose to examine Thailand because it serves as a good example of a bank-based, small open economy, which has experienced both a boom (in the early 1990s) and a bust (the crisis of 1997-1998). Furthermore, Thailand has gone through major institutional reforms (e.g., the banking supervisory policy upgrade, the change in investment promotion policies, the establishment of a deposit insurance agency to replace the blanket guarantee, the change from a pegged to a flexible FX regime, and the enforcement of the New Financial Institutions Act), which potentially help reduce moral hazard problems at several levels. Thailand is also a good representative country. Based on the measures of the degree of openness used by Bekaert et al. (2005) and Bekaert, Harvey, Lundblad and Siegel (2007) (e.g., official equity market openness year, market segmentation measure (LEGO)), Thailand ranks near the middle among all countries as well as among all the emerging countries in the sample. The rankings of Thailand for most of the economic performance and quality of institution measures used by Bekaert et al. (2005) are also in line with other countries.¹⁴ Hence, Thailand is not an outlier, and it is a good example of a country to which the model can be applied. For reference, some additional facts about Thailand and the financial reforms it enacted are provided in Appendix H.

To investigate changes in moral hazard problems due to institutional reforms, the parameters measuring the severity of moral hazard problems for pre-crisis, crisis, and post-crisis periods are estimated using the equilibrium conditions in Appendix A and a GMM estimation approach. If the quality of institutions and domestic policies has been significantly altered and the moral hazard problems have been reduced, the values of the parameters measuring the severity of moral hazard problems for the post-crisis period should be significantly different from those for the pre-crisis period. In particular, those parameter values should indicate a lower degree of moral hazard problems after a crisis.

To estimate the net benefits of international capital flows, we conduct a scenario analysis. The direct costs (i.e., bailout costs) and the indirect costs (i.e., output losses) of capital flows under each scenario are analyzed relative to the base scenario to assess the impact of changes in one or more moral hazard parameters on those costs.

5.2 Hypotheses

The following specific hypotheses are formed to test whether there have been changes in the quality of institutions and domestic policies in a crisis country, leading to significant reductions in moral hazard problems after a crisis.

¹⁴ The only exceptions are real GDP growth and judicial efficiency, in which Thailand ranks third among 95 countries and 46th among 47 countries, respectively.
5.2.1 Moral Hazard Problem at the Bank Level

As noted above, with lax banking supervision and an expected future government bailout, banks have an incentive to pay dividends from their profits from PLs to their shareholders and maintain minimal loan loss provisions against their NPL losses. Parameter $\nu$, which measures the level of banks’ loan loss provisions, determines the level of NPL losses that banks can accumulate in each period. Thus, it indicates the degree of the moral hazard problem at the bank level and can be used as a proxy for the quality of institutions and policies with respect to banking supervision. Before the crisis, banking supervision policies, such as loan classification and loan loss provisioning rules, were quite lax, and bank monitoring was inadequate. After the crisis, banking supervision policies were improved and became more stringent. If more effective banking supervision leads to a significantly higher level of banks’ loan loss provisions, parameter $\nu$, should be higher and the moral hazard problem at the bank level should be less severe after a crisis. The specific predictions for the null hypothesis ($H_0$) and alternative hypothesis ($H_A$) are

$H_0^{1}: \nu_{\text{before}} = \nu_{\text{after}}$

$H_A^{1}: \nu_{\text{before}} < \nu_{\text{after}}$  \hspace{1cm} (Hypothesis 1).

5.2.2 Moral Hazard Problem at the Corporate Level

As a way to promote investment in a country, the Thai government provided subsidies and tax incentives to firms. Our model predicts that these incentives increased firms’ expected profits and induced firms to invest more than they optimally do without the government subsidies or tax incentives, leading to overinvestment. Parameter $n$, which indicates the level of government subsidies or tax incentives and the degree of overinvestment, measures the degree of the moral hazard problem at the corporate level and can be used as a proxy for the quality of institutions and policies with regard to corporate investment. After the crisis, Thailand tightened fiscal policies and revised their investment promotion policies. If such revisions led to a significant reduction in both direct and indirect government subsidies or tax incentives provided to firms, the value of parameter $n$, which indicates the level of government subsidies or tax incentives to the corporate sector and the degree of overinvestment, should be lower after a crisis. The specific predictions for $H_0$ and $H_A$ are

$H_0^{2}: n_{\text{before}} = n_{\text{after}}$

$H_A^{2}: n_{\text{before}} > n_{\text{after}}$  \hspace{1cm} (Hypothesis 2).
5.2.3 Moral Hazard Problems at the International Level

Before the crisis, there was a widely held perception that government guarantees for corporate and financial investment existed. Our model predicts that foreign creditors were willing to lend excessively to banks in Thailand with the presumption that a government guarantees existed. Parameter $\psi_1$, which measures the interest rate sensitivity to the aggregate level of banks’ net foreign borrowing, reflects the level of risks that foreign investors perceive and factor into their required rates of return. Hence, parameter $\psi_1$ measures the degree of a moral hazard problem at the international level and the quality of institutions and policies relating to foreign investors’ estimation of risks. After the crisis, Thailand replaced the blanket guarantee with a limited guarantee through the establishment of a deposit insurance agency. If the crisis and the replacement of the blanket guarantee with a limited guarantee caused foreign creditors to significantly adjust their risk perceptions and demand much higher interest rates, parameter $\psi_1$ should be higher after a crisis. Thus, the specific predictions for H$_0$ and H$_A$ are

\[ H_0^3: \psi_1^{\text{before}} = \psi_1^{\text{after}}, \]
\[ H_A^3: \psi_1^{\text{before}} < \psi_1^{\text{after}} \]  
(Hypothesis 3).

In countries with rigid FX regimes, foreign investors expect the governments of those countries to be committed to stable FX rates and to intervene in the FX markets when there are material changes in the factors driving FX rate movement, such as interest rate differentials. Hence, FX rates are expected to be less responsive to the interest rate differentials and to deviate more from the conventional UIP. Parameter $P_\epsilon$, which measures the expected FX rate deviation from the conventional UIP, serves as a measure of another moral hazard problem at the international level and a proxy for the quality of institutions and policies with regard to FX rates. Thailand adopted a rigid FX regime before the crisis. At the onset of the crisis, Thailand let the baht float and continued to maintain a flexible exchange rate policy. If the changes in FX regimes cause foreign investors to significantly adjust their expectations about the FX rates, the absolute value of $P_\epsilon$ should be higher before the crisis than after the crisis. Thus, the specific predictions for H$_0$ and H$_A$ are

\[ H_0^4: |P_\epsilon^{\text{before}}| = |P_\epsilon^{\text{after}}|, \]
\[ H_A^4: |P_\epsilon^{\text{before}}| > |P_\epsilon^{\text{after}}| \]  
(Hypothesis 4).
6. DATA

We collect monthly data from January 1993 to June 2007. Table 1 describes the series we collect and how each variable is obtained or computed. Monthly data on real sector indices are obtained from the Bank of Thailand (BOT) while real sector data with lower frequencies are derived from Thailand’s National Economic and Social Development Board (NESDB). These data are in real terms at 1988 prices and are seasonally-adjusted (SA). The employed labor, international reserves, and bank data are obtained from the BOT. The monetary aggregate and interest rate data are derived from the International Financial Statistics (IFS) of the International Monetary Fund (IMF). Exchange rate, inflation rate, and price level data are obtained from Datastream.

Table 2 reports summary statistics of the variable levels in panel A and first-differences (changes) in panel B for the whole sample period. The average annual traded output in real terms (real output) is 2.93 trillion baht (around 83 billion USD) while the average annual private investment in traded sectors in real terms (real investment) is 592 billion baht (around 17 billion USD). Banks’ foreign borrowing is on average 8.9 billion USD. Time variation in most level variables is relatively small compared to the mean. The exceptions are the banks’ net foreign borrowing and the domestic real deposit rate which have relatively high standard deviations compared to their means. In addition, the banks’ net foreign borrowing is highly right-skewed; thus, its mean (8.9 billion USD) is much higher than its median (1.9 billion USD). According to the augmented Dickey-Fuller (ADF) unit roots tests, all change variables are stationary whereas all level variables are not.

As noted above, we hypothesize that the variables behave differently before and after the crisis due to the crisis and the reforms, thus the sample is divided into 3 sub-periods, using June 1997 and December 2000 as breakpoints. The three sub-periods are (i) the pre-crisis period from January 1993 to May 1997, (ii) the crisis period from June 1997 to December 2000, and (iii) the post-crisis period from January 2001 to June 2007. We end the sample before the current financial crisis which is widely cited as beginning in July 2007. However, we subsequently provide an anecdotal discussion of Thailand’s situation during the recent crisis.

Table 3 reports summary statistics of the variable levels in panel A and changes in panel B for the pre-crisis, crisis, and post-crisis periods. Figure 1 plots time-series patterns of the level variables.

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15 When actual monthly data are not available (which is the case for output, investment, and consumption), relevant monthly indices are used to approximate actual monthly data. In a few cases, observations at the beginning and end of the sample are not available, so the series are extended using predicted values based on a regression method utilizing closely related explanatory variables.

16 June 1997 was the month in which the operations of 16 insolvent finance companies were suspended while December 2000 was the month in which the financial reform in Thailand ended (see Appendix H for details).
over time. As seen in Table 3 and Figure 1, the domestic macroeconomic and financial variables tend to move in an adverse direction during the crisis. For example, the levels of real output, real consumption, and the real monetary aggregate exhibit an increasing trend from the pre-crisis to post-crisis periods. Such a positive trend is disrupted during the crisis. The average changes in those variables are the lowest in the crisis period. The data also reveal the investment boom and an influx of capital flows to the banking sector in the pre-crisis period. The average real investment and banks’ net foreign borrowing are the highest in the pre-crisis period at 846 billion baht (around 24 billion USD) and 28.8 billion USD, respectively. The boom is however followed by a big drop in real investment during the crisis and a declining trend for banks’ net foreign borrowing since the crisis. Average real investment is much lower at 377 billion baht (around 11 billion USD) during the crisis and average banks’ net foreign borrowing declines to 16.1 billion USD during the crisis and then to -8.6 billion USD after the crisis. In addition, the data show that international reserves were depleted extremely quickly after the BOT’s attempt to defend the baht in early 1997, and the real value of the local currency against foreign currency depreciated substantially after the government decided to switch from a pegged exchange rate to a managed float in July 1997.

7. EMPIRICAL METHODOLOGY

The univariate analysis suggests that there have indeed been two structural changes in Thailand during the sample period. Consequently, we seek to estimate the parameters of interest for each sub-period. Because the time-series data are not stationary in levels, the model structural equations need to be rearranged in first-difference form to ensure stationarity. In addition, co-movements among those variables before, during, and after the crisis, suggest that interest rates are more volatile than the variables depending on them. A preliminary analysis of the co-movements among variables is thus conducted by looking at the correlations between the left-hand side (LHS) and the right-hand side (RHS) variables in the structural equations in Appendix A. Table 4 restates the equilibrium conditions and reports the correlations between the LHS and the RHS variables. Most of the correlations (in bold font) are of expected sign and of significant magnitude; however, some are not. We discuss these issues now in more detail.

According to the equilibrium conditions (A2), (A8) and (A9) in Appendix A, the real net capital stock (whose change determines the level of real investment), the growth rate of real consumption, and the real monetary aggregate are supposed to move closely with the domestic interest rate. However, the univariate analysis in Section 6 suggests that these variables are much less volatile than the domestic interest rate. In addition, the correlation between the real investment and the change in the real deposit rate and the correlation between the growth rate of real consumption and the lagged real deposit rate are
not strong and not of the expected sign. A possible explanation could be that firms and households smooth their investment, consumption, and money holding decisions over the business cycle, weakening the contemporaneous relationships between those variables and the relevant interest rates. This suggests that it is more appropriate to use moving averages of interest rates over the business cycle, rather than one-period interest rates, in the equilibrium conditions (A2), (A8) and (A9). In computing the moving averages of interest rates, we assume the business cycle last 11 years (though our analysis is not significantly affected by using a shorter window). Table 5 compares the correlations between the selected macroeconomic variables and the relevant interest rates when using one-period interest rates versus eleven-year moving averages of interest rates. The results show that the correlations when using the eleven-year moving averages of interest rates are of the expected sign, and the magnitudes are larger.

There exist real-world frictions and factors that are not explicitly considered by the model. For example, Figure 1C shows that real investment is very persistent. Empirically, the persistence of investment (e.g., due to large-scale long-term projects) suggests a need to include lagged investment as an additional explanatory variable for current investment and modify the equilibrium condition (A3) as follows.

\[
I_t = \text{Inv}_0 \cdot \left[ K^M_t - (1 - d) K^M_{t-1} \right] + \text{Inv}_1 \cdot [I_{t-1}] \tag{M1},
\]

where \( K^M_t \) is the level of capital stock calculated from the model, and parameters \( \text{Inv}_0 \) and \( \text{Inv}_1 \) indicate how much current investment is determined by the model and how much by previous period’s investment, respectively.\(^{17}\)

Due to the limitation of the data regarding the details of the government financial account, assumptions have to be made to ensure that the budget constraint of the public sector holds. Because the focus of this research is not primarily on the public sector, it is assumed for the empirical analysis that public sector policies (i.e., international reserves (R) and inflation rate (\( \pi \))) are exogenous. It is also assumed that the bailout period, in which there will be a series of transfers of the remaining banks’ NPL losses to the government, starts one year after the first sudden stop.

The ADF tests for unit roots suggest that all the observed endogenous variables are not stationary. Consequently, the estimation is based on change variables, and the equilibrium conditions

\(^{17}\) This modification will however affect the magnitude of the impact of a sudden stop on bank lending to the corporate sector and on firms’ investment predicted by the model. When banks face a credit cut by foreign creditors of the amount \( (1 - \phi) \left[ F^0 - (e_i/P_i) R_{t+1} \beta \right] \), bank lending and firms’ investment will decline by \( \text{Inv}_0 (1 - \phi) \left[ F^0 - (e_i/P_i) R_{t+1} \beta \right] \), rather than by \( (1 - \phi) \left[ F^0 - (e_i/P_i) R_{t+1} \beta \right] \). Similarly, transfers that banks receive from the government to finance their cash shortfalls during a sudden stop will be \( \left[ 1 - \text{Inv}_0 (1 - \phi) \right] \left[ F^0 - (e_i/P_i) R_{t+1} \beta \right] \), rather than \( \phi \left[ F^0 - (e_i/P_i) R_{t+1} \beta \right] \).
are rearranged in the form of first difference equations. Appendix E presents the equilibrium conditions in first difference form after the modifications.

7.1 Calibration and Estimation

The parameters of interest \((\nu, n, \Psi_1, P_e)\), along with the related parameters which are anticipated to change after the crisis \((\Psi_0, \text{Inv}_0, \text{Inv}_1)\), are estimated for the pre-crisis, crisis, and post-crisis periods using the partial-sample generalized method of moments (GMM) approach while all other parameters are specified exogenously (i.e., obtained from related studies or calibrated using long-run data relations). Table 6 lists exogenously-determined parameters and describes how these parameters are obtained. Given the values of exogenously-determined parameters and the assumption that \(X_0=F_0=FX_0=AFX_0=0\), the parameter values \((\nu, n, \Psi_0, \Psi_1, P_e, \text{Inv}_0, \text{Inv}_1)\) are estimated to fit the following first difference equations,

\[
\begin{align*}
\text{Inv}_n, \nu, \text{fn}(t) &= b_0(1-t) \\
\text{Inv}_0, \text{Inv}_1 \text{fn}(t) &= \psi_0(1-t) \\
\rho_e &- \rho_e = fn(\gamma_0, \psi_0), \\
(\epsilon_e, P_e) - (\epsilon_{e,1}, P_{e,1}) &= fn(P_e), 
\end{align*}
\]

for each sub-period.\(^{18}\)

To address the endogeneity problem and to increase the number of moment conditions for better identification, we utilize several global financial market and economic indicators as well as their own lagged variables are utilized as instruments. These include the change in the world interest rate, the change in the world inflation rate, the percentage change in the world industrial production index, and the log return on the spot JPY/USD exchange rate. Appendix F provides the descriptions and the sources of variables used as instruments. These variables are considered good instruments, since they are not likely to be impacted by changes in economic and financial market conditions of a small open economy and hence are not determined by any of the endogenous variables in the model. Furthermore, theoretically and conceptually they can help explain variations in endogenous variables of the model. Since we choose the same instruments for each sub-period, our choice of instruments is unlikely to bias our tests of hypotheses 1-4.

7.2 GMM and Hypothesis Testing Methodology

Our hypotheses can be tested using F-statistics with two known breakpoints (as there are three sub-periods). Since the model developed in this paper is in the form of non-linear simultaneous equations, the F-test for non-linear simultaneous equations models by Andrews and Fair (1988), with the applications for GMM discussed by Andrews (1993), is most appropriate. Three types of F-tests are proposed by Andrews and Fair (1988): Wald-type, LM-type, and LR-type. Since parameter values are estimated under the alternative hypothesis that values are different across sub-periods, Wald-type

\(^{18}\) Note that only equations (E2),(E4),(E5), and (E8) in Appendix E are relevant. All other equations are determined by exogenously-determined parameters; therefore, there are no parameter values to be estimated from those equations.
statistics for hypothesis testing is most appropriate. However, the F-test by Andrews and Fair (1988) was originally developed for one known breakpoint. This test therefore needs to be slightly modified to accommodate two known breakpoints. The steps to calculate GMM estimators for each sub-period (partial sample GMM estimators) and Wald statistics with two known breakpoints following the idea of Andrews and Fair (1988) and Andrews (1993) are outlined in Appendix G.

8. EMPIRICAL RESULTS

Partial-sample GMM estimators of parameters \( (\upsilon, n, \Psi_0, \Psi_1, P_{\varepsilon}, \text{Inv}_0, \text{Inv}_1) \), along with their approximate standard errors, t-statistics, and p-values, are reported in Table 7. Almost all of the parameter estimates are significantly different from zero. The exceptions are the estimated values of the interest rate sensitivity to the world interest rate \( (\psi_0) \) for the crisis and post-crisis periods, the interest rate sensitivity to the aggregate level of banks’ net foreign borrowing \( (\psi_1) \) for the pre-crisis period, the expected FX rate deviation from the conventional UIP \( (P_{\varepsilon}) \) for the post-crisis period, and the loan loss provisioning ratio \( (\upsilon) \) for the crisis period. The estimate of \( \upsilon \) for the crisis period is set to zero, the lower bound of allowed parameter values. The estimate of \( \upsilon \) for the post-crisis period is set to the upper bound value of one. Besides, the J-statistic for the test of over-identifying restrictions suggests that the null hypothesis that the moment conditions included in the GMM estimation are zero cannot be rejected.

In general, the values of the parameters of interest are significantly different across sub-periods. Table 8 reports the Wald statistics and the \( p \)-values for the structural break tests.\(^{19} \) Recall that \( \upsilon \), the loan loss provisioning ratio, can be interpreted as a measure of the moral hazard problem at the bank level. The estimated values are 52\%, 0\%, and 100\% for the pre-crisis, crisis, and post-crisis periods, respectively. The value of 52\% indicates that banks did not maintain sufficient provisions to cover their NPL losses before the crisis, and the under-provisioning problem became more severe during the crisis. However, after the crisis, the estimation indicates that banks have maintained 100\% loan loss provisions for their NPL losses. Such a change can be largely explained by the stricter loan loss provisioning rules and improved banking supervision standard, which were part of the financial system reforms in Thailand. The estimated values of parameter \( n \), which indicates the level of government subsidies (or taxes if negative) to the corporate sector as well as the degree of the moral hazard problem at the corporate level, exhibit a downward trend, from -3.8 before the crisis, to -13.0 during the crisis, and -29.0 after the crisis, and such differences are statistically significant. This trend is consistent with the

\(^{19}\)The structural break tests for parameter \( \upsilon \) cannot be conducted since the values of \( \upsilon \) for the crisis and post-crisis periods are at the boundaries of the parameter value range.
fact that the Board of Investment of Thailand changed the investment promotion policies by lowering tax incentives and imposing more stringent criteria for firms eligible for tax privileges after the crisis.\textsuperscript{20}

Recall that one of the moral hazard problems at the international level is captured by parameter $\psi_1$ (a measure of the interest rate sensitivity to the aggregate level of banks’ net foreign borrowing in 10 trillion USD unit). The estimated value is not different from zero before the crisis whereas it is estimated to be 0.84 during the crisis and 1.46 after the crisis. On the other hand, parameter $\psi_0$ (a measure of the interest rate sensitivity to the world interest rate) is estimated to be 1.18 before the crisis while it is not significantly different from zero during and after the crisis. The differences in the estimated values of $\psi_0$ and $\psi_1$ for the pre- and post-crisis periods are significant at 1% and 10% confidence levels, respectively. These results suggest that the foreign borrowing rate, which previously moved with the world interest rate before the crisis, is largely determined by the aggregate level of banks’ net foreign borrowing since the crisis. This shift likely reflects a change in foreign creditors’ perceptions of risks associated with their lending to the banking sector in Thailand after witnessing the crisis and acknowledging the plan by the government to replace the blanket guarantee with a limited guarantee. Particularly, an increase in the aggregate level of banks’ net foreign borrowing of 10 billion USD is expected to be accompanied by a rise in the foreign borrowing rate of 1.0% per annum during the crisis and 1.8% per annum after the crisis to compensate for foreign creditors’ higher risks from the greater amount of their lending to the banking sector in Thailand.

The estimated values of parameter $P_\varepsilon$ also reflect the changes in the expected FX rate deviation from the conventional UIP by market participants. $P_\varepsilon$ before the crisis (0.0044) is positive and larger in magnitude than $P_\varepsilon$ after the crisis (which is not significantly different from zero). This suggests that the expected FX rate deviation from the UIP is much smaller after 2000. This is intuitive, since Thailand switched from a pegged FX rate to a managed float regime with significantly less market intervention by the government. However, $P_\varepsilon$ during the crisis is highly negative at -0.0095, indicating that market participants expected the FX rate to depreciate more than the level suggested by the UIP relationship. This potentially worsened the situation during the crisis. Parameters $\text{Inv}_0$ and $\text{Inv}_1$, which measure how much actual investment is determined by contemporaneous investment and how much by lagged investment, are in general not significantly different across sub-periods. Only the difference between $\text{Inv}_0$ for the crisis and post-crisis periods is significant at 10% confidence level. These results suggest that the relationship between lagged and current investment is stable as would be the case if a simple

\textsuperscript{20} Some could argue that there are factors other than changes in investment promotion policies which can explain the estimated reduction in $n$ since the crisis. For example, lower demand for goods during the recession may cause a reduction in the use of production capacity during the crisis, which could lead to the estimated decrease in $n$. However, this factor cannot explain the greater reduction in $n$ estimated for the post-crisis period, when the economy has exited the recession.
mechanical relationship (such as that dictated by large long-lived projects) is primarily responsible for determining this parameter.

In sum, the empirical results show that the values of all the parameters measuring the severity of moral hazard problems are significantly different across sub-periods, especially between the pre- and post-crisis periods. These significant changes in the parameter values suggest that the changes in the quality of institutions and domestic policies in Thailand after the crisis bring about substantial reductions in the moral hazard problems at all levels. At the bank level, the improved banking supervision and the more stringent loan loss provisioning rules lead to the higher banks’ loan loss provisioning ratio after the crisis. At the corporate level, the changes in the investment promotion policies by the Board of Investment can explain the lower level of government subsidies or tax incentives to firms. At the international level, the occurrence of the crisis and the plan to replace the blanket guarantee with a limited guarantee (through the establishment of a deposit insurance agency) cause foreign creditors to change their estimations of risks stemming from their lending to the banking sector in Thailand. In addition, the change from a fixed FX rate to a managed float causes foreign investors to adjust their expectations about the FX rate. The improvement in the foreign investors’ risk estimations and expectations about the FX rate leads to the higher interest rate sensitivity to the aggregate level of banks’ net foreign borrowing and the lower expected FX rate deviation from the UIP relationship.

The estimation results however depend on exogenously-determined parameters. As a robustness check, the sensitivity analysis is conducted to examine the effects of changes in those exogenously-determined parameters on the estimation results, and the main results do not change appreciably. Other issues with regard to the partial-sample GMM estimation, i.e., convergence to a local minimum rather than the global one, choices of kernels and bandwidth parameters for the estimation of the optimal weighting matrix, and different alternatives for breakpoints, are also investigated. Our results are found to be robust to different combinations of extreme starting values, different kernels and bandwidth parameters, and different breakpoints.

9. SCENARIO ANALYSIS OF DIRECT AND INDIRECT COSTS OF CAPITAL FLOWS

In this section, the parameter values derived from the calibration and estimation\(^{21}\) in Section 8 are used to generate endogenous variables in the scenarios where the degree of moral hazard problems is high and where it is low. The goal is to assess the impact of changes in the quality of institutions and domestic policies on the costs and benefits of international capital flows to an open economy like

\(^{21}\)If the estimated value of parameter is not significantly different from zero, the value of zero will be used instead.
Thailand. In other words, we seek to understand if changes in institutions are actually effective and if so which are most beneficial.

9.1 Costs and Benefits of International Capital Flows

A central debate in the international finance literature is the magnitude of the benefits from international capital flows as they relate to capital available for real investment and higher output growth. Specifically, the benefits of greater investment must be weighed against the potentially large costs of international capital flows if a country relying more on foreign capital becomes significantly vulnerable to a crisis. A crisis not only creates large bailout costs to the government, but it also leads to output losses, especially when a sudden stop occurs in concurrence with a crisis.22

The model in this paper is designed to capture the effect of changes in moral hazard problems on the key benefits and costs of international capital flows emphasized by prior literature. In this model, international capital flows serve as an additional source of financing for firms’ investment. During good times, international capital flows, together with moral hazard problems, help fuel an economy, causing higher investment and output (the key benefits of the capital flows). However, the capital flows and the moral hazard problems also allow banks to accumulate losses and excessively borrow from abroad as well as induce firms to overinvest. These excessive risk-taking activities make a country more vulnerable to a sudden stop and a crisis, which will normally result in substantial economic costs. Bank bailouts through transfers of bank losses to the government as a result of a crisis are the direct costs to a country. In addition, output losses as a result of credit cuts by foreign creditors are considered the indirect costs.

9.2 Scenario Predictions

Based on the mechanism of the model, we make the following conjectures about the effects of changes in the quality of institutions and policies on the costs of international capital flows to a country like Thailand.

An increase in the interest rate sensitivity to the aggregate level of banks’ net foreign borrowing ($\psi_1$) could either positively or negatively impact an economy, depending on the time-series pattern of the banks’ net foreign borrowing. If the changes in the aggregate level of banks’ net foreign borrowing are mostly negative, an increase in $\psi_1$ leads to a greater reduction in domestic interest rates, which results in higher output (higher investment) and lower bailout costs (lower NPL losses).23 In contrast, if these

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22 As suggested by Hutchison and Noy (2005), crises with sudden stops of capital flows have a larger negative impact on output growth than those without sudden stops.
23 Lower domestic interest rates directly reduce interest owed by non-performing companies while indirectly inducing greater investment and bank lending to the corporate sector, leading to higher NPLs. In this model, the
series are mostly positive, an increase in $\psi_1$ causes a larger increase in domestic interest rates, thereby lowering output and increasing bailout costs. Since the data show that the actual changes in the aggregate level of banks’ net foreign borrowing for Thailand are mostly negative during the sample period, it is anticipated that an increase in $\psi_1$ will benefit the country by raising the output and reducing the bailout costs.

A reduction in the interest rate sensitivity to the world interest rate ($\psi_0$), which occurs in conjunction with an increase in $\psi_1$, could either benefit or harm a country, depending upon the time-series pattern of the world interest rate. If changes in the world interest rate are mostly positive, a decrease in $\psi_0$ causes domestic interest rates to increase less with the world interest rate. The lower domestic interest rates result in higher output and lower bailout costs. If they are mostly negative, a decrease in $\psi_0$ causes domestic interest rates to decrease less with the world interest rate. The higher domestic interest rates cause a reduction in output and an increase in bailout costs. Since the actual changes in the world interest rate during the sample period are mostly positive, it is expected that a decrease in $\psi_0$ will benefit the country by increasing output and lowering the bailout costs.

An increase in the banks’ loan loss provisioning ratio ($\upsilon$) as a result of improved banking supervision leads to a lower level of banks’ cumulative NPL losses and lower bailout costs. The lower banks’ cumulative losses also results in a smaller credit cut by the foreign creditors during a sudden stop, a smaller decline in firms’ investment and a lower reduction (or an increase) in output during the crisis.

A decrease in the level of government subsidies or tax incentives ($n$) leads to a reduction in firms’ investment and lower output. This conjecture is consistent with the view by Stiglitz (2002), in which contractionary fiscal policies during crises, especially the Asian financial crisis, have adverse effects on crisis countries since they make serious recessions even deeper. Firms also reduce their demand for bank loans, leading to lower banks’ NPL losses and lower bailout costs.

A decrease in the expected FX rate deviation from the UIP ($P_\epsilon$) as a result of an adoption of a more flexible FX regime leads to a higher real exchange rate (local currency depreciation). As a result, the value of the country’s international reserves in local currency increases, resulting in a smaller cut in credit by foreign creditors during a sudden stop. Hence, there will be a smaller cut in investment by firms, leading to a lower reduction (an increase) in output. There will also be a smaller decrease in banks’ lending and NPL losses, causing an increase in bailout costs during a sudden stop. These effects are however expected to be quite small, since they take place only during a sudden stop.

9.3 Scenarios
The analysis in this section covers four groups of selected scenarios, as described in detail in Table 9. The base scenario serves as the benchmark case where the moral hazard problems at all levels are severe as all parameter values (υ, n, Ψ₀, Ψ₁, Pε, Inv₀, Inv₁) are set at the pre-crisis levels. Group A scenarios facilitate a ‘what if’ analysis when only one aspect of the moral hazard problems is adjusted to the post-crisis level. In Group B scenarios, it is assumed that parameter υ, which measures the moral hazard problem at the bank level, and another aspect of the moral hazard problems are concurrently adjusted to the post-crisis levels. This is to examine if there are additional benefits and costs from addressing two aspects of the moral hazard problems at the same time. Scenario C1 uses different parameter values (as derived from the partial-sample GMM estimation) for each sub-period. This scenario should therefore reflect the situation closest to what has happened in Thailand.

9.4 Assumptions

As the parameter values are estimated using first difference equations, the series of endogenous variables are also determined (in changes) using the modified equilibrium relations in Appendix E. The series of variables in levels are then computed using specified initial values. For stock variables and flow variables which have their own lagged variables on the right hand side of the equations, the actual values for January 1993 are used as the initial values. Implied values are used for flow variables which do not have their own lagged variables on the right hand side of the equations. For exogenous variables, the actual series of NPL ratios, inflation rates, world interest rates, employed labor, and international reserves are utilized, rather than simulating them using AR(1) processes. This creates scenarios as close as possible to what has happened in Thailand during 1993-2007.

9.5 Results

Table 10 presents the magnitude of the estimated direct and indirect costs for each scenario, in comparison with the actual data. The estimated direct costs (bailout costs) are the sum of banks’ NPL losses transferred to the government while the actual direct costs are the sum of actual government lending to the Financial Institutions Development Funds. The estimated indirect costs are demonstrated in terms of the average annual traded output (output) and the average annual output growth over February 1993 – June 2007 for comparison with commonly used data. The direct costs and the average annual output are also reported as future values in June 2007 to account for the time value of money.

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24 The analysis in section 9 considers only a certain number of scenarios. Other possible scenarios and the sensitivity analysis are discussed in Appendix I as robustness checks.

25 Data on government lending to the Financial Institutions Development Funds (FIDF) are obtained from the Bank of Thailand.
The direct costs estimated from the model range from 0% of output in scenario A1, B1, B2 and B3 (when there is no moral hazard problem at the bank level) to 18.02% of output or 21.56% of output (in future value) in scenario C1 when different parameter values for each sub-period are used. This range overlaps with the estimated bailout costs of over 20% of output by Kaminsky and Reinhart (1998). However, when compared with the actual bailout costs (32.69% of output or 36.78% of output in future value) and the estimated costs of restructuring and recapitalizing the banking system (35% of GDP) by Burnside et al. (2000), the direct costs estimated from this model are much lower. This is largely due to the implicit assumption that the principal part of loans granted to the corporate sector is fully collateralized. Hence, there are no losses from the principal part, and banks’ NPL losses estimated from the model include only losses from the interest part. In reality, although loans had been fully collateralized at the origination, the value of collaterals pledged against those loans dropped significantly during the crisis. In addition, there is no run by domestic depositors in this model. Hence, banks in this model may face smaller cash shortfalls during a sudden stop than when there is also a run by depositors, which is often observed in crisis countries including Thailand. This could be another reason for obtaining the estimated direct costs that are lower than the actual costs.

Scenario C1 provides the highest estimate of the direct costs, since it allows all parameters to be different across sub-periods and to reflect the worse-than-expected economic downturns during the crisis period. Scenario A4 and the base scenario provide the second and third highest estimates. As expected, the base case, in which all types of moral hazard problems are assumed to be at the pre-crisis levels, generates high direct costs. However, scenario A4 yields the results not much different from the base case. This suggests that the change in the expected FX rate deviation from the UIP (the change in $P_\epsilon$ from 0.0044 in the base case to 0 in scenario A4), which may result from the change in an FX regime, does not help reduce the bailout costs when other moral hazard problems are still severe.

Consistent with the analysis of the model in section 4, what matters most to the direct costs is the moral hazard problem at the bank level. Once the loan loss provisioning ratio, $\psi$, is set at 100% (scenario A1), i.e., there is no accumulation of NPL losses in banks, the direct costs are estimated to be zero. The improvement in foreign investors’ estimation of risks associated with their lending to the banking sector in Thailand (i.e., the changes in $\Psi_0$ from 1.18 to 0 and $\Psi_1$ from 0 to 1.46 in scenario A3), which makes it more expensive for banks to increase their foreign borrowing, also helps reduce the bailout costs substantially from 14.12% in the base case to 6.11% of output in future value. However, the reduction in government subsidies or tax incentives to the corporate sector (the change in $n$ from -3.84 to -29.02 in scenario A2), which leads to lower investment and lower bank lending to the corporate
sector, plays a very small role in reducing the bailout costs. Relative to the base case, the direct costs in this scenario decline by only 0.17% of output in future value.

In addition to bailout costs, a sudden stop of capital flows may cause a deeper recession or a substantial reduction in output during and after a crisis. The changes in output are thus a measure of the indirect costs (if negative) or benefits (if positive) of international capital flows to a country. In Table 10, the indirect costs or benefits are analyzed in terms of the average annual output and the average annual output growth rate. The estimated average output ranges from 2.92 to 3.10 trillion baht. This range covers the average actual output over February 1993 – June 2007 of 2.94 trillion baht. However, the estimated average output growth rate is between 2.06% and 3.21% per annum, which is much lower than the actual output growth rate of 4.40% per annum.

In all the scenarios except A2, B1 and C1, the average output is slightly higher than, and the average output growth rate is almost the same as, in the base case. On the other hand, scenarios A2, B1 and C1, in which the level of government subsidies (or taxes if negative) (n) is set at the post-crisis level, demonstrate the lower average output and average output growth rate. These results suggest that the reduction in government subsidies or tax incentives to the corporate sector creates the substantial indirect costs to the country by lowering the average output and the average output growth rate.

To have a complete picture of which policy combinations would benefit the country the most under the selected scenarios, the direct and indirect costs are simultaneously analyzed. Here the indirect costs are analyzed in term of the sum of the output over the sample period, rather than the average, so that it can be added to the direct costs (which are the sum of the bailout costs over the same period) to obtain the total costs. In addition, the direct, indirect, and total costs are relative to those in the base case for better comparison. Results are presented in Table 11.

Considering the total costs among all of the group A scenarios, the results are as conjectured. The increase in the loan loss provisioning ratio to 100% (scenario A1) has the largest benefit since it substantially reduces the bailout costs as well as slightly helps increase the output. The improvement in foreign investors’ estimation of risks (scenario A3) also has a significant positive impact on both the direct and indirect costs. However, the reduction in government subsidies or tax incentives (scenario A2) hurts, rather than benefits, the country since it leads to a substantial decline in output. The decrease in the expected FX rate deviation from the UIP (scenario A4) does not have a significant effect.

These results indicate that, in a typical bank-based open economy, the moral hazard problem at the bank level plays a key role in creating the bailout costs. Hence, the first priority should be given to the improvement in the quality of institutions or domestic policies that could potentially help reduce the
moral hazard problem at the bank level, such as the improvement in banking supervision. Group B scenarios combine policies to examine whether there are additional costs or benefits from implementing two sets of policies together. The results for scenario B1 suggest that the combination of the improved banking supervision and the reduction in government subsidies or tax incentives hurts the economy. Although the stricter loan loss provisioning rule significantly reduces the bailout costs, the reduction in government subsidies or tax incentives results in the substantially lower output. In contrast, the results for scenario B2 suggest that the net benefit from implementing the policies to improve banking supervision together with those to improve foreign investors’ estimation of risks is larger than when each set of policies is implemented alone (scenario A1 or A3). The impact of the policies to improve the expected FX rate deviation from UIP, either implemented alone (scenario A4) or with the policies to improve banking supervision (scenario B3), is minimal.

In sum, the results from the scenario analysis suggest that the combination of the policies to improve banking supervision and those to improve foreign investors’ estimation of risks is most beneficial to a country like Thailand. In contrast, the policies to reduce government subsidies or tax incentives to the corporate sector hurt the country by substantially lowering output. This result is consistent with the view by Stiglitz (2002), who argues that tightening fiscal policies during crises have adverse impacts on crisis countries since they make serious recessions even deeper.

10. CONCLUSION

This paper studies the transmission mechanism of international capital flows via the banking sector to the real sector when moral hazard problems are present. The model developed describes a bank-based open economy like those in Asia, Latin America, and much of Europe. We pay particularly close attention to the role of the quality of institutions and domestic policies in (i) reducing moral hazard problems and (ii) determining the net benefit of international capital flows to a country in the long run.

The theoretical model is developed in a general equilibrium framework with three main ingredients reflecting the key observations of open countries which have experienced crises. First, the banking sector plays a major role in channeling international capital flows to the real sector. Second, there are structural and policy distortions, resulting in three layers of moral hazard problems in an economy before a crisis: (1) lax loan loss provisioning rules and inadequate banking supervision leading to excessive lending, excessive foreign borrowing, and an accumulation of NPL losses at the bank level, (2) government subsidies or tax incentives leading to overinvestment at the corporate level, and (3) expected government guarantees and stable exchange rates leading to excessive lending by foreign investors to the banking sector in another country, foreign investors’ underestimation of risks, and a greater expected exchange rate deviation from the uncovered interest rate parity at the international
level. Third, a sudden stop of capital flows is triggered when the expected level of the government’s contingent liabilities exceeds the level of the country’s international reserves.

The model explains what has happened in many open countries which have experienced crises. The model shows that more available capital from international capital flows via the banking sector, together with the three layers of moral hazard problems, leads to excessive foreign borrowing and risk-taking behavior not only in the banking sector, but also in the real sector. The increasing level of foreign borrowing and cumulative losses as a result of risk-taking activities takes the economy away from its equilibrium. Once the level of cumulative losses reaches a certain threshold, foreign investors stop lending to the country and a sudden stop of capital flows occurs. This model therefore highlights the role of international capital flows and moral hazard problems in fueling an open economy during a boom as well as making a country more vulnerable to a sudden stop and a crisis. Although the model in this paper is rich in several dimensions, there are some simplifying assumptions and missing components, which could be areas for future research. These include the assumptions that loans are fully collateralized, there is no run by domestic depositors, NPLs to total loans ratio is exogenous, and there is no role of bank FX hedging.

The primary contribution of this paper is our finding that the quality of institutions and domestic policies matters and that reforms can be effective. Our empirical estimation shows that deliberate financial reforms in Thailand instituted after the Asian crisis resulted in significant reductions in moral hazard problems at all levels. In addition, the results from the scenario analysis suggest that the policies to increase the effectiveness of banking supervision and those to improve foreign investors’ estimation of risks, especially when implemented together, significantly help increase the net benefit of international capital flows by increasing the output and reducing the bailout costs. However, the policies to reduce government subsidies or tax incentives to the corporate sector hurt, rather than benefit, the country, as the cost from the lower output exceeds the benefit from the lower bailout costs. These results suggest that policies to reduce a moral hazard problem in a particular sector not only have an immediate impact on that particular sector, but also affect other sectors as well as the whole economy in the long run. Furthermore, some policy combinations are better than others in different situations. It is therefore very important that policy makers and related authorities carefully consider policy interactions and indirect effects to identify optimal policy reforms.
REFERENCES


Reinhart, C. M., and K. S. Rogoff, 2008e, This Time is Different: A Panoramic View of Eight Centuries of Financial Crises, Harvard University working paper.


APPENDIX A: Equilibrium Conditions

Corporate Sector

In aggregate, the total capital stock \((K_t) = N_k t\), the total employed labor \((L_t)= N_l t\), the total demand for bank loans \((e_t) = N e_i t\), the total cumulative supply of newly-issued bonds or stocks \((\text{cap}\cdot K_t) = N \cdot \text{cap} \cdot k_t\), and the total investment \((I_t)= N I_i t\). The following equations summarize the equilibrium conditions for the corporate sector.

- **Aggregate output**\(^{26}\): \(Y_{t+1} = AK_t^a L_t^{1-a}\)  
  \(\text{(A1)}\)

- **Optimal capital stock**: 
  \[
  K_t = \begin{cases} 
  K_t^D = \bar{L} \left( \frac{\alpha(A + n)}{r_t + \xi + d} \right)^{1-a} & \text{if } \left( \frac{e_t}{P_t} \right) R_{t-1} \geq \beta F_t \\
  K_t^D - (1-\varphi) \left( F_t^D - \frac{e_t}{P_t} \left( \frac{R_{t+1}}{\beta} \right) \right) & \text{if } \left( \frac{e_t}{P_t} \right) R_{t-1} < \beta F_t 
  \end{cases}
  \]  
  \(\text{(A2\_i)}\)

- **Optimal investment**: \(I_t = (K_t - K_{t-1}) + d \cdot K_{t-1}\)  
  \(\text{(A3)}\)

- **Firms’ budget constraint**: \(K_t = e_t + \text{cap} \cdot K_t^D\)  
  \(\text{(A4)}\)

where \(F_t = \begin{cases} 
  F_t^D = (1 + r_{t+1}) F_{t-1} + X_t & \text{if } \left( \frac{e_t}{P_t} \right) R_{t-1} \geq \beta F_t \text{ and not during the bailout period}, \\
  F_t^D - \varphi \left( F_t^D - \frac{e_t}{P_t} \left( \frac{R_{t+1}}{\beta} \right) \right) & \text{if } \left( \frac{e_t}{P_t} \right) R_{t-1} < \beta F_t , \\
  0 & \text{from the start to the end of the bailout plan (bailout period)} \text{ since there will be a series of transfers of the remaining } F_t \text{ to the government to clean up the banking system,} \\
  \end{cases} \)

\[
X_t = (1-u)(NPL_{t-1}) e_{t-1} (r_{t-1} + \xi) , \\
\]

\[
\begin{align*}
e_t = & \begin{cases} 
 e_t^D = (1 - \text{cap}) K_t^D & \text{if } \left( \frac{e_t}{P_t} \right) R_{t-1} \geq \beta F_t , \\
 e_t^D - (1-\varphi) \left( F_t^D - \frac{e_t}{P_t} \left( \frac{R_{t+1}}{\beta} \right) \right) & \text{if } \left( \frac{e_t}{P_t} \right) R_{t-1} < \beta F_t . 
\end{cases} 
\end{align*}
\]

\(^{26}\)In this setup, there is no uncertainty in aggregate output since \(A\) and \(\alpha\) are constant and \(K_t\) and \(L_t\) are predetermined.
Banking Sector

In aggregate, the total supply of bank lending to the corporate sector \((e_t) = M e_t^i\), the total demand for household deposits \((a_t) = M a_t^i\), the total demand for foreign borrowing \((b_t) = M b_t^i\), the total dividends paid by banks to the household sector \((X_t) = M X_t^i\), the cumulative NPL losses \((F_t) = M F_t^i\), the total FX profits or losses \((FX_t) = M FX_t^i\), and the cumulative FX profits or losses \((AFX_t) = M AFX_t^i\). The following equations summarize the equilibrium conditions for the banking sector.

- **Optimal real lending rate:**
  \[ r_t^i = \left( \frac{1}{1 - NPL_t} \right) \left( r_t + \xi \right) \]  
  \( \text{(A5)} \),

- **Optimal real deposit rate:**
  \[ r_t = t^b_t = t^e_t = \psi_t^{\omega} + \psi_t^w (b_t - \hat{b}) \]  
  \( \text{(A6)} \),

- **Banks’ budget constraints:**

  **Flow:**

  Before the start of the bailout plan

  \[ e_t - e_{t-1} = a_t - a_{t-1} + \frac{e_t}{P_t} b_t - \frac{e_{t-1}}{P_t} b_{t-1} - (AFX_t - AFX_{t-1}) - (F_t - F_{t-1}) \]  
  \( \text{(A7a}_i \text{)}, \)

  Since the start of the bailout plan

  \[ e_t - e_{t-1} = a_t - a_{t-1} + \frac{e_t}{P_t} b_t - \frac{e_{t-1}}{P_t} b_{t-1} - (AFX_t - AFX_{t-1}) - (F_t - F_{t-1}) - (GA_t - GA_{t-1}) \]  
  \( \text{(A7a}_ii \text{)}, \)

  **Stock:**

  Before the start of the bailout plan

  \[ e_t = \left( \frac{e_t}{P_t} \right) b_t + a_t - AFX_t - F_t \]  
  \( \text{(A7b}_i \text{)}, \)

  Since the start of the bailout plan

  \[ e_t = \left( \frac{e_t}{P_t} \right) b_t + a_t - AFX_t - F_t - GA_t \]  
  \( \text{(A7b}_ii \text{)}, \)

  where \( GA_t = (1 + r_{t-1})GA_{t-1} + \text{transfer}_t \),

  \[ \text{transfer}_t = \begin{cases} 0 & \text{if } \left( \frac{e_t}{P_t} \right) R_{t-1} \geq \beta F_t \text{ and not during the bailout period}, \\ \phi \left( F_t^D - \frac{e_t}{P_t} R_{t-1} \beta \right) & \text{if } \left( \frac{e_t}{P_t} \right) R_{t-1} < \beta F_t , \\ F_t^D & \text{during the bailout period}, \end{cases} \]

  \[ FX_t = \left( \frac{e_t}{P_t} - \frac{e_{t-1}}{P_{t-1}} \right) (1 + r_{t-1}) b_{t-1} , \]

  \[ AFX_t = (1 + r_{t-1})AFX_{t-1} + FX_t . \]
**Household Sector**

The following equations summarize the equilibrium conditions for the household sector.

- **Optimal consumption:**
  \[ C_t = \left( \frac{1 + r_{t+1}}{1 + \delta} \right) C_{t-1} \]  
  \[ \quad \text{(A8),} \]

- **Optimal real monetary aggregate:**
  \[ \frac{M_t}{P_t} = zC_t (1 + i_t) \frac{i_t}{i_t} \]  
  \[ \text{where } (1 + i_t) = (1 + \pi_t)(1 + r_t) \text{ and } \frac{P_{t+1}}{P_t} = 1 + \pi_t , \]
  \[ \text{(A9),} \]

- **Households’ budget constraint:**
  \[ a_t - a_{t-1} = r_{t-1} a_{t-1} + (1 - \eta) \left( Y_t + S_t - d \cdot K_{t-1} - r_{t-1} e_{t-1} + X_t \right) \]  
  \[ - C_t - \frac{M_t - M_{t-1}}{P_t} - \text{cap} \cdot (K_t^0 - K_{t-1}^0) \]  
  \[ \quad \text{(A10),} \]
  \[ \text{where } S_t = nK_{t-1}^a L_{t-1}^{1-\alpha} . \]

**Public Sector**

- **Government’s budget constraint:**
  Before the first sudden stop
  \[ \frac{\varepsilon_t}{P_t} (R_t - R_{t-1}) = \eta \left( Y_t + S_t - d \cdot K_{t-1} - r_{t-1} e_{t-1} + X_t \right) + \frac{M_t - M_{t-1}}{P_t} + r_{t-1} \frac{\varepsilon_t}{P_t} R_{t-1} - G_t - S_t \]  
  \[ \text{(A11_i),} \]

  During and after the first sudden stop
  \[ \frac{\varepsilon_t}{P_t} (R_t - R_{t-1}) = \eta \left( Y_t + S_t - d \cdot K_{t-1} - r_{t-1} e_{t-1} + X_t \right) + \frac{M_t - M_{t-1}}{P_t} + r_{t-1} \frac{\varepsilon_t}{P_t} R_{t-1} - G_t - S_t + (L_t^0 - (1 + r_{t-1}) L_{t-1}^0) \]  
  \[ \text{(A11_ii).} \]

**National Account (combination of (A4), (A7a), (A10), (A11))**

Before the first sudden stop
\[ Y_t = I_t + C_t + G_t + \frac{\varepsilon_t}{P_t} \left( (R_t - R_{t-1}) - (b_t - b_{t-1}) - r_{t-1} R_{t-1} + r_{t-1} b_{t-1} \right) \]  
\[ \text{(A12_i),} \]

During and after the first sudden stop
\[ Y_t = I_t + C_t + G_t + \frac{\varepsilon_t}{P_t} \left( (R_t - R_{t-1}) - (b_t - b_{t-1}) - r_{t-1} R_{t-1} + r_{t-1} b_{t-1} \right) - (L_t^0 - (1 + r_{t-1}) L_{t-1}^0) \]  
\[ \text{(A12_ii).} \]

**Modified Uncovered Interest Rate Parity**

\[ \frac{\varepsilon_{t+1}}{\varepsilon_t} = \frac{(1 + i_{t+1})}{(1 + i_t) (1 + P_t)} \Rightarrow \left( \frac{\varepsilon_{t+1}/P_{t+1}}{\varepsilon_t/P_t} \right) = \frac{(1 + r_t)}{(1 + i_t^w) (1 + P_t)} \]  
\[ \text{(A13).} \]
# APPENDIX B: Parameters and Variables

| Parameters |  
| --- | --- |
| $\alpha$ | Income share of capital |
| $A$ | Average production technology factor |
| $n$ | Firms’ additional revenue or cost factor due to government subsidies or taxes |
| cap | Fraction of firms’ investment financed by capital markets |
| (1-cap) | Fraction of firms’ investment financed by bank loans |
| $d$ | Capital depreciation rate |
| $\Psi_0$ | Interest rate sensitivity to the world interest rate |
| $\Psi_1$ | Interest rate sensitivity to the aggregate level of banks’ net foreign borrowing |
| $\hat{b}$ | Perceived optimal level of aggregate banks’ net foreign borrowing |
| $\xi$ | Operating expense factor |
| $\upsilon$ | Loan loss provisioning ratio |
| $\delta$ | Time preference factor |
| $\chi$ | Preference for money holdings relative to consumption |
| (a measure of households’ degree of (liquidity) risk aversion) |
| $\eta$ | Personal income tax rate |
| $P_e$ | Expected exchange rate deviation from conventional uncovered interest rate parity |
| $\beta$ | Fraction of banks’ cumulative NPL losses which are expected by foreign creditors to be covered by the country’s international reserves |
| $\phi$ | Fraction of banks’ cash shortfalls subsidized by the government during a sudden stop. |
| (1-$\phi$) | Effect of a sudden stop on firms’ investment |

| Exogenous Variables |  
| --- | --- |
| $i^w$ | World nominal interest rate |
| $\pi$ | Inflation rate |
| $L$ | Employed labor |
| NPL | Fraction of low-type firms = Banks’ non-performing loans to total loans ratio |
| $G$ | Government spending |

<p>| Endogenous |<br />
| --- | --- |
| $Y$ | Output |</p>
<table>
<thead>
<tr>
<th>Variables</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>K = Capital stock</td>
<td></td>
</tr>
<tr>
<td>I = Investment</td>
<td></td>
</tr>
<tr>
<td>e = Bank lending to the corporate sector</td>
<td></td>
</tr>
<tr>
<td>b = Banks’ net foreign borrowing</td>
<td></td>
</tr>
<tr>
<td>a = Household deposits with banks</td>
<td></td>
</tr>
<tr>
<td>C = Consumption</td>
<td></td>
</tr>
<tr>
<td>M/P = Real monetary aggregate</td>
<td></td>
</tr>
<tr>
<td>$\varepsilon/P$ = Real exchange rate</td>
<td></td>
</tr>
<tr>
<td>r = Domestic real deposit rate</td>
<td></td>
</tr>
<tr>
<td>$r^l$ = Domestic real lending rate</td>
<td></td>
</tr>
<tr>
<td>i = Domestic nominal deposit rate</td>
<td></td>
</tr>
<tr>
<td>S = Government subsidies or taxes to the corporate sector</td>
<td></td>
</tr>
<tr>
<td>X = Dividends paid by banks to the household sector</td>
<td></td>
</tr>
<tr>
<td>F = Banks’ cumulative NPL losses</td>
<td></td>
</tr>
<tr>
<td>FX = Banks’ FX profits or losses</td>
<td></td>
</tr>
<tr>
<td>AFX = Banks’ cumulative FX profits or losses</td>
<td></td>
</tr>
<tr>
<td>$L^f$ = Government liabilities as a result of bank bailouts</td>
<td></td>
</tr>
<tr>
<td>R = International reserves</td>
<td></td>
</tr>
<tr>
<td>GA = Good assets</td>
<td></td>
</tr>
<tr>
<td>Transfer = Transfer of banks’ NPL losses to the government</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX C: Steady State Solutions

(C1) At a steady state, the loan loss provisioning ratio, $\tilde{\nu}$, must be 100% and hence, $\overline{X} = 0$, $\overline{F} = 0$, $\overline{GA} = 0$, and $\overline{G} = 0$.

(C2) Assume that the steady state values for exogenous variables are the long-run averages.

(C2.1) $\tilde{i}^w = \text{average}(i^w_t)$,

(C2.2) $\tilde{\pi} = \text{average}(\pi_t)$,

(C2.3) $\tilde{L} = \text{average}(L_t)$,

(C2.4) $\text{NPL} = \text{average}(\text{NPL}_t)$,

(C2.5) $\tilde{G} = \text{average}(G_t)$.

(C3) At a steady state, the exchange rate and the price level grow at the same rate $\tilde{\pi}$.

$$\frac{\tilde{e}}{e_{t-1}} = \frac{P_t}{P_{t-1}} = (1 + \tilde{\pi}) \Rightarrow \frac{\tilde{e}}{P_t} = \frac{\tilde{e}_{t-1}}{P_{t-1}} = \frac{1}{\tilde{P}}.$$ Hence, $\overline{FX} = 0$ and $\overline{AFX} = 0$.

(C4) Based on (C3), the real exchange rate, $\tilde{e}/P$, is constant at a steady state. Assume that $\overline{e/P} = \text{average}(\tilde{e}_t/P_t)$.

$$\frac{\tilde{e}}{P} = 1 \Rightarrow \frac{\tilde{e}_t}{P_t} = \frac{\tilde{e}_{t-1}}{P_{t-1}} = \frac{\overline{\pi}}{\overline{P}}.$$ Hence, $\overline{FX} = 0$ and $\overline{AFX} = 0$.

(C5) Based on (C4),

$$\frac{\tilde{e}}{P} = 1 = \frac{(1 + \tilde{r}_{t-1})}{(1 + \tilde{i}^w_{t-1})(1 + \tilde{\pi}_t)} \Rightarrow \tilde{r} = (1 + \tilde{i}^w)(1 + P_{\tilde{r}}) - 1.$$ (C6) $\tilde{C} = \left(\frac{1 + \tilde{r}}{1 + \delta}\right) \tilde{C} \Rightarrow \delta = \tilde{r}$.

(C7) $\tilde{r} = \psi_0 \tilde{i}^w + \psi_1 (\tilde{b} - \hat{b}) \Rightarrow \tilde{b} = \hat{b} + \tilde{r} - \psi_0 \tilde{i}^w / \psi_1$.

(C8) $\tilde{r}' = \left(\frac{\tilde{r} + \xi}{1 - \text{NPL}}\right)$.

(C9) $\tilde{i} = (1 + \overline{\pi})(1 + \tilde{r}) - 1$. 
\[
(C10) \quad \bar{K} = \bar{L} \left( \frac{\alpha(A+n)}{r + \xi + d} \right)^{\frac{1}{1-a}}.
\]

\[
(C11) \quad \bar{c} = (1 - \text{cap})\bar{K} = (1 - \text{cap})\bar{L} \left( \frac{\alpha(A+n)}{r + \xi + d} \right)^{\frac{1}{1-a}}.
\]

\[
(C12) \quad \bar{Y} = AK^a\bar{L}^{-a} = A\bar{L} \left( \frac{\alpha(A+n)}{r + \xi + d} \right)^{\frac{a}{1-a}}.
\]

\[
(C13) \quad \bar{S} = nK^a\bar{L}^{-a} = n\bar{L} \left( \frac{\alpha(A+n)}{r + \xi + d} \right)^{\frac{a}{1-a}}.
\]

\[
(C14) \quad \frac{\bar{M}}{P} = \chi\bar{C} \frac{(1+r)(1+\pi)}{(1+r)(1+\pi) - 1}.
\]

\[
(C15) \quad \bar{b} - \bar{b} = \sqrt{\frac{\bar{P}}{\bar{P}}} \left[ \frac{(\bar{K} - \bar{K}) - \eta\bar{P}(1 - \text{cap})\bar{K}}{(1-n)(\bar{Y} + \bar{S}) + \eta\bar{X} + (1-n)d\bar{K} + \bar{C}} \right]
\]

\[
(C16) \quad \bar{a} - \bar{a} = \bar{a} + (1-n)(\bar{Y} + \bar{S} - d \cdot \bar{K} - \bar{r}(1 - \text{cap})\bar{K}) - \bar{C} - \left( \frac{\pi}{1+\pi} \right) \left( \frac{\bar{M}}{\bar{P}} \right) - \text{cap} (\bar{K} - \bar{K})
\]

\[
(C17) \quad \frac{\bar{G}}{\bar{P}}(\bar{R} - \bar{R}) = \eta[\bar{Y} + \bar{S} - d \cdot \bar{K} - \bar{r}(1 - \text{cap})\bar{K}] + \left( \frac{\pi}{1+\pi} \right) \left( \frac{\bar{M}}{\bar{P}} \right) + \bar{r} \left( \frac{\bar{G}}{\bar{P}} \right) \bar{R} - \bar{G} - \bar{S}
\]

\[
(C18) \quad \bar{R} = \frac{\bar{G} + \bar{S} - \eta[\bar{Y} + \bar{S} - d \cdot \bar{K} - \bar{r}(1 - \text{cap})\bar{K}] - \left( \frac{\pi}{1+\pi} \right) \left( \frac{\bar{M}}{\bar{P}} \right) - \text{cap} (\bar{K} - \bar{K})}{\frac{\bar{G}}{\bar{P}} \bar{P} + \bar{r} \left( \frac{\bar{G}}{\bar{P}} \right) - \bar{G} - \bar{S}}.
\]
APPENDIX D: Linear Approximations and Solutions for Difference Equations

Linear approximations around the steady state values of b and C

Change in C equation:

\[ C_t - C_{t-1} = \frac{\psi C}{1 + \delta} (b_{t-1} - \bar{b}) \]  \hspace{1cm} (D1).

Change in b equation:

\[ b_t - b_{t-1} = \frac{A'}{1 - C'} (C_{t-1} - \bar{C}) + \frac{1 + B'}{1 - C'} (b_{t-1} - \bar{b}) \]  \hspace{1cm} (D2),

where

\[ A' = \frac{1}{\bar{P}} \left[ 1 + \left( -\frac{\eta \cdot (\delta + \xi + d)}{(1 - \alpha) \cdot (1 + \pi)} \right) \right] \]

\[ B' = \frac{1}{\bar{P}} \left[ \frac{\bar{K} \cdot \psi_1}{(1 - \alpha) \cdot (\delta + \xi + d)} - \frac{\eta \cdot (1 - \text{cap}) \bar{K} \cdot \psi_1}{(1 - \alpha) \cdot (\delta + \xi + d)} \right. \]

\[ + \frac{(1 - \eta) \cdot (\delta + \xi + d) \cdot (\bar{Y} + \bar{S})}{(1 - \alpha) \cdot (\delta + \xi + d)} - \frac{(1 - \eta) \cdot \bar{K} \cdot \psi_1}{(1 - \alpha) \cdot (\delta + \xi + d)} \]

\[ + \frac{\bar{C} \psi_1}{1 + \delta} + \frac{\chi \bar{C} \psi_1 \cdot \bar{P}}{1 + \delta} + \frac{\chi \bar{C} \psi_1 (1 + \delta)}{(1 + \delta)(1 + \pi) - 1} + \frac{\chi \bar{C} \psi_1 (1 + \delta)(1 + \pi)}{(1 + \delta)(1 + \pi) - 1} \]

\[ - \psi_1 \cdot \bar{P} \cdot \bar{C} + \delta \cdot \psi_1 \cdot \bar{P} \cdot \bar{b} + \delta \cdot \bar{P} \]

\[ C' = \frac{1}{\bar{P}} \left[ \frac{\bar{K} \cdot \psi_1}{(1 - \alpha) \cdot (\delta + \xi + d)} + \frac{\chi \bar{C} \psi_1 (1 + \pi)}{(1 - \alpha) \cdot (\delta + \xi + d)} + \frac{\chi \bar{C} \psi_1 (1 + \delta)(1 + \pi)}{(1 + \delta)(1 + \pi) - 1} \right]^2 \]
Linearized difference equations (D1) and (D2) can be written in the matrix form as follows.

\[
\begin{pmatrix}
C_t - C_{t-1} \\
b_t - b_{t-1}
\end{pmatrix} =
\begin{pmatrix}
0 & c \\
b & a
\end{pmatrix}\begin{pmatrix}C_{t-1} - \bar{C} \\
b_{t-1} - \bar{b}
\end{pmatrix}
\]

(D3),

where \( a = \frac{1+B'}{1-C'} - 1 \), \( b = \frac{A'}{1-C'} \), and \( c = \frac{\psi\bar{C}}{1+\delta} \).

Since \( A' > 0 \), (1-C') > 0 and (1+B') > (1-C'), a, b, and c in equation (D3) are all positive. By setting equation (D1) (or \( C_t - C_{t-1} \)) and equation (D2) (or \( b_t - b_{t-1} \)) to zero, we have

\[ \text{Locus } \Delta C = 0: \quad b_{t-1} = \bar{b} \quad (D4), \]

\[ \text{Locus } \Delta b = 0: \quad \frac{b_{t-1} - \bar{b}}{C_{t-1} - \bar{C}} = -\frac{b}{a} < 0 \quad (D5). \]

The phase diagram plotting the loci \( \Delta C = 0 \) and \( \Delta b = 0 \) can be depicted as follows.

Q is an equilibrium point where all endogenous variables are at a steady state. There are both stable paths leading to the steady state (e.g., PQ and RQ) and unstable paths leading to an exploding economy. Hence, this equilibrium is a saddle point.
Solutions for linearized difference equations

- Equation (D3) can be rewritten as

\[
\begin{pmatrix}
C_1 - \overline{C} \\
\lambda_1 - \overline{b}
\end{pmatrix} =
\begin{pmatrix}
1 & c \\
b & a + 1
\end{pmatrix}
\begin{pmatrix}
C_{i-1} - \overline{C} \\
\lambda_{i-1} - \overline{b}
\end{pmatrix}
\]

(D6).

- Let \(X_i = \begin{pmatrix} C_i - \overline{C} \\ \lambda_i - \overline{b} \end{pmatrix}\) and \(A = \begin{pmatrix} 1 & c \\ b & a + 1 \end{pmatrix}\). Equation (D6) can be denoted as

\[X_i = A \cdot X_{i-1}\]

(D7).

- If \(A\) has distinct eigenvalues, there exists a nonsingular matrix \(E\) such that \(A = E \cdot W \cdot E^{-1}\) and hence

\[X_i = E \cdot W \cdot E^{-1}X_{i-1}\]

(D8),

where \(E = \) eigenvector matrix with elements \(\begin{pmatrix} e_1 & e_2 \\ 1 & 1 \end{pmatrix}\),

\(W = \) eigenvalue matrix with elements \(\begin{pmatrix} \omega_1 & 0 \\ 0 & \omega_2 \end{pmatrix}\),

\(E^{-1} = \) the inverse of eigenvector matrix with elements \(\begin{pmatrix} g & h \\ i & j \end{pmatrix} = \begin{pmatrix} \frac{1}{e_1-e_2} & -\frac{e_2}{e_1-e_2} \\ -1 & \frac{e_1}{e_1-e_2} \end{pmatrix} \).

- Since \(X_{i-1} = E \cdot W \cdot E^{-1}X_{i-2}\),

\[X_i = E \cdot W \cdot E^{-1}(E \cdot W \cdot E^{-1}X_{i-2}) = E \cdot W^2 \cdot E^{-1}X_{i-2} = E \cdot W^3 \cdot E^{-1}X_0\]

(D9).

- General solutions for two linearized difference equations are

\[C_i - \overline{C} = \omega_i \cdot \omega_i^{-1} \cdot [g \cdot (C_0 - \overline{C}) + h \cdot (b_0 - \overline{b})] + e_2 \cdot \omega_2^{-1} \cdot [i \cdot (C_0 - \overline{C}) + j \cdot (b_0 - \overline{b})]\]

(D10),

\[b_i - \overline{b} = \omega_i \cdot \omega_i^{-1} \cdot [g \cdot (C_0 - \overline{C}) + h \cdot (b_0 - \overline{b})] + \omega_2 \cdot \omega_2^{-1} \cdot [i \cdot (C_0 - \overline{C}) + j \cdot (b_0 - \overline{b})]\]

(D11).
If both eigenvalues, \( \omega_1 \) and \( \omega_2 \), are less than 1 (greater than 1), the equilibrium is stable (unstable). However, if one of the eigenvalues is greater than 1 while the other is less than 1 (say, \( \omega_1 > 1 \) and \( \omega_2 < 1 \)), the equilibrium is a saddle point where it is stable in some directions, but unstable in others. When the equilibrium is a saddle point, unstable paths (the path with \( \omega_1 > 1 \)) can be ruled out by setting an additional condition so that the term containing the unstable eigenvalue \[ g \cdot (C_0 - \bar{C}) + h \cdot (b_0 - \bar{b}) \] in equations (D10) and (D11) is equal to zero, i.e.,

\[
(C_0 - \bar{C}) = -\frac{h}{g} \cdot (b_0 - \bar{b}) = e_2 \cdot (b_0 - \bar{b}) \tag{D12}
\]

Hence, the solutions to difference equations, which lead to stable paths, are

\[
C_0 - \bar{C} = e_2 \cdot (b_0 - \bar{b}) \tag{D13},
\]

\[
b_t - \bar{b} = \omega_2^t \cdot (b_0 - \bar{b}) = \omega_2 \cdot (b_{t-1} - \bar{b}) \tag{D14},
\]

\[
C_t - \bar{C} = e_2 \cdot \omega_2^t \cdot (b_0 - \bar{b}) = e_2 \cdot (b_t - \bar{b}) \tag{D15}.
\]
APPENDIX E: Equilibrium Conditions in the Form of First Difference Equations

\[ Y_t - Y_{t-1} = A(K^a_{t-2}L_{t-1}^{1-a} - K^a_{t-1}L_{t-2}^{1-a}) \quad (E1), \]

\[ I_t - I_{t-1} = \text{Inv}_0 \cdot \left[ K^M_{t-1} - (1 - \delta) K^M_{t-2} \right] + \left( \text{Inv}_1 - 1 \right) \cdot \left[ I_{t-1} \right] \quad (E2), \]

\[ r^i_t - r^i_{t-1} = \left( \frac{r_t + \xi}{1 - \text{NPL}_{t-1}} \right) - \left( \frac{r_{t-1} + \xi}{1 - \text{NPL}_{t-1}} \right) \quad (E3), \]

\[ r_t - r_{t-1} = \psi_0 \left( i^w_t - i^w_{t-1} \right) + \psi_1 \left( b_t - b_{t-1} \right) \quad (E4), \]

\[ b_t - b_{t-1} = \begin{cases} \frac{1}{\epsilon_t} \left[ \left( I_t - d \cdot K^a_{t-1} \right) - \eta \cdot (K^a_{t-1} - \text{cap} \cdot K^D_{t-1}) ight. \\ \left. - (1 - \eta)(Y_t + S_t) + \eta X_t + (1 - \eta)dK_{t-1} + C_t \right] \quad \text{if } \left( \frac{\epsilon_t}{\beta} \right) R_{t-1} \geq \beta F_t \quad (E5_i), \end{cases} \]

\[ \frac{1}{\epsilon_t} \left[ \left( I_t - d \cdot K^a_{t-1} \right) - \eta \cdot (K^a_{t-1} - \text{cap} \cdot K^D_{t-1}) \\ \left. - (1 - \eta)(Y_t + S_t) + \eta X_t + (1 - \eta)dK_{t-1} + C_t \right] \quad \text{if } \left( \frac{\epsilon_t}{\beta} \right) R_{t-1} < \beta F_t \quad (E5_{ii}), \]

\[ C_t - C_{t-1} = \left( \frac{1 + i^{MA}_{t-1}}{1 + \delta} - 1 \right) C_{t-1} \quad (E6), \]

\[ \frac{M_t}{P_t} - \frac{M_{t-1}}{P_{t-1}} = \chi \left[ \frac{C_t (1 + i^{MA}_t)}{1^{MA}_t} - \frac{C_{t-1} (1 + i^{MA}_{t-1})}{1^{MA}_{t-1}} \right] \quad (E7), \]

\[ \frac{\epsilon_t}{P_t} - \frac{\epsilon_{t-1}}{P_{t-1}} = \left( \frac{1 + r_{t-1}}{(1 + i^w_t)(1 + P_t)} \right) \left( \frac{\epsilon_{t-1}}{P_{t-1}} \right) \quad (E8), \]
where $K_t^M = K_t^{MD} = I \left( \frac{\alpha(A + n)}{r_{t,MA} + \xi + d} \right) ^{\frac{1}{\lambda - a}}$ if \( \frac{\epsilon_t}{P_t} R_{t-1} \geq \beta F_t \),

\[
K_t^{MD} - (1 - \varphi) \left( F_t - \left( \frac{\epsilon_t}{P_t} \right) \left( \frac{R_{t-1}}{\beta} \right) \right)
\]

if \( \frac{\epsilon_t}{P_t} R_{t-1} < \beta F_t \),

\[
K_t = (1 - d)K_{t-1} + I_t,
\]

\[
K_t^D = \begin{cases} 
K_t & \text{if } \frac{\epsilon_t}{P_t} R_{t-1} \geq \beta F_t, \\
K_t + \text{inv}_\varphi (1 - \varphi) \left( F_t^D - \left( \frac{\epsilon_t}{P_t} \right) \left( \frac{R_{t-1}}{\beta} \right) \right) & \text{if } \frac{\epsilon_t}{P_t} R_{t-1} < \beta F_t.
\end{cases}
\]

\[
(1 + i_t) = (1 + \pi_t)(1 + r_t),
\]

\[
X_t = (1 - \nu)(\text{NPL}_{t-1})(K_{t-1} - \text{cap} \cdot K_{t-1}^D)(r_{t-1} + \xi),
\]

\[
F_t^D = (1 + r_{t-1})F_{t-1} + X_t,
\]

\[
F_t = \begin{cases} 
F_t^D & \text{if } \frac{\epsilon_t}{P_t} R_{t-1} \geq \beta F_t \text{ and not during the bailout period,} \\
F_t^D - (1 - \text{inv}_\varphi (1 - \varphi)) \left( F_t^D - \left( \frac{\epsilon_t}{P_t} \right) \left( \frac{R_{t-1}}{\beta} \right) \right) & \text{if } \frac{\epsilon_t}{P_t} R_{t-1} < \beta F_t,
\end{cases}
\]

0 from the start to the end of the bailout plan (bailout period) since there will be a series of transfers of the remaining $F_t$ to the government to clean up the banking system,

\[
r_t^{MA} = \text{Eleven-year moving average of monthly real deposit rates},
\]

\[
i_t^{MA} = \text{Eleven-year moving average of monthly nominal deposit rates},
\]

\[
S_t = nK_{t-1}^a L_{t-1}^{1-a}.
\]
<table>
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APPENDIX G: Steps to Calculate Partial-Sample GMM Estimators and Wald Statistics

Step 1: Estimate parameter values for each sub-period (pre-crisis, crisis, and post-crisis periods) simultaneously using two-step GMM

Step 1.1: Form 3 sets of moment conditions for 3 sub-periods, i.e., \( m(W_t, \beta_1, \delta) \), \( m(W_t, \beta_2, \delta) \), and \( m(W_t, \beta_3, \delta) \), and arrange them in the following way.

\[
\bar{m}_t(\theta, \pi_1, \pi_2) = \frac{1}{T} \sum_{t=1}^{T} \begin{pmatrix} m(W_t, \beta_1, \delta) \\ m(W_t, \beta_2, \delta) \\ m(W_t, \beta_3, \delta) \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix} + \frac{1}{T} \sum_{t=1}^{T} \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}
\in \mathbb{R}^{3v},
\]

where \( T\pi_1 \) is the first breakpoint, \( T\pi_2 \) is the second breakpoint (\( 0 \leq \pi_1 \leq \pi_2 \leq 1 \)), \( \theta = (\beta_1, \beta_2, \beta_3, \delta) \in \mathbb{B} \times \mathbb{B} \times \Delta \subset \mathbb{R}^p \times \mathbb{R}^p \times \mathbb{R}^p \times \mathbb{R}^q \), \( \beta = \) Parameters of interest, which are assumed to be different across sub-periods (i.e., \( \beta_1 \) for pre-crisis period, \( \beta_2 \) for crisis period, and \( \beta_3 \) for post-crisis period), \( \delta = \) Other parameters, which are assumed be constant throughout the whole sample period,

\( m(\cdot, \cdot, \cdot) \) is a function from \( W \times B \times \Delta \) to \( \mathbb{R}^o \),

\( W_t \) are observed sample and \( W \subset \mathbb{R}^k \).

Step 1.2: First stage GMM

1.2.1 Use a sub-optimal weighting matrix, \( (I \otimes Z'Z)^{-1} \), where \( Z \) is the vector of instruments (This is equivalent to applying non-linear two-stage least squares) to estimate the initial values of parameters \( (\beta_1, \beta_2, \beta_3, \delta) \) [denoted by \( (\tilde{\beta}_1, \tilde{\beta}_2, \tilde{\beta}_3, \tilde{\delta}) \)].

1.2.2 Use the estimated initial values of those parameters from step 1.2.1, \( (\tilde{\beta}_1, \tilde{\beta}_2, \tilde{\beta}_3, \tilde{\delta}) \), to calculate the optimal weighting matrix, \( \gamma(\pi_1, \pi_2) \), for the second stage GMM. The estimation of the optimal weighting matrix involves the following additional steps.
1.2.2.1 Calculate heteroskedasticity and autocorrelation consistent (HAC) covariance matrix estimators for each sub-period.

\[
\hat{S}_1(\pi_1, \pi_2) = \sum_{v=0}^{T_{\pi_1}-1} k(v/l(T_{\pi_1})) \times \frac{1}{T_{\pi_1}} \sum_{u=1}^{T_{\pi_1}} (m(W_{t-u}, \tilde{\beta}_1, \tilde{\delta})) (m(W_{t-v}, \tilde{\beta}_1, \tilde{\delta}))',
\]

\[
+ \sum_{v=1}^{T_{\pi_1}-1} k(v/l(T_{\pi_1})) \times \frac{1}{T_{\pi_1}} \sum_{u=1}^{T_{\pi_1}} (m(W_{t-v}, \tilde{\beta}_1, \tilde{\delta})) (m(W_{t-v}, \tilde{\beta}_1, \tilde{\delta}))',
\]

\[
\hat{S}_2(\pi_1, \pi_2) = \sum_{v=0}^{T_{\pi_2}-T_{\pi_1}-1} k(v/l(T_{\pi_2} - T_{\pi_1})) \times \frac{1}{T_{\pi_2} - T_{\pi_1}} \sum_{u=1}^{T_{\pi_2}} (m(W_{t-u}, \tilde{\beta}_2, \tilde{\delta})) (m(W_{t-v}, \tilde{\beta}_2, \tilde{\delta}))',
\]

\[
+ \sum_{v=1}^{T_{\pi_2}-T_{\pi_1}-1} k(v/l(T_{\pi_2} - T_{\pi_1})) \times \frac{1}{T_{\pi_2} - T_{\pi_1}} \sum_{u=1}^{T_{\pi_2}} (m(W_{t-v}, \tilde{\beta}_2, \tilde{\delta})) (m(W_{t-v}, \tilde{\beta}_2, \tilde{\delta}))',
\]

\[
\hat{S}_3(\pi_1, \pi_2) = \sum_{v=0}^{T_{\pi_3}-T_{\pi_2}-T_{\pi_1}-1} k(v/l(T - T_{\pi_2})) \times \frac{1}{T - T_{\pi_2}} \sum_{u=1}^{T_{\pi_3}} (m(W_{t-u}, \tilde{\beta}_3, \tilde{\delta})) (m(W_{t-v}, \tilde{\beta}_3, \tilde{\delta}))',
\]

\[
+ \sum_{v=1}^{T_{\pi_3}-T_{\pi_2}-T_{\pi_1}-1} k(v/l(T - T_{\pi_2})) \times \frac{1}{T - T_{\pi_2}} \sum_{u=1}^{T_{\pi_3}} (m(W_{t-v}, \tilde{\beta}_3, \tilde{\delta})) (m(W_{t-v}, \tilde{\beta}_3, \tilde{\delta}))',
\]

where \( k(.) = \) kernel,\(^{27}\)

\( l(n) = \) bandwidth parameter,

\( n = \) number of observations.

1.2.2.2 Multiply each \( \hat{S}(\pi_1, \pi_2) \) by the proportion of sample for each sub-period and arrange them in block diagonal form to be used as the optimal weighting matrix in step 1.3 as follows.

\[
\hat{\gamma}(\pi_1, \pi_2) = \text{Diag}\left[ \frac{\hat{S}_1^{-1}(\pi_1, \pi_2)}{\pi_1}, \frac{\hat{S}_2^{-1}(\pi_1, \pi_2)}{\pi_2 - \pi_1}, \frac{\hat{S}_3^{-1}(\pi_1, \pi_2)}{1 - \pi_2 - \pi_1} \right].
\]

\(^{27}\)There are several choices of kernel functions, e.g., Bartlett, Parzen, and Quadratic Spectral. Newey-West (Bartlett) kernel is used in this estimation.
Step 1.3: Second stage GMM

Minimize the following objective function using the moment conditions from step 1.1 and the optimal weighting matrix from step 1.2.2.2 to obtain the partial sample GMM estimators of \( (\beta_1, \beta_2, \beta_3, \delta) \) [denoted by \( \hat{\theta} = (\hat{\beta}_1, \hat{\beta}_2, \hat{\beta}_3, \hat{\delta}) \)].

\[
\bar{m}_t(\hat{\theta}(\pi_1, \pi_2), \pi_1, \pi_2)' \hat{\gamma}(\pi_1, \pi_2)(\hat{\theta}(\pi_1, \pi_2), \pi_1, \pi_2) = \inf_{\theta \in \Theta} \bar{m}_t(\theta, \pi_1, \pi_2)' \hat{\gamma}(\pi_1, \pi_2) \bar{m}_t(\theta, \pi_1, \pi_2).
\]

Step 2: Calculate Wald statistics

\[
W_t(\pi_1, \pi_2) = \hat{\theta}(\pi_1, \pi_2)' H(\hat{\Omega}(\pi_1, \pi_2)H)'^{-1} H \hat{\theta}(\pi_1, \pi_2),
\]

where \( \hat{\theta}(\pi_1, \pi_2) = \) Parameter vector,

\( \hat{\Omega}(\pi_1, \pi_2) = \) Estimated covariance matrix of parameter vector \( \hat{\theta}(\pi_1, \pi_2), \)

\[
H = \begin{cases} 
[I_p : 0 : -I_p : 0] & \text{for } H_0: \hat{\beta}_1 = \beta_1, \\
[I_p : -I_p : 0 : 0] & \text{for } H_0: \hat{\beta}_1 = \beta_2, \\
[0 : I_p : -I_p : 0] & \text{for } H_0: \hat{\beta}_2 = \beta_3.
\end{cases}
\]

Step 3: Critical values

In the case where breakpoints (\( \pi_1 \) and \( \pi_2 \)) are known, \( W_t(\pi_1, \pi_2) \) has a chi-square distribution with \( p \) degrees of freedom under the null hypothesis, where \( p \) is the number of restrictions.
APPENDIX H: Recent Economic and Financial History of Thailand

Thailand experienced an economic boom in the late 1980s through the mid 1990s and subsequently a bust in the late 1990s along with much of Southeast Asia. Thailand’s real GDP grew at an average annual rate of 9% during 1987–1996. The real GDP growth rate dropped to -1.4% in 1997 and -10.6% in 1998. Since 1999, the economy has had uninterrupted growth at an average rate of 4.5% per annum. GDP in 2007 (current prices) is estimated to be 8.5 trillion baht (around 243 billion USD).\(^{28}\) Market capitalization of publicly traded equities at the end of 2007 was 6.6 trillion baht (around 190 billion USD) or about 78% of GDP.\(^{29}\)

Thailand is largely a bank-based economy. The ratio of bank lending to total external finance during 1993–2007 was between 35% and 78% with an average at 52% (Akrasanee, 2008). Based on a survey by the Bank of Thailand in 2002, loans from financial institutions accounted for more than 90% of firms’ external funds. Hence, the banking sector plays a major role in channeling funds to the corporate sector in Thailand.

As documented by Alba et al. (1999), in the late 1980s through early 1990s, the Thai government embarked on a program to further liberalize the current and capital account as well as the financial sector, but continued to keep its exchange rate pegged to a basket of currencies. Policies included improved tax treatment and reduced tax impediments to portfolio inflows during 1986–1992, the removal of ceilings on bank deposit and lending rates during 1989–1992, and freeing of current account transactions and foreign exchange restrictions by the end of 1994. Perhaps the most important change was the establishment of the Bangkok International Banking Facility (BIBF) in 1993 as a means to promote Thailand as a regional financial center. BIBFs benefited from several tax and regulatory advantages. For example, the corporate income tax for BIBFs were capped at 10%, and short-term BIBF monetary instruments, unlike other deposit-type instruments, were not subject to the 7% cash reserve requirements. In addition, the Board of Investment (BOI) initiated investment promotion privileges both in terms of tax and non-tax incentives (e.g., exemption of import duty and value added tax (VAT) on machinery and raw materials, corporate income tax exemption, and permission to bring in foreign workers, own land and take or remit foreign currency abroad).

Financial liberalization together with the pace of economic growth, stable exchange rates, and attractive interest rate differentials resulted in a surge in private capital inflows to Thailand in the late 1980s and the early 1990s. As documented by Alba et al. (1999), during 1988–1996, Thailand

\(^{28}\) GDP data are obtained from the Office of National Economic and Social Development Board (NESDB).

\(^{29}\) Stock market capitalization data are obtained from the Thai Bond Market Association (ThaiBMA).
received the cumulative amount of capital inflows of 100.3 billion USD (55% of 1996 GDP or 9.4% of GDP on average per annum). As most of the inflows were in the form of loans, the ratio of foreign debt to total debt of Thailand increased from 59.1% in 1988 to 94.1% at the end of 1997 (Alba et al., 1999). Moreover, there was a rapid build-up of private short-term debt. The Bank of Thailand estimated that short-term external debt increased from 10 billion USD (12% of GDP) in 1990 to 41 billion USD (24% of GDP) in 1995. During this period, financial institutions played a key and increasing role in transmitting capital inflows. The share of bank foreign borrowing as a percent of total inflows rose from 10% during 1988-1992 to 60% during 1993-1996, and the increase in short-term debt of 30 billion USD during 1990-95 was attributed almost entirely to banks. In contrast, the net inflows of foreign direct investment (FDI) were relatively stable since FDI investors aimed for longer-run returns and were attracted by special privileges from the government’s BOI and long-term macroeconomic outlook (Siamwalla, Vajragupta and Vichyanond, 1999).

The influx of capital flows to Thailand was accompanied with a lending boom, excessive spending and investment, and a declining quality of bank assets. Credit outstanding grew at an average rate of 22% per annum in real terms during 1988-1995. The loan-to-deposit ratio of commercial banks rose from 96% in 1988 to 112% in 1995, suggesting that banks substituted riskier loan assets for lower risk assets (e.g., cash and government bonds). The situation was aggravated by an increasing tendency for bank loan appraisals to be based on collateral value more than cash flow. Moreover, banking supervision did not meet international best practices at that time. For example, bank loans were not considered impaired until being delinquent for 6 months, as opposed to 3 months which is the standard international practice. The on-site supervision also focused on transaction testing rather than major risk assessment.

The deteriorating economic conditions started to manifest in 1996, and the crisis hit the country in 1997. Thailand’s current account deficit rose to 8% of GDP during 1995-1996. At the same time, there was a sign of ailing financial institutions. Bangkok Bank of Commerce was seized by the Bank of Thailand in May 1996. In March 19987, 10 finance companies were ordered to raise capital, and the operations of 16 insolvent finance companies were suspended in June 1997. In early 1997, there was a wide anticipation of baht devaluation, leading to large capital outflows (mostly from the financial sector). Such huge capital outflows caused a rapid depletion of the country’s international reserves as the country attempted to defend the pegged exchange rate. The Thai government floated the baht on July 2, 1997 after running out of reserves. This was followed by the suspension of additional 42 finance companies’ operations on August 5, 1997.
Thailand requested IMF assistance and attempted to regain public confidence as well as to improve the quality of institutions and domestic policies through several reform measures. Immediate measures include the closure of 56 finance companies, the blanket guarantee for financial institutions’ depositors and creditors to stop the run, and the financial restructuring package to facilitate recapitalization in the banking sector. Other reforms included the establishment of a credit bureau and upgrading supervisory policies to international standards. Starting from the accounting period ending on December 31, 1998, financial institutions were required to classify and set provisions for their assets according to the borrowers’ financial condition and debt repayment ability as well as the length of non-payments. Under the new rules, a loan which is 3 months overdue must be classified as substandard and subject to 20% loan loss provision at the minimum. Since 1999, the supervision of financial institutions by the Bank of Thailand has focused on risk management rather than transaction testing.

A number of other permanent measures, such as the New Financial Institutions Act, aimed to provide a more effective framework for ensuring the country’s financial stability, the improvement of accounting standards and guidelines, and the establishment of a deposit insurance agency to replace the blanket guarantee with a limited guarantee. In addition, the Board of Investment revised Thailand investment policies to reduce the government’s fiscal burden. Several tax privileges were reduced, and the efficiency and effectiveness of tax privileges was enhanced. For example, the priority of tax privileges is now given to regions with low income and inadequate investment, small and medium enterprises, and five main sectors (i.e., agriculture and agricultural products, projects related to technological and human resource development, public utilities and infrastructure, environmental protection and conservation, and targeted industries). These reform measures may help reduce the moral hazard problems at the bank, international, and corporate levels.

30 This discussion draws from information provided in the Bank of Thailand’s Supervision Report 2000.
APPENDIX I: Sensitivity Analysis

The scenario analysis in Section 9 consider only a certain number of scenarios. In most of the scenarios considered, except scenario B2, the interest rate sensitivity to the aggregate level of banks’ net foreign borrowing ($\psi_1$) is set at the pre-crisis level which is zero. Hence, any change that affects banks’ net foreign borrowing does not have any impact on domestic interest rates. When $\psi_1$ is greater than zero, there might be additional effects of changes in the quality of institutions and domestic policies via the interest rate channel. Therefore, it might be interesting to examine those additional effects when the policies to improve the moral hazard problem at each level are implemented under the condition that the interest rate channel is working (i.e., $\psi_1$ is greater than zero). In addition, since the results in section 9.5 are based on exogenously-determined parameters, it would be interesting to examine how the results are impacted by a change in each of the exogenously-determined parameters both directly and indirectly through the interest rate mechanism.

This appendix first describes the role of the domestic interest rates as the mechanism through which any change affecting some parts of an economy is transmitted to the other parts. Then it examines the additional effects when the policies to reduce each level of the moral hazard problems are implemented under the condition that the interest rate channel is working. Finally, it explores how the results are affected by a change in each of the exogenously-determined parameters both directly and indirectly via the interest rate mechanism.

Interest Rate Mechanism

The equilibrium conditions of the model suggest that the domestic real interest rate ($r_t$) affects the decisions of all agents in an economy. Particularly, the firms’ level of capital stock ($K$), money holdings by households ($M$), and current consumption relative to future consumption of households ($C_t/C_{t+1}$) decrease with the domestic real interest rate. In addition, dividends paid by banks to their shareholders ($X$) from performing loan (PL) profits increase with the domestic real interest rate. Those decisions determine the output ($Y$), the amount of government subsidies or taxes to the corporate sector ($S$), the amount of bank lending to the corporate sector ($e$), the amount of deposits from the household sector ($a$), as well as the aggregate level of banks’ net foreign borrowing ($b$). At the same time, the domestic real interest rate ($r$) is also determined by the aggregate level of banks’ net foreign borrowing ($b$). Hence, any change that affects the aggregate level of banks’ net foreign borrowing ($b$), either directly or indirectly through the variables {$K, M, C, X, Y, S, e, a$}, will have additional impacts on the whole economy through the domestic real interest rate ($r$).
How well this interest rate mechanism works however depends on the value of parameter $\psi$. Recall that $\psi$ measures the interest rate sensitivity to the aggregate level of banks’ net foreign borrowing. Hence, the higher the value of $\psi$, the greater the additional impacts of a change in one of the endogenous variables on the whole economy via the interest rate channel. However, when $\psi$ is zero, this channel is cut, and there is no additional effect via the interest rate channel.

**Additional Effects When $\psi$ is Greater than Zero**

This section examines the additional effects via the interest rate channel of changes in the quality of institutions and domestic policies to mitigate moral hazard problems on the direct and indirect costs of international capital flows when $\psi$ is greater than zero.

1) An increase in the loan loss provisioning ratio ($\upsilon$)

The results for scenario A1 in section 9.5 suggest that an increase in the loan loss provisioning ratio ($\upsilon$), when $\psi$ is set at the pre-crisis level (i.e., zero), benefits a country like Thailand by substantially lowering bailout costs and slightly increasing output. In addition to these direct effects, a smaller cut in credit by foreign creditors as a result of the higher loan loss provisioning ratio causes banks’ net foreign borrowing ($b$) to decrease less during a sudden stop. When $\psi$ is greater than zero, the lower reduction (or the increase) in $b$ causes the domestic real interest rate ($r$) to go up, leading to lower output and higher bailout costs. The counter indirect effect from the increase in the loan loss provisioning ratio on the bailout costs is however much smaller than the positive direct effect. Hence, when combined with the direct effects, the increase in the loan loss provisioning ratio leads to the much lower bailout costs; however, the output slightly decreases.

In scenario B2 when the policies aiming to improve banking supervision (an increase in $\upsilon$) and those aiming to improve foreign creditors’ estimation of risks (a reduction in $\psi_0$ and an increase in $\psi_1$) are implemented together, the country benefits more from the lower bailout costs and the higher output than when each set of policies is implemented alone. This is because the positive direct effects from the increase in the loan loss provisioning ratio, the increase in $\psi_1$ (when changes in $b$ are mostly negative), and the decrease in $\psi_0$ (when changes in the world interest rate are mostly positive) more than outweigh the negative indirect effects via the interest rate channel of the increase in the loan loss provisioning ratio.

2) A reduction in the level of government subsidies or tax incentives ($n$)

The results for scenario A2 in section 9.5 indicate that a decrease in the level of government subsidies or tax incentives ($n$), when $\psi$ is set at zero, leads to much lower output (due to lower investment) and slightly lower bailout costs (due to lower bank lending to the corporate sector).
Apart from these direct effects, the decrease in the government subsidies or tax incentives and the lower output reduce firms’ profits and dividends paid by firms to households. With lower income, households deposit less money in banks, resulting in banks increasing demand for foreign borrowing. When \( \psi_1 \) is greater than zero, the higher level of banks’ net foreign borrowing causes the domestic real interest rate \( (r) \) to increase, leading to a further reduction in investment and output as well as an increase in bailout costs. The negative indirect impact (via the increase in \( r \)) of the decrease in \( n \) on the bailout costs is stronger than the positive direct impact (via the reduction in investment and thus bank lending to the corporate sector). Hence, when the interest rate mechanism is working (\( \psi_1 \) is greater than zero), the decrease in the government subsidies or tax incentives leads to even greater negative impacts on the economy through the greater reduction in the output and the higher bailout costs.

3) A decrease in the expected exchange rate deviation from the uncovered interest rate parity (\( P_\infty \))

A decrease in the expected exchange rate deviation from the UIP (\( P_\infty \)), when \( \psi_1 \) is zero, has a minimal impact on output and bailout costs, as suggested by the results for scenario A4 in section 9.5. However, when the interest rate mechanism is working (when \( \psi_1 \) is greater than zero), a local currency depreciation as a result of the lower \( P_\infty \) reduces the demand for banks’ net foreign borrowing in foreign currency (\( b \)). Hence, when the simulated changes in banks’ net foreign borrowing are mostly negative, the local currency depreciation causes a lower reduction in banks’ net foreign borrowing, leading to a lower reduction (an increase) in the domestic real interest rate. The increase in the domestic real interest rate as a result of the lower \( P_\infty \) in this case causes lower output and higher bailout costs. On the other hand, when changes in banks’ net foreign borrowing are mostly positive, the local currency depreciation causes a lower rise in banks’ net foreign borrowing, leading to a smaller increase (a decrease) in the domestic real interest rate. The decrease in the domestic real interest rate as a result of the lower \( P_\infty \) brings about higher output and lower bailout costs in this case. Therefore, when the interest rate channel is working, the decrease in \( P_\infty \) benefits a country only in the situation when the country is, most of the time, the net foreign borrower, i.e., when changes in banks’ net foreign borrowing are mostly positive.

Changes in Exogenously-Determined Parameters

This part examines how sensitive the results are to a change in each of the exogenously-determined parameters both in the cases where \( \psi_1 \) is zero and \( \psi_1 \) is greater than zero.
1) A decrease in households’ degree of (liquidity) risk aversion ($\chi$)

A decrease in households’ degree of risk aversion ($\chi$) causes a decline in both the level and the magnitude of a change in households’ demand for money holdings, which has no direct effect on output or bailout costs. However, when $\psi_1$ is greater than zero, the lower level of households’ money balances as a result of the decrease in $\chi$ leads to higher households’ deposits with banks and lower banks’ demand for foreign borrowing. The reduction in banks’ net foreign borrowing leads to a decrease in the domestic real interest rate, resulting in higher output and lower bailout cost. Hence, the decrease in households’ degree of (liquidity) risk aversion benefits the country through the interest rate mechanism by increasing the total output and lowering the bailout costs.

2) An increase in the production technology factor (A) and a rise in the income share of capital ($\alpha$)

Both an increase in the production technology factor (A) and a rise the income share of capital ($\alpha$) result in higher output, providing a greater incentive for firms to increase their investment. Banks’ lending to the corporate sector increases, as a result of the higher investment, leading to higher banks’ NPL losses and higher bailout costs.

When $\psi_1$ is greater than zero, there are two additional effects via the interest rate mechanism. First, the higher output as a result of the higher A or $\alpha$ leads to higher firms’ profits and higher dividends paid by firms to households. With higher income, households deposit more money in banks, reducing banks’ demand for foreign borrowing ($b$) and causing the domestic real interest rate to go down. Hence, investment and output increase and bailout costs decrease. Second, the higher investment as a result of the higher A or $\alpha$ causes firms to increase their demand for bank loans, increasing banks’ demand for foreign borrowing and driving the domestic real interest rate up. As a result, output declines and bailout costs rise. If the economy starts with a high level of wealth or output, the increase in A or $\alpha$ leads to a bigger rise in output and the first additional effect dominates the second one. Hence, output increases and bailout costs decrease (even after combining with the negative direct effect from the higher bailout costs) in this case. On the other hand, if the economy starts with a low level of wealth or output, the increase in A or $\alpha$ leads to a smaller increase in output and the second additional effect can outweigh the first. In this case, output decreases (increases less when combined with the direct effect) and bailout costs rise.
3) An increase in the capital depreciation rate (d)

A higher capital depreciation rate (d) increases firms’ expenses and reduces firms’ expected profits, causing firms to lower their investment and their demand for bank loans. This leads to lower output and lower bailout costs.

When $\psi_1$ is greater than zero, there are two additional effects via the interest rate channel. First, the increase in firms’ expenses and the decrease in firms’ output as a result of the higher capital depreciation rate reduce the amount of dividends paid by firms to households. With lower income, households reduce their deposits with banks, causing banks to increase their demand for foreign borrowing (b). The higher b causes the domestic real interest rate to go up, leading to lower output and higher bailout costs. Second, the decrease in firms’ investment and their demand for bank loans reduces banks’ demand for foreign borrowing, causing the domestic real interest rate to decline. As a result, output increases and bailout costs decrease. If the economy starts with a high level of wealth or output, the increase in d leads to a larger decrease in output and the first additional effect is stronger than the second. Hence, output decreases, and bailout costs increase (decrease less when combined with the direct effect) in this case. On the other hand, if the economy starts with a low level of wealth or output, the increase in d leads to a smaller decrease in output and the second additional effect dominates the first one. Therefore, output increases (decreases less when combined with the direct effect) and bailout costs decrease in this case.

4) An increase in the operating expense factor ($\xi$)

A rise in banks’ operating expenses (as measured by $\xi$) increases banks’ losses from NPLs, resulting in higher bailout costs. Banks also charge higher lending rates to firms to cover their higher expenses, causing firms to lower their investment. As a result, output declines.

The increase in banks’ NPL losses as a result of the higher $\xi$ leads to a larger credit cut by foreign creditors, leading to a greater reduction in banks’ net foreign borrowing during a sudden stop. When the interest rate mechanism is working, the greater reduction in banks’ net foreign borrowing causes the domestic real interest rate to sharply decline, leading to an increase (a smaller decrease when combined with the direct effect) in investment and output as well as a reduction in bailout costs (even after combining with the negative direct effect from the higher bailout costs).

5) An increase in the fraction of firms’ investment financed by capital markets (cap)

A greater fraction of firms’ investment financed by capital markets (cap) leads to a reduction in banks’ lending to the corporate sector, a decrease in banks’ NPL losses, and lower bailout costs.
The lower level of banks’ NPL losses also causes a smaller credit cut by foreign creditors during a sudden stop, resulting in a lower reduction (a slight increase) in output.

The smaller credit cut by foreign creditors during a sudden stop as a result of the higher cap results in a smaller decrease (an increase) in banks’ net foreign borrowing. When the interest rate mechanism is working, the increase in banks’ net foreign borrowing causes the domestic real interest rate to go up, leading to a decrease in output (even after combining with the positive direct effect from the slightly higher output) and a rise (a smaller decrease when combined with the direct effect) in bailout costs.

6) An increase in the personal income tax rate (\( \eta \))

A higher personal income tax rate does not have any direct effect on output or bailout costs. However, such a change leads to lower household income after tax, causing households to deposit less money in banks. This causes banks to increase their demand for foreign borrowing. When \( \psi_1 \) is greater than zero, the higher level of banks’ net foreign borrowing causes the domestic real interest rate to go up, resulting in higher bailout costs and lower output.

7) An increase in the time preference factor (\( \delta \))

An increase in the time preference factor has no direct impact on output or bailout costs. This change however causes a reduction in household consumption, leading to a greater amount of household deposits with banks and lower banks’ demand for foreign borrowing. When the interest rate mechanism is working, the decrease in banks’ net foreign borrowing causes a reduction in the domestic real interest rate, leading to lower bailout costs and higher output.

8) An increase in the weight given to contemporary investment predicted by the model \( (\text{inv}_0) \) and a decrease in the weight given to lagged investment \( (\text{inv}_1) \) lead to a decrease in investment because contemporary investment predicted by the model (the model prediction part) is generally lower than lagged investment (the lagged part). The lower investment results in lower output and lower demand for bank loans. Hence, this change in the relative weight between the model prediction part and the lagged part results in lower output as well as lower bailout costs.

The increase in the weight given to the model prediction part \( (\text{inv}_0) \) also leads to a larger cut in credit by banks to firms during a sudden stop.\(^{31}\) The reduction in banks’ lending causes banks’

\[^{31}\text{A cut in credit by banks to firms during a sudden stop is equal to} \quad \text{inv}_0 (1 - \varphi) \left( F_0 + \frac{\epsilon_i}{P_1 + \frac{R_{1+i}}{\beta}} \right) \.]
demand for foreign borrowing and thus the domestic real interest rate to go down. As a result, output increases (decreases less when combined with the direct effect) and bailout costs decrease.

9) A decrease in the fraction of banks’ cumulative losses which are expected by foreign creditors to be covered by the country’s international reserves \((\beta)\) leads to a smaller cut (an increase) in credit by foreign creditors during a sudden stop. As a result, there will be a smaller cut in banks’ lending to the corporate sector and a lower reduction in investment, leading to higher bailout costs and higher output.

Additionally, when the interest rate mechanism is working, the smaller cut in credit by foreign creditors as a result of the decrease in \(\beta\) causes a smaller reduction (an increase) in banks’ net foreign borrowing. Consequently, the domestic real interest rate decreases less (increases), leading to much higher bailout costs and lower output (even after combining with the positive direct effect from the higher output).

10) An increase in the parameter determining the fraction of banks’ cash shortfalls subsidized by the government during a sudden stop \((\phi)\) reduces a cut in credit by banks to the corporate sector. This change leads to a smaller reduction (an increase) in firms’ investment, an increase in output, an increase in banks’ lending, as well as a slight increase in banks’ losses transferred to the government during a sudden stop. However, the remaining banks’ cumulative NPL losses, which are transferred to the government after the sudden stop, are lower. The net effect of the increase in \(\phi\) is thus a small reduction in bailout costs and a small increase in output.

When the interest rate mechanism is working, there are two additional indirect effects via the interest rate channel. First, the smaller cut in credit by banks to the corporate sector and the smaller reduction in firms’ investment during a sudden stop, as a result of the increase in \(\phi\), lead to a smaller reduction (an increase) in banks’ lending to firms and greater banks’ demand for foreign borrowing. Hence, the domestic interest rate increases, leading to lower output and higher bailout costs. Second, the smaller reduction (the increase) in output as a result of the increase in \(\phi\) increases firms’ profits and dividends paid by firms to households. Households therefore deposit more money in banks, lowering banks’ demand for foreign borrowing and causing the domestic real interest rate to go down. This second indirect effect, in contrast to the first indirect effect, causes output to increase and bailout costs to decrease. Combined with the direct effects, the net effects of the increase in \(\phi\) when \(\psi_1\) is greater than zero are an increase in both output and bailout costs. However, the magnitudes of those effects are small.
Figure 1: Time-Series Patterns of Variables

This figure shows monthly time-series of macroeconomic, financial market, and bank variables of Thailand as well as the world interest rate from January 1993 to June 2007. Panels A to C plot the annualized real traded output, the real net capital stock of the private sector, and the annualized real private investment in traded sectors. Panels D to F plot the annualized real private consumption, the real monetary aggregate, and the banks’ net foreign borrowing. Panels G to I show monthly time-series of the real exchange rate, the annualized domestic nominal deposit rate, and the annualized domestic real deposit rate. Panels J to L plot the annualized domestic real lending rate, the employed labor, and the banks’ non-performing loans to total loans ratio. Panels M, N and P plot the international reserves net of the Bank of Thailand’s forward position, the annualized world nominal interest rate, and the annualized domestic inflation rate, respectively. The details about how these variables are obtained or computed are described in table 1.
Table 1: Descriptions and Data Sources of Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y = Real Traded Output (Real Output)</td>
<td>$Y = \text{Predicted monthly real output} = a_y + b_y \times \text{monthly manufacturing production index}$</td>
<td>Monthly seasonally adjusted (SA) manufacturing production index from the Bank of Thailand (BOT)</td>
</tr>
<tr>
<td></td>
<td>• Estimate $a_y$ and $b_y$ by regressing the actual quarterly real output divided by 3 on the average monthly manufacturing production index for each quarter.</td>
<td>Quarterly SA GDP at 1988 prices from the Office of National Economic and Social Development Board (NESDB) (Traded output = Total GDP subtracted by the GDP from (1) financial intermediations and (2) real estate, renting and business activities)</td>
</tr>
<tr>
<td></td>
<td>• Predicted monthly real output = $a_y + b_y \times \text{monthly manufacturing production index}$.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• If sum of the predicted monthly real output within a quarter is not equal to the actual quarterly real output, the difference is divided by 3 and equally adjusted to the predicted value of monthly real output.</td>
<td></td>
</tr>
<tr>
<td>I = Real Private Investment in Traded Sectors (Real Investment)</td>
<td>$I = \text{Predicted monthly real investment} = a_I + b_I \times \text{monthly investment index}$</td>
<td>Monthly private investment index from 1995 to 2007 and the index components from 1993 to 2007 from the BOT</td>
</tr>
<tr>
<td></td>
<td>• Construct a new investment index without the real estate component by taking out residential construction area and domestic cement sales components from the private investment index obtained from the BOT.</td>
<td>Annual SA net capital stock and annual capital depreciation of the private sector at 1988 prices (excluding the banking, insurance, and real estate sectors) from the NESDB</td>
</tr>
<tr>
<td></td>
<td>• Derive annual real investment for year $y$ ($I_y$) from the following equation.</td>
<td></td>
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<tr>
<td></td>
<td>$I_y = K_y - K_{y-1} + \text{Deprey}$</td>
<td></td>
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<tr>
<td></td>
<td>$K_y$ = Real net capital stock at the end of year $y$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$K_{y-1}$ = Real net capital stock at the end of year $y-1$</td>
<td></td>
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<tr>
<td></td>
<td>$\text{Deprey}$ = Annual capital depreciation for year $y$</td>
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<tr>
<td></td>
<td>• Estimate $a_I$ and $b_I$ by regressing the actual $I_y$ divided by 12 on the average monthly new investment index for year $y$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Predicted monthly real investment ($I_m$) = $a_I + b_I \times \text{monthly new investment index}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• If sum of $I_m$ within a year is not equal to $I_y$, the difference is divided by 12 and equally adjusted to the predicted value of $I_m$</td>
<td></td>
</tr>
<tr>
<td>K = Real Net Capital Stock of the Private Sector (Real Net Capital Stock)</td>
<td>$K = \text{Predicted real net capital stock at the end of each month according to the following equation}$</td>
<td>Annual SA net capital stock and annual capital depreciation of the private sector at 1988 prices (excluding the banking, insurance, and real estate sectors) from the NESDB</td>
</tr>
<tr>
<td></td>
<td>$K_m = K_{m-1} + I_m - \text{Deprey}/12$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$K_{m-1}$ = Real net capital stock at the end of month $m-1$ of year $y$</td>
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</tr>
<tr>
<td></td>
<td>$K_m$ = Real net capital stock at the end of month $m$ of year $y$</td>
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<tr>
<td></td>
<td>$I_m$ = Predicted monthly real investment for month $m$ of year $y$</td>
<td></td>
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<tr>
<td></td>
<td>$\text{Deprey}$ = Annual capital depreciation for year $y$</td>
<td></td>
</tr>
<tr>
<td>Variable</td>
<td>Description</td>
<td>Source</td>
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<td>----------------------------------</td>
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<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>C = Real Private Consumption (Real Consumption)</td>
<td>( C = \text{Predicted monthly real consumption} = a_C + b_C \times \text{monthly consumption index} )</td>
<td>Monthly private consumption index from 1995 to 2007 and the index components from 1993 to 2007 from the BOT. This series is extended backwards to 1993 using the predicted value of the index based on the regression of the index on its own components. Quarterly SA private consumption at 1988 prices from the NESDB.</td>
</tr>
<tr>
<td>M = Nominal Monetary Aggregate</td>
<td>( M = \text{Seasonally adjusted M1} )</td>
<td>Monthly M1 from 1993 to 2006 from the International Financial Statistics of the IMF (IMF-IFS). The series is extended forwards to 2007 using the predicted value of M1 based on the regression of M1 on narrow money (a new measure replacing M1).</td>
</tr>
<tr>
<td>b = Aggregate Banks’ Net Foreign Borrowing</td>
<td>( b = \text{Net foreign liabilities (Foreign liabilities} - \text{Foreign assets) of all banks and finance companies (This is equivalent to the stock of net international capital flows via the banking sector)} )</td>
<td>Aggregate foreign liabilities and aggregate foreign assets of all banks and finance companies from the BOT.</td>
</tr>
<tr>
<td>ε = Nominal Exchange Rate</td>
<td>( \varepsilon = \text{Spot THB/USD exchange rate} )</td>
<td>Monthly spot THB/USD exchange rate (end of period) from Datastream</td>
</tr>
<tr>
<td>i = Domestic Nominal Deposit Rate</td>
<td>( i = 3\text{-month Thai baht deposit rate} )</td>
<td>Monthly data from the IMF-IFS</td>
</tr>
<tr>
<td>il = Domestic Nominal Lending Rate</td>
<td>( i_l = 3\text{-month Thai baht lending rate} )</td>
<td>Monthly data from the IMF-IFS</td>
</tr>
<tr>
<td>NPL = Banks’ Non-Performing Loans to Total Loans Ratio</td>
<td>NPL from 1998 to 2007 = Actual non-performing loans to total loans ratio of all banks and finance companies NPL before 1998 = Predicted monthly NPL using coincident economic index as an explanatory variable</td>
<td>Monthly NPL data from 1998 to 2007 from the BOT Monthly coincident economic index from 1993 to 2007 from the BOT</td>
</tr>
<tr>
<td>R = International Reserves</td>
<td>( R = \text{International reserves, net of forward positions by the BOT} )</td>
<td>Monthly data from the BOT</td>
</tr>
<tr>
<td>Variable</td>
<td>Description</td>
<td>Source</td>
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<tr>
<td>$i^w = \text{World Nominal Interest Rate}$</td>
<td>$i^w = 3$-month US certificate of deposit (secondary market) interest rate</td>
<td>Monthly data from the IMF-IFS</td>
</tr>
<tr>
<td>$\pi = \text{Domestic Inflation Rate}$</td>
<td>$\pi = \text{Change in consumer price index (CPI) from the same month of the previous year}$</td>
<td>Monthly change in CPI from Datastream (Source: Ministry of Commerce)</td>
</tr>
<tr>
<td>$P = \text{Price Level}$</td>
<td>$P = \text{CPI/ CPI at 1988 prices}$</td>
<td>Monthly CPI from Datastream (Source: Ministry of Commerce)</td>
</tr>
</tbody>
</table>
Table 2: Summary Statistics for the Whole Sample Period

This table reports the summary statistics of the variables used in the parameter estimation and the scenario analysis for the whole sample period from January 1993 to June 2007. Panel A presents the mean, the standard deviation, the median, the maximum, and the minimum of each variable in levels. Panel B exhibits statistics for changes in each variable.

Panel A: Levels

<table>
<thead>
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<th>Median</th>
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<td>2,930,432</td>
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<td>(%)</td>
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Panel B: Changes

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<th>Minimum</th>
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* These variables are annualized from monthly data.
** Real deposit rate (r) = (1+i)/(1+π) -1 and real lending rate (r') = (1+i')/(1+π) -1.
Table 3: Summary Statistics for Each Sub-Period

This table reports the summary statistics of the variables used in the parameter estimation and the scenario analysis for each sub-period: (1) pre-crisis period from January 1993 to May 1997, (2) crisis (and reform) period from June 1997 to December 2000, and (3) post-crisis period from January 2001 to June 2007. Panel A presents the mean, the standard deviation, the median, the maximum, and the minimum of each variable in levels. Panel B exhibits the statistics for changes in each variable.

### Panel A: Levels

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<th>Variable</th>
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<th>Standard Deviation</th>
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<th>Maximum</th>
<th>Minimum</th>
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<td>(million baht)</td>
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<td>Standard Deviation</td>
<td>Median</td>
<td>Maximum</td>
<td>Minimum</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------------------------</td>
<td>-----------------------</td>
<td>---------------</td>
<td>------------</td>
<td>--------------------</td>
<td>-------------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td>$\Delta Y^*$</td>
<td>ΔReal Output</td>
<td>(million baht)</td>
<td>Pre-Crisis</td>
<td>14,022</td>
<td>41,170</td>
<td>14,396</td>
<td>150,061</td>
<td>-60,848</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Crisis</td>
<td>378</td>
<td>58,661</td>
<td>5,936</td>
<td>139,690</td>
<td>-137,586</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Post-Crisis</td>
<td>13,575</td>
<td>54,503</td>
<td>8,682</td>
<td>138,547</td>
<td>-105,965</td>
</tr>
<tr>
<td>$\Delta I^*$</td>
<td>ΔReal Investment</td>
<td>(million baht)</td>
<td>Pre-Crisis</td>
<td>-1,364</td>
<td>38,107</td>
<td>-1,902</td>
<td>118,245</td>
<td>-164,403</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Crisis</td>
<td>-6,705</td>
<td>24,535</td>
<td>-1,424</td>
<td>21,900</td>
<td>-122,659</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Post-Crisis</td>
<td>2,779</td>
<td>16,202</td>
<td>3,749</td>
<td>48,212</td>
<td>-67,192</td>
</tr>
<tr>
<td>$\Delta C^*$</td>
<td>ΔReal Consumption</td>
<td>(million baht)</td>
<td>Pre-Crisis</td>
<td>8,402</td>
<td>32,217</td>
<td>7,327</td>
<td>109,962</td>
<td>-69,845</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Crisis</td>
<td>-1,954</td>
<td>41,441</td>
<td>-154</td>
<td>100,662</td>
<td>-120,367</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Post-Crisis</td>
<td>7,213</td>
<td>33,479</td>
<td>5,020</td>
<td>74,466</td>
<td>-71,223</td>
</tr>
<tr>
<td>$\Delta M/P$</td>
<td>ΔReal Monetary Aggregate</td>
<td>(million baht)</td>
<td>Pre-Crisis</td>
<td>1,537</td>
<td>6,139</td>
<td>1,415</td>
<td>24,320</td>
<td>-13,113</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Crisis</td>
<td>211</td>
<td>12,711</td>
<td>556</td>
<td>37,820</td>
<td>-34,627</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Post-Crisis</td>
<td>2,030</td>
<td>8,063</td>
<td>1,709</td>
<td>30,342</td>
<td>-31,436</td>
</tr>
<tr>
<td>$\Delta b$</td>
<td>ΔBanks’ Net Foreign Borrowing</td>
<td>(million USD)</td>
<td>Pre-Crisis</td>
<td>876</td>
<td>881</td>
<td>826</td>
<td>2,724</td>
<td>-818</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Crisis</td>
<td>-1,265</td>
<td>1,465</td>
<td>-1,004</td>
<td>894</td>
<td>-8,229</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Post-Crisis</td>
<td>-262</td>
<td>1,073</td>
<td>-65</td>
<td>1,603</td>
<td>-4,661</td>
</tr>
<tr>
<td>$\Delta e/P$</td>
<td>ΔReal FX rate</td>
<td>(baht/USD)</td>
<td>Pre-Crisis</td>
<td>-0.082</td>
<td>0.133</td>
<td>-0.074</td>
<td>0.129</td>
<td>-0.829</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Crisis</td>
<td>0.192</td>
<td>1.647</td>
<td>0.135</td>
<td>4.711</td>
<td>-6.098</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Post-Crisis</td>
<td>-0.102</td>
<td>0.356</td>
<td>-0.099</td>
<td>1.046</td>
<td>-1.127</td>
</tr>
<tr>
<td>$\Delta i^*$</td>
<td>ΔNominal Deposit Rate</td>
<td>(%)</td>
<td>Pre-Crisis</td>
<td>-0.005</td>
<td>0.518</td>
<td>0</td>
<td>1.500</td>
<td>-2.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Crisis</td>
<td>-0.145</td>
<td>0.804</td>
<td>0</td>
<td>2.250</td>
<td>-3.250</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Post-Crisis</td>
<td>-0.010</td>
<td>0.229</td>
<td>0</td>
<td>0.750</td>
<td>-0.750</td>
</tr>
<tr>
<td>$\Delta r$</td>
<td>ΔReal Deposit Rate</td>
<td>(%)</td>
<td>Pre-Crisis</td>
<td>0.006</td>
<td>0.528</td>
<td>-0.075</td>
<td>1.516</td>
<td>-1.909</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Crisis</td>
<td>0.050</td>
<td>0.611</td>
<td>-0.189</td>
<td>1.858</td>
<td>-1.723</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Post-Crisis</td>
<td>0.013</td>
<td>0.479</td>
<td>0</td>
<td>1.447</td>
<td>-1.614</td>
</tr>
<tr>
<td>$\Delta r^{**}$</td>
<td>ΔReal Lending Rate</td>
<td>(%)</td>
<td>Pre-Crisis</td>
<td>0.033</td>
<td>0.193</td>
<td>0.019</td>
<td>0.432</td>
<td>-0.377</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Crisis</td>
<td>0.033</td>
<td>0.228</td>
<td>-0.017</td>
<td>0.433</td>
<td>-0.491</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Post-Crisis</td>
<td>0.072</td>
<td>0.396</td>
<td>0.083</td>
<td>1.113</td>
<td>-1.330</td>
</tr>
<tr>
<td>$\Delta L$</td>
<td>ΔEmployed Labor</td>
<td>(million)</td>
<td>Pre-Crisis</td>
<td>0.033</td>
<td>0.193</td>
<td>0.019</td>
<td>0.432</td>
<td>-0.377</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Crisis</td>
<td>0.033</td>
<td>0.228</td>
<td>-0.017</td>
<td>0.433</td>
<td>-0.491</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Post-Crisis</td>
<td>0.072</td>
<td>0.396</td>
<td>0.083</td>
<td>1.113</td>
<td>-1.330</td>
</tr>
<tr>
<td>$\Delta NPL$</td>
<td>ΔBanks’ NPL</td>
<td>(% of total loans)</td>
<td>Pre-Crisis</td>
<td>-0.275</td>
<td>1.304</td>
<td>-0.218</td>
<td>2.211</td>
<td>-3.272</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Crisis</td>
<td>-0.102</td>
<td>2.458</td>
<td>0</td>
<td>4.799</td>
<td>-9.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Post-Crisis</td>
<td>-0.117</td>
<td>0.906</td>
<td>0</td>
<td>5.000</td>
<td>-5.000</td>
</tr>
<tr>
<td>$\Delta R$</td>
<td>ΔInternational Reserves</td>
<td>(million USD)</td>
<td>Pre-Crisis</td>
<td>-320</td>
<td>2,945</td>
<td>240</td>
<td>1,686</td>
<td>-18,268</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Crisis</td>
<td>587</td>
<td>1,003</td>
<td>353</td>
<td>3,747</td>
<td>-2,458</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Post-Crisis</td>
<td>667</td>
<td>1,285</td>
<td>523</td>
<td>5,431</td>
<td>-2,167</td>
</tr>
<tr>
<td>$\Delta i^*$</td>
<td>ΔWorld Nominal Interest Rate</td>
<td>(%)</td>
<td>Pre-Crisis</td>
<td>0.049</td>
<td>0.167</td>
<td>-0.005</td>
<td>0.500</td>
<td>-0.240</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Crisis</td>
<td>0.001</td>
<td>0.202</td>
<td>0.010</td>
<td>0.630</td>
<td>-0.830</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Post-Crisis</td>
<td>0.004</td>
<td>0.182</td>
<td>0</td>
<td>0.260</td>
<td>-0.610</td>
</tr>
<tr>
<td>$\Delta \pi^*$</td>
<td>ΔInflation Rate</td>
<td>(%)</td>
<td>Pre-Crisis</td>
<td>0.023</td>
<td>0.492</td>
<td>0.090</td>
<td>0.980</td>
<td>-1.510</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Crisis</td>
<td>0.072</td>
<td>0.720</td>
<td>0.110</td>
<td>1.720</td>
<td>-2.360</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Post-Crisis</td>
<td>0.005</td>
<td>0.465</td>
<td>0</td>
<td>1.520</td>
<td>-1.450</td>
</tr>
</tbody>
</table>

* These variables are annualized from monthly data.
** Real deposit rate ($r = (1+i)/(1+\pi) -1$) and real lending rate ($r^{\prime} = (1+i^{\prime})(1+\pi) -1$).
Table 4: Preliminary Correlation Analysis

This table reports the correlations between the left-hand side (LHS) and the right-hand side (RHS) variables of the equilibrium conditions derived from the model over January 1993 to June 2007. In this table, Y = Real output, K = Real net capital stock, I = Real investment, C = Real consumption, M/P = Real monetary aggregate, ε/P = Real exchange rate, b = Banks' net foreign borrowing, L = Employed labor, NPL = Non-performing loans to total loans ratio, r' = Real lending rate, r = Real deposit rate, i = Nominal deposit rate, and i^w = World nominal interest rate.

<table>
<thead>
<tr>
<th>Equilibrium Condition</th>
<th>LHS Variable</th>
<th>RHS Variable</th>
<th>Expected Sign</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real Output</td>
<td>Y_t</td>
<td>K_{t-1}</td>
<td>+</td>
<td>0.7813</td>
</tr>
<tr>
<td></td>
<td>L_{t-1}</td>
<td>+</td>
<td>0.9542</td>
<td></td>
</tr>
<tr>
<td>Real Net Capital Stock</td>
<td>K_t</td>
<td>r_t</td>
<td>-</td>
<td>-0.6042</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real Investment</td>
<td>I_t</td>
<td>r_t - r_{t-1}</td>
<td>-</td>
<td>0.0373</td>
</tr>
<tr>
<td>Real Lending Rate</td>
<td>r'_t</td>
<td>r_t</td>
<td>+</td>
<td>0.9161</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NPL_{t-1}</td>
<td>+</td>
<td>0.6609</td>
</tr>
<tr>
<td>Real Deposit Rate</td>
<td>r_t</td>
<td>i^w_t</td>
<td>+</td>
<td>0.5072</td>
</tr>
<tr>
<td></td>
<td>b_t</td>
<td>+</td>
<td>0.7168</td>
<td></td>
</tr>
<tr>
<td>Growth Rate of Real Consumption</td>
<td>C_{t-1}/C_{t-1}</td>
<td>r_{t-1}</td>
<td>+</td>
<td>-0.0009</td>
</tr>
<tr>
<td>Real Monetary Aggregate</td>
<td>M_t/P_t</td>
<td>C_t</td>
<td>+</td>
<td>0.9759</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>-0.6734</td>
</tr>
<tr>
<td>Growth Rate of Real Exchange Rate</td>
<td>e_t/P_t</td>
<td>r_{t-1}</td>
<td>+</td>
<td>0.1241</td>
</tr>
<tr>
<td></td>
<td>e_t/P_t</td>
<td></td>
<td>-</td>
<td>0.0890</td>
</tr>
<tr>
<td>Change in Banks' Net Foreign Borrowing</td>
<td>b_{t-1} - b_{t-1}</td>
<td>I_t</td>
<td>+</td>
<td>0.4105</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>-0.1462</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>0.0931</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>+</td>
<td>0.0451</td>
</tr>
</tbody>
</table>

This table reports the correlations between the left-hand side (LHS) and the right-hand side (RHS) variables of the equilibrium conditions derived from the model over January 1993 to June 2007. In this table, Y = Real output, K = Real net capital stock, I = Real investment, C = Real consumption, M/P = Real monetary aggregate, ε/P = Real exchange rate, b = Banks' net foreign borrowing, L = Employed labor, NPL = Non-performing loans to total loans ratio, r' = Real lending rate, r = Real deposit rate, i = Nominal deposit rate, and i^w = World nominal interest rate.
Table 5: Correlations between Selected Macroeconomic Variables and Relevant Interest Rates

This table compares the correlations between the selected macroeconomic variables and the relevant interest rates over January 1993 to June 2007 when using one-period interest rates versus eleven-year moving averages of interest rates.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Expected Sign</th>
<th>One-Period Interest Rates</th>
<th>Eleven-Year Moving Averages of Interest Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real Net Capital Stock ($K_t$)</td>
<td>-</td>
<td>-0.6042</td>
<td>-0.8742</td>
</tr>
<tr>
<td>vs. Real Deposit Rate ($r_t$)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real Investment ($I_t$)</td>
<td>-</td>
<td>0.0373</td>
<td>-0.2742</td>
</tr>
<tr>
<td>vs. Change in Real Deposit Rate ($r_t - r_{t-1}$)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth Rate of Real Consumption ($C_t / C_{t-1}$)</td>
<td>+</td>
<td>-0.0009</td>
<td>0.0138</td>
</tr>
<tr>
<td>vs. Lagged Real Deposit Rate ($r_{t-1}$)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real Monetary Aggregate ($M_t / P_t$)</td>
<td>-</td>
<td>-0.6734</td>
<td>-0.9795</td>
</tr>
<tr>
<td>vs. Nominal Deposit Rate ($i_t$)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 6: Exogenously-Determined Parameters

This table presents the values of exogenously-determined parameters and describes how they are derived. These parameter values are generally obtained from related studies or calibrated using long-run data relations.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Calculation/Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>0.31238</td>
<td>The average income share of capital over 1993-2005. Source: Jetin (2007)</td>
</tr>
<tr>
<td>$A$</td>
<td>168</td>
<td>Solve for the value of $A$ that makes the long-run relation $\bar{Y} = \Lambda K^{a}L^{1-a}$ hold.</td>
</tr>
<tr>
<td>$\text{cap}$</td>
<td>0.48</td>
<td>$1 –$ The average ratio of bank loans to total external finance over 1993-2007. [Total external finance = Sum of bank loans, stock market capitalization, and outstanding of domestic bonds] Source: Akrasanee (2008)</td>
</tr>
<tr>
<td>$d$</td>
<td>0.0051</td>
<td>The average yearly capital depreciation rate of the private sector over 1993-2007 divided by 12. Source: The Office of National Economic and Social Development Board (NESDB)</td>
</tr>
<tr>
<td>$\hat{b}$</td>
<td>0</td>
<td>Assumed to be zero, i.e., when the aggregate level of banks’ net foreign borrowing is zero, the interest rate applied to banks’ foreign lending and borrowing transactions is exactly equal to the world interest rate.</td>
</tr>
<tr>
<td>$\xi$</td>
<td>0.002</td>
<td>Solve for the value of $\xi$ that makes the long-run relation $\bar{r} = \frac{\bar{r} + \xi}{1 - \text{NPL}}$ hold.</td>
</tr>
<tr>
<td>$\chi$</td>
<td>0.01</td>
<td>Solve for the value of $\chi$ that makes the long-run relation $\frac{M}{P} = \chi \left(\frac{1 + \bar{r}(1 + \pi)}{(1 + \bar{r})(1 + \pi) - 1}\right)$ hold.</td>
</tr>
<tr>
<td>$\delta$</td>
<td>0.0017</td>
<td>Use the value of $\delta$ that makes the long-run relation $\delta = \bar{r}$ hold.</td>
</tr>
<tr>
<td>$\beta$</td>
<td>1</td>
<td>This is the worst case scenario in which foreign creditors expect the country’s international reserves to cover the full amount of banks’ cumulative NPL losses.</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0</td>
<td>This is the worst case scenario in which the government provides the least support to banks during a sudden stop. The government support during a sudden stop however does not include the transfers of the remaining cumulative NPL losses to the government to clean up the banking system during the bailout period.</td>
</tr>
</tbody>
</table>
Table 7: Parameter Estimates from Partial-Sample GMM Estimation

This table reports the estimated values of the parameters measuring the severity of moral hazard problems and the related parameters for each sub-period from the partial-sample GMM estimation. The loan loss provisioning ratio \((\upsilon)\) indicates the degree of the moral hazard problem at the bank level. The level of government subsidies (if positive) or taxes (if negative) \((n)\) measures the severity of the moral hazard problem at the corporate level. The interest rate sensitivity to the aggregate level of banks’ net foreign borrowing \((\psi_0)\) and the expected exchange rate deviation from the uncovered interest rate parity (UIP) measure the degree of the moral hazard problems at the international level. The related parameters, which may change over time, include the interest rate sensitivity to the world interest rate \((\psi_1)\), the weight given to contemporary investment predicted by the model \((\text{Inv}_0)\), and the weight given to lagged investment in the investment equation \((\text{Inv}_1)\). The approximate standard errors, t-statistics, p-values, as well as the J-statistic for over-identifying restrictions test are also reported.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sub-Period</th>
<th>Estimate</th>
<th>Approx. Std. Err.</th>
<th>T-Statistic</th>
<th>Approx. P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loan Loss Provisioning Ratio ((\upsilon))</td>
<td>Pre-Crisis ((\upsilon_{sub1}))</td>
<td>0.5215 ***</td>
<td>0.0763</td>
<td>6.84</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td></td>
<td>Crisis ((\upsilon_{sub2}))</td>
<td>0 +</td>
<td>-</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td></td>
<td>Post-Crisis ((\upsilon_{sub3}))</td>
<td>1 +</td>
<td>-</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Government Subsidies or Taxes ((n))</td>
<td>Pre-Crisis ((n_{sub1}))</td>
<td>-3.84 ***</td>
<td>0.85</td>
<td>-4.49</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td></td>
<td>Crisis ((n_{sub2}))</td>
<td>-13.01 ***</td>
<td>1.67</td>
<td>-7.78</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td></td>
<td>Post-Crisis ((n_{sub3}))</td>
<td>-29.02 ***</td>
<td>1.24</td>
<td>-23.37</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Interest Rate Sensitivity to the World Interest Rate ((\psi_0))</td>
<td>Pre-Crisis ((\psi_{0,sub1}))</td>
<td>1.1797 ***</td>
<td>0.2370</td>
<td>4.98</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td></td>
<td>Crisis ((\psi_{0,sub2}))</td>
<td>-0.1645</td>
<td>0.1114</td>
<td>-1.48</td>
<td>0.1416</td>
</tr>
<tr>
<td></td>
<td>Post-Crisis ((\psi_{0,sub3}))</td>
<td>0.0585</td>
<td>0.1135</td>
<td>0.52</td>
<td>0.6071</td>
</tr>
<tr>
<td>Interest Rate Sensitivity to the Aggregate Level of Banks' Net Foreign Borrowing ((\psi_1))</td>
<td>Pre-Crisis ((\psi_{1,sub1}))</td>
<td>-0.1500</td>
<td>0.5460</td>
<td>-0.27</td>
<td>0.7890</td>
</tr>
<tr>
<td></td>
<td>Crisis ((\psi_{1,sub2}))</td>
<td>0.8360 **</td>
<td>0.3540</td>
<td>2.36</td>
<td>0.0193</td>
</tr>
<tr>
<td></td>
<td>Post-Crisis ((\psi_{1,sub3}))</td>
<td>1.4610 **</td>
<td>0.6860</td>
<td>2.13</td>
<td>0.0347</td>
</tr>
<tr>
<td>Expected FX Rate Deviation from the Uncovered Interest Rate Parity ((P_e))</td>
<td>Pre-Crisis ((P_{e,sub1}))</td>
<td>0.0044 ***</td>
<td>0.0004</td>
<td>10.62</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td></td>
<td>Crisis ((P_{e,sub2}))</td>
<td>-0.0095 ***</td>
<td>0.0023</td>
<td>-4.12</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td></td>
<td>Post-Crisis ((P_{e,sub3}))</td>
<td>0.0014</td>
<td>0.0011</td>
<td>1.37</td>
<td>0.1714</td>
</tr>
<tr>
<td>Weight Given to Contemporary Investment ((\text{Inv}_0))</td>
<td>Pre-Crisis ((\text{Inv}_{0,sub1}))</td>
<td>0.0682 **</td>
<td>0.0269</td>
<td>2.53</td>
<td>0.0122</td>
</tr>
<tr>
<td></td>
<td>Crisis ((\text{Inv}_{0,sub2}))</td>
<td>0.0267 **</td>
<td>0.0132</td>
<td>2.02</td>
<td>0.0450</td>
</tr>
<tr>
<td></td>
<td>Post-Crisis ((\text{Inv}_{0,sub3}))</td>
<td>0.0796 ***</td>
<td>0.0269</td>
<td>2.96</td>
<td>0.0035</td>
</tr>
<tr>
<td>Weight Given to Lagged Investment ((\text{Inv}_1))</td>
<td>Pre-Crisis ((\text{Inv}_{1,sub1}))</td>
<td>0.9508 ***</td>
<td>0.0187</td>
<td>50.85</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td></td>
<td>Crisis ((\text{Inv}_{1,sub2}))</td>
<td>0.9460 ***</td>
<td>0.0184</td>
<td>51.39</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td></td>
<td>Post-Crisis ((\text{Inv}_{1,sub3}))</td>
<td>0.8742 ***</td>
<td>0.0441</td>
<td>19.82</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

J-Statistic for the test of overidentifying restrictions: 66.9335

P-value of chi-square with 108 - 21 = 87 degrees of freedom: 0.9458

\(sub1, sub2, sub3\) denote pre-crisis, crisis, and post-crisis periods, respectively.

***, **, * indicate significance at the 1%, 5%, and 10% confidence levels, respectively.

+ The estimated value is below (above) the lower (upper) bound. Hence, the lower (upper) bound value is assigned to this parameter. The standard error is not reported.
Table 8: Wald Statistics for Structural Break Tests

This table reports the Wald statistics and the p-values for the structural break tests. Particularly, the tests for the differences in the values of the parameters measuring the severity of moral hazard problems are conducted for pre-crisis and post-crisis periods, pre-crisis and crisis periods, as well as crisis and post-crisis periods. The tests are also undertaken for each parameter as well as all parameters in combination. The level of government subsidies (if positive) or taxes (if negative) (n) measures the severity of the moral hazard problem at the corporate level. The interest rate sensitivity to the aggregate level of banks’ net foreign borrowing ($\psi_1$) and the expected exchange rate deviation from the uncovered interest rate parity (UIP) measure the degree of the moral hazard problems at the international level. The related parameters, which may change over time, include the interest rate sensitivity to the world interest rate ($\psi_0$), the weight given to contemporary investment predicted by the model (Inv0), and the weight given to lagged investment in the investment equation (Inv1). The tests for the differences in the loan loss provisioning ratio ($\psi$), which measures the severity of the moral hazard problem at the bank level, cannot be conducted since the lower bound and upper bound values are assigned to the loan loss provisioning ratios for the crisis and post-crisis periods, respectively.

<table>
<thead>
<tr>
<th>Test</th>
<th>Wald Statistic</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-Crisis VS. Post-Crisis Periods</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$n_{\text{sub1}} = n_{\text{sub3}}$</td>
<td>279.19 ***</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>$\psi_{0,\text{sub1}} = \psi_{0,\text{sub3}}$</td>
<td>18.21 ***</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>$\psi_{1,\text{sub1}} = \psi_{1,\text{sub3}}$</td>
<td>3.36 *</td>
<td>0.0669</td>
</tr>
<tr>
<td>$P_{e,\text{sub1}} = P_{e,\text{sub3}}$</td>
<td>6.80 ***</td>
<td>0.0091</td>
</tr>
<tr>
<td>$\text{Inv}<em>{0,\text{sub1}} = \text{Inv}</em>{0,\text{sub3}}$</td>
<td>0.09</td>
<td>0.7641</td>
</tr>
<tr>
<td>$\text{Inv}<em>{1,\text{sub1}} = \text{Inv}</em>{1,\text{sub3}}$</td>
<td>2.56</td>
<td>0.1097</td>
</tr>
<tr>
<td>All parameters$<em>{\text{sub1}}$ = All parameters$</em>{\text{sub3}}$</td>
<td>313.56 ***</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td><strong>Pre-Crisis VS. Crisis Periods</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$n_{\text{sub1}} = n_{\text{sub2}}$</td>
<td>23.42 ***</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>$\psi_{0,\text{sub1}} = \psi_{0,\text{sub2}}$</td>
<td>26.35 ***</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>$\psi_{1,\text{sub1}} = \psi_{1,\text{sub2}}$</td>
<td>2.28</td>
<td>0.1312</td>
</tr>
<tr>
<td>$P_{e,\text{sub1}} = P_{e,\text{sub2}}$</td>
<td>35.12 ***</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>$\text{Inv}<em>{0,\text{sub1}} = \text{Inv}</em>{0,\text{sub2}}$</td>
<td>1.92</td>
<td>0.1663</td>
</tr>
<tr>
<td>$\text{Inv}<em>{1,\text{sub1}} = \text{Inv}</em>{1,\text{sub2}}$</td>
<td>0.03</td>
<td>0.8549</td>
</tr>
<tr>
<td>All parameters$<em>{\text{sub1}}$ = All parameters$</em>{\text{sub2}}$</td>
<td>128.01 ***</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td><strong>Crisis VS. Post-Crisis Periods</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$n_{\text{sub2}} = n_{\text{sub3}}$</td>
<td>59.12 ***</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>$\psi_{0,\text{sub2}} = \psi_{0,\text{sub3}}$</td>
<td>1.97</td>
<td>0.1609</td>
</tr>
<tr>
<td>$\psi_{1,\text{sub2}} = \psi_{1,\text{sub3}}$</td>
<td>0.66</td>
<td>0.4181</td>
</tr>
<tr>
<td>$P_{e,\text{sub2}} = P_{e,\text{sub3}}$</td>
<td>18.66 ***</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>$\text{Inv}<em>{0,\text{sub2}} = \text{Inv}</em>{0,\text{sub3}}$</td>
<td>3.12 *</td>
<td>0.0774</td>
</tr>
<tr>
<td>$\text{Inv}<em>{1,\text{sub2}} = \text{Inv}</em>{1,\text{sub3}}$</td>
<td>2.26</td>
<td>0.1328</td>
</tr>
<tr>
<td>All parameters$<em>{\text{sub2}}$ = All parameters$</em>{\text{sub3}}$</td>
<td>120.67 ***</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

sub1, sub2, sub3 denote pre-crisis, crisis, and post-crisis periods, respectively.

***, **, * indicate significance at the 1%, 5%, and 10% confidence levels, respectively.
Table 9: Scenario Analysis

This table describes the scenarios used to assess the impact of changes in the quality of institutions and domestic policies to reduce moral hazard problems on the direct and indirect costs or benefits of international capital flows to an open economy like Thailand. The base scenario serves as the benchmark case where all estimated parameter values are set at the pre-crisis levels. In group A scenarios, only one aspect of the moral hazard problems is adjusted to the post-crisis level. In group B scenarios, the loan loss provisioning ratio ($\nu$), which measures the severity of the moral hazard problem at the bank level, and another aspect of the moral hazard problems are concurrently adjusted to the post-crisis levels. Scenario C1 uses different parameter values (as derived from the partial-sample GMM estimation) for each sub-period.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Description</th>
<th>Parameter Value Used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$\nu$</td>
</tr>
<tr>
<td>Base</td>
<td>All parameters at the pre-crisis values</td>
<td>0.5215</td>
</tr>
<tr>
<td>A1</td>
<td>↑ Loan loss provisioning ratio ($\nu_{sub1}$ is increased to $\nu_{sub3}$)</td>
<td>1</td>
</tr>
<tr>
<td>A2</td>
<td>↓ Government subsidies or taxes ($n_{sub1}$ is reduced to $n_{sub3}$)</td>
<td>0.5215</td>
</tr>
<tr>
<td>A3</td>
<td>↑ Interest rate sensitivity to the aggregate level of banks’ net foreign borrowing ($\Psi_{1,sub1}$ is increased to $\Psi_{1,sub3}$, and $\Psi_{0,sub1}$ is decreased to $\Psi_{0,sub3}$)</td>
<td>0.5215</td>
</tr>
<tr>
<td>A4</td>
<td>↓ FX rate deviation from the uncovered interest rate parity ($P_{\varepsilon,sub1}$ is reduced to $P_{\varepsilon,sub3}$)</td>
<td>0.5215</td>
</tr>
<tr>
<td>B1</td>
<td>Scenario A1 + A2</td>
<td>1</td>
</tr>
<tr>
<td>B2</td>
<td>Scenario A1 + A3</td>
<td>1</td>
</tr>
<tr>
<td>B3</td>
<td>Scenario A1 + A4</td>
<td>1</td>
</tr>
<tr>
<td>C1</td>
<td>Different parameter values for each sub-period</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Pre-crisis period</td>
<td>0.5215</td>
</tr>
<tr>
<td></td>
<td>- Crisis period</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>- Post-crisis period</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 10: Direct and Indirect Costs in Comparison with the Actual Data

This table reports the estimated direct and indirect costs or benefits of international capital flows under different moral hazard scenarios as described in Table 9. The actual direct and indirect costs or benefits to Thailand during January 1993 to June 2007 are also reported for comparison. The estimated direct costs are the sum of banks’ NPL losses transferred to the government while the actual direct costs are the sum of actual government lending to the Financial Institutions Development Funds (FIDF). The indirect costs or benefits are the effect of international capital flows and moral hazard problems on both the level and growth of output. The average annual output and the average annual output growth rate are annualized from monthly output and monthly output growth rate, respectively. % of output is based on the output of June 2007. ‘No Time Value’ means that the time value of money is not taken into account while ‘Future Value’ means that the amount in each period t is multiplied by (1+ average real deposit rate)^(T-t) to account for the time value of money, where T-t is the number of periods between period t and June 2007.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Direct Costs</th>
<th>Indirect Costs</th>
<th>Avg Output Growth Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amount (Million Baht) % of Output Avg Output</td>
<td>Amount (Million Baht) % of Output Avg Output</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No Time Value Future Value No Time Value Future Value</td>
<td>No Time Value Future Value No Time Value Future Value</td>
<td></td>
</tr>
<tr>
<td>Base: All parameters at the pre-crisis values</td>
<td>460,209 551,283 11.79% 14.12% 3,098,466 3,562,214</td>
<td>3.21%</td>
<td></td>
</tr>
<tr>
<td>A1. ↑ Loan loss provisioning ratio</td>
<td>- - 0% 0% 3,098,663 3,562,448</td>
<td>3.21%</td>
<td></td>
</tr>
<tr>
<td>A2. ↓ Government subsidies or taxes</td>
<td>427,912 512,985 11.64% 13.95% 2,988,725 3,441,424</td>
<td>2.79%</td>
<td></td>
</tr>
<tr>
<td>A3. ↑ Interest rate sensitivity to the aggregate level of banks' net foreign borrowing</td>
<td>197,656 238,267 5.06% 6.11% 3,102,801 3,567,176</td>
<td>3.21%</td>
<td></td>
</tr>
<tr>
<td>A4. ↓ FX rate deviation from the uncovered interest rate parity</td>
<td>461,023 552,054 11.81% 14.14% 3,098,473 3,562,222</td>
<td>3.21%</td>
<td></td>
</tr>
<tr>
<td>B1. Scenario A1 + A2</td>
<td>- - 0% 0% 2,988,930 3,441,666</td>
<td>2.79%</td>
<td></td>
</tr>
<tr>
<td>B2. Scenario A1 + A3</td>
<td>- - 0% 0% 3,102,585 3,566,944</td>
<td>3.21%</td>
<td></td>
</tr>
<tr>
<td>B3. Scenario A1 + A4</td>
<td>- - 0% 0% 3,098,663 3,562,448</td>
<td>3.21%</td>
<td></td>
</tr>
<tr>
<td>C1. Different parameter values for each sub-period</td>
<td>596,703 714,076 18.02% 21.56% 2,919,919 3,372,412 2.06%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actual Data</td>
<td>1,274,561 1,433,792 32.69% 36.78% 2,935,264 3,369,606 4.40%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 11: Direct, Indirect and Total Costs Relative to the Base Scenario

This table reports the estimated direct, indirect, and total costs or benefits of international capital flows under different moral hazard scenarios relative to the base scenario. The relative direct costs are the difference between the sum of the bailout costs in each scenario and the sum of the bailout costs in the base scenario. The relative indirect costs (-) or benefits (+) are the difference between the sum of the output in each scenario and the sum of the output in the base scenario. The sum of the output \( \approx \) The average annual output in table 10 * 173 periods /12.

The relative total costs are the sum of the relative direct costs and the relative indirect costs. 'No Time Value' means that the time value of money is not taken into account while 'Future Value' means that the amount in each period \( t \) is multiplied by \((1+ \text{average real deposit rate})^{(T-t)}\) to account for the time value of money, where \( T-t \) is the number of periods between period \( t \) and June 2007.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Benefits (+) or Costs (-) Relative to the Base Case</th>
<th>Direct Costs</th>
<th>Indirect Costs</th>
<th>Total Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Time Value</td>
<td>Future Value</td>
<td>No Time Value</td>
<td>Future Value</td>
</tr>
<tr>
<td>A1. ↑ Loan loss provisioning ratio</td>
<td>460,209</td>
<td>551,283</td>
<td>2,843</td>
<td>3,375</td>
</tr>
<tr>
<td>A2. ↓ Government subsidies or ↑ taxes</td>
<td>32,296</td>
<td>38,298</td>
<td>(1,582,088)</td>
<td>(1,741,385)</td>
</tr>
<tr>
<td>A3. ↑ Interest rate sensitivity to the aggregate level of banks' net foreign borrowing</td>
<td>262,552</td>
<td>313,016</td>
<td>62,497</td>
<td>71,533</td>
</tr>
<tr>
<td>A4. ↓ FX rate deviation from the uncovered interest rate parity</td>
<td>(814)</td>
<td>(771)</td>
<td>101</td>
<td>121</td>
</tr>
<tr>
<td>B1. Scenario A1 + A2</td>
<td>460,209</td>
<td>551,283</td>
<td>(1,579,146)</td>
<td>(1,737,893)</td>
</tr>
<tr>
<td>B3. Scenario A1 + A4</td>
<td>460,209</td>
<td>551,283</td>
<td>2,843</td>
<td>3,375</td>
</tr>
<tr>
<td>C1. Different parameter values for each sub-period</td>
<td>(136,495)</td>
<td>(162,792)</td>
<td>(2,574,049)</td>
<td>(2,736,305)</td>
</tr>
</tbody>
</table>

Unit: Million Baht