# Estimating the Impact of a Monetary Shock on Small Open Economy

Thailand During the Asian Crisis 1997

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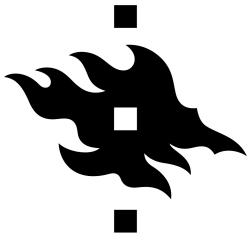

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**Abstract**

In this thesis, I analyze the causes and consequences of the Asian Crisis 1997 and simulate it with Dynare. The model includes financial accelerator mechanism, which in part explains the dynamics and the magnitude of the crisis via balance sheet effects. I find that the major components of the crisis were highly similar to other crisis that had happened in other emerging economies: High levels of foreign-currency denominated debt, unsound financial regulation, and fixed exchange rates with skewed valuation. Even though this simulation do not specifically incorporated different exchange rate regimes into the simulation, the previous literature draw a clear conclusion that flexible exchange rates lessen the shock's effects on the economy.

Thailand, as well as other ASEAN-countries during the crisis, faced severe economic contraction as well as changes in political landscape: Due to the crisis, Thailand's GDP contracted over 10 percent, the country lost almost a million jobs, and the stock exchange index fell 75 percent. In addition, the country underwent riots, resignation of ministers, and several political changes towards more democratic institutions, even though faced some backlash and re-entry of authoritarian figures later. As the crisis worsened, IMF collected a large rescue package that was given to ASEAN-countries with preconditioned austerity policies.

The simulation with recalibrated parameter-values seems to be relatively accurate. The dynamics and the impact of the crisis is captured realistically with correct magnitudes. The financial accelerator mechanism accounts a large part of the shock's impact on investment and companies net worth, but do not account much on overall decline in output.

Tässä tutkielmassa analysoin vuoden 1997 Aasian talouskriisin syitä ja seurauksia, sekä simuloin kriisin Dynaren avulla. Malli sisältää niin sanotun rahoitusakseleraattorin, joka osaltaan selittää kriisin dynamiikkaa ja voimakkuutta taseissa tapahtuvien muutosten kautta. Aasian kriisin keskeiset taustatekijät eivät olleet epätavallisia, vaan muissakin kehittyvien talouksien kriiseissä on havaittu samoja riskitekijöitä. Näitä ovat muun muassa korkea toisessa valuutassa otettu velan määrä, huonosti järjestetty rahoitusmarkkinoiden sääntely sekä kiinteät valuuttakurssit epäluonnollisella hinnoittelulla. Vaikka tämän tutkielman simulaatio ei erikseen sisällä eri valuuttakurssijärjestelmien vertailua, on aiempien tutkimusten johtopäätös selkeä: Kelluva valuuttakurssi lieventää yllättävän shokin vaikutuksia talouteen.

Thaimaa, kuten useat muut ASEAN-maat, kokivat merkittävän taantuman kriisin puhjetessa. Kriisillä oli myös vaikutuksia alueen politiikkaan. Thaimaan BKT supistui yli 10 prosenttia, maa menetti lähes miljoona työpaikkaa ja pörssin yleisindeksi putosi 75 prosenttia. Näiden lisäksi maassa puhkesi laajat mellakat ja muutoksia poliittisessa johdossa. Thaimaa koki merkittäviä institutionaalisia muutoksia, jotka edistivät hiljalleen autoritäärisen alueen kehittymistä kohti läpinäkyvämpää ja laajempaa demokratiaa. Kriisin syvetessä IMF järjesti merkittävän apupaketin, jonka avulla ASEAN-maat pystyivät nousemaan nopeammin lamasta. Paketin ehtoina oli useita tiukennuksia talous- ja veropolitiikan harjoittamiseen.

Tutkielman simulaatio on suhteellisen tarkka, kun mallin parametrin on kalibroitu vastaamaan Thaimaan kokemusta kriisistä: Shokin vaikutukset eri muuttujiin ovat muodoltaan ja voimakkuudeltaan realistiset. Mallin keskiössä oleva rahoitusakseleraattori-mekanismi selittää suuren osan shokin vaikutuksesta investointeihin ja yritysten nettoarvoon, mutta ei ole merkittävä selittävä tekijä BKT:n laskulle.

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# 1 Introduction

Asian Financial Crisis began in July 1997 in Thailand. It spread throughout the South-East Asia quickly and affected countries in the region profusely. Economists have studied the occurrence and its causes and consequences in order to understand it better. In addition, the point of interest has also been the crisis' similarities to other crisis in emerging economies. Given the extensive literature, modelling, and knowledge today, the key factors that increase the risks for crises as well as the dynamics on how crises often spread in the economy are well known.

The main purpose of this thesis is answer following questions: How did the widely spread monetary shock in Asia in 1997, later known as the Asian Financial Crisis, affect a small open economy, the Thailand's economy? What caused the crisis? How did the economy get back to its natural economic equilibrium? I am conducting a simulation of the crisis using Christensen & Dip (2007) model and calibrating the parameters in accordance with Thailand's experience. The model includes financial accelerator mechanism, which plays a central role in explaining the crisis and its dynamics via balance sheet effects. Similar models has been used extensively when simulating crisis in emerging economies.

The key papers for this thesis are Gertler, Gilchrist & Natalucci (2007) (Gertler et al. onwards), and the Christensen & Dip (2007). Both models are highly similar and include the financial accelerator mechanism. The financial accelerator mechanism is explained in detail in the literature review -section. Gertler et al (2007) constructed and estimated a model on Asian Crisis in accordance with Korea's experience. Their model was accurate and the financial accelerator mechanism played an important role: It explained half of the decline in economic activity and output. Christensen & Dip (2007) simulated similar model and calibrated it with post-1979 US data. They tested the significance of the financial accelerator mechanism in explaining crisis. They align with Gertler et al. (2007) by concluding that the results provide evidence in favour of including the mechanism in the model. The model without the mechanism was statistically rejected. With parameter-values from Thailand's central bank and relevant studies, I am expecting that the model is able to account relatively well for Thailand's experience

in this thesis. It is expected that the financial accelerator mechanism and balance sheet effects play a central role in explaining the impact of crisis in this simulation as well.

Hence, the points of interest in this thesis are also the model's accuracy regarding to the effects of the shock to key economic variables, such as GDP, consumption, inflation, and net worth of the companies, as well as the investigation of the extent of balance sheet effects and financial accelerator mechanism to overall decline in the economy. By analyzing and modeling the occurrence carefully, the purpose is to understand monetary shocks, their effects, and possible solutions better.

The impact of 1997 crisis was significant for ASEAN-countries[1]. According to Berg (1999), the recession was the deepest in the area since World War II. Thailand, South-Korea and Indonesia were hit the hardest. Naturally, the crisis also had several political consequences in ASEAN-countries which expanded to have global implications as well. For example in Indonesia, the president and the military leader Suharto had to resign after being forced to apply a emergency loan from IMF, which further revealed the corrupted state of the government and worsened riots in the country. In addition, the crisis and IMF's intervention caused a rise in anti-Western sentiment across ASEAN-countries. Especially George Soros, an Hungarian-American investor and hedge-fund manager, was seen to be one of the main players initiating the crisis.

As the latest COVID-19 has shown, an unanticipated shock to an economy can still hit quickly with severe consequences. Hence, it is important to have a profound understanding on the dynamics and factors of crises in order to dampen them down fast.

[1]ASEAN, abbreviation from "Association of Southeast Asian Nations", is a intergovernmental organization in South-East Asia that comprises ten countries. It focuses on regional cooperation and facilitating economic, social and political integration and growth.

# 2 Literature Review

The literature review -section focuses on five topics: Financial crises on small open economies, relevant modeling and framework, financial accelerator mechanism, the causes and effects of the Asian Crisis 1997 on Thailand's economy, and the political consequences of the crisis. The topics are discussed separately, but some level of overlapping is present. For example, the first part's discussion on financial crises' common factors are sought to be described pragmatically, connecting them primarily to Thailand and the Asian Crisis.

Before proceeding further, it is worthwhile to point out that different crises often have slightly different causes and effects as the timing and conditions vary. Therefore, one model or explanation is likely unable to explain thoroughly the questions and phenomena of interest in general, even though the core principles, actors and rigidities of the models are similar, and the crises often share common features. The collection of papers discussed in the following chapters is not all inclusive but rather a relatively compact review of the essential papers and views for this research.

## 2.1 Financial Crises on Small Open Economies

Feldstein (2003) delivers a profound analysis on the factors that are related to financial crises and economic downturn in emerging economies. He emphasizes that the type of exchange rate regime, occurring debt deflation, growing current account deficit, levels of foreign exchange liabilities and reserves, state and quality of financial supervision, and the level of restrictions on capital account convertibility affect the likelihood and severity of crises in emerging market economies.

He connects the fixed interest rate, current account deficit, and debt deflation together by arguing that growing current account deficit caused by fixed exchange rate was, for example, the primary cause for Asian and Mexican Crises in 1990s. In Thailand, the initially stable and trusted baht-dollar peg encouraged companies and investors to borrow relatively cheap dollars. The country had high interest rates, and the companies and investors were told by the Thai government that the exchange rate would remain

unchanged. Eventually, the current account deficit grew to unsustainable levels.

At first, the foreign lenders were induced (by high interest rates) to continue financing the continuously growing current account deficit, but eventually the risks and fear of devaluation grew too high. As the foreign lenders were no longer willing to extend loans and provide additional financing, they started to draw their money out. In addition, as the domestic residents began to convert their funds and the trust towards domestic currency weakened further, the economic decline and devaluation of currency became more inevitable. The government tried to protect the currency with the usage of foreign exchange reserves and forward market moves, but eventually had no other choice than let the baht float. Moreover, as baht devalued, Thailand faced the consequences of debt deflation and deteriorating balance sheets as large amounts of the debt were denominated in dollars. Feldstein (2003) points out that Thailand was not unusual in "experiencing the ravages of debt deflation" when baht devalued. Analyzes of other crises in emerging economies have also shown that high levels of foreign currency -denominated private debt, such as the debt denominated in dollars, is risky for the economy in a long run. (Feldstein 2003.)

Hence, corporations and countries may avoid high levels of foreign currency-denominated debt in order to reduce riskiness and harmful consequences of the currency's sudden devaluation. In a national level, large amounts of short-term foreign currency liabilities compared to the country's foreign exchange reserves increases the probability for crisis. In practice, this problem can be mainly avoided by sound financial supervision and regulating the amount of additional foreign currency liabilities relative to the country's foreign currency reserves. However, countries may be reluctant to hold large foreign currency reserves as the opportunity cost for holding relatively low yielding reserves, like dollar-denominated ones, is high. Adopting floating exchange rate initially and thereby avoiding a highly overvalued currency would reduce the risk for currency crisis. (Feldstein 2003.)

The rest of the factors presented by Feldstein (2003) were the restrictions on the capital account convertibility[2] and the state of financial supervision.

[2]Restrictions for foreigners and local residents to buy and sell currency for portfolio

By establishing restrictions on capital account convertibility, an economy can reduce possibly volatile capital flows and stabilize domestic financial markets. However, economies also benefits from capital inflows and therefore restrictions may slow down the investments and growth. Feldstein (2003) presents an example of a compromise arrangement which was conducted in Chile. In Chile, short-term capital inflows were taxed by requiring the money to be held in the country for a period of time without paid interest. This kind of an arrangement could provide most of the advantages of foreign capital inflows and reduce the excess volatility of speculative behaviour.

However, Chilean-type restrictions on capital account convertibility have caused skepticism among economists. For example, Krugman (1999) argues that the short-term loans are not the only possible sources of capital flight. He points that even if all of the foreign debt is long-term, it is unlikely to actually protect the country from a financial crisis. If a crisis is expected to occur, the holders of domestic short-term debt will refuse to roll it over. This leads to devaluing currency and can cause bankrupts even though the foreign debts were long-term. Nevertheless, well working financial system unarguably need some financial supervision and healthy, but not too restrictive, regulation. For example, Lauridsen (1998), and Nidhiprabha (1998) stresses the lack of supervision and restrictions as highly important factors in Asian Crisis. Krugman (1999) also points out, regardless of his critique towards Chilean-type of restrictions, that some level and type of regulation are sound. Feldstein (2003) emphasizes that had the banking supervision in Thailand been more attentive, they would not have allowed the banks to accept so high levels of dollar-denominated debt, given the artificially fixed exchange rate in the country with inadequate levels of foreign currency reserves, and where the borrowers generally did not have the ability to earn dollars. As an option, banking supervision could mainly focus on the relative amount of foreign currency debt and worry about the type of the debt secondarily. (Feldstein 2003.)

Kaminsky & Reinhard (1999), Gertler et al. (2007) and Céspedes, Chang & Velasco (2000) also align with the statement regarding to the connection between the chosen exchange rate regime and the severity of crisis. They conclude that the areas with fixed exchange rate perform the worst. Gertler

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investments

et al. (2007) simulated counterfactual scenarios where the Korean economy during the Asian Crisis 1997 would have had flexible and fixed exchange rates. The scenario with flexible exchange rates did recover the fastest from the shock and the one with fixed exchange rates performed the worst.

Kaminsky & Reinhard (1999) studied 20 countries from 1970 to mid-1995, which encompassed 76 currency crises and 26 banking crises, and found a connection between the need of defending the pegged exchange rate and the probability for severe financial strain. They also found that the peak of a banking crisis often comes after the currency crashes, i.e. in the case of fixed exchange regime, when the central bank is forced to let the currency float freely. This suggests that high interest rates that were set to defend the exchange rate exacerbated existing problems or created new ones, such as declined investments. Hence, the collapse of a currency can initially worsen the banking crisis and activate a vicious spiral via the debt deflation, declined net worth of companies and reduced investments. However, as Gertler et al. (2007) demonstrated, staying with fixed exchange regime can be more harmful in the long run, even though the devaluation of the currency can hurt the economy at first. The connection between pegged exchange rate and financial strains is shown to be existing long: For example, Eichengreen (1992) showed that the countries which stayed on the gold standard during the Great Depression suffered more severe economic and financial distress than the ones who let their currency float earlier.

However, countries do have some rational grounding for initially adopting fixed exchange rates, given the extensive literature about their riskiness. Feldstein (2003) analyzes the pros and cons of the policy. He points out that a fixed interest rates help the country to achieve price stability by acting as a nominal anchor. By eliminating excess volatility in the economy, foreign investors are more likely to bring capital and in overall, doing business is more convenient in a less unstable environment. However, if the situation in the economy changes through time and the currency becomes highly overvalued, the country with fixed exchange rates faces either high interest rates, extensive usage of foreign currency reserves or abandoning the peg, or possibly all of them sequentially. This chain of events happened in Thailand, as described earlier. Instead, if a country adopts floating exchange rates, a growing current account deficit will generally be self-correcting as the currency devalues in the markets. With devaluing currency, country's export

flourishes but the costs from foreign currency-denominated debt rises. However, a floating currency can cause unnecessary volatility and slow down the economic growth, especially if the country's economy is fragile. Devereux, Lane & Xu (2006) point out that price levels in emerging markets are in general more sensitive to fluctuations in exchange rates compared to developed countries. An exchange rate shock in emerging market economies often raises aggregate inflation much faster, which makes the choosing of the right monetary policy vital. Therefore, several emerging countries with underdeveloped financial supervision and monetary system aim for stability and adopt fixed exchange rates despite the risks. (Feldstein 2003.)

## 2.2 Modeling and Framework

There are similarities as well as differences between the models, approaches, and conclusions used in different papers on financial crises and emerging markets. Krugman (1999) points out, that there are roughly three "generations" of models regarding to the financial crises in emerging economies. "First generation" papers such as Krugman (1979) and Flood & Garber (1984) emphasize that the crises are products of budget deficits: the need of the government for seigniorage to cover the budget deficit eventually leads to speculative attacks and the collapse of a fixed exchange rate. "Second generation" models, such as Obstfeld (1994), emphasize that pursuing expansionary monetary policy under fixed exchange rate lead to distrust towards the currency and causes pressure on interest rates, which eventually lead to economic decline.

Gertler et al. (2007), Céspedes, Chang & Velasco (2000) and Krugman (1999) belong to the "third generation" that emphasizes the roles of the exchange rate policy and the balance sheet effect. Aghion, Bacchetta & Banerjee (2000), Devereux, Lane & Xu (2006), and the model of this thesis, Christensen & Dip (2008), basically also belong to this same subset. Given the frictions in credit markets, these papers focus on how deteriorating borrowers' balance sheets enhance the financial accelerator mechanism that amplifies the financial distress further. The literature review regarding to the models and framework will be focusing on the "third generation" paper.

Céspedes, Chang & Velasco (2000) focused on the connections between exchange rates, balance sheets, and different economic variables in a small open economy. In the case of an external shock, domestic real interest rates

are higher under a peg, which have negative effects on current investments and future output. Surprisingly, they also argue that after an financial shock, the net worth of companies is lower under fixed exchange rates than in the case of flexible ones. The usual conclusion is often the contrary, especially with foreign currency -denominated debt; if a company has foreign currency -denominated debt, the overall reduction in the net worth after a shock is higher under flexible exchange rates as the relative share of debt increases due to devaluing domestic currency. Authors argue that some level of real depreciation occur under both exchange rate regimes, but in the case of fixed rates, the previously mentioned effect of higher fall in output eventually leads to a higher overall decline in net worth. However, the authors did not test their claim's validity with data, so the conclusion must be handled with caution. (Céspedes, Chang & Velasco 2000.)

Aghion, Bacchetta & Banerjee (2000) analyzed the optimal interest rate policy when a country faces a currency crisis. They conclude that increasing interest rates has ambiguous effect on firms which have foreign currency liabilities. On the one hand, increased domestic interest rates decrease the burden from the foreign currency liabilities but on the other hand, makes it more difficult to borrow money domestically. They conclude that if the proportion of foreign currency debt is not large or when the domestic investment and production are sensitive to changes in interest rates, it might not be optimal to implement tight monetary policy after a currency crisis. (Aghion, Bacchetta & Banerjee 2000.)

Devereux, Lane & Xu (2006) studied the effects of different monetary policies as the economy faces an exogenous shock. They compared three different monetary policy rules: a fixed exchange rule and two types of inflation targeting rules (CPI inflation targeting and more specified subset of the CPI inflation targeting which focused only on the prices of non-traded goods). They highlight the importance of the degree of exchange rate pass-through[3], With high pass-through, i.e. when the prices of goods response quickly to changes in exchange rates, fixed exchange rates and CPI inflation targeting stabilize inflation (and exchange rates), but at the expense of instability in the real economy. In the case of low exchange rate pass-through, the tradeoff between inflation volatility and output volatility is eliminated by

[3]i.e. the responsiveness of imported goods' prices to changes in exchange rates.

focusing on inflation targeting rules. Policy maker can target CPI inflation and allow high nominal exchange rate volatility in order to stabilize the real economy. Authors claim, that by following a price stability rule, the output volatility as well as inflation volatility are lower than under the fixed exchange rule. Therefore, the overall conclusion of Devereux, Lane & Xu (2006) aligns with the other papers: Policy makers should set flexible exchange rates.

Chari, Kehoe & McGrattan (2003) emphasize that the actual reason for financial crises could be productivity shocks. They show that the efficiency and labor wedges account for a majority of the decline. However, the decline in productivity may be an outcome of the crisis, not a cause. Gertler et al. (2007) demonstrates that the most of the variation in measured productivity can be explained by appealing to endogenous utilization of capital. Within their model, declines in output and investment cause decrease in capital utilization, which leads to declined productivity. They use the electricity utilization as a proxy for capital utilization (which according to Burnside, Eichenbaum & Rebelo (1995) is a decent proxy) and showed that it fell sharply in tandem with measured productivity.

However, the majority of these papers discussed deliver qualitative results. The merit of Gertler's et al. (2007) paper from the perspective of this research is the development of quantitative model and actual measurements on the impacts of the occurred phenomenon. Hence, some of the parameter-values of interest are taken from Gertler et al (2007). Christiano, Gust & Roldos (2002) also conducted a quantitative analysis. They focused on the effects of an interest rate cut during a crisis, i.e. monetary transmission, and analyzed the conditions under which the cut has positive effects on the economy. They argue that when the model includes frictions in adjusting the level of output and in the rate at which the output can be used in other parts of the economy, the cut in the interest rate will lead to declined employment and output. In the scenario where the frictions are excluded from the model, a cut promotes economic upswing.

However, Christiano, Gust & Roldos (2002) did not test their model's performance with real data. Therefore, Gertler's et al. (2007) which has been demonstrated to match an actual crisis, provides more valuable and practical information for this research. In addition, the Korean economy (which was under their investigation), was relatively similar to Thailand's

economy and the crisis of interest was the same. Both countries had fixed exchange rates but were forced to abandon the peg and let the currency float after the crisis hit the economy. However, the economic conditions between Korea and Thailand are not perfectly alike. Therefore, the model will be calibrated somewhat differently with new parameter-values.

Christensen & Dip (2007) estimated their model with post-1979 US data. The model is based on Bernanke et al (1999). Even though US is not considered as an emerging economy, the model is de facto highly similar to the ones. The main reasons for choosing their model as a basis for this thesis was that the model was tested, calibrated, and demonstrated to be accurate. In addition, the Dynare-codes for their model can be found from the Macroeconomic Model Data Base[4]. For practical purposes, it is sound to begin with initially working coding and rewrite, -organize, and calibrate it afterwards.

The core framework of their model is similar to Céspedes, Chang & Velasco (2000) and Gertler et al. (2007). For the sake of clarity and transparency, it might be worthwhile to point out that Bernanke's, Gertler's & Gilchrist's (1999) financial accelerator framework is based on earlier works of Kiyotaki & Moore (1997) and Bernanke & Gertler (1989). The mechanism connects the borrower's balance sheet to the terms of credit and to the demand for capital. It magnifies the effects of a shock and, for example, according to Gertler et al. (2007), explained about a half of the decline in economic activity in Korea in 1997.

## 2.3 Financial Accelerator Mechanism

Korinek (2011) and Bernanke & Gertler (1989) explains the dynamics of the financial accelerator mechanism. The mechanism initiates from the connection between the financial markets and the real economy as firms need external financing for their investments and growth. Firm's ability to borrow depends mainly on its net worth and in the case of international financing, also on country-level risk-factors. Given the asymmetric information in financial markets, especially on international level, the lenders are likely to

[4]www.macromodelbase.com

have imperfect information about the borrower's true solvency. Therefore, lenders often require borrowers to set forth their ability to pay the loan back, usually in a form of collateralized assets, as well as with some level of additional costs to cover the risk premium. In the case when the value of these collateralized assets fall and balance sheets deteriorate, firms net worth decline and their ability for additional financing gets more difficult and expensive. Decreased economic activity cuts the asset prices down and in the case of having foreign currency liabilities, devaluing currency increases the debt burden, deteriorating the balance sheets further. This cyclical process of falling asset prices, deteriorating balance sheets, tightening financing conditions and declining economic activity is called the financial accelerator. It explains in part, how a small change in financial markets can eventually have a large impact on the economy. According to Kiyotaki & Moore (1997), this dynamic interaction between asset prices in borrowers' balance sheets and credit limits turns out to be the transmission mechanism by which the effects of these shocks are amplified. (Korinek 2011.)

Bernanke, Gertler & Gilchrist (1996) emphasize that the financial accelerator is based on three assumptions that are also robust to actual findings. Firstly, external finance is more expensive than internal one, unless the external finance is fully collateralized. This higher cost of external finance reflects the agency costs of lending that arises from asymmetric information. Secondly, the external finance premium is inversely correlated with the borrower's net worth. This assumption is analysed more profoundly soon. The third assumption is that a fall in the borrower's net worth reduces the borrower's spending, production and the ability to get external financing. The third point amplifies the financial accelerator's effects: as a negative shock to the economy reduces the net worth of firms (borrowers from the financial perspective), the spending and production effects are also larger. (Bernanke, Gertler & Gilchrist 1996.)

The second assumption that borrower's net worth and the agency costs of investment are inversely correlated forms the basis for balance sheet effects: High or growing borrower net worth, i.e. "credit-worthiness", reduces the agency costs and risk premia of financing investments and vice versa; declining borrower's net worth, as in the times of debt-deflation, can cause fluctuations, increased agency costs and declined investments. Hence, borrower net worth

is often higher when the economy does well and the agency costs decline[5]. The inverse correlation has another important implication: exogenous shocks to borrower net worth that occur independently of economy-wide output can initiate real fluctuations. Gertler (1998) pointed out that deteriorating credit-market conditions, such as sharp increases in bankruptcies and insolvencies, rising levels of real debt, declining asset prices and bank failures, are hence not only the consequences of a declining economy, but can actually be the central factors that initially depress the economy. (Bernanke & Gertler 1989.)

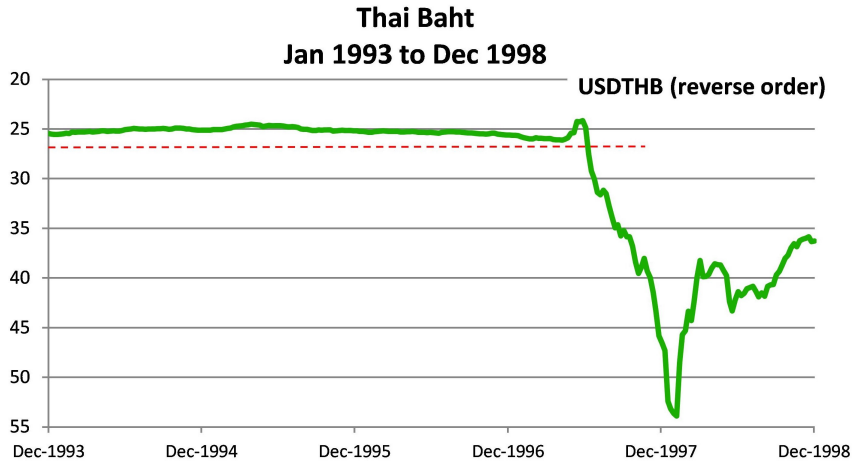
## 2.4 The Asian Crisis 1997 — Thailand's Economy

The Asian Crisis fully began in July 1997. Thailand's currency baht was pegged competitively to US Dollars (25 bath to a dollar) and faced severe speculative attack (Feldstein 2003). Eventually, as the Thai government ran out of foreign currency reserves which were used to defend the currency, bath was let to float on 2nd of July. This caused significant devaluation of the currency, large-scale distrust and chain reaction of events, which culminated into a region-wide crisis (Khan 2004, 2). The crisis spread around the Asia, affecting Indonesia, South-Korea, Malesia, Philippines, and Hong Kong. After massive interventions and new policies, the countries were able to recover. According to Krugman (1998), the crisis and its impact were largely unanticipated, even though the growing levels of current account deficits in Southeast Asia as well as the countries' weak immunity to financial crises were known.

Lauridsen (1998) and Corsetti, Pesenti & Roubini (1999) deliver analyses on the causes and consequences of the crisis on Thailand. They emphasize that the initial reasons for the crisis were the growing current account deficit and careless lending/borrowing under fixed exchange rate regime, combined with the accumulation of nonperforming loans in the financial sector. According to Corsetti, Pesenti & Roubini (1999), Thailand's current account deficit was one of the highest in the region: over 6 percent of GDP virtually in every year in 1990s, approaching 9 percent in 1995 and 1996. In addition to the fixed exchange rate, Thailand had relatively high domestic interest rates. For example, the domestic borrowers were able to borrow money off-shore 11

[5]Net worth is procyclical, so agency costs raise during recession

Figure 1: Exchange rate between US Dollar and Thai Baht




with 5-8 percent, while the domestic rates were over 10 percent.(Lauridsen 1998.)

As a result, foreign investments flowed to Thailand at increasing pace and led to significant increases in external, foreign currency debt. In the early 1990s, the investments per GDP -ratio was averaging over 40 percent, compared to the 25-30 percent ratios a decade earlier. From the beginning of 1990s to the spring of 1997, the external debt rose from 40$ billion to 80$ billion and exceeded 90$ billion in the autumn 1997. In addition, the total outstanding debt per GDP -ratio increased from 34 percent to 51. According to Nidhiprabha (1998), almost 70 percent of total foreign debt was private debt and large proportion of it was short-term. Therefore, the unexpected and sharp devaluation of the baht increased the real levels of debt significantly in the firms where the debt was denominated in dollars.(Lauridsen 1998.)

The speculative bubble in Thailand grew as the investors and companies did not have enough places to invest money soundly. As a result, a large proportion of the new investments were non-productive. A significant amount of money flowed to the real estate sector and inflated prices. According to Lauridsen (1998), the number of new houses built in 1992-1996 was double the estimate in the national plan. Hence, the supply of housing was much higher than demand; vacancy rates of residential and office apartments were

25-30 and 14 percent, respectively. However, the land values in Bangkok kept growing and eventually, surpassed even the ones of San Francisco. Thurow (1998) described the peculiarity of the grossly inflated prices by pointing out that "a city where per capita productivity is less than one tenth that of San Francisco, should not have higher land values".

Nidhiprabha (1998) analyzes the effect of financial liberation to crisis. In Thailand, gradual financial liberation was already undertaken in the early 1990s. Prematurely and without sound financial institutions, the Thai government began to free the financial sector. This was conducted by calling on the market mechanism to level the interest rates and by forming several financial institutions in order to acquire foreign funds from international financial markets. Feldstein (2003) also highlight the effects of relatively premature liberalization policies by pointing out that the Anand's government's decision in 1992 to establish the Bangkok International Banking Facilities (BIBF) made it possible for banks to borrow foreign currencies abundantly abroad and lend the money in Thailand. However, the process of gradual financial liberalization ended in 1995, as the economy became overheated and first alarming signals from high current account deficit arise. Due to premature liberalization, Thailand undertook too much off-shore borrowing. By 1996, the BIBF's lending to domestic companies amounted to almost twice the size of the monetary base. Thus, the vulnerability of Thai economy was already high before the July 1997. In fact, the currency attack against baht had already began in July 1996. (Nidhiprabha 1998.)

Thai economy began to slow down in 1996; GDP's growth rate was the lowest in a decade and due to the appreciated value of the baht, the export declined. The baht appreciated because Dollar, to which the baht was pegged, had appreciated. This sudden slump in exports accelerated the currency attacks, which led to high interbank rates and the usage of foreign currency reserves. In the spot foreign exchange markets, the Bank of Thailand used over 23 billion US$ of its reserves in order to defend the baht before giving up. Baht lost half of its value, settling around 50 baht to a dollar -exchange rate. In addition, the Thailand's stock exchange index fell by 35 percent in 1996 and plunged further by 56 percent in 1997. (Nidhiprabha 1998.)

Before the crisis, Thailand had low unemployment rates. In 1996. the

unemployment rate was just 1.1 percent, but rose to 3.4 percent in 1998. These rates still sounds relatively low in international standards, but nevertheless, the increase was over 200 percent. In absolute standards, almost a million jobs were lost. Moreover, the real wages fall almost 10 percent. (Bulletin on Asia-Pacific Perspectives (2002.)

After the crisis spread further, the IMF collected a rescue package that was the second largest bail-out in the history at the time. The total value of the package was over 17$ billion. Within the bail-out package, IMF demanded Thailand to adopt an austerity program and restructuring policies, where taxation were increased and fiscal spending cut significantly. The Bank of Thailand followed the requirements and in addition, suspended several debt-ridden finance companies. Eventually, the Thai economy as well as the South-East Asia as a whole began to recover from the crisis. In Thailand, interbank rate declined from 25 percent of 1997 to 8 percent in September 1998. The share of short term foreign currency debt in private sector declined and foreign direct investments rose to 3.3$ billion, compared to 1.8$ billion in the corresponding period in 1997. Eventually, Thailand's economy recovered and continued to develop rather quickly. The country was even able to pay its loans back to IMF four years ahead of schedule. (Feldstein 2002.)

## 2.5 Political Consequences of the Crisis

Haggard (2000) analyzes the political aspects and the consequences the crisis had on Asian countries in his book *The Political Economy of the Asian Financial Crisis*. He states that before crisis, the political systems in the region were mainly authoritarian or semi-democratic, led by nontransparent and somewhat corrupted governments. However, without democratic and fully inclusive economic institutions, the countries nevertheless experienced high levels of economic growth, investments, and even upward social mobility. Before the crisis, the political ideology and the way of conducting business in East, called as "Asian values"[6], did enjoy great support widely across the

[6]"Asian values" refers to a communitarian political ideology were loyalty towards authorities such as corporation or nation, and high work ethics were praised with the cost of individual freedom and self-determination. In the world of business, deals were based on trust and respect, not on actual signed contracts. The way of conducting business changed after the crisis into a more formal style with formal contracts.

South-East Asia. (Haggard 2000, 217-218.)

In national levels, several countries in the area faced political turmoil and riots. One of the main reason, in addition to the weakening economic conditions, was the somewhat unwanted help from IMF. Haggard (2000, 7) argues that the tight policy content of the IMF's programs created a lot of heat among the citizens, politicians, and even economists. Some economists claimed that IMF's actions in fact sent markets a signal on countries' weak conditions, rather than stabilizing the declining exchange rates and the economy. In addition, the kind of austerity program that was partly seen as a foreign interuption on Asian's businesses created some anti-Western sentiment across ASEAN-countries. These negative attitudes towards westerners grew stronger as Hungarian-American investor and hedge-fund manager George Soros was claimed to be one of the key players who initially started the speculative war against Asian currencies. Even Mahathir bin Mohamad, the prime minister of Malaysia, publicly accused Soros of speculating with currencies and ruining Malaysia's economy. In 2006, several years after the crisis, Mahathir bin Mohamad stated in the public press conference that Soros had been innocent[7].

Teehankee (2007) and MacIntyre (2001) analyze the political aspects of the crisis and the atmospheric transitions from more authoritarian regimes into more democratic ones, and vice versa. Mainly, the direction was towards further democratization but for example in Thailand, earlier pro-democracy uprising and institutional reforms faced backlash. The democratization that had at least somewhat reduced the long-lasting military interventionism in politics succeeded after the crisis, but led to a coup against Thaksin Shinawatra's goverment and the re-entry of military intervention several years later. Lauridsen (1998) also points out that the democratization was already occurring but advanced further after the crisis. He refers to the Constitution Drafting Assembly (CDA) which aimed towards fair election practices, eradicating "money politics", ensuring individual rights as well as in overall, increasing political accountability. However, Teehankee (2007) also argues that within the democratization, the crisis also led to a rise of traditional populist politicians, like Shinawatra in Thailand. Shinawatra was

[7]"Malaysian ex-premier Mahathir and billionaire Soros end feud". ABC News. Agence France-Presse. December 15, 2006.

able to register great electoral success in Thailand's rural areas by promising, for example, a million Baht for every village in Thailand.

In Thailand, the crisis led to a resignation of Prime Minister and General Chavalit Yongchaiyudh. Yongchaiyudh was the one initially announcing that baht would not be devalued. At 6th of November 1997, six month after devaluing and growing pressure from public as well as from the King, he stepped aside. MacIntyre (2001) points out that the pressure towards immobile, indecisive, and corrupted government was not unusual in Thailand's politics. He argues that also the governments led by Silapa-archa, Leekpai, and Choonhavan all had suffered from similar problems and pressures; afflicted by corruption scandals, built by unstable multiparty coalition arrangements, and implementing very little on economic growth and inclusive economic institutions. Teehankee (2007) also points out that the pressure came from international financial institutions and markets, referring especially to the levels of external finance premium rates and the trust towards Thai economy as a whole.

In addition to Thailand, Indonesia was another country that faced steep economic contraction and political changes. For example, Indonesian rupiah devalued from its pre-crisis level of 2600 rupiah to one dollar to over 14 000 rupiah to a dollar at January 1998. Indonesian GDP contracted 13.5 percent that year. After 32 years in policial power in Indonesia, the authoritarian president Suharto was forced the resignation by the rising turbulence[8] and displeased pro-democracy movement. During the planning of IMF's rescue package, the level of corruptness in Suharto's goverment became more apparent as the government's budget balance was examined more in detail. Eventually, the Vice President Bacharuddin Jusuf Habibie replaced him and replaced some controversial ministers from the cabinet.(Teehankee 2007.)

[8]1998 riots in Indonesia, also known as 1998 Tragedy, eventually caused more than thousand deaths and material damage worth over 3 trillion rupiah.

# 3 The Model

The crisis and its impact on the economy is captured with a simple New Keynesian small open economy model by Christensen & Dib (2007), where financial accelerator mechanism connects the borrowers' balance sheets' conditions to the terms of credit. The model is based on Bernanke, Gertler & Gilchrist (1999). Through the previously described dynamics, an unanticipated shock cause movements in asset prices, which provides the main source for overall economic decline. The model will be calibrated further to match the 1997 crisis.

The model consists households, three types of domestic firms, foreign sector and a government sector. Households work, save, and consume goods that are either produced domestically or exported from abroad. Domestic and exported goods are imperfect substitutes in this model.

Domestic economy includes three types of producers: entrepreneurs, capital producers, and retailers. Entrepreneurs produce wholesale goods and finance their acquisition of capital used in the production by borrowing from financial intermediaries. Due to the asymmetric information in the capital market, the demand for capital and its price (external financing premium) depends on entrepreneurs' financial position. In turn, capital producers build new capital. The last type of the firms are the retailers. They costlessly package wholesale goods supplied by the entrepreneurs in order to produce final output. Retail market is monopolistic with rigid prices. The role of the retail sector in this model is to provide the source of nominal price stickiness.

In addition, the model has an institution with authority on policies (central bank) that takes care of the monetary policy. The central bank adjusts the policy coefficients of output, inflation and money-growth rate according to its predetermined targets. The monetary policy is conducted via adjustments in nominal interest rate.

## 3.1 Households

Household's utility comes from three sources; consuming products and services, holding money balances, and having leisure time outside of work. Let $C_t$ be a composite of tradable consumption goods, $M_t/p_t$ real money balances, and $1 - h_t$ leisure, where $h_t$ denotes the labor supply. Consequently, the households expected utility function is given as:

$$U_0 = E_0 \sum_{t=0}^{\infty} \beta^t u(c_t, M_t/p_t, h_t) \tag{1}$$

where $\beta$ is the periodical discount factor ensuring that the logical time-preferences hold[9].

Represented as a single-period constant elasticity of substitution -utility function, the function takes the form:

$$u(\cdot) = \frac{\gamma e_t}{\gamma - 1} log\Big[c_t^{\frac{\gamma-1}{\gamma}} + b_t^{\frac{1}{\gamma}} \Big(\frac{M_t}{p_t}\Big)^{\frac{\gamma-1}{\gamma}}\Big] + \eta log(1 - h_t), \tag{2}$$

where $\gamma$ and $\eta$ are structural parameters[10] denoting the constant elasticity of substitution between consumption, leisure and money. $e_t$ and $b_t$ denote "taste" shocks for consumption and money-demand, respectively. The shocks follow first-order autoregressive processes, but are not specified further in this thesis as the shocks are not realised in the subsequent simulation.

Households assets at period $t$ consists nominal deposits $D_{t-1}$ and cash $M_t$. The deposits are exclusively held in financial intermediaries (banks). These deposits pay nominal interest rate, $R_t$, while cash held outside of banks yield no interest. Households receive salary by working in firms $W_t h_t$, where $W_t$ represents, for simplifying reasons, the economy-wide nominal wage. In addition, households receive divident payments $\Omega$ from retailer firms as well as (lump-sum) transfer $T_t$ from the monetary authority.

Households use their funds in accordance with their utility function, etc. to consumption $c_t$, and allocating the rest between cash $M_t$ and deposits $D_t$.

[9]The standard assumption is that consuming etc. now at time $t$ is in principle more valuable than conducting it later. This means that $0 < \beta < 1$.

[10]$\gamma$, $\eta > 0$.

Hence, the household's budget constraint is:

$$P_t c_t + M_t + D_t \leq W_t h_t + R_{t-1} D_{t-1} + M_{t-1} + T_t + \Omega_t. \tag{3}$$

### 3.1.1 Household optimization problem

Households maximize their expected lifetime utility functions subject to the single-period utility function and budget constraint:

$$\max_{c_t, M_t, h_t, D_t} U_0 = E_0 \sum_{t=0}^{\infty} \beta^t u(c_t, M_t/p_t, h_t) \tag{4}$$

s.t.

$$u(\cdot) = \frac{\gamma e_t}{\gamma - 1} log\Big[c_t^{\frac{\gamma-1}{\gamma}} + b_t^{\frac{1}{\gamma}} \Big(\frac{M_t}{p_t}\Big)^{\frac{\gamma-1}{\gamma}}\Big] + \eta log(1 - h_t) \tag{5}$$

and

$$P_t c_t + M_t + D_t \leq W_t h_t + R_{t-1} D_{t-1} + M_{t-1} + T_t + \Omega_t \tag{6}$$

### 3.1.2 First order conditions of households

The first-order conditions of the previously described household's maximization problem are[11]:

$$\lambda_t = \frac{e_t c_t^{-\frac{1}{\gamma}}}{c_t^{\frac{\gamma-1}{\gamma}} + b_t^{1/\gamma} m_t^{\frac{\gamma-1}{\gamma}}} \tag{7}$$

$$\lambda_t - \beta E_t\Big(\frac{\lambda_{t+1}}{\pi_{t+1}}\Big) = \frac{e_t b_t^{1/\gamma} m_t^{-1/\gamma}}{c_t^{\frac{\gamma-1}{\gamma}} + b_t^{1/\gamma} m_t^{\frac{\gamma-1}{\gamma}}} \tag{8}$$

$$\lambda_t w_t = \frac{\eta}{1 - h_t} \tag{9}$$

[11]Equation (8) describes the demand of money. These equations are later simplified by log-linearizing for Dynare-simulation. Due to practical purposes, the equations are the same as in Christensen & Dib (2007) which includes additional shocks not realizing in this thesis.

$$\frac{\lambda_t}{R_t} = \beta E_t\Big(\frac{\lambda_{t+1}}{\Pi_{t+1}}\Big), \tag{10}$$

where $\lambda$ is the Langrangian multiplier weighting the budget constraint and $w_t$, $m_t$, and $\pi_t$, denoting real wages, real money balances, and the inflation rate, respectively.

## 3.2 Firms

### 3.2.1 Capital Producers

Capital producers repair depreciated capital and construct new capital goods. They are assumed to operate under perfect competition. The production of new capital is subject to shock $x_t$, which affects the marginal efficiency of investments.

Capital producers' optimization problem is shown as:

$$\max_{i_t} E_t\Big[q_t x_t i_t - i_t - \frac{\chi}{2}\Big(\frac{i_t}{k_t} - \delta\Big)^2 k_t\Big], \tag{11}$$

where $i_t$ denotes the investment goods that are created by buying final goods from retailers in order to produce better investment goods, $x_t i_t$. These are combined with existing capital to produce new capital $k_{t+1}$. The last term, $\frac{\chi}{2}\Big(\frac{i_t}{k_t} - \delta\Big)^2 k_t$, describes the capital adjustment costs.

The first order condition of this problem is the Tobin's Q equation:

$$E_t\Big[q_t x_t - 1 - \chi\Big(\frac{i_t}{k_t} - \delta\Big)\Big] = 0 \tag{12}$$

It connects the price of capital to the marginal adjustment costs. These costs affect to the responsivity of investment to shocks and consequently to the price of capital. Given the nature of the financial accelerator mechanism, these costs play a central role in the model, affecting directly the entrepreneurs' net worth. If the costs are excluded, the price of capital is constant, i.e, $q_t = 1$

for all $t$.

Given the depreciation rate $\delta$ and the shock $\chi_t$, the capital stock evolves as:

$$k_{t+1} = \chi_t i_t + (1-\delta)k_t, \tag{13}$$

which simply means that the capital stock at $t+1$ is equal to the sum of new capital created and the rest of what is left at the capital stock at time $t$ after depreciation.

### 3.2.2 Entrepreneurs

Entrepreneurs are risk neutral operators who produce wholesale goods and need some external financing for it. Due to agency problem, the external financing is assumed to be more expensive than internal funds. Entrepreneurs are assumed to have finite expected horizon in a sense that they cannot accumulate enough funds to fully finance their own needs. Each entrepreneur survive with the probability $\upsilon$, which gives the expected horizon $\frac{1}{1-\upsilon}$. The amount of entrepreneurs is assumed to be stationary: new entrepreneurs replace the ones who exit.

Entrepreneur's production function is typical Cobb Douglas, combining labour $h_t$ and capital $k_t$:

$$Y_t = k_t^{\alpha}(A_t h_t)^{1-\alpha} \tag{14}$$

where the technology shock $A_t$ follows stationary AR(1)-process, affecting all entrepreneurs equally.

Their demand for capital depends on the expected marginal returns and costs. Hence, in the optimal capital demand function, the expected marginal return of capital is equal to the cost, i.e.:

$$E_t f_{t+1} = E_t\Big[\frac{z_{t+1} + (1-\delta)q_{t+1}}{q_t}\Big], \tag{15}$$

where $z_{t+1}$ denotes the marginal productivity of capital at $t+1$, $\delta$ being the capital depreciation rate, and $q_t$ being the real value of capital at the

period $t$.

The price of external finance premium $S(\cdot)$ depends on the entrepreneur's net worth $n_t$ and leverage ratio, i.e. $S(\cdot) = S(\frac{n_{t+1}}{q_t k_{t+1}})$. Entrepreneur's net worth evolves according to:

$$n_{t+1} = v\upsilon_t + (1-v)g_t, \tag{16}$$

where $\upsilon_t$ is the net worth of surviving entrepreneurs, $1-v$ is the proportion of new ones entering the economy and $g_t$ is a lump sum new entrepreneurs receive from the ones who depart the economy. The net worth of surviving entrepreneurs is calculated as:

$$\upsilon_t = \Big[f_t q_{t-1} k_t - E_{t-1} f_t (q_{t-1} k_t - n_t)\Big], \tag{17}$$

where the first term is the ex post return on capital held and the latter, $(E_{t-1} f_t)(\cdot)$ denotes the cost of borrowing in previous period $t-1$.

The premium is inversely correlated with entrepreneur's net worth. For simplicity, all entrepreneurs choose the same leverage ratio. Consequently, the external finance premium depends only on the aggregate leverage ratio and not on entrepreneur-specific factors. As their relative indebtedness rises, the loand becomes more risky and the cost of external capital increases. By incorporating the external finance premium into the function, the optimality condition takes form:

$$E_t f_{t+1} = E_t\Big[\frac{S(\cdot)R_t}{\pi_{t+1}}\Big] \tag{18}$$

Log-linerizing the equation (16), given the form of external finance premium, delivers:

$$\hat{f}_{t+1} = \hat{R}_t - \hat{\pi}_{t+1} + \psi(\hat{q}_t + \hat{k}_{t+1} - \hat{n}_{t+1}), \tag{19}$$

where $\psi$ denotes the elasticity of external finance premium when entrepreneur's relative indebtedness changes.

Finally, entrepreneurs maximize their profits according to the first order conditions of the production function (14):

$$z_t = \alpha \xi_t \frac{y_t}{k_t}, \tag{20}$$

$$w_t = (1-\alpha) \xi_t \frac{y_t}{h_t}, \tag{21}$$

$$y_t = k_t^{\alpha} (A_t h_t)^{1-\alpha}, \tag{22}$$

where $\xi_t$ is the Langrangian multiplier denoting marginal cost, $w_t$ being the wage and $z_t$ the marginal productivity of capital.

### 3.2.3 Retailers

Retailers buy wholesale goods from the entrepreneurs, differentiate the goods a little, and finally sell the products in the markets. They are monopolistically competitive agents who are presented as a continuum. The retail sector is incorporated in order to obtain inflation inertia through Calvo pricing, where the retailers can adjust their expected optimal pricing with a certain probability $(1-\phi)$[12].

Given the retailer's profit function, $\Omega_{t+l}(j) = \Big(\Pi^l \tilde{p}_t(j) - p_{t+l}\xi_{t+l}\Big) y_{t+l}(j)$, the retailer $j$ who can adjust their pricing at time $t$ chooses prices $\tilde{p}_t$ according to the following optimization problem:

$$\max_{\tilde{p}_t(j)} E_0 \Big[ \sum_{l=0}^{\infty} (\beta\phi)^l \lambda_{t+l} \Omega_{t+l}(j)/p_{t+l} \Big] \tag{23}$$

s.t.

$$y_{t+l}(j) = \Big( \frac{\tilde{p}_t(j)}{p_{t+l}} \Big)^{-\theta}.^{13} \tag{24}$$

The first-order condition of this maximization problem is:

$$\tilde{p}_t(j) = \frac{\theta}{\theta - 1} \frac{E_t \sum_{l=0}^{\infty} (\beta\phi)^l \lambda_{t+l} y_{t+l}(j) \xi_{t+l}}{E_t \sum_{l=0}^{\infty} (\beta\phi)^l \lambda_{t+l} y_{t+l}(j) \pi^l / p_{t+l}} \tag{25}$$

[12]This also means that the proportion $\phi$ of retailers who cannot change their pricing must charge according to the previously estimated prices and inflation.

[13]Demand function of the retailer $j$

Given also the aggregate price function, $p_t^{1-\theta} = \phi(\pi p_{t-1})^{1-\theta} + (1-\phi)\tilde{p}_t^{1-\theta}$, these functions delivers the following log-formed New Keynesian Phillips Curve:

$$\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \frac{(1-\beta\phi)(1-\phi)}{\phi}\hat{\xi}_t, \tag{26}$$

where $\xi_t$ denotes the real marginal cost.

## 3.3 Government and Monetary Policy

The country's central bank can adjust the nominal interest rate, $R_t$ in response to devations of inflation, money-growth rate, and output. This section of the model does not perfectly match the monetary conditions of Thailand in 1997 as it excludes the exchange rate policies. However, given the firm consensus on the effects of different exchange rate policies described in the literature review -section, it is safe to assume that the common conclusion regarding flexible exchange rate's superiority is sound. Despite the lack of including specific exchange rate policy-functions in the model, it takes into account other important aspects of the crisis, such as suddenly rising interest rates and the following debt-deflation with financial accelerator mechanism, and hence delivers a decent basis for simulating the crisis.

In the model, monetary policy is conducted via the changes in nominal interest rate ($R_t$), which responses to fluctuations in the steady state -levels of inflation ($\pi_t$), money growth rate ($\mu_t = \frac{M_t}{M_{t-1}}$), and output ($y_t$), i.e.:

$$\frac{R_t}{R} = \left(\frac{\pi_t}{\pi}\right)^{\varrho_\pi}\left(\frac{y_t}{y}\right)^{\varrho_y}\left(\frac{\mu_t}{\mu}\right)^{\varrho_\mu} exp(\varepsilon_{Rt}), \tag{27}$$

where $exp(\varepsilon_{Rt})$ is the monetary policy shock and $\varrho_\pi$, $\varrho_y$ and $\varrho_\mu$ are the policy coefficients for inflation, output, and money-growth rate, respectively. These coefficients are chosen by the central bank.

# 4 Steady-State equilibrium and the log-linearized system

Given the nature of the study, the model's steady-state -form[14] must be acquired in order to see the abnormal deviations from the normal situation. The steady-state equilibrium of the system is given as[15]:

$$q = 1;$$

$$\xi = \frac{\theta - 1}{\theta};$$

$$R = \pi/\beta;$$

$$f = SR/\pi;$$

$$f = z + 1 - \delta;$$

$$\delta c = \Big[1 + b\Big(\frac{\pi}{\pi - \beta}\Big)^{\gamma - 1}\Big]^{-1};$$

$$\delta m = \delta c b\Big(\frac{\pi}{\pi - \beta}\Big)^{\gamma};$$

$$\tfrac{k}{y} = \alpha\frac{\xi}{z};$$

$$\tfrac{c}{y} = 1 - \delta\frac{k}{y};$$

$$wh\lambda = \frac{(1-\alpha)(\lambda c)\xi}{c/y};$$

$$h = \frac{wh\lambda}{\eta + wh\lambda};$$

$$y = Ah\Big(\tfrac{k}{y}\Big)^{\alpha/(1-\alpha)};$$

[14] Steady-state equilibrium means that the economy is in stable situation in its steady or mildly growing path, where, for example, the capital growth rate equals the depreciation rate, i.e. $k_{t+1} = k_t$, etc.

[15] As the model is the same as Christensen & Dip (2007), the steady-state equilibrium and the log-linearized system are equivalent to those shown at their Appendix.

$i = \delta k.$

In addition, the whole model must be log-linearized in order to acquire the deviations to be shown in percentages[16] rather than in absolute terms. The log-linearized model typed into Dynare is given as:

$$\big((1-\gamma)\lambda c - 1\big)\hat{c}_t = \gamma\hat{\lambda}_t + \frac{\lambda m(R-1)}{R}(\hat{b}_t + (\gamma-1)\hat{m}_t) - \gamma\hat{e}_t;$$

$$\frac{\gamma\hat{R}_t}{(R-1)} = \hat{b}_t + \hat{c}_t - \hat{m}_t;$$

$$h\hat{h}_t = (1-h)(\hat{w}_t + \hat{\lambda}_t);$$

$$\hat{y}_t = \alpha\hat{k}_t + (1-\alpha)\hat{h}_t + (1-\alpha)\hat{A}t;$$

$$y\hat{y}_t = c\hat{c}_t + i\hat{i}_t;$$

$$\hat{w}_t = \hat{y}_t + \hat{\xi}_t - \hat{h}_t;$$

$$\hat{z}_t = \hat{y}_t + \hat{\xi}_t - \hat{k}_t;$$

$$\hat{mu}_t = \hat{m}_t - \hat{m}_{t-1} + \hat{\pi}_t;$$

$$\hat{R}_t = \varrho_\pi\hat{\pi} + \varrho_\mu\hat{\mu}_t + \varrho_y\hat{y}_t + \varepsilon_{Rt};$$

$$\hat{f}_t = \frac{z}{f}\hat{z}_t + \frac{1-\delta}{f}\hat{q}_t - \hat{q}_{t-1};$$

$$\hat{q}_t = \chi(\hat{i}_t - \hat{k}_t) - \hat{x}_t;$$

$$\hat{\pi}_t = \beta\hat{\pi}_{t+1} + \frac{(1-\beta\phi)(1-\phi)}{\phi}\hat{\xi}_t;$$

$$\hat{\lambda}_{t+1} = \hat{\lambda}_t - \hat{R}_t + \hat{\pi}_{t+1};$$

$$\hat{k}_{t+1} = \delta\hat{i}_t + \delta\hat{x}_t + (1-\delta)\hat{k}_t;$$

[16] i.e. $\hat{\pi}_t = log\frac{\pi_t}{\pi}$, etc.

$$\hat{f}_{t+1} = \hat{R}_t - \hat{\pi}_{t+1} + \psi(\hat{q}_t + \hat{k}_{t+1} - \hat{n}_{t+1});$$

$$\frac{\hat{n}_{t+1}}{vf} = \frac{k}{n}\hat{f}_t - \big(\frac{k}{n} - 1\big)(\hat{R}_{t-1} - \hat{\pi}_t) - \psi\big(\frac{k}{n} - 1\big)(\hat{k}_t + \hat{q}_{t-1}) + \big(\psi\big(\frac{k}{n} - 1\big) + 1\big)\hat{n}_t;$$

# 5 Model Parametrization

The model will be calibrated in order to acquire decent correctness of the dynamics and the magnitude of the crisis. Some of the basic parameter-values are set according to "textbook" -standards. Rest of the parameter-values are a mixture of Christensen & Dip (2007), Gertler et al. (2007), and Thailand's Central Bank's estimates[17].

The values for discount factor $\beta$ and depreciation rate $\delta$ are 0.9926 and 0.0105, respectively. These values are Thailand's central bank's estimations. The beta-value 0.9926 corresponds to real interest rate of 3% per year and the delta-value of 0.0105 corresponds to 4.2% annual depreciation rate. The share of capital $\alpha$ is given the typical value of 0.33

As Gertler et al. (2007) pointed out, the shock to borrowing premium is technically equivalent to a shock to interest rate. Hence, the crisis is simulated via unanticipated upward shock to the interest rate $r$ with standard deviation of 1. The financial accelerator mechanism, $\psi$, is given the value of 0.05, which is also used by Bernanke et al (1999). Christensen $ Dip (2007) used 0.042, but their study was calibrated to US economy. Given the nature of the smaller economy of Thailand, a higher value is more suitable. By setting a higher value for $\psi$, the accelerator mechanism affects more severely. The parameter value for external finance premium is set to 1.0075, which was used in both of the studies.

The coefficients for responses to deviations in monetary policy function is a mixture of Gertler et al. (2007) and Christensen & Dip (2007). The coefficients for output gap $\varrho_y$ and inflation gap $\varrho_\pi$ are 2 and 0.75, respectively. These values comes from the Korean economy during the Asian Crisis. However, due to the similarity of these economies, they are likely to provide a decent approximation for Thailand's situation. The coefficient for money growth rate is set to 0.65. The steady-state inflation rate is set to 1.0074, according to the central bank. This corresponds to 3% annual inflation.

The parameter for capital adjustment cost $\chi$ is set to 0.59 according to

[17]Tanboon, S. (2008). The Bank of Thailand Structural Model for Policy Analysis. Bank of Thailand Discussion paper.

Christensen & Dip (2007). As pointed out in the same paper, the value for capital adjustment cost plays an important role in a system with financial accelerator. Had the adjustment cost been set higher, the capital price would respond to shocks with a greater magnitude and further having a greater impact on the net worth of firms.

The survival rate of entrepreneurs $\nu$ is 0.9728. The same value was also used by Bernanke et al (1999). The value for price stickiness $\phi$ is set to 0.75. In practice this means that on average, the prices are estimated to be fixed for a year. The ratio of entrepreneurs' capital to their net worth $\frac{k}{n}$ is 1.8. This is a intermediate value of Gertler et al. (2007) and Christensen % Dip (2007), who used 1.1 and 2, respectively. Gertler et al. (2007) points out, that their ratio is twice as high as the historical U.S average. But given the high indebtedness in Asia during the crisis, a high leverage ratio is suitable. Given the form of the model and to financial accelerator to work correctly, the value must be higher than 1.

The rest of the parameters and constant-values are the same as Christensen & Dip (2007): Weight of leisure in the utility function $\eta$ equals 1.315, which corresponds to household spending one third of its time in market activities. Constant elasticity of substitution between consumption and real balances $\gamma$ is set to 0.05 and the langrange multiplier associated with the production function $\xi$ is 0.833.

# 6 Model Simulation

The crisis is simulated with a normally distributed 1% unanticipated shock, with $\sigma = 1$, to interest rate that follows AR(1) stationary process. The coefficient for the process is 0.95. The dynamics of key economic factors can be seen from figure 2 and the impulse response functions from figure 4. In addition, the effects of the financial accelerator mechanism are simulated roughly by setting the parameter-value for $\psi$ equal to zero[18]. The results from this simulation with the mechanism turned off can be seen from figure 3 and the subsequent impulse response functions from figure 5.

Following the shock, the nominal interest rate naturally jumps and the rest of the factors decline. Output, consumption, investment, hours of work, inflation, and net worth all decline, as expected. The output's response is -0.34%, which is reasonably in line with the data, given the fact that the GDP at constant prices fell 10 percent[19] and when estimating that during the largest spike, the interest rate increased around 30 percentages[20]. When turning the financial accelerator off, the output's response is -0.29%. The difference is not as large as in Christensen & Dip (2007) or Gertler et al. (2007), but clearly shows that it does have an impact. In Christensen & Dip (2007), the output's response was -0.44% and without the mechanism -0.39%.

Investment were more sensitive to the shock, responding by -1.27%. This seems natural as the leverage-ratio was high and deteriorating firms' balance sheets made additional investing difficult. The investments' response to the shock is highly sensitive to the given value of capital to net worth -ratio. Had the value been set higher, as in Christensen & Dip (2007), the investments would have fallen more sharply and vice versa. The net worth of the companies reacts even more sensitively as the investments, by -1.56%. It is (naturally) also extremely sensitive on the capital to net worth -ratio. As seen from the figures below, investment and net worth do not return to their original levels quickly. Net worth of the companies remain under steady-state

[18]Christensen & Dip (2007) did two different simulations without the financial accelerator mechanism; one with readjusted parameter-values and another with the original ones. In this simulation, the other parameter-values remain the same when analysing the case without the mechanism.

[19]According to IMF database

[20]https://www.imf.org/external/np/exr/ib/2000/062300.htm, Chart 5

-levels long, which was also seen in Thailand. Using rough measures, it took three years for the economy to recover and by measuring the Thailand stock market (SET50) index -value, it did not recover to its pre-crisis levels until 2018[21]. Christensen & Dip (2007) estimated that investment and net worth reacted by -1.1% and -1.4%, respectively. When turning the mechanism off, the investment's reaction dropped to -0.7%.

By comparing these results to data of Thailand's investment-levels, the sensitive reaction of -1.27% seems correct. The investment levels[22] dropped steeply; from the level of around 17 billion US dollars in early 1998 to 7 billion US dollars after the shock. The decline in the share of investments per GDP dropped from around 36 percentages of GDP to 20 percentages. By turning the financial accelerator off, the responses of investment and net worth drop to -0.46% and -0.65%, respectively. Hence, the presence of the mechanism results much larger dip within these more capital related factors, compared to the output that was affected less. These results align with the other key papers, Christensen & Dip (2007) and Gertler et al. (2007), as well as with the whole idea and structure of the financial accelerator mechanism. They also concluded that the financial accelerator has a major impact on net worth via the dynamics explained in previous chapters.

The hours worked reacts by -0.51% and with the mechanism turned off by -0.43%. This means that the financial accelerator does not affect working hours so severely as investment and net worth, but nevertheless has some impact. The difference between these effects can be explained at least partly via the impact on net worth: When companies are hit worse in the model with financial accelerator, the economy stalls and lose more jobs. In Christensen & Dip (2007), hours reacted somewhat more. With the mechanism, the hours reacted -0.67% and without by -0.7%. Hence, the hours dipped more when turning the mechanism off, unlike in this simulation.

[21]It is important to point out that the pre-crisis stock market -prices were highly inflated and the recovery plunged as the 2008 crisis occurred.

[22]Measured by gross fixed capital formation- and investment per GDP -datasets from ceicdata.com. These are presented in figures 7. and 8..

# 7 Concluding Remarks

In this thesis I pondered on the causes and consequences of the Asian Crisis 1997, and with the re-calibrated model of Christensen & Dip (2008), conducted a simulation of the occurrence via an unanticipated shock to the nominal interest rate. The model had Calvo-style nominal price rigidities and a financial accelerator mechanism.

It was found that the major components of the crisis were highly similar to other crisis that had happened in other emerging economies: High (foreign-currency) indebtedness, unsound financial regulation and fixed exchange rates with abnormal valuation. Even though this simulation did not specifically incorporated different exchange rate regimes into the simulation, the literature and previous DSGE-simulations draw a clear conclusion that flexible exchange rates lessen the shock's effects on the economy.

In addition, the large literature on the economic and political consequences of the crisis align with one another: The impact was economically severe and caused major changes to the political landscape as well as to the way how business was conducted afterwards. It also had an impact on the way democracy was valued and practiced in Asia as well as on how international relations, especially towards western institutions, was appreciated. Before the crisis, the ASEAN-countries were mainly authoritarian or semi-democratic, but underwent a phase towards democratization when corrupted governments in Thailand and Indonesia, for example, resigned under pressure. In addition to these ruling governments, western institutions such as IMF, received critique on its actions and interference on the crisis. Some argued that IMF's rescue package worsened the situation by signalling the countries' weak conditions to the markets. Moreover, the terms under which the package was given, mainly demands for countries to increase taxation and cut spending, were not always welcomed warmly. However, the countries nevertheless recovered and continued to develop further.

The simulation of the crisis was relatively accurate. The model was typed into Dynare in log-linearized form in order to see the following deviations from steady-state equilibrium in percentages. The reactions and their magnitudes the shock had on economic factors, such as output, net worth of the companies,

and investment, were on the right level and their hump-shaped form looked realistic. The simulation was conducted with 1% increase in interest rate, which was technically equal to an increase in external finance premium. By estimating that the interest rate increased about 30 percentages, the overall real effects were able to be calculated. Even though some measurements and data, like real decline in Thai companies' net worth's, was difficult to accurately acquire, the magnitudes in overall seems correct.

For the simulation to be describing the Asian Crisis even better, one addition for further simulations would be the inclusion of previously debated exchange rate policies. Moreover, even though none of the models or simulations regarding the Asian Crisis I have seen have not incorporated the external help (IMF's rescue packages) into calculations, it would be interesting to do so. For example, with some predetermined parameter-values, "an unanticipated" help in a form of a new positive shock at some time $t + n$ would hit the economy and change the after-crisis course again.

Figure 2: The economy's response to the 1% shock with Financial accelerator on

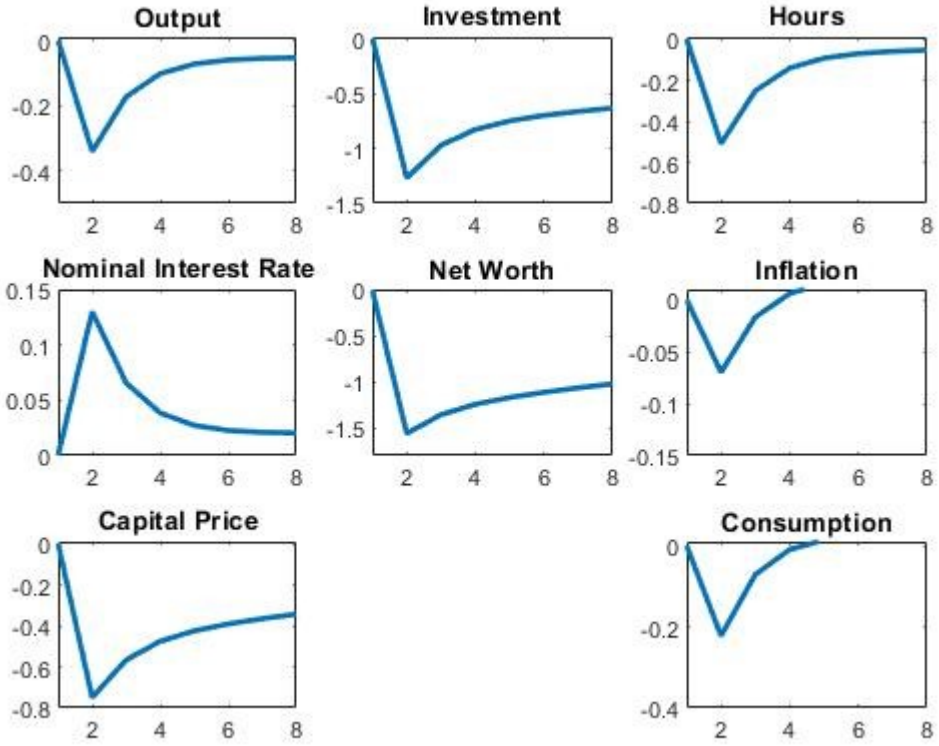


Figure 3: The economy's response to the 1% shock with the Financial accelerator turned off

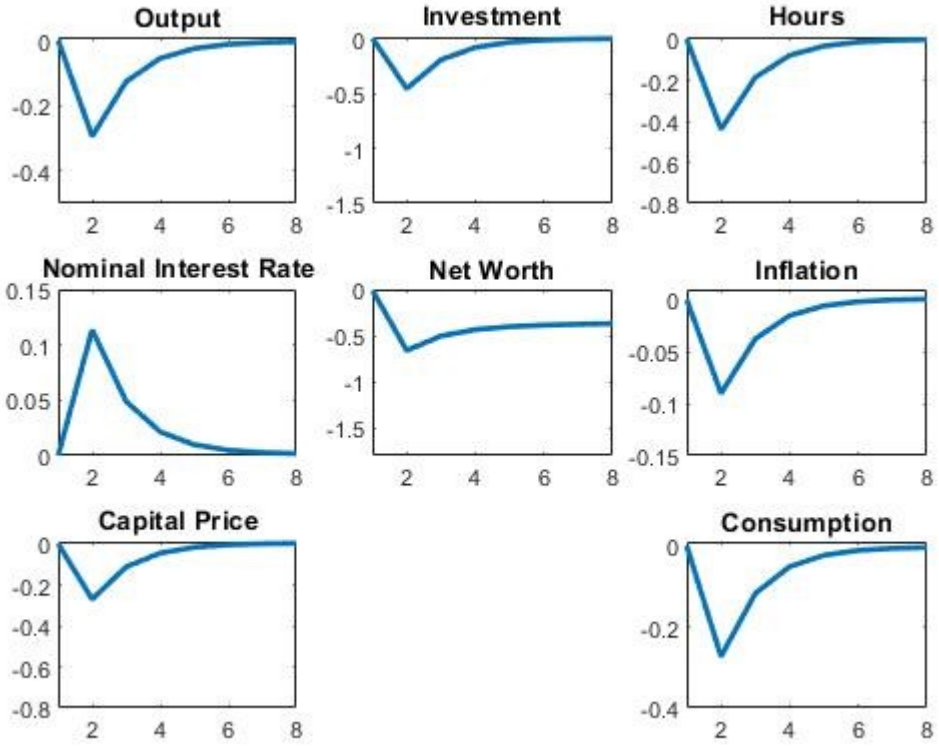


Figure 4: Impulse response functions of the shock

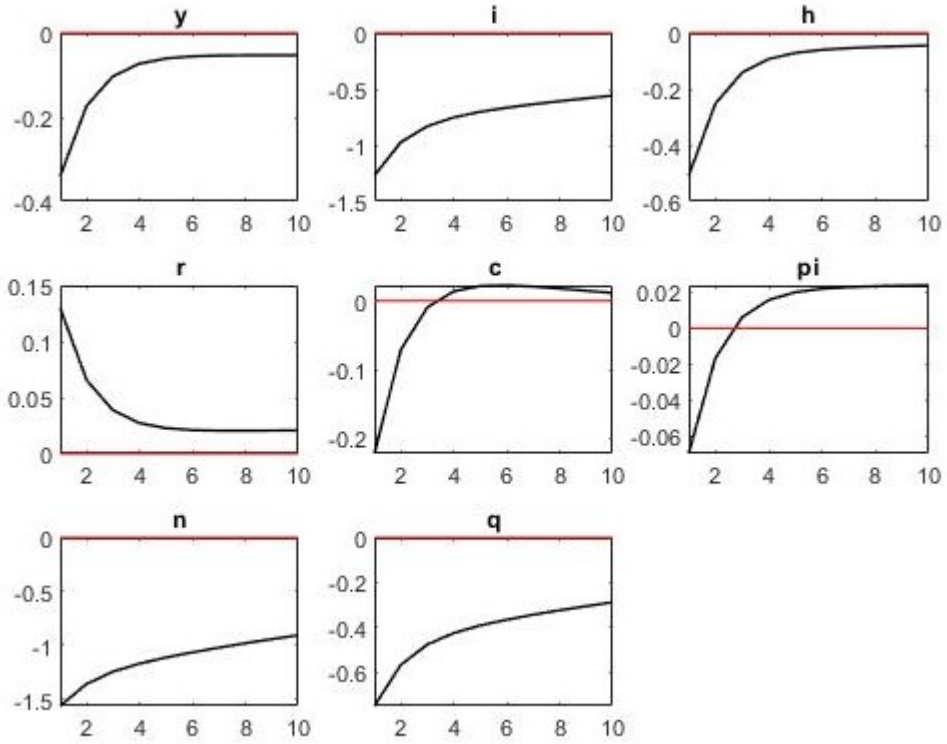


Figure 5: Impulse response functions of the shock, Financial accelerator turned off

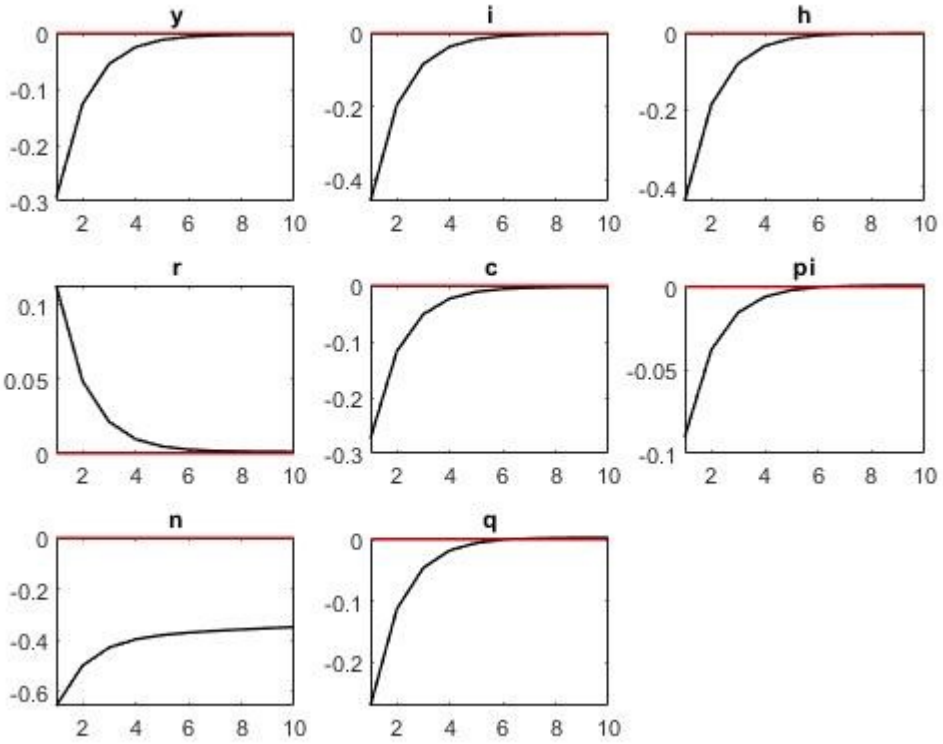


Figure 6: Thailand's Nominal GDP from March 1993 to December 2003


Figure 7: Thailand's Investment: % of GDP from March 1993 to December 2003

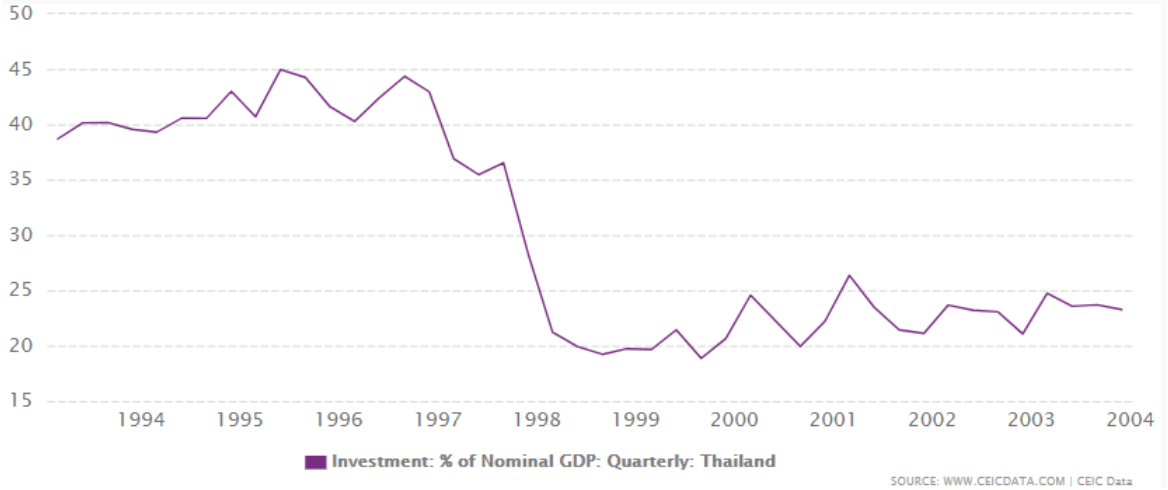


Figure 8: Thailand's Investment: Gross Capital Formation from March 1993 to Decemeber 2003

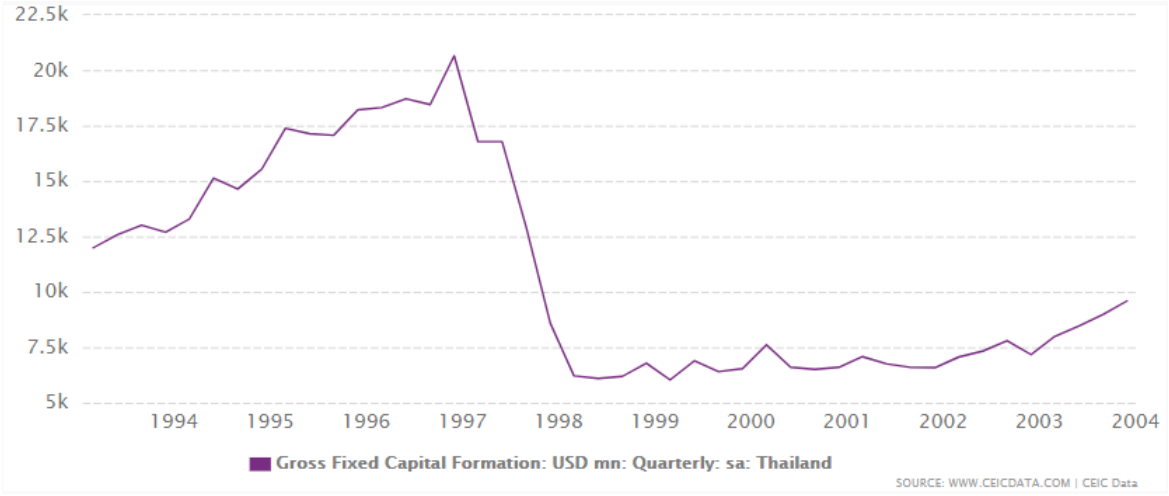
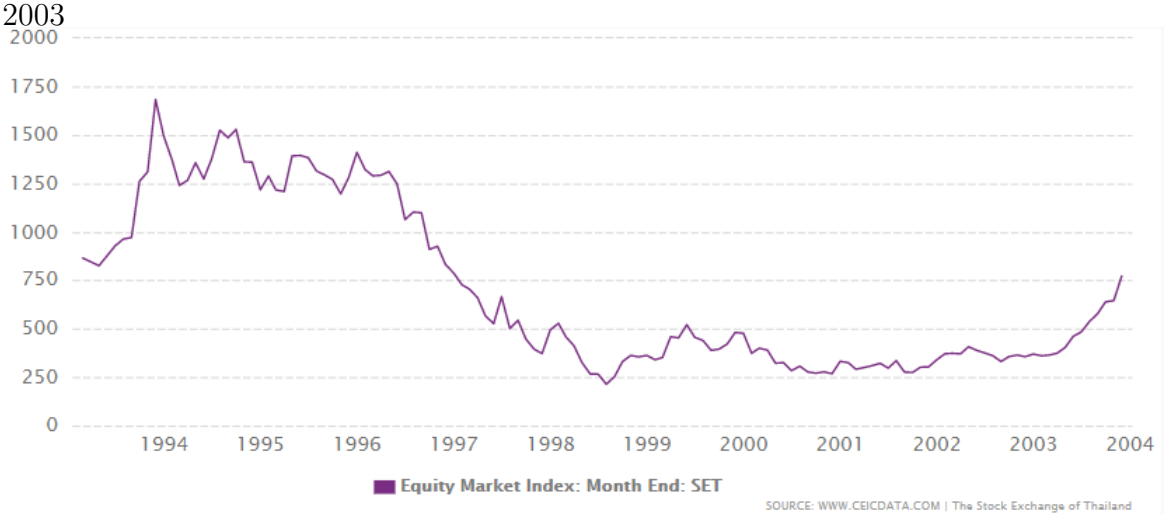



Figure 9: Thailand's Equity Market Index from March 1993 to December 2003



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