



ธนาคารแห่งประเทศไทย

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สถานะทางการเงินของธนาคารกลางและนัยเชิงนโยบาย
(Central bank balance sheet and policy implications*)

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ข้อคิดเห็นที่ปรากฏในบทความนี้เป็นความคิดเห็นของผู้เขียน
ซึ่งไม่จำเป็นต้องสอดคล้องกับความเห็นของธนาคารแห่งประเทศไทย

บทคัดย่อ

การเข้าดูแลเสถียรภาพทางเศรษฐกิจในระยะที่ผ่านมา ส่งผลให้สถานะทางการเงินของธนาคารกลางถดถอยลงและเริ่มเป็นที่สนใจของสาธารณชนมากขึ้นว่าจะสร้างข้อจำกัดหรือเป็นอุปสรรคต่อการตัดสินใจดำเนินนโยบายในระยะยาวของธนาคารกลางหรือไม่ บทวิจัยนี้มุ่งเน้นตอบปัญหาดังกล่าวโดยวิเคราะห์จากหลักการประสบการณ์ต่างประเทศ และความสัมพันธ์ทางสถิติ ข้อสรุปที่พบ คือ ระดับการดำรงทุนของธนาคารกลางที่ลดลงไม่ได้ส่งผลกระทบต่อประสิทธิภาพในการดำเนินนโยบายโดยตรง โดยมี “ความน่าเชื่อถือของธนาคารกลาง” เป็นปัจจัยสำคัญที่เอื้อให้ธนาคารกลางสามารถดำเนินนโยบายได้อย่างมีประสิทธิภาพ แม้จะเผชิญกับภาวะขาดทุน หรือส่วนทุนติดลบ ธนาคารกลางสามารถรักษาความน่าเชื่อถือได้จากการสร้างความมั่นใจต่อสาธารณชนว่าธนาคารกลางยังยึดมั่นในหลักการและวินัยทางการเงินอย่างเคร่งครัด มีความโปร่งใส รวมทั้งรักษฐานะทางการเงินในระยะยาว เพราะการขาดทุนหรือรั่วอาจสร้างความประมาทต่อความน่าเชื่อถือได้เช่นกัน บทวิจัยได้มีการพิจารณาทางเลือกในการปรับปรุงฐานะทางการเงินในเชิงหลักการ ซึ่งได้ข้อสรุปว่า ธนาคารกลางไม่ควรใช้ทางเลือกที่ขัดแย้งต่อเป้าหมายหลักในการดำเนินนโยบาย เช่น การลดอัตราดอกเบี้ยให้ต่ำกว่าระดับที่เหมาะสมกับเศรษฐกิจ เพราะแนวทางดังกล่าวจะกระทบต่อความน่าเชื่อถือและเสถียรภาพทางเศรษฐกิจ และท้ายที่สุดจะยิ่งบั่นทอนฐานะทางการเงินในระยะยาว

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Central bank balance sheet and policy implications*

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Abstract

The role of maintaining economic stability, especially during the increasing challenge from the uncertainty and volatility in the global economy, results in the weakened balance sheet conditions in many central banks. This has brought into the public spotlight whether it will constrain the policy implementation in the long run or not. This research paper aims to explore the answer through principle, country case studies and statistical relationship. The main findings suggest that the central bank capital erosion does not directly affect the policy effectiveness. Central bank credibility is the key factor allowing central bank to achieve the policy objectives even with the financial losses or negative capital. Credibility can be obtained by increasing transparency, ensuring public that central bank always sticks to its core mandate and discipline, and can maintain long term financial sustainability. The policy choices to reduce financial vulnerabilities are also discussed in this paper. The findings suggest that such policy should not conflict with central bank core mandate, for instance, the policy rate reduction below the appropriate level of the economy. It could affect central bank credibility and economic stability, which consequently worsen central bank financial status further.

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Central bank balance sheet and policy implications

Introduction

Although central banks have evolved over decades, and sometimes centuries, their objective remains to be policy making institution rather than profit making institution. However, they are structured financially like private institutions. With this, their ability to pursue objective are sometimes unavoidably in doubted when the financial status get weakened. Main concerns are whether it will complicate the central bank policy decision, open doors to political interferences, or even hamper the policy effectiveness.

Recently, the issue of central bank financial status and its policy implication has become topical for both advanced and emerging economies again during the ongoing global financial crisis. In order to restore stability of the economy and the financial system, many central banks expand the scope of their mandates¹ and introduce new monetary policy tools. Many central banks influence the size and composition of their balance sheet in order to achieve its policy objective. As a result, balance sheet of many central banks was subjected to heightened financial exposure and vulnerability to losses.

The question comes in mind is whether the weaken central bank financial status affect their policy effectiveness. An analysis from the review of principle, related literatures, and country case studies suggest a cautious “no” answer. In principle, central bank balance sheet is different from private in many aspects, thus information from reading central bank financial report is insufficient to infer to their policy outcome. The review of previous literatures suggests that the evidence of the impact of central bank balance sheet on the monetary policy effectiveness remains inconclusive. The previous empirical studies show that the relationship is weak and non-robust to alternative econometric methodology. Many also found the non-linear relationship between the two, i.e., the weaken central bank balance sheet affect the policy only in extreme circumstance. The review of country case studies illustrates example of countries that failed to achieve favorable policy outcome even before experiencing financial losses, as well as countries that successfully operate their policy regardless of the persistent financial losses.

The broad research question of this paper is to analyze whether central bank finances matter. This paper argues that credibility is the main factor behind success of the policy and proves that there is no direct relationship between central bank financial status and the policy effectiveness. A sound financial status can be treated as an implicit factor determining credibility instead. This paper also contributes to the literatures by identifying compositions of central bank credibility. Each composition or factor is derived from an analysis of the country case studies and related literatures. The statistical analysis was offered to confirm the relationship. The results

¹ According to Stone, Fujita and Ishi (2011), central banking was introduced at around the end of 17th century, primarily to help government issues debt, and thereafter took broader policy responsibilities from issuer of reserve money to lender of last resort and supervision, in some cases. The trend was shift toward a narrow and well-defined central bank policy scope during the 20th century, as a range of quasi-fiscal activities roles posed some problems to inflation and central bank balance sheets (Gerlach et. al, 2009). See histories of central banking in Goodhart (1988), De Kock (1974) and Bagehot (1878).

suggest that central bank with higher credibility statistically associates with lower inflationary outcome, which is proxy for monetary policy effectiveness.

The organization of the paper started with the principle of central bank balance sheet, where each element of balance sheet and its interaction with the monetary policy are discussed. Readers with background knowledge of central bank balance sheet can skip this part. The second part of the paper attempts to elaborate the source of central bank capital² erosion in case of the Bank of Thailand. The source of financial weakness in other central banks is also discussed, to illustrate different nature of balance sheet problem in each country due to different economic environment, central bank mandate and institutional setup. The paper also examines whether the central bank balance sheet matter to their policy. The third part of the paper analyzes the issue through the review of the principles, related literatures and the country case studies. These help identifying the role of credibility in explaining the policy success of central banks that incur financial losses. The fourth part of the paper identifies factors determining credibility and statistically tests the relationship between central bank financial status, credibility and policy effectiveness. Lastly, the alternative solutions to the financial weakness will be examined.

Section 1: Principle of central bank balance sheet

1.1 Central bank balance sheet structure

The main mandates of central banks are to ensure the monetary and financial stability by means of implementing monetary policy. In principle, central banks can exploit their monopoly power of supplying domestic currency to banks in order to control or influence the price of money-level of short-term interest rates of the exchange rate (Gray 2006). In this sense, it reflects that their pursuit of policy objectives has a direct bearing on their balance sheets. Therefore, in order to understand the impacts on the central bank balance sheet from the policy implementation, it is essential to start from the understanding about the structure of central bank balance sheet.

Table 1: Stylized central bank balance sheet elements

Assets	Liabilities
Foreign reserves	Monetary base
Domestic assets	- <i>Currency in circulation</i>
	- <i>Reserves of banks</i>
	Deposit of government
	Open market operations (OMOs)
	Capital and reserves

Central bank balance sheets have common elements (the stylized central bank balance sheet elements are shown in the Table 1). The asset side consists of two main items, namely foreign reserves (including gold) and domestic assets. On the liability side, it can be divided into four main items: monetary base, deposit of government, open market operations and capital and

² In this paper, the word capital and equity will be used interchangeably.

reserves (table 1). Although the balance sheet elements are quite similar among central banks, their structures vary considerably depending on the monetary regime, operational framework and policy conducts in the past. The detail of each element is discussed below.

Foreign reserves: this item can be accumulated from the foreign exchange intervention or receiving as a gift from the government as part of its capital. The variation of foreign assets size depends on the exchange rate regime and balance of payments fluctuations (Ganley 2003). It is likely that central banks in emerging economies hold more foreign reserves compared to the economy size since most of them adopt the fixed-exchange rate or managed float regime. Therefore, central banks are obliged to prevent too much appreciation of the exchange rate if the countries are confronting with massive capital inflows. Moreover, foreign reserves also played an essential role as the first line of defense against shocks when countries experience the abrupt capital reversal during the global economic crisis. With this purpose, adequate foreign reserves holding will help strengthen countries' credibility from the foreign investors.

Domestic assets: Domestic assets on central bank balance sheet can be substantial in some countries especially the advanced economies³. In general, central banks hold the domestic assets in the form of government bonds or repo transactions with banks which mostly are the results of the liquidity-injecting operations. (The further detail about the operations will be touched in '*Open Market Operations – OMOs*'). However, since the recent crisis, profiles of domestic assets holdings in advanced economies have changed significantly. As a result of unconventional measures, some central banks have accumulated more unconventional domestic assets such as commercial papers or corporate bonds. Another possible type of domestic assets is the lending to the government. However, concerns on central bank independence have recently become more considerable, and most central banks adopt the 'no-monetary-financing rule' (Gray 2006). This item therefore has been removed or become less significant on the central bank asset side.

Monetary base: The monetary base is the amount of money which central bank had created and injected into the economy. It reflects the demand for central bank money. More importantly, this item is the main source of central bank income or so-called seigniorage⁴ since the central bank is a monopoly supplier of money (or monetary base). Besides, due to the interest-free and irredeemable characteristics, the monetary base is sometimes viewed as a capital or quasi-capital rather than a liability of central banks (Darbyshire 2011). Generally, monetary base consists of two main components: currency in circulation and reserves of banks

(1) Currency in circulation: This item represents the demand for physical banknotes of the economy. Such demand varies widely across countries and mostly demand-determined. The main factor driving the growth of this item is the growth of the economy (nominal GDP). The level of interest rates has a marginal impact on the expansion of the banknotes. Other factors which influence the demand for banknotes are the advancement of

³ In Mar 2012, Fed held domestic assets around 98% of the total assets, while at the same period the domestic assets on the BOT's balance sheet account for only 6% of the total assets.

⁴ Seigniorage is the difference between the cost of money creation (or cost of banknotes printing) and the interest payments received on the total amount of money created.

payment systems, the perceived soundness of the banking system, credibility of the central bank, and the level of trust in domestic.

(2) Reserves of banks: Reserves of banks are one of the most crucial items on the central bank balance sheet for monetary policy implementation. Central banks need to achieve the desired level of the interest rate by adjusting the quantity of the banks' reserves. Generally commercial banks maintain reserves at the central bank for two purposes. Firstly, they are obliged to maintain deposits at the central bank to fulfill the reserve requirement which set at the certain percentage of their deposit bases (required reserves). Secondly, commercial banks may hold more cash than the required level for the payment and settlement purpose (free or voluntary reserves).

Deposit of government: In most countries, the governments have deposit accounts at the central bank. This is due to the fact that most central banks are de jure bankers to the governments. Furthermore, having deposit accounts at central banks help reduce the credit risks to the governments since theoretically speaking, central banks are risk-free authorities. However, remunerations of the governments' deposits vary across countries. In some countries, the governments are very keen to manage and invest to earn some interest on their free liquidity, and then the funds placed at the central banks can be less significant on the central bank liability side.

Open market operations-OMOs: OMOs are main tools of central banks used for liquidity management. As a monopoly supplier of monetary base, a central bank needs to conduct OMOs to ensure that there is a sufficient liquidity in the banking system to meet banks' demand for reserves and settlement balances (banks' reserves) in order for keeping the price of liquidity (interest rate) at the desired level (central bank target or policy rate).

If there is a liquidity shortage in the system, the central bank can inject the liquidity by purchasing government bonds in the secondary market or conducting repo transactions with banks, for instance. In contrast, if there is any liquidity surplus in the banking system, central bank is required to mop up the excess liquidity by issuing central bank bills/bonds or conducting reverse repo transactions with banks.

Capital and reserves: Capital of the central bank is normally paid up by the government. This item can be built up by retained earnings after the profit remittance to the government. In principle, central bank needs to maintain some amount of capital for two main reasons. Firstly, capital is the legacy from the history since some central banks have evolved from the clearing houses or commercial banks. Secondly, adequate capital can play as a tool to preserve the financial independence of the central bank. The role of central bank capital and the policy implications will however be discussed in the section 3.

1.2 Difference between central bank and private enterprises balance sheets

Recently, central bank balance sheets and financial performances have been put into the public spotlight. However, public views on the central bank financial position are mostly based on the conventional concept of private enterprise financial strength. However, such approach may be inappropriate and very misleading (Stella 2008). Several reasons why the financial

positions of central bank and private enterprises should be viewed differently are observed and explained in this section.

First, central banks are authorities which are founded to achieve policy objectives rather than to maximize profits (Cukierman 2011). However, central banks cannot achieve the objectives by just giving orders, but they need to become one of the players in the market. In other words, central bank functions are deployed on its balance sheet and then income statement will be inevitably affected (Martinez 2004). Furthermore, in some circumstances, to achieve the policy objectives, central bank may need to conduct some operations even though such operations can jeopardize their own financial strength. For instance, many central banks in emerging economies have conducted the sterilized foreign exchange intervention to limit their own local currency appreciation during the recent global economic crisis. But these operations have created more risks onto the central banks' balance sheets in terms of higher currency mismatch. Meanwhile, they also incurred heavy cost of liquidity absorption to the central banks which may lead to the deterioration of capitals from negative carry problem⁵.

Besides, with the de jure mandates of preserving the economic stability, it can be seen that central banks are producing the public goods (monetary and financial stability) to the economy. Similar to other public goods such as national defense, all economic agents enjoy and obtain some benefits from the economic stability. Thus, in principle, if central banks have some financial difficulties from pursuing the de jure mandates, people who had enjoyed the benefits in the past should be responsible for the incurred losses resulting from the central bank operations. This rationale implies that central banks, in principle, are always implicitly guaranteed by the government. Given that the government comes with the taxing power, financial insolvency is never an issue for central banks.

Next, central banks have privileged power of creating money. Under the normal circumstance, as a monopolistic enterprise supplying money, central bank should normally make profit or enjoy full seigniorage⁶ from creating money (Vaez-zadeh 1991). This can be implied that central banks are theoretically designed to be a self-financing organization, and liquidity problem cannot be an issue for central banks since unlimited money can be created to pay debts in the domestic currency as long as the central bank credibility has not been deteriorated. And central banks can operate with the negative capitals since the future seigniorage will help replenish the central bank capitals later. Nevertheless, theory and practice do not necessarily go together in the real world. In reality, central banks cannot excessively exploit this power to earn seigniorage since doing that can heighten the inflationary pressure which may undermine price stability objective. In additions, the amount of real resources that the central bank can appropriate is limited (Buitter 2008, Darbyshire 2011).

Last but not least, there are no supervisory rules or global accounting standard for central banks. Unlike private companies or commercial banks, central banks do not need to comply with the supervisory rules such as capital adequacy ratio. Additionally, they are not

⁵ The scenarios where the pursuit of policy objectives weakens central bank financial position will be discussed in detail in the section 3.

⁶ Seigniorage is the difference between the face value of money and the cost of money creation such as printing cost.

required to adopt the accounting standard. Even though some central banks have moved to the International Financial Reporting Standards (IFRS), but most of them have not been fully adopted the IFRS. Two main factors can explain why the accounting treatment of balance sheet items used in practice varies cross countries. One point is that the IFRS is not suitable for central banks in some circumstances capitals since the IFRS accounting rule will make central bank capital levels more vulnerable. Most central banks prefer adopting their own standard like national GAAP or national IFRS so as to safeguard their financial positions. This can be seen that during the recent crisis, many central banks have modified the accounting system to an asymmetric manner to help replenish their capitals and preserve the financial independence⁷. Moreover, in some cases, central banks are having accounting constraints since the accounting treatment has been specified by laws or the legal rules. The Bank of Thailand (BOT) can be a good example in this case. The BOT is required by laws to keep two separate accounts: one for the Banking Department and the other one for the Issue Department. The accounting treatment for the issue department's account has been indicated in the Currency Act, B.E. 2501. (See Box A for more information about the BOT accounting system).

To sum up, central banks and private enterprises have various different characteristics in terms of institutional objectives and mandates, legal structure and the accounting standard. Hence, the concept of financial strength which is widely adopted for evaluating private enterprises is not appropriate for the central bank. In order to understand the central bank financial positions and evaluate the performance of the central bank reasonably, the public should focus more on the *'policy performance'* which reflects in the economic stability rather than on the *'financial performance'*.

⁷ More information can be found in Horakova (2011).

Box A: Summary of the Bank of Thailand's Accounting System

The Bank of Thailand Act, B.E. 2485 and the Currency Act, B.E. 2501 require the BoT to keep two separate accounts: one for the Banking Department and the other for the Issue Department.

The Banking Department's Account is called the "General Account". It includes all businesses of the Bank of Thailand except those related to the issuance and management of bank notes. The financial statements of the General Account are prepared in accordance with standard accounting practices.

The BoT is obliged to remit 75% of its annual net profit in the General Account to the government. The other 25% of the annual net profit is accumulated in the General Account's "Ordinary Reserve". In 1998, the government issued the Emergency Decree Empowering the Ministry of Finance to Borrow and Administer the Borrowing to Assist the Financial Institutions Development Fund B.E. 2541, stipulating that the amortization of the 500 billion baht bonds, issued in accordance with the Decree, is to be funded by the privatization proceeds and at least 90% of the annual profits remitted by the Bank of Thailand. Very little proceeds have been received so far from the privatization program and the BoT had not been able to remit any profit to the government for a number of years since the 1997 currency crisis because the General Account had accumulated substantial foreign exchange losses.

Therefore, to enhance the Bank of Thailand's capacity to remit profits to the government for this amortization, the government issued two Emergency Decrees to enable a one-time transfer of 165,000 million Baht from the Special Reserve Account in the Issue Department to the BoT's General Account in order to eliminate the accumulated losses⁸ and allow the use of assets in the Issue Department's Special Reserve Account to back up notes issued.

In 2012, the government issued the Emergency Decree on Revising Management of Ministry of Finance Loans to Support the Financial Institutions Development Fund (FIDF), B.E. 2555. Under the new Emergency Decree, the annual net profit in the General Account must be transferred to the "Account for Amortization of the Principal to Fiscalize the FIDF Losses" for repaying the FIDF debt principal and interest.

The Issue Department's Account comprises three accounts, namely the Currency Reserve Account, the Annual Yield Account, and the Special Reserve Account.

1. **The Currency Reserve Account (CR)** Assets used to back-up the notes issued are held in this account. The notes issued must be fully backed by assets at all time. Eligible assets include gold, foreign currencies, foreign securities and Thai government securities.

⁸ The transferred amount after deducting the accumulated losses is recorded as retained earnings in the General Account.

The total value of gold, foreign currencies and foreign securities must be at least 60% of the total amount of the notes issued.

2. The Annual Yields Account (or the Benefit Account – BR) Earnings on the assets in all three accounts are credited to the Annual Yields Account and expenditures related to printing, issuing and managing bank notes as well as fees for managing the assets in all the three accounts are debited from it. Moreover, assets in the Annual Yields Account are used to compensate the fall in value of assets in the Currency Reserve Account. The closing balance, net of all expenses and valuation losses, at the end of the year had previously been transferred to the Special Reserve Account, but since 2002 the positive closing balance has been transferred to a new account⁹ set up within the General Account to pay off the principal on the bonds issued in accordance with the Emergency Decree Empowering the Ministry of Finance to Borrow and Administer the Borrowing to Assist the Financial Institutions Development Fund Stage Two, B.E. 2545.

In the case where the assets in the Annual Yields Account in any year is not sufficient to expend as mentioned above, the expenditure will be drawn from the SR Account to the extent of the deficit. Moreover, if the assets in the SR Account are not sufficient, the shortfall will be drawn from the Treasury Balance. The Treasury Balance will be reimbursed fully in the following years once there is any surplus of assets left in the Annual Yields Account after such expenditure.

3. The Special Reserve Account (SR) This is simply the retained earning account. It is the accumulated profit of all the three accounts over the years. Any increases in the value of the assets in the Currency Reserve Account are also transferred into this account.

In June 2002, the Emergency Decrees was issued allowing the use of assets in the SR Account for backing issued banknotes. Prior to this, an increase in the amount of banknotes issued always required a transfer of assets from the General Account to the Issue Department's Currency Reserve Account.

Asset Valuation

At the end of the year, asset valuation is conducted. This involves FX revaluation and marking to market all foreign securities. Since the value of assets in the CR Account must equal the total amount of the notes issued at all times, a decrease in the value of assets in the CR Account has to be compensated by assets from the Annual Yields Account, the SR Account and the Treasury Balance respectively, while an increase in the value of assets in the CR Account will be transferred to the SR Account.

⁹ The account is named "Account for Amortization of the Principal to Fiscalize the FIDF Losses".

1.3 Information obtained from central bank balance sheets

The asset side of the central banks may reflect the past monetary policy decisions. If the asset size expands remarkably while the composition does not alter, it can be implied that the central banks have adopted the quantitative easing measures. A good example for this case is the government bonds outright purchase operation. Consequently, the asset size of the central bank balance sheet simply increased, but the compositions of the asset side remained unchanged, while the monetary base has been expanded by the increase in banks' reserves accounts (Figure 1). Yet if the operations of central banks cause only the changes in the compositions on the central bank assets, it means the central banks have adopted the qualitative easing measures (Figure 2).

Figure 1: Quantitative easing

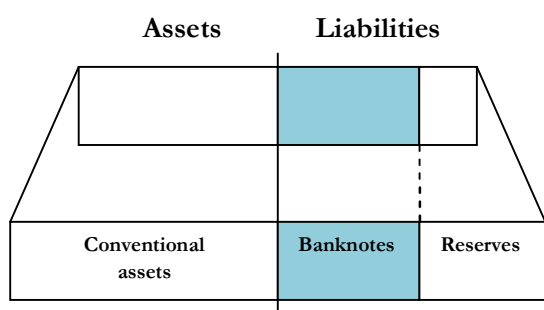
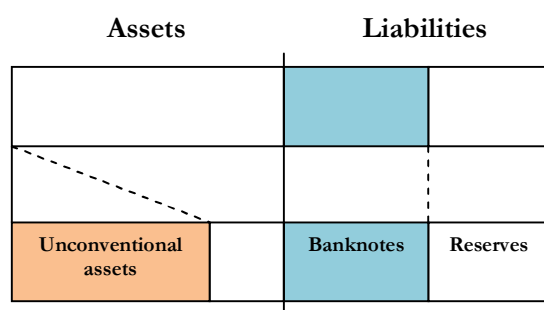


Figure 2: Qualitative easing



Source: Lenza, Pill and Reichlin (2010)

However, the distinction between quantitative and qualitative measures with the above definition is from the textbook perspective. In practice, such distinction cannot be applied to the real central bank operations since some measures have impacts on both size and composition of the central bank balance sheet.

In addition to the information of policy decision obtained from the asset size and compositions, the liability side can reflect the liquidity management framework of the central bank as well. The central banks' sizes and compositions of the liability have changed remarkably, especially those in advanced economies. For example, the Bank of England changed the liquidity management framework from the corridor system to the floor system by mopping up the excess liquidity through the remuneration on reserves balances instead of conducting OMOs. This can be witnessed from the sudden expansion of banks' reserves. In some countries where the reserve requirement having been used as an active liquidity management tools, the banks' reserves can play a big part of the central bank liabilities such as the case of People's Bank of China. The empirical evidences of impacts on central bank balance sheets from unconventional measures will be discussed in the next section.

Table 2: Impacts on central bank balance sheet from the foreign exchange intervention

Assets	Liabilities
Foreign reserves	Monetary base
Domestic assets	- <i>Currency in circulation</i>
	- <i>Reserves of banks</i> ① ↑ ② ↓
	Deposit of government
	Open market operations (OMOs) ② ↑
	Capital and reserves

3. Quantitative easing measures

During the recent global economic crisis, many central banks especially those in advanced economies have adopted the unconventional policies mainly the quantitative easing measures by purchasing massive amount of assets including government bonds, commercial papers or corporate bonds. From the implementation of quantitative easing measures, on the asset side, the domestic assets such as government bonds or commercial papers increase. At the same time, central the bank injects the liquidity by increasing the money in the banks' reserves accounts (Stage 1). To offset the impact on liquidity which might affect the interest rates in the money market, central banks need to conduct OMOs to drain the excess liquidity (Stage 2). Therefore, it is obvious that size and composition of the central bank balance sheet are affected from the implementation of quantitative easing measures.

Table 3: Impacts on central bank balance sheet from the implementation of quantitative easing measures

Assets	Liabilities
Foreign reserves	Monetary base
Domestic assets	- <i>Currency in circulation</i>
	- <i>Reserves of banks</i> ① ↑ ② ↓
	Deposit of government
	Open market operations (OMOs) ② ↑
	Capital and reserves

Section 2: From policy actions to financial outcome

2.1 Sources of central bank financial weakness

Financial status of several central banks was affected by the recent crisis, which heightened their financial exposures and increased their vulnerability to potential losses. The extent of the financial impact is determined by several factors such as the balance sheet structure, economic environment, policy functions assigned to the central bank, and institutional arrangements.

Structurally, **the width of areas of responsibility** of central banks determines the extent to which a central bank bear risks associated with its activities on its own balance sheet (BIS, 2005). For instance, central bank that act as a pure agent for the government has narrower mandate and could naturally transfer the main risk associated with its activities to government. Central bank would not hold foreign assets on their balance sheet but rather manage foreign assets on behalf of government. Their operating costs are thus small. In contrast, central bank that acts as principal has complete discretion over how it acts and is responsible for losses it incurs. Central banks in emerging market economies (EMEs, hence forth) tend to have wider area of responsibilities and act as principal. They have to manage risk through their own balance sheet.

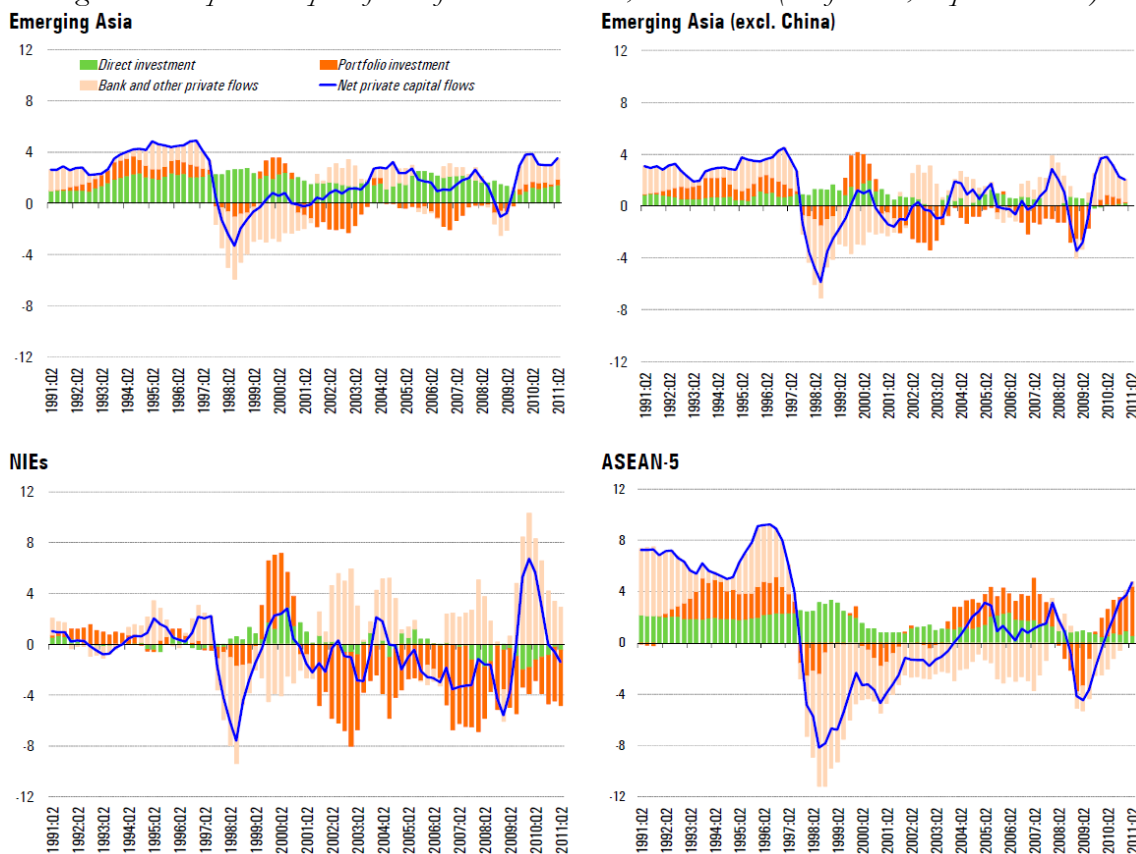
Acting mainly as principal, **balance sheet structure** of central bank in EMEs has high exposure to exchange rate and interest rate risk. These central banks need to hold foreign currency securities on their balance sheet for several reasons, such as for the purpose of foreign exchange market intervention, to ensure currency convertibility¹⁰, and insufficient domestic securities suitable for holding. Central banks in EMEs cannot easily invest at home; they thus invest mainly in G3 reserve currencies. There are three main reasons for this, namely, exchange rate regime, market underdevelopment and regulations. The fixed or manage floated regime may require them to invest in foreign currency instrument, especially in the currencies of major trading partners. In addition, financial market in the emerging market economies may not be sufficiently deep enough to prevent distortion being created if central bank invests at home. Lastly, many central banks including the BoT are subjected to the regulations that only allow an investment in high credit assets. Holding reserves asset denominated in G3 currencies also give higher liquidity conditions. With the balance sheet structure given above, it is unavoidable to experience the currency mismatch between the asset side (foreign reserve assets) and the liability side (liquidity absorbing operation) of the balance sheet.

Apart from the structural factors, there have been changes in **global macroeconomic environment** and financial landscape over the decade. This gives implications on central bank policy actions and their balance sheet outcome. In fact, the size of the central banks' balance sheets had already expanded considerably before the crisis through the foreign currency reserve

¹⁰ BIS (2005) suggest that the need to hold foreign currency convertibility is especially in situations where “exchange rate is not fully floating or when central bank need to operate on its own account to demonstrate its independence in conducting monetary policy”.

accumulation with the purpose of being a precaution¹¹ against the possibility of sudden stop of international capital flows. However, at the beginning of the global rebalancing process in 2005, there has been persistent capital flows from developed economies into the EMEs which have higher economic growth prospects. In addition, EMEs also experiences the current account surplus. Figure 3 illustrates the current account balance and source of foreign fund flows into EMEs. These two factors resulted in the sharp appreciation pressure on EMEs currencies. Several central banks tried to resist the strong appreciation pressure to allow for economic adjustment. Considering **central bank function** aspects, the recent global financial crisis has led many central banks to expand their policy tools with the objective to support their financial system stability¹² and macroeconomic stability roles. There has been a shift of major central bank balance sheet policies into a range of quasi-fiscal activities in case of developed economies through the asset purchase and liquidity injection, and through temporarily resisting the foreign exchange rate appreciation in case of smaller advanced economies and emerging market economies.

Figure 3: Net private capital flows of selected countries, 1990-2011 (% of GDP, 4 quarters MA)



Source: Balakrishnan et al. (2012)

Note: NIEs of Asia includes Hong Kong, Korea, Singapore, and Taiwan

¹¹ With the past experience of financing long term project with short term external borrowing before the eruption of the Asian financial crisis in 1997, central banks are aware of the need to build up buffer against the shock. Several researches support this view that the reserve accumulation in Asia was for precautionary purpose such as Jeanne (2007) and, Aizeman and Lee (2007); other added that the EMEs sought to avoid being the most attractive targets for speculative attacks (Cheung and Qian; 2009).

¹² The scope of policy function varies country by country. Some central bank do not have mandate to supervise the financial institution. See further information from central bank survey by Central Banking Service (2010).

The emergence of the global financial crisis in 2008 hit the balance sheet of central banks in EMEs through two main channels. First, **negative carry**; the situation when the returns on holding foreign reserve asset are lower than the domestic interest rates paid on the central bank liability side. Interest rate paid on the reserves asset experience the historical low level. This is because the G3 economies are severely hit by the crisis, thus central banks need to use the expansionary policy. The current policy interest rates of countries in G3 are near zero level. In contrast, emerging market economies have better economic growth, which results in the relatively higher and more volatile inflation rates. With this, interest rate in EMEs has not reached the lower bound either. Second, the **foreign exchange valuation losses**¹³ as a result of local currency appreciation pressure. The EMEs were affected by the influx of volatile capital flows from developed countries after the expansionary monetary policy through interest rate cut and quantitative easing measures. The flows were to search for higher yields and foreign exchange gain from local currency denominated assets with respect to their better economic growth prospects. Unfortunately, EMEs have a relatively narrow and less developed capital markets than the advanced economies. As a result, the foreign exchange market is more sensitive to a huge amount of persistent capital flows.

The slowdown in global economic activities also significantly affects the export led growth economies like EMEs. The slump in export demand results in lower export receipt. The policies of central banks in EMEs thus give importance to macroeconomic concerns after early 2009. Many central banks attempt to stem the currency appreciation pressure to allow time for business operators to adjust to the lower export demand and lower export revenue after converting the receipt into local currency. With this, one would see that many central banks unavoidably need to continue increasing their foreign currency exposure.

Advanced economies experienced problem of high degree of financial stress, policy interest rates reaching the lower bound, and the complexity of their financial system (Stone, Fujita and Ishi, 2011). Central banks in advanced economy such as FED, BoE and ECB need to adopt the expansionary stance of monetary policy. When the interest rate tools reached the lower bound, the unconventional balance sheet policies were utilized as part of local currency liquidity easing measures. Operations include widening availability of counterparties, expanding the maturity of liquidity providing operations and liquidity injection. This results in the expansion of the central bank balance sheet and higher vulnerability to credit risk.

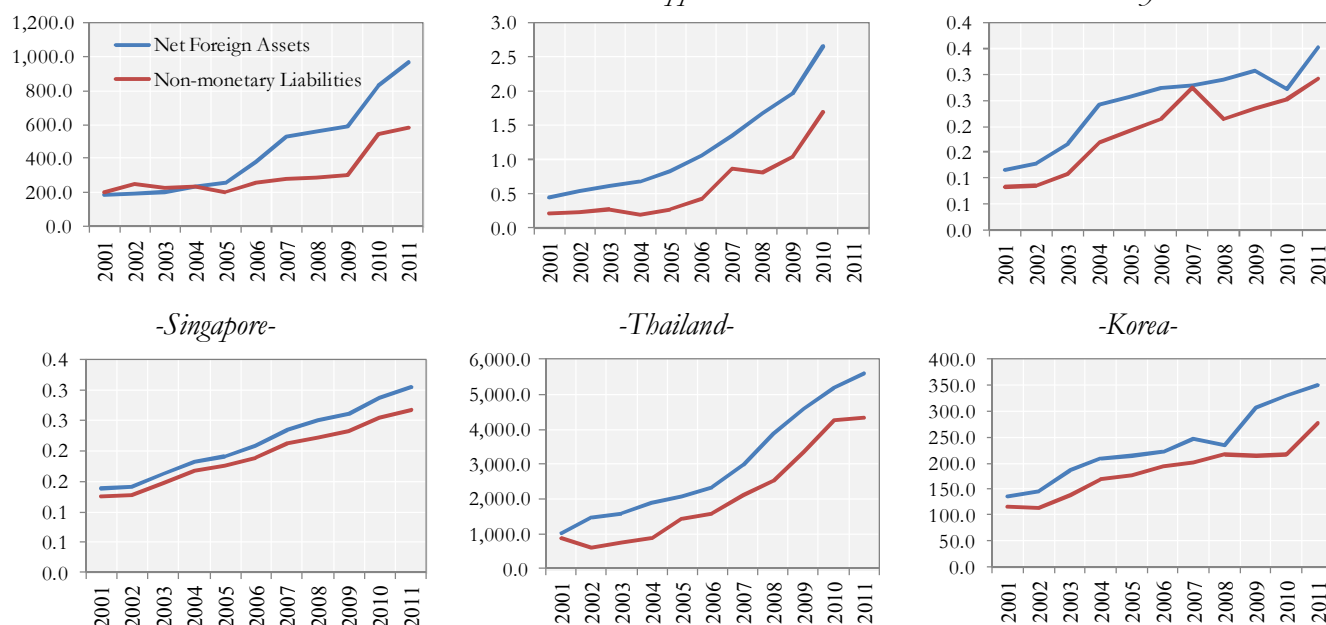
In contrast, central banks in EMEs need to curb excessive volatility in foreign exchange market through the foreign exchange reserve accumulation. To maintain price stability, many of these reserves also have been sterilized via the issuance of the non-monetary liabilities by central banks, with the sterilization instruments held largely by domestic banks. As a result the expansion of the liabilities at central bank comes along with the foreign exchange reserve asset build up, resulting in the blow up of the central bank balance sheet. The dramatic growth of the foreign exchange reserves in emerging Asia over the past decade also bring in the foreign

¹³ Valuation losses occur with the conversion of reserve assets from G3 denominated currencies to local currency. The local currency appreciation pressure results in the declining value of reserves after converting into in local currency.

exchange exposure. Figure 4 illustrates that central banks have increased sterilization¹⁴ in response to increasing reserve accumulation. The figure displays the domestic currency unit of total stock of foreign reserves and total non-monetary liabilities of central banks, which are proxy of sterilization. The non-monetary liabilities are defined as total liabilities less monetary base and foreign liabilities.

Smaller advanced economies, such as Israel, Switzerland and Sweden also undertook large foreign exchange intervention in order to stem their currency appreciation. The buildup of foreign exchange reserves began in March 2009 in case of SNB and March 2008 in case of Israel. Swiss franc and Israel shekel appreciated rapidly after the financial crisis due partly to their safe haven status. However, the foreign exchange asset purchase is not sterilized as reserve money rose broadly in line with foreign exchange reserves.

Figure 4: Foreign exchange reserves and Central bank non-monetary liabilities of central banks
-Indonesia- -Philippines- -Malaysia-



Unit: trillion of local currency Source: Author's calculation, data collected from IMF IFS, BOK, MAS and BOT

Lastly, **institutional arrangements** also determine central bank financial status. Many measures have been adopted to safeguard the central bank financial strength. Three common measures are observed and discussed in this section.

First, in some countries the target level of capital or conditions to not transfer profits to the government are specified in the central bank acts or laws. These mechanisms are designed not only to safeguard the central bank capital levels, but also help replenish central bank capitals by not remitting profits to the government if the central bank capitals are negative or below the

¹⁴ Sterilization tools vary in each country. For instance, a combination of sterilization bills and required reserves are employed in the sterilization process in case of China (Greenwood, 2008). Singapore's foreign exchange reserves are significantly sterilized using the direct borrowing, which help withdrawing liquidity from the domestic banking system. The Bank of Thailand uses the Open Market Operation.

de jure target. For instance, Bank of Israel law specifies the instruction of profit transferred to the government, and from such instruction, it can be implied that the capital is targeted at 2.5 per cent of total assets¹⁵. Also, the Federal Reserve is required by law to maintain the capital at 6 per cent of its member bank capital¹⁶. Another example is the case of Bank of Canada. It is also stated in the central bank act that the bank can collect the partial surplus available from the operations in the reserve fund as long as the reserve fund is less than five times the paid-up capital.¹⁷

Second, some central banks are established to act as agents for the government. For example, in China, the central bank has to remit all the profits to the government while the government will cover all the expenses and losses incurred from the central bank operations. However, a central bank may act as an agent only for some certain operations as well. The Reserve Bank of New Zealand (RBNZ) is an obvious example. It is explicitly stated in the Act that the RBNZ must transfer any exchange gains (whether realized or unrealized) incurred from the foreign exchange operations. Meanwhile, the government must be responsible for any exchange losses (whether realized or unrealized) caused by the foreign exchange operations¹⁸.

The last measure is the risk-and-cost-sharing agreement between the central bank and government. During the stressed episode, a central bank is required to act as a lender of last resort to provide the liquidity into the banking system or as a market maker of last resort to alleviate the liquidity squeeze in the market. Yet both roles may expose the central bank to greater financial risks on the balance sheet which may lead to the deterioration of capital. In some countries, the agreement between the government and central bank to share some risks caused by the role of lender and market maker of last resort is introduced. For example, during the crisis, the Bank of England (BOE) has established a subsidiary company– the BOE Asset Purchase Facility Fund Limited (APFF) to improve liquidity in the credit markets by borrowing money from BOE to purchase high-quality assets. To mitigate the financial risks which may jeopardize the financial position of BOE, the risk-sharing agreement between the government and the BOT has been made. Under the agreement, the BOE will be indemnified by the HM Treasury against losses incurred from the lending operations and the risks will be transferred to the Treasury. The Reserve Bank of India (RBI) is also a successful case of sharing sterilization cost with the government. In 2004, RBI and the government launched the Monetary Stabilization Scheme (MSS). Under the MSS, RBI can issue the treasury bills or government bonds on behalf of the government for the sterilization purpose. The cost of issuance will be absorbed by the fiscal budget. (RBI 2004) Doing so has helped reduce the financial burden on the RBI's balance sheet significantly.

2.2 Resulting financial outcome

As mentioned earlier, there has been dramatic change in the size and composition of the balance sheet of central banks in both advanced economies and EMEs. However, resulting financial outcome between advanced and emerging economies are different in term of timing,

¹⁵ See Bank of Israel Law, 5770-2010

¹⁶ See Federal Reserve Act, Section 5

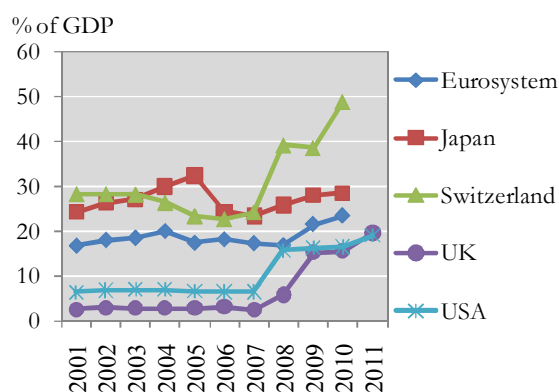
¹⁷ See Bank of Canada Act, R.S.C., 1985, c. B-2 Current to May 2, 2012

¹⁸ See Reserve Bank of New Zealand Act

magnitude and source. First, the considerable expansion of central banks' balance sheets in EMEs had already happened before the crisis as mentioned earlier. After crisis, balance sheet expanded gradually as part of the intervention in foreign exchange market to curb the excessive volatility. In case of the advanced economies, balance sheet expanded abruptly with the extensive use of the credit and quantitative easing measures. Second, the enlargement of the balance sheet of central banks in the advanced countries was far greater than those in EMEs. However, in comparison with the economic size, the expansion in case of EMEs is greater as it is more than double of its economy. Figure 5 and 6 show the large balance sheet expansion in emerging Asia and in advanced economies in term of GDP. Lastly, the asset expansion was primarily due to the buildup of foreign exchange reserve in case of EMEs and the domestic asset purchase in case of advanced economies.

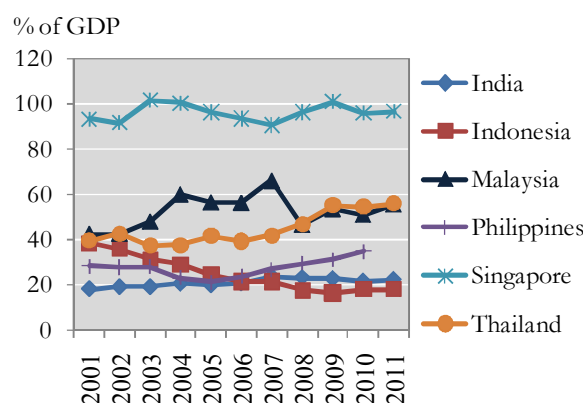
The recent balance sheet operations (bond purchase) of central banks in advanced economies have not incurred central bank losses so far. However, their financial exposures have increased considerably. It also resulted in the maturity mismatch from central bank purchase of government bonds from private sector and financed by bank reserves, which creates vulnerability to an increase in interest rates.

Figure 5: Total assets to GDP (Advanced economies)



Source: IMF IFS and BOT

Figure 6: Total assets to GDP (Emerging economies)

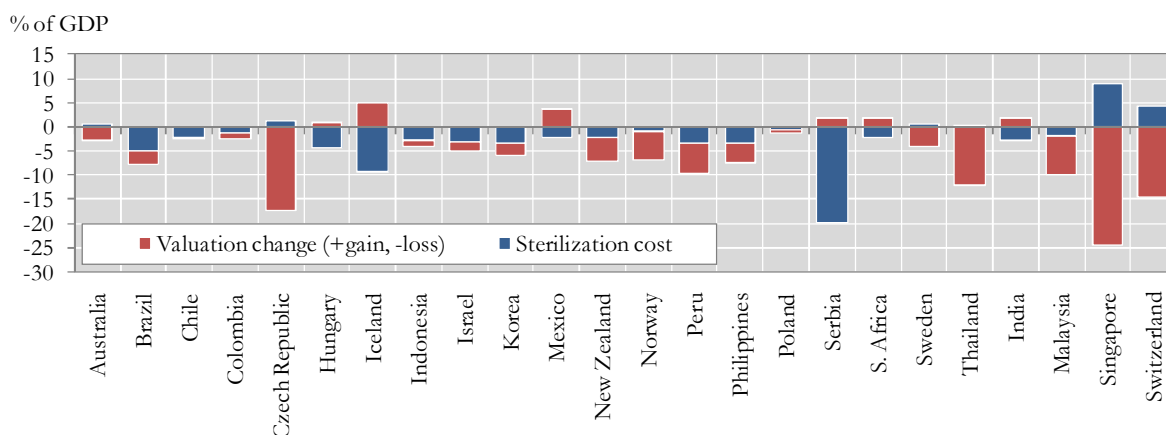


Some emerging market economies and smaller advanced economies have increasing foreign exchange exposure and negative carry. In case of central banks that employs open market operation (OMO) sales as tools for liquidity mop-up. There is a substantial amount of the cost of sterilization owing to large gap between domestic interest rates and the return from foreign exchange reserve assets. Figure 7 illustrates the cumulated central bank losses from sterilization costs and valuation change¹⁹ from 2000 to the latest data at the end of 2011, with unit of ratio to

¹⁹ The method of calculation adopted from Loffler, Schnabl and Schobert (2010). Valuation change of foreign reserves is the product of net foreign asset (NFA) and the changes of the nominal exchange rate. Sterilization cost is defined as the summation of seigniorage and the sterilization costs in narrow sense. The seigniorage is defined as the income from holding foreign reserves which is the counterpart of interest-free base money, calculated as the product of the currency in circulation (CIC) and the foreign interest rates. Sterilization costs in narrow sense in defined as the difference between NFA and CIC times the spread between the foreign and domestic interest rates. Assume that the foreign assets are held in the US treasury bills with one year maturity.

GDP and accumulated. Valuation losses occur when the influx of capital inflows led to a sustained appreciation pressure on the domestic currency. Many countries experience huge amount of the valuation losses such as Singapore, Switzerland (see, Jordan, 2011), Czech Republic, and Malaysia.

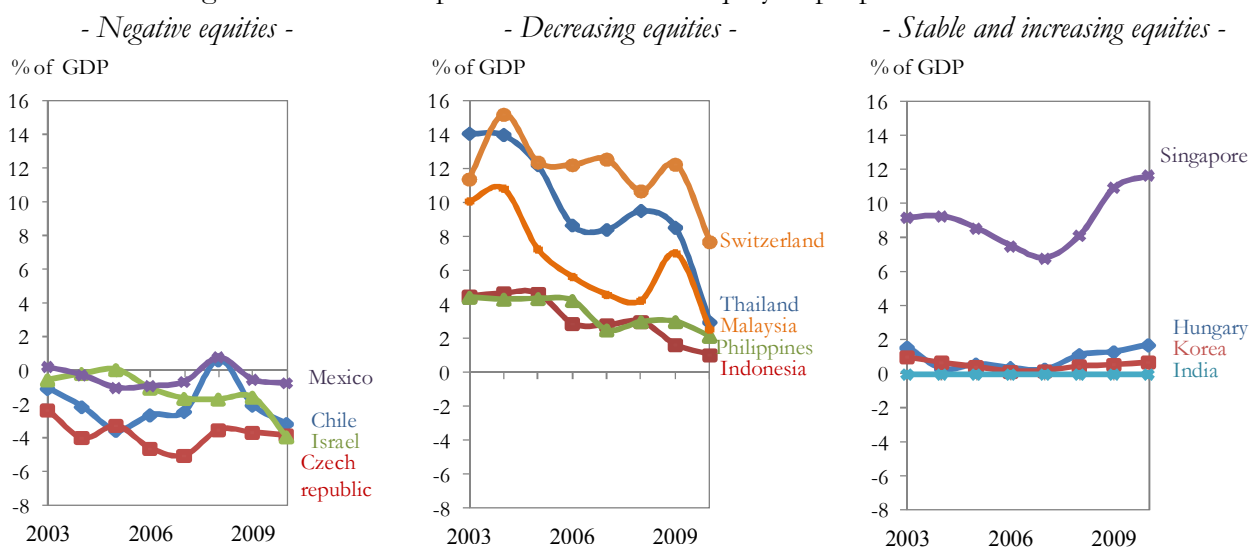
Figure 7: Cumulated sterilization costs and valuation change from 2000 to 2011



Source: Authors' calculation. Data collected from IMF IFS

The change in size and composition of balance sheet lead to the capital erosion in case of many central banks in EMEs and small advanced economies. Some central banks have already experienced negative equity such as Czech National Bank, central bank of Chile, Bank of Israel, and Bank of Mexico, etc. Figure 8 illustrates time series plots of central bank equity as proportion to GDP. One observes that Thailand is experiencing capital erosion, which is similar to other EMEs. On the last panel, equity level of some central banks is in good condition; however, this is owing to the special arrangement between central banks and government. For instance, in Mar 2009, Monetary Authority of Singapore (MAS) increased its issued and paid-up capital with the government approval to strengthen the MAS's capital and reserves, in light of a potentially volatile financial market environment going forward. (MAS 2009)

Figure 8: Time series plots of central bank equity as proportion to GDP



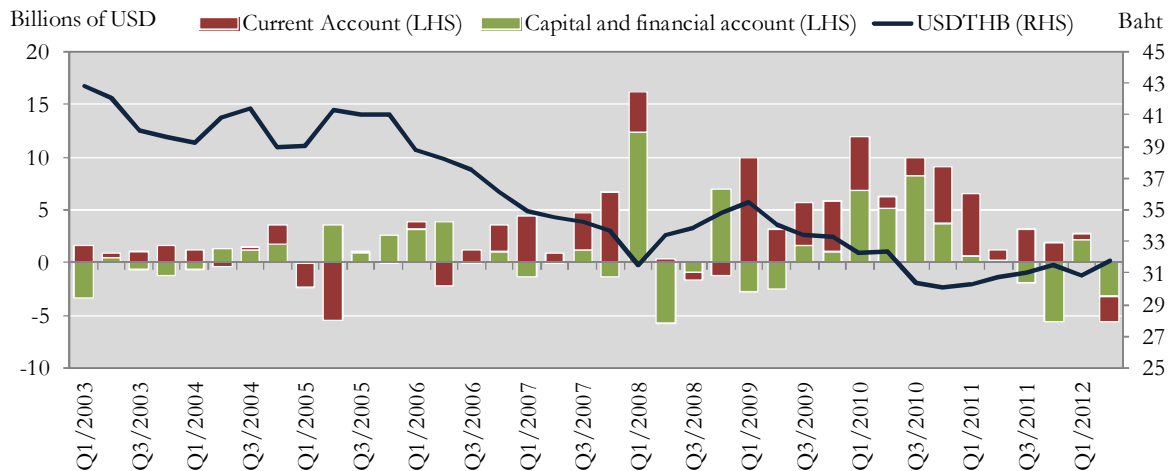
Source: CEIC, and central banks' annual reports

2.3 Balance sheet conditions of the Bank of Thailand (BoT)

The recent global financial crisis also poses challenge on a small country like Thailand, through the influx of the volatile capital flows and the slowdown in export demand. The Bank of Thailand itself experiences the capital erosion and the balance sheet expansion, which was the result of the monetary operations to restore stability in the economy.

In fact, balance sheet of the Bank of Thailand was gradually expanded before the global financial crisis. Thailand gradually accumulated reserves after the Asian financial crisis for precautionary motives. The surge of international capital flows from developed economies to EMEs in 2005 necessitated the continuation of the reserve accumulation. During the period, the balance of payment was in surplus position due to favorable export performance, the receipt of foreign direct investment flows, and the capital flows into Thai equity market (see figure 9). With this, it created huge expansion of the supply of dollar resulting in the strong appreciation pressure on the baht. The gross international reserves has increased year-on-year by 15 billion USD in 2006 and 20 billion USD in 2007.

Figure 9: Thailand's Balance of Payment



Source: BOT

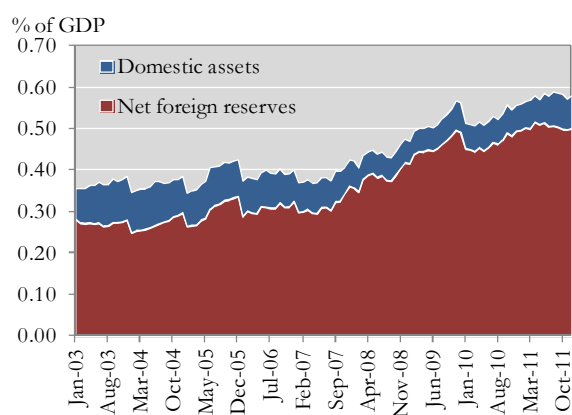
Unfortunately, due to the eruption of global financial crisis in 2008, many central banks in EMEs as well as the Bank of Thailand had to stand ready to lessen the crisis spillovers in order to safeguard the economic stability. With that attempt, the Bank of Thailand needed to increase the exposures to foreign exchange inevitably. Firstly, the severe global economic downturn brought in a slump of the demand of Thai export from the G3 countries, which were Thailand's major trading partners. Moreover, Thailand was not only affected by the pressure of severe external economic environment. On the internal front, the domestic demand, especially investment, was subdued from the chronic political conflicts; situation was exacerbated by the natural disaster. Export has thus been the main economic growth engine. In addition, the adoption of near-zero interest rate policies and the quantitative easing measures during the crisis led to the influx of capital flows into Thailand. During 2009 - 2010, massive amount of short-term and yield-enhancing flows flooded into Thailand to invest in equity and bond markets. This pushed the appreciation pressure on Thai Baht. To lessen the impact on Thai economy which might be passed through the export channel, the Bank of Thailand stepped into the foreign

exchange market to limit the volatility of the currency. This can be witnessed from the expansion on the asset side by largely increasing in the gross international reserves by 61 billion USD between 2009 and 2010.

Nonetheless, Thailand was not the only country who was impacted from the massive capital inflows. Many EMEs also experienced the same situation owing to the better economic growth prospect of the countries in EMEs in comparison with the G3 countries. Similarly, their economies were affected by the slowdown in their export demand from the developed countries. The central banks in EMEs adopted the similar policy responses which were aiming to curb excessive volatility in the foreign exchange market to maintain the competitiveness of their export sectors, especially during the shrinking global demand for exports.

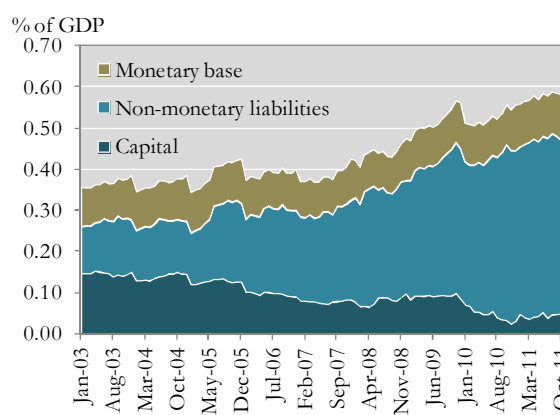
The major reason for the Bank of Thailand intervention in the foreign exchange market was to curb the excessive exchange rate volatility in order to allow time for private enterprise, especially the SMEs, to make adjustment from shocks. This was to restore the economic stability and the continuation of the economic growth. However, the objective of the intervention was not to weaken the baht for better price competitiveness. One would observe that the objective of the intervention was to ensure that the movement of the baht was in line with the regional currency. In addition, the intervention was to ensure that the movements of the real effective exchange rate remain consistent with the economic fundamental, i.e., neither under- nor-overvalued.

Figure 10: Bank of Thailand's Assets



Source: BOT

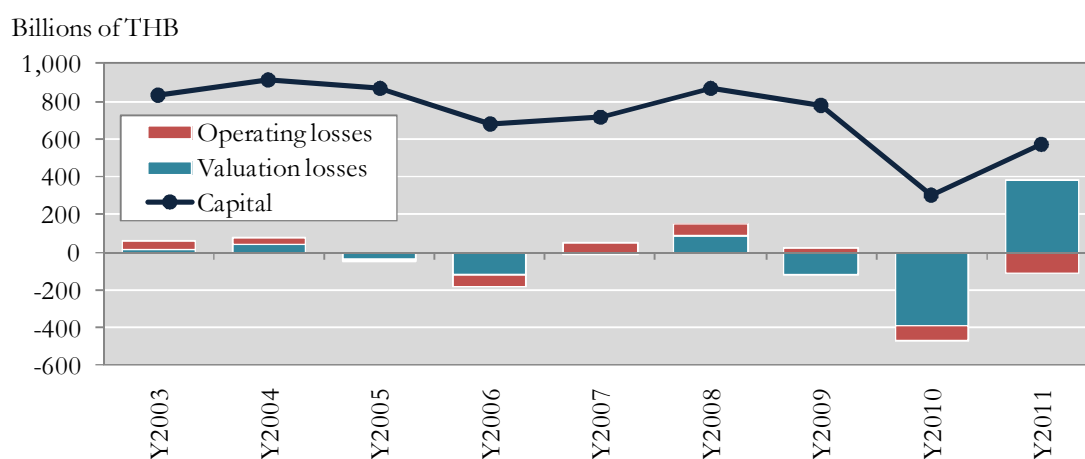
Figure 11: Bank of Thailand's Liabilities



However, the foreign exchange intervention can also be viewed as the liquidity-injecting operation. And if the liquidity remained in the system exceeds the demand for it, interest rates in the money market might be affected which can further be harmful to the transmission mechanism of the monetary policy. In order to avoid such situation, the Bank of Thailand needed to sterilize the excess liquidity by conducting Open Market Operations (OMOs) such as bond outright sales, bilateral repurchase or Bank of Thailand bills and bonds issuance. The OMOs which mainly reflect in the “non-monetary liabilities” can therefore be viewed as the mirror image of the expansion of the foreign reserves on the asset side.

As aforementioned, the major part of the assets is in the form of foreign reserves, while the main component on the liability is in the form the non-monetary liabilities from liquidity-absorbing operations or OMOs which are the interest-bearing liabilities. With the current balance structure, the BOT is exposing with the huge mismatch in terms of currency and interest rate. And the mismatch on the balance sheet has deteriorated the Bank of Thailand capital for two sources. The first source is from the ‘negative carry’ problem. Due to the currency mismatch on the BOT’s balance sheet and the near-zero interest rate policy in G3, the interests earning from the reserve management which conventionally investing in G3 or reserve currencies are lower than interests paid for the liquidity-absorbing activities. Also, the mismatch on the BOT’s balance sheet contributes the ‘revaluation losses’ to the deterioration of the BOT’s capital. Along with the Baht appreciation trend, the revaluation loss will be incurred when the foreign assets are converted into Baht term (see figure 12).

Figure 12: Contributions to the BOT’s capital erosion



Source: Authors’ calculation

At this point, it can be seen that the change in the global economic environment recently has resulted in the weak financial positions of many central banks especially in EMEs including Thailand. Looking forward, there are many unforeseeable events that could have impacts on the balance sheet status. Thus, concerns about whether the financial strength matters for the effectiveness of monetary policy have been more frequently raised. The next chapter is entirely devoted for this issue.

Section 3: Review of the link from financial weakness to policy capacity

This section aims to answer whether financial weakness impair the monetary policy effectiveness, and under what circumstance. The question will be addressed through the review of the principle of central bank balance sheet, related earlier literatures, and the country case studies. This section argues that central bank credibility is the most important factor determining the policy outcome; financial status can be regarded as one of the credibility component. This will be discussed further in section 4. The econometric study suggests that there is no direct relationship between central bank financial status and the policy outcome. In addition, central bank credibility has a statistically significant relationship with the policy outcome.

3.1 Review of principle

Financial status of central bank extends beyond private accounting convention.

Normally, central banks do not face insolvency and liquidity risk. Being the issuer of the legal tender, central banks basically cannot become illiquid in the domestic currency. Once equity becomes negative, central banks are not forced to declare bankruptcy as in private corporation case. There are three main reasons why interpretation of central bank capital is extended beyond committed capital as in private case. First, money issued by central bank acts more like equity capital than central bank liability as they bear no interest and can be a source of revenue. Second, there is no bankruptcy provision, negative capital is possible and is often observed. In corporate sense, one could calculate the limits to how far the financial losses can go before bankruptcy and operation failure. In the central bank sense, the calculation is not straight forward as the limits are not tight, given good quality institution and credibility. Third, the state is the beneficial owner of the central bank. The state usually have unlimited liability and generally regard the nation's interest to ensure central bank can function. The special arrangement between states and central banks (as mentioned in section 2.1) can be organized to provide an additional source of financial strength for central banks. In some case, the policy co-operations from states can help reducing financial burden of central banks. These three reasons support that **in principle central bank losses do not directly cause immediate financial problems or directly impair monetary policy.**

Central bank losses are not associated with a poor performance as in private case. In fact, central bank performance is appraised on how well the institution delivers the policy outcomes. Many policy actions justified by central bank mandate end up with financial losses. Sometimes losses were persistent so that capital has crossed the negative territory. BIS (2005) have listed several circumstances where the pursuit of policy objective weakens the central bank financial position. Here are some of them:

(1) Pursuit of exchange rate and price stability in the face of massive capital flows

The massive and volatile capital inflow has been major challenge for central banks in emerging Asia, including Thailand, especially after the global financial crisis (as discussed in section 2.1). Central banks in these countries also need to ensure that the massive capital flows does not generate higher inflation outcome from excessive increase in liquidity. They thus need to sterilize the inflows using domestic currency liabilities.

Normally, interest rates in EMEs are higher than those of the advanced economies, due to their stronger momentum for high economic growth and the higher country risk premium. In the normal circumstance, the costs of negative carry were usually covered by their seigniorage revenue. However, during the crisis where the foreign currency exposure expand rapidly, the negative carry become substantiate that it results in capital erosion or capital losses.

(2) Pursuit of financial stability in the face of liquidity shortage

The unique capacity to create promptly unlimited nominal amount of liquidity puts a central bank in a position of an effective lender of last resort. During a credit crunch, a central bank is providing emergency liquidity to trouble financial institutions who struggled to borrow from inter-bank markets. Equipping with standard risk management tools, central banking

normal practice is collecting high-grade collaterals and making a haircut. This measures help mitigate risk when borrowers default. However, a central bank may inevitably accept lower quality collaterals i.e. loan or junk bond, to prevent the failure of significant financial institutions (SIFIs), which might cause a spillover effect. Thus, a central bank absorbs higher credit risk to safeguard the financial system and real economy as a whole. This is the case of advanced economies such as G3 and the UK during the global financial crisis.

(3) Pursuit of price stability at the interest rate near the zero lower bound

To conduct the expansionary policy under the zero lower bound, a central bank could utilize unconventional monetary operations. It may actively purchase fixed income securities, such as sovereign and corporate bond in the market, hoping to lower market yield curves to incentivize more investments. Suppose a central bank successfully stimulates the economy, and the interest rate begins to rise. Value of sovereign bond acquired during the quantitative easing will gradually fall according to the inverse relationship between interest rate and bond price. In this case, a central bank incurs losses whenever the economy turns around. Japan is a country facing such circumstance at present. The direct impacts of central bank losses are the excess money injection into the economy and incapability to distribute profit to the treasury. The losses should be viewed as a cost of attainment policy objective, which is minimized by central bank's risk management techniques. Admittedly, the practical approach to minimize losses from central bank policy has not been well defined yet.

Although negative equity is unavoidable in the circumstance that benefits to society and it does not immediately affect the policy effectiveness, central bank cannot feel comfortable with it either due to two main reasons; 1) technically, there can be limits to seigniorage earning in some circumstances, and 2) requesting assistance from government can be difficult. Details are as follows;

First reason; technically, there exist the maximum resources a central bank can extract through seigniorage without pushing inflation up, as discussed by the inflation tax laffer curve in Buiter (2008). In addition, there are circumstances where negative capital cannot resumes to positivity in the long run, namely, the economy falling into deflationary trap and the bank note growth rate dropping below nominal interest rate (Bindseil et al, 2005). In addition, there is a threshold through which losses could create impacts on central bank's policy implementation. Stella (2005) suggested that losses and deterioration of the central bank's balance sheet can go on indefinitely as long as it does not exceed the sustainable level of seigniorage and provided that the central bank need not maintain price or exchange rate stability.

Second reason; without an explicit legal arrangement, requesting for government's recapitalization is problematic because (1) it is politically costly for central bank independence²⁰, (2) timeliness is somehow questionable²¹, and (3) it is not hard to imagine that the government

²⁰ It could be at stake owing to undesirable bailout conditions. For example, in exchange for the capital injection scheme, governments could replace the central bank's governor or the monetary policy committees with their advocates, or maybe impose policy guidelines or restrictions for the central bank's future practice.

²¹ The budget approval process usually takes time and effort to pass parliament. The single year budgeting principle can mess things up as it may involve the renegotiation and reallocation of expense and revenue among central government parties (see Stella and Lonnberg (2008) for more historical perspectives)

and central bank budget are constrained at the same time during crisis period²² (Sinclair and Milton, 2011).

This led us to explore the existence of the link between central bank financial weakness and their policy implication from previous literatures. If exists, the question of under what circumstance and channel through which financial weakness could have impact on the policy shall be addressed.

3.2 Review of earlier literatures

Previous literatures found that the policy performance need not be impaired by the adverse financial outcome. Many have found that central bank financial status could affect its policy only in case of severe financial difficulty. In addition, the link from financial strength to policy is not straight forward, since the financial strength is just part of the monetary policy institutional set-up.

In the literatures, there are three main channels through which the severe financial losses could affect central bank policy. The first channel is the **policy decision and implementation**. In an extreme case, central banks with very weak financial status may be reluctant to implement actions that are warranted from the policy perspective but risk deteriorating the financial position further. For instance, the monetary policy independence (of maintaining price stability) could be limited when central bank try to avoid/escape from the negative equity by allowing higher inflation. Earlier literatures, led by Stella (1997), argued that a large negative net worth of central bank was likely to hamper central bank independence and affect its policy objective, in particular, price stability. Stella and Lonnberg (2008) also found that central bank financial status could affect its policy only in case of severe financial difficulty, and term the situation as “Policy insolvency²³”. Other literatures, such as Sims, 2004; Bindseil et al., 2004; Stella, 2005 and Ize, 2005, also come into similar conclusion. Adler et al. (2010) also confirm the non-linearity in relationship using theoretical model and suggest that central bank financial weakness can affect its policy decision in an extreme case as explained by the large negative interest rate deviation from Taylor’s rule. Axel, Gunther and Franziska (2010) pointed out that a debtor central bank had higher inflation bias if it cared about losses. Moreover, a central bank trying to get around this problem in an improper fashion i.e. investing its international reserve too aggressive might end up losing reputation instead. Vaez-zadeh (1991) also suggested that the substantial losses and its persistence can constraint the central bank’s operational capacity.

In some circumstances, central banks may encounter more challenging environments to formulate policies, as public doubt on central bank ability or willingness to pursue any loss-making activities. For instance, case of Japan in early 2002, the policy credibility was undermines

²² Cukierman (2011) suggested that although central bank is not liquidated when its capital become negative, most central banks hold positive amount of capital as insurance against political interference in their policy. For instance, the recapitalization from government can probably make central bank fall into pressure to ease monetary policy in order to contribute to finance deficit or to stimulate economic growth.

²³ Policy insolvency is opposed to technical insolvency. It refers to situation in which central banks’ policies become affected by their financial weakness.

when the market believe that the central bank may change policy course to avoid losses²⁴. This partly brings forward to the second channel, the impact on the **policy effectiveness**, which depends on the ability to anchor market expectation and need policy credibility. When a central bank has made a remarkable losses or its equity has replenished, doubts on the causes of losses and the financial sustainability are likely to arise. For central banks with monetary policy objective of maintaining price stability, the transmission mechanism can be impaired if the policy lose its credibility. In this context, the monetary policy cannot anchor inflation expectation. The resulting high inflation relating to central bank financial weakness could thus signal policy failure.

Earlier literatures prove the financial link to policy outcome by observing ability to maintain price stability, through inflation outcome. The links are found to lack robustness with respect to the choice of alternative measures of financial strength and the econometric technique. Paper led by Kluh and Stella (2008) found statistically significant and non-linear²⁵ negative relationship between central bank financial strength and inflation. In other words, only in case of severe losses and strong impairment of central bank balance sheet would result in the policy ineffectiveness. Benecka et al. (2012) extended Kluh and Stella (2008) work to explore the robustness of their result by using more country sample, more recent data sample, more alternative way of calculating financial strength, alternative control variables and econometric technique. The paper yield contrasting results and find rather weak and non-robust links between several measure of central bank financial strength and inflation. The latter view also argues that **the link from financial strength to inflation is not straight forward, since the financial strength is just part of the monetary policy institutional set-up.**

The last channel is **central bank independence**, which could be compromised after the recapitalization from the government. When central bank loses its autonomy, public may also doubt on its policy flexibility. Cukierman (2011) suggested that most central banks hold positive amount of capital as insurance against political interference in their policy. For instance, the recapitalization from government can probably make central bank fall into pressure to ease monetary policy in order to contribute to finance deficit or to stimulate economic growth. At the same time, the paper also highlighted the importance of other institutional aspects, such as the range of central bank responsibility and risk assumed, central bank independence, the exchange rate regime, and the degree of fiscal responsibility. The paper also suggested that negative central bank capital does not always prevent the achievement of price stability.

Many literatures pay attention to the role of central bank credibility in explaining policy effectiveness. Sims (2004) formulated the general equilibrium model showing how credible a central bank can commit to a stable price level during extreme circumstances. Ize (2005) and Buiters (2007a, 2007b) argued that a central bank should meet its inter-temporal budget constraint to maintain the credibility of inflation targeting. Some other literatures also suggested that having

²⁴ Many mistakenly interpret the Bank of Japan governor speech in 2003 as a case of excessive concern with avoidance of losses in the balance sheet as part of the reason for the monetary policy of the Bank of Japan that was not sufficiently expansionary. (Cukierman, 2011)

²⁵ Non-linear relationship implies that the impact of financial status on policy outcome occurs in the extreme financial loss case.

an outstanding communication with stakeholders about the rationale of its policy and having strong governance are essential for the central bank survival.

Up to this point, it is useful to extend the analysis to the country case study. Many central banks such as Czech Republic, Chile, Israel and Mexico could impressively deliver stable financial and economic condition even in face of persistent losses. In contrast, central banks in less developed economies and Latin American countries during 1980s fail to achieve their policy objective. The following section aims to identify conditions that make different policy outcome between the two cases.

3.3 Review of country case studies

Past experience of central banks suggest that **credibility is the foremost factor determining the policy outcome**. In the year of 1980s, central banks in developing economies and Latin American countries failed to achieve their policy objectives. The common source of problem stemmed from the central bank operations, mainly quasi-fiscal activities, which had a conflict with the central bank mandates and policy objective. With this, the policy credibility could be destroyed even before the occurrence of central bank financial losses. On the other hand, some central banks could impressively deliver stable financial and economic condition even in face of persistent losses and negative capital. Some common characteristics of the successful central banks operating with weak financial position are the ability to maintain policy credibility. Detail discussions are as follows.

From the historical perspective, the operations that were in conflict with the central bank core principle and mandates would lead to the policy inefficiency and failures. These also consequently led to financial losses, both from the operation itself and from the costly policy exercise after losing policy credibility. In the past, many central banks were mainly served as the arm-length of the government²⁶ and were assigned to support the fiscal activities. These activities generally created losses and go much beyond (sometimes in conflict with) conventional central banking functions to maintain price and exchange rate stability. With this, the monetary policy unavoidably lost their credibility from central banks' **low degree of accountability, transparency and policy autonomy**²⁷. Example of activities include 1) monetizing the excessive government deficits for the ambitious public investment programs and populist policies, which eventually led to the hyperinflation in case of Central Bank of Brazil and Central Reserve Bank of Peru in 1980s (Dem, Mihailovici and Gao 2001), 2) excessively intervened in the foreign exchange market to appreciate the local currency for supporting the import sector in

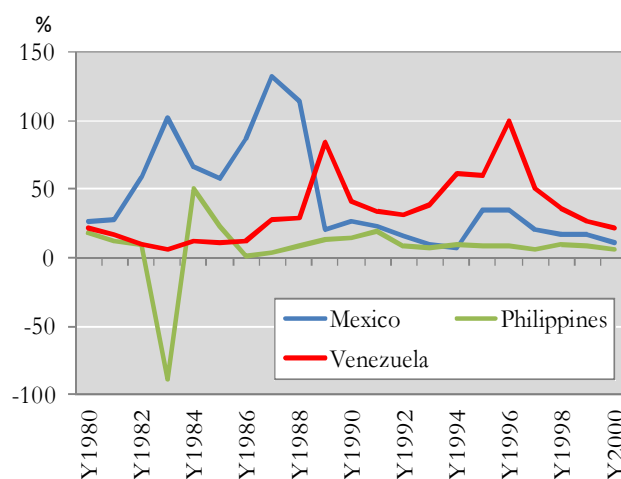
²⁶ Before the mid-1980s, most central banks were dominated by government and are served as divisions of treasuries or ministries of finance (Cukierman, 2011, chapter 2). At that time, their functions vary and are often conflicting, such as helping finance government expenditures, stimulate economic activities and exports, maintaining price stability and financial stability. However, the modern monetary policy making principle during the last two decades come into consensus that central bank should be more independent from government in term of both policy setting and policy action. The first implies that central bank should focus on core objective in maintaining price stability, the latter means that central bank should be free to set monetary policy instrument independently of other branch of government. The function that remains the same over time is to safeguard the stability of the financial system, particularly during the time of financial crisis.

²⁷ The quasi-fiscal activities led many central banks to the insolvency position and undermine their independence and also their monetary policy objective. Some central banks even cover loss by an expansion of central bank money, which in turn affect the price stability and their monetary policy credibility.

case of Central Bank of Venezuela in 1980s. This resulted in the losses of public confidence on the local currency and become dollarized economies. In addition, the attempt to tighten monetary policy in the latter period also exacerbated their already weak financial position; and 3) performing fiscal function²⁸ by lending to private sector and government in case of Central Bank of Philippines (CBP). The over-lending consequently resulted in the insolvency as the financial burden was excessive that the money and bonds issue from CBP was not accepted in the financial market. Other extreme cases are National Bank of Liberia-NBL (in 1980s-1990s) and central bank of Costa Rica (in 1981-85), where the financial weakness (originated from the quasi-fiscal operations) has led to clear problems in pursuing price stability, as reflected in the double digit inflation rates. In addition, the NBL was expelled from the local check clearing house for repeated settlement failure (BIS, 2011).

In conclusion, central banks that fail to achieve their policy objectives are typically in less advanced countries and are typically have weaker governance and institutional structure. The vulnerabilities to credibility mainly stem from an inability to keep the monetary policy discipline and from political interference in their policy decision and implementation. This consequently led to the policy ineffectiveness and sometimes further worsen the financial status.

Figure 13: Inflation rates in Mexico, Philippines and Venezuela during the 1980s and the 1990s

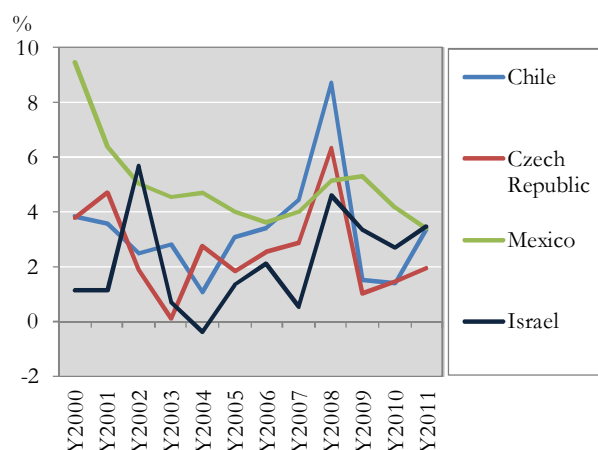


Source: IMF

Previously, there were examples of central bank policy actions and outcome that was affected by the financial weakness. However, some central banks can successfully operate with the negative capital over decades reflecting with the stable inflation rates and sound macroeconomic conditions. Four central banks which are commonly referred as successful central banks with weak financial status are Czech National Bank (CNB), Central Bank of Chile (CBC), Bank of Israel (BOI) and Bank of Mexico (BOM).

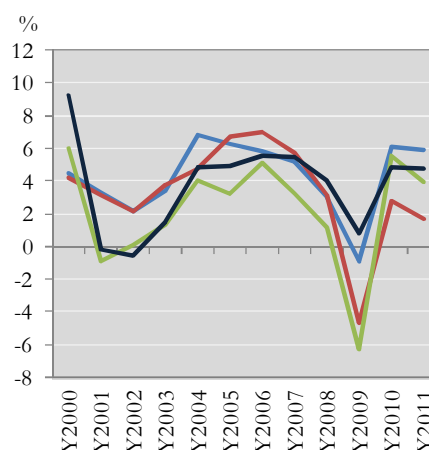
²⁸ During the 1980s, the CBP performed fiscal functions by lending to priority sectors considered by government at a subsidized rate. Meanwhile the exchange rate risk was accumulated from the swap operations and forward cover facility. This resulted in the recorded huge amount of losses on the balance sheet since the CBP exposed to negative carry and exchange rate risk from performing fiscal functions. The chronic losses resulted to the insolvency of the CBP and the new central bank, the Bangko Sentral ng Pilipinas (BSP) was established in 1993. More details can be found in Lamberte 2002.

Figure 14: inflation rates during the 2000s in selected countries



Source: IMF

Figure 15: GDP growth rates during the 2000s in selected countries



It is useful to explore the success factors of these countries in details. One would observe that these central banks share common characteristics that allow them to gain trust from public. Details are as follows. **First, the sources of losses are widely acceptable and correspond to their policy objective of maintaining macroeconomic and financial system stability.** Besides, **transparency and accountability in central bank communication** is the second key success factors. Communications of these central banks aims to convey three main messages; (1) central bank will not compromise its policy objective with their improving financial status, (2) **financial status of central bank can be improved and sustain in the long run** through improving financial and economic environment and/or measure to improve their financial status, and (3) **central bank policy independence remain intact.**

Losses of CNB were mainly due to the sterilized foreign exchange intervention in the 1990s. Later, the CNB changed the exchange rate regime from the fixed to float exchange rate in 1997. This resulted to the huge amount of valuation losses on the central bank balance sheet and brought the CNB's capital into the negative territory for the first time in 1999 (Frait and Holub 2011). Another interesting case is the CBC, which recorded losses since 1992 as a result of the historic banking system recapitalization in the late 1980s and the mismatch on the balance sheet from the sterilized intervention in the 1990s (Stella and Lonnberg 2008, Dalton and Dziobek 2005). Similarly, BOM incurred losses in 2004 due to large exchange rate mismatch from the needed to conduct the sterilized foreign exchange intervention to curb the volatility in the foreign exchange market during the exchange rate attack of 1994 (Dalton and Dziobek 2005). BOI is another case of central banks which recorded losses stemming from the foreign-exchange-related operations. In 1992, BOI adopted the inflation targeting framework with the crawling-band exchange rate system. During the period between 1994 and 1998, BOI intervened in the foreign exchange market to defend the band's limit, and this led to the accumulated losses on the BOI's balance sheet in 1999. However, losses recorded on these central banks are mainly valuation losses which are different from the unsuccessful cases mentioned earlier that losses generated from quasi-fiscal activities. And valuation losses do not create inflationary pressure since they are unrealized losses which do not have an impact on the liquidity in the system. This

point was pronounced by many studies and views of central bankers (Cincibuch et al. 2009, CNB 2010, Frait and Holub 2011 and Cukierman 2011).

These central banks have successfully convinced stakeholders that they would primarily focus on policy objectives. The BOI's actions also helped justify this point. Although the BOI's capital became negative due to the reserves accumulation, in 2008 BOI still decided to increase its foreign reserves substantially²⁹. Such actions gained the public confidence that the BOI insisted on the primacy of policy objective over the financial concerns. CNB is another interesting example. CNB clearly communicates that the negative capital of CNB is a result of sound monetary policy and it does not jeopardize the CNB's financial independence since CNB's seigniorage income is still sufficient to gain public confidence. And going forward, the capital would be replenished over time by the future seigniorage (BIS 2009 and Czech National Bank 2010).

Furthermore, **good coordination and good relationship between the central bank and the government** is also one of the common characteristics. For example, during the year between 2006 and 2008, CBC was partially recapitalized by the government without losing its independence and the government runs the budget surplus which helps lessen the inflationary pressure. The case of Mexico is also a good example. BOM has successfully made an arrangement to borrow the government securities for the sterilization from the government instead of directly accumulating from the outright purchase in the secondary market. This helps reduce the cost of sterilization in a way that no additional liquidity will be added into the banking system. This example can also be witnessed in the case of Israel that the government supported the foreign exchange policies. Therefore, it is unlikely that the political interference which may affect the central bank independence would be the case. With this, one would observe that countries that are endowed with **sufficient institutional quality and government efficiency** would at least allow their central bank to resist financial and political pressure better.

At this stage, it can be concluded from the logical sense and country case studies that the main factor behind the success of central bank policy is the credibility from the public. The credibility of central banks can be built up by the commitment to the pursuit of the core central bank mandates: price and economic stability. Communication with the public regarding the sources of losses is also vital since it helps promote the transparency of the policy implementation. Besides, good relationship with the government will also help strengthen the central bank credibility. One can draw a main finding from the country case study that **central bank that successfully operated in face of financial losses never allow themselves to fall into the extreme circumstance**. These central banks successfully address the channels (as discussed in section 3.2) through which the financial outcome would affect the policy, namely, policy decision and implementation, policy effectiveness and central bank independence. In contrast, central banks that fail to obtain credibility unavoidably lead themselves into channels that constrain their policy capacity. However, the relationship between the credibility and policy success will be explored to confirm such a proposition from the statistical point of view in the next section.

²⁹ BOT clearly stated that the policy conducts to achieve the *de jure* goals of price stability. See more detail in the Questions and answers about the Bank of Israel's policy on the BOI's website.

Section 4: The role of credibility in determining policy effectiveness

The conditions for continued policy success alongside low or negative capital are **credibility**, as discussed in the previous section. The statistical test in this section aims to confirm the previous finding that explanatory power of the central bank financial status is rather weak³⁰ and further argues that credibility plays more important and robust role to policy outcome, through a more straightforward relationship between the two. Steps for an analysis in this section are as follows;

The **first step** is to identify and to group factors combining into central bank credibility, and construct the credibility index. The principal component analysis (PCA) is employed to calculate the linear combination of institutional factors determining credibility. This help comparing relative credibility condition of sample countries. The **second step** is to further employ the computed credibility index to test the statistical relationship with the level of inflation.

4.1 Construction of credibility index

The credibility index consists of 7 factors as follows;

- (1) Central bank transparency
- (2) Central bank financial sustainability
- (3) Scope of central bank function
- (4) Central bank autonomy
- (5) Government balance
- (6) Country institutional quality
- (7) Financial development

There are three major areas governing central bank credibility. The first one obviously lies within the central bank action, which consist of factors (1)-(3) of the index. The second area is the relationship with government, namely, factors (4)-(5). The last area is the external environment, which are factors (6)-(7). The sources and details of index are provided in Appendix I. Rationale of each factor composing into the credibility index is presented below.

Central bank policy **transparency** is one of the major factors in enhancing credibility. Public should perceive that central banks commit to their mandate and believe in integrity and accountability, while their financial status is not part of the policy decision. Their balance sheet problem can be sorted out in separation to the monetary policy decision process.

In addition, BIS (2011) suggested one of the major factors for the policy success alongside the negative equity is that the reasons for central bank losses are politically acceptable. The country case studies also conclude that the major reason for losses should relate to the accomplishment of central bank objectives. It is thus vital for central banks to communicate

³⁰ Due to the limitation of data, the basic OLS regression is employed. To preserve the degree of freedom, the credibility index formed by PCA is employed in the regression, instead of using each of seven indicators. Other statistical methodology that involves time dimension is not suitable for this exercise since the credibility is formed by the institutional factors, which are qualitative by nature and are time invariant. In addition, there is limited data availability; there are only 43 sample central banks in the study, while the time span in the consideration is not long.

reason for losses with their stakeholders, which are government and public³¹. One would see that highly credible central banks such as Czech National Bank, Central bank of Chile, Swiss National Bank give importance to communication. Earlier literatures also support the role of transparency in enhancing policy effectiveness. For instance, increased transparency associated with lower inflation (Chortareas et al., 2002), as well as lower inflation variability (Dincer and Eichengreen, 2007). Lastly, more precise and transparent communication makes policy more predictable using the case of FED (Ehrmann and Fratzscher, 2007).

In addition to transparency, central bank must ensure public that they can achieve **long term financial strength**. If central bank can sustain its pursuit of policy objectives that involve financial risk, doubt from public will be less likely to occur. In contrast, if the doubt of financial status occurs, they can be self-fulfilling in their negative impact on policy capacity, as transmission mechanism can be weakened or even turn into reverse. The measure of financial sustainability is by the structural flow measures³². Calculation method can be found in BIS (2005).

As mentioned in section 2.1, the **nature and scope of the functions** of central banks indicates the degree of the risk that central bank faces with. This also gives implication on central bank financial strength and its credibility. Cukierman (2011) suggested that greater width of areas of responsibility, the larger recommended level of capital as a risk buffer.

In addition, effectiveness of central bank communication is crucial in cultivating trust and understanding from public. Public should be aware of rationale for policy exercise, and be ensured that central banks always stick to their core mandate. The level of financial literacy, public awareness, and effectiveness of financial markets as reflected by **financial development** can be important factor that helps enhancing effectiveness of central bank communication. It is thus, one of the determining factors for central bank credibility, though the aid in facilitating monetary policy transmission mechanism. Previous literatures also give importance to this factor. For example, improvement of efficiency in financial system is expected to increase efficiency of the link between policy rate and money market rate (Woodford, 2002). To keep market calm and bond yield low; not only central banks must be independent, they must also be perceived as independent and expected to remain independent (Hawkins, 2003). Under stressed episode, public expectation as to how central bank respond to deterioration in financial position determine stabilization efforts (Sims 2004)

The greater **central bank autonomy**, the less likely for central bank to fall under pressure to perform operations that is in conflict with their mandate. Lesson in the past of central banks in Latin American countries in section 3.3 suggest that the policy success or failure depends very much on ability to maintain monetary policy discipline and to fulfill their mandate

³¹ The communication can be via the financial statement, central bank staff report, press release, and speech by governor.

³² The steady state capitals are also calculated to cross check the measure of the financial sustainability using the structural flows method. The two measures are found to be consistent with each other. In addition, altering between the two measures does not change the statistical relationship between credibility and policy efficiency in the regression.

and responsibilities. Earlier empirical studies also show that greater **autonomy** on average helped maintain low inflation level, using sample data of 163 central banks in Arnone et al. (2007) and sample data of 37 central banks in Crowe and Meade (2008).

Many times, discipline does not rest solely on central banks action; it depends on other environmental factors especially, relationship with government and **institutional quality**. Institutional quality refers to government efficiency³³ and regulatory quality. The institutional quality is found to be an important factor in the credibility index because it reflects the chance of political interference and the chance of the policy cooperation between central bank and government. In the earlier literature, institutional quality incorporating these two aspects appears to be significant factor in regression of the link from financial strength to policy outcome (BIS 2011).

The case study of Chile shows that negative level of central bank capital may not have an impact on price stability, as it depends on **the long run stance of fiscal policy**. In spite of increasingly negative level of central bank capital, Chile could successfully reduce inflation level with the aid of a sustained fiscal policy of budgetary surplus. In addition, the political aspect of government balance is that the greater government's tendency to create deficits, the more important it is to protect the independence of central bank (Cukierman, 2011).

Next, the method of principal component analysis (PCA) is utilized to construct the central bank credibility index. The methodology is useful in obtaining the meaningful index out of complex and multidimensional elements of credibility. The objective of PCA in this study is to decrease dimension of the data, by computing the linear combinations of the seven variables explaining central bank credibility. The linear combinations are computed such that the maximum variance is extracted from the variables. For most of the developing countries, the completed data for 7 variables are not available, the credibility index obtained are thus totaled of 43 central banks.

The PCA is a linear transformation of the data to a new coordinate system. The direction with the greatest variance is lied on the first coordinate (called the first principal component), the second greatest variance on the second coordinate (the second principal component), and so on. In this instance, the first principal components are employed as an aggregate measure of the credibility, which explain the maximum variance of 50 percent. The results for the proportion of variance explained by the principal components and their accumulated values are reported in appendix II. Coefficients of each variable are presented below.

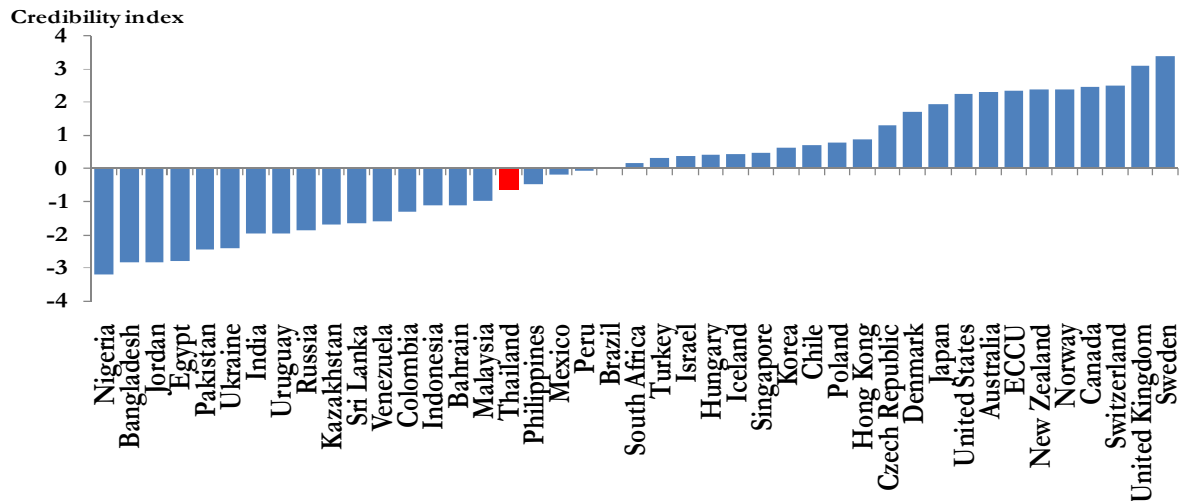
$$PCA = 0.46*Transparency + 0.44*Financial\ development + 0.24*Independence + 0.48*Institutional\ Quality + 0.10*Government\ balance - 0.45*Function + 0.32*Sustainability$$

³³ Government efficiency captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Regulatory quality captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. See Kaufman, Kraay, Mastruzzi (2010) for further details.

From the relationship, the sign in front of the central bank function variable is negative. This suggests that the greater scope of function the central banks have, the lower credibility score could be. This is relevant to the discussion in section 2.1. Central banks with greater scope of function are normally EMEs, and assume higher risk and responsibility, as they opt to manage risk and perform policy purely through their own balance sheet.

The credibility score of sampled central banks are presented in figure 16. The vertical axis represents the credibility score calculated from the first principal components.

Figure 16: The calculated credibility index



Source: Authors' calculation from PCA

The calculated credibility index suggests that central banks in advanced economies obtain higher credibility score due to the better institutional structure. Central banks that currently use their balance sheet structure as a policy tool, such as G3 and UK, stand among the top ten strong credibility indexes. Central banks that could have financial losses for decades, such as Czech and Chile, obtain high level of credibility. One would observe that central bank with high credibility usually are allowed to have wiggle room in their activities. In addition, central banks in these countries have smaller need for financial buffer; the smaller equity to economic size is a good example. In contrast, central banks in developing countries, including Thailand, obtain lower credibility score, as located in the left hand side panel of the figure. This implies that central banks in these countries are considered more vulnerable especially in face of financial losses. Nevertheless, the credibility score for the case of the Bank of Thailand is relatively in the lower-middle of the sample group, which is quite close to those of Israel and Mexico. Central banks in these two countries already had negative equity for several years but could achieve favorable policy outcome.

Due to the higher vulnerability to credibility comparing to central banks in advanced countries, it leaves no much room for flexibility in case of the Bank of Thailand and other central banks in developing economies. It is thus vital for them to further improve their policy transparency and financial sustainability, which are two major credibility factors under their direct control. This is especially true when other credibility factors beyond central banks control, which are rest on external environment and relationship with government, can possibly get

worse during an anomaly time. The balance sheet resolution scheme introduced by the Bank of Thailand is an example of the pre-emptive action to restore credibility even before the financial outcome could have impact on their policy decision and policy effectiveness.

The credibility index will be used further to assess the role of credibility in the policy effectiveness.

4.2 Statistical relationship between credibility and policy effectiveness

The computed credibility index is employed to test the statistical relationship with the level of inflation. The financial outcome can be added as a regressor in the equation, this helps confirm the weak relationship between financial status and inflation outcome. Each variable represents an average values over 2006 to 2011. This study follows many of previous papers which focused exclusively on one dimension of policy success, which is the achievement of the price stability. The focused is justified in Benecka et al (2011) by two grounds. First, high inflation would be a clear sign of policy failure since the price stability is considered as the primary objective of monetary policy, no matter what policy regime it is. Second, “higher inflation is a way to boost seigniorage, meaning that there is a potentially straightforward transmission between a central bank’s desire to overcome its financial weakness and policy outcomes”.

Following Benecka et al. (2012), several structural determinants of inflation are employed as **control variables** in the regression of inflation, such as level of economic development as captured by real GDP per capita, trade openness, capital account openness, and dummy variable for inflation targeting framework³⁴. The dummy value equals to one if the central bank adopt the inflation targeting regime. Data sources and data explanation are provided in Appendix I.

The analysis starts with the scatter plots of inflation and credibility index in figure 17, which suggest a clear negative relationship. In contrast, scatter plots of relationship between inflation and capital is rather weak in figure 18.

Figure 17: Scatter plots of inflation and credibility index

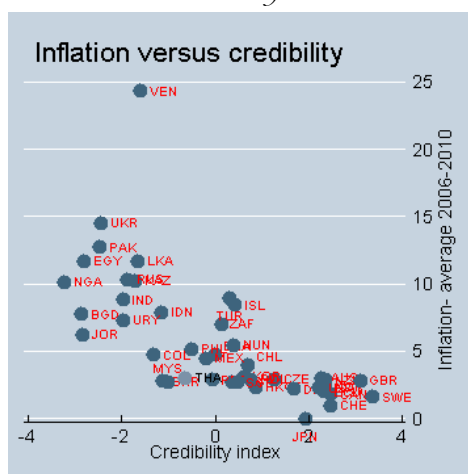
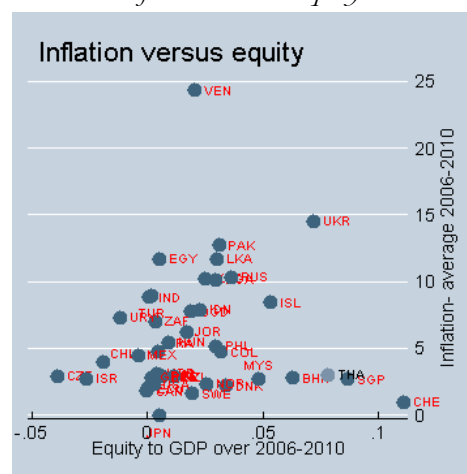


Figure 18: Scatter plots of inflation and ratio of central bank equity to GDP



³⁴ Batini, et al. (2005) argued that countries adopting inflation targeting regime tend to have lower inflation than others.

The regression results are presented in table 4. The results confirm previous studies that the explanatory power of central banks' financial strength indicators is rather weak, while the credibility indicator plays a more important and robust role in determining policy success. Central banks with higher level of credibility are able to maintain lower level of inflation. In fact, the result may convey two main messages. First, institutional setup, which each central bank involves with, determines its ability to anchor inflation expectation. Second, central bank financial status does not have direct impact on central bank policy effectiveness. However, it is rather considered to be part of the institutional factors, concerning the financial sustainability issue.

The regression has controlled for other inflation determinant indicators, which also found to be significant. The signs of relationships are as expected. The control variables are statistically significant with correct signs. The more developed countries are expected to have lower level of inflation, as they have higher ability to curb inflation expectation. In other words, the transmission mechanisms of advanced countries are more effective than the less advanced economies. There also exist negative and significant links between inflation and openness, both in terms of trade and capital account. The trade openness could reduce the inflationary pressure while the financial openness can lower the cost of borrowing for government. The dummy for inflation targeting regime is quite weak in this case, although the sign is correct. This implies that other important elements, such as institutional factors that determine credibility, play more important role in explaining monetary policy effectiveness than commitment by adoption of the inflation targeting regime.

Table 4: Regression analysis of inflation (over 2006-2011)

Variables	Coefficient	Robust S.E.	T-value
Credibility index	-1.32	0.50	-2.62***
Capital/GDP	-17.90	16.67	-1.07
Real GDP growth	0.65	0.40	1.63*
Trade openness	-0.01	0.01	-2.31**
Capital account openness	-1.15	0.56	-2.07**
IT dummy	-2.54	1.91	-1.33

Section 5: Solutions to the financial weakness

Up to this point, one observes that financial weakness is not the major concern for the policy outcome, unless it is in a severely distressed position. Several credible central banks never allow themselves into that situation, as it may be able to technically limit the policy operations and/or invite public perception that central banks care about their financial status.

First, it is important to stress here that a good policy is the financially feasible and sustainable. Central banks do not implement policy at all cost, but rather carefully choose the policy option that is effective and help deliver outcome that is correspond with their mandate. Central bank financial status is not part of concern in the policy decision process; credible central bank will never compromise their policy decision with the financial outcome.

Second, losses and risks to central bank balance sheet are inescapable results of policy actions that benefit the economy since the primacy of central bank's policy objective outweighs their financial consequences. Once the losses occurs, the loss reduction or further-loss

prevention system should be introduced, by central banks itself and/or in corporation with government. Public should also perceive that central banks can retain its long term financial strength.

The analysis of the solution to financial weakness starts with the case of a hypothetical central bank to explore the possible outcome of each option in principle. Next, the case for the bank of Thailand will be discussed.

5.1 Alternative solutions and their implications to macro-economy

This section is motivated by exploring alternative solutions to central bank financial status and evaluating the corresponding macroeconomic and financial outcomes, using the simulation model. The macroeconomic conditions are incorporated in the model to allow the feedback between central bank financial status and macroeconomic outcome.

The Monte Carlo technique³⁵ is employed to simulate the capital and inflation paths under scenarios listed below. The balance sheet simulation model by Bindseil et al (2005) is modified by allowing adverse feedback of the central bank financial status to the policy efficiency³⁶, by allowing the influence of credibility. Scenario analysis is added to the original model and is chosen corresponding to common situations in the emerging economy, such as a high country risk premium and the abundant foreign reserve accumulation, while most parameters are kept similar to the original paper. Details of the model construction can be found in the Appendix III.

It is important to note here that numbers appear in the simulation results are hypothetical; they are thus not necessary represent any real world amounts. It rather helps visualize and compare the macroeconomic and financial outcomes under different scenarios. In this context, the improvement in the level of capital and the lower inflation level are considered desirable outcome. Each graph has three lines, the median (thick line) and 0.05 and 0.95 percentiles (dot-lines). These paths are the cross-section of the simulated data in each period with 1000 replications.³⁷

Before moving on to the scenario analysis, it is useful to discuss factors determining sustainability³⁸ of central bank capital. The growth of monetary base play significant role in allowing the sustainable path of capital. According to the model, when the monetary base growth rate drops below the certain threshold, the unsustainable path is observed. The threshold depends on a spread of long-term profitability of foreign reserve management and domestic nominal interest rates.

Given a certain set of parameter, it is not unusual for central bank operations to temporarily drive its capital down to a negative territory. According to the simulation results,

³⁵ The Monte Carlo simulation technique is a well-known tool in the field of financial engineering actively used in pricing exotic derivative and risk management. The technique makes use of the computational power to generate stochastic processes of the interested phenomena.

³⁶ The modified model in this paper allows the adverse feedback loop by assuming that the inflation expectation can be increased once the level of capital turns negative. Details can be found in appendix III.

³⁷ All parameters in simulations are provided in appendix IV.

³⁸ The unsustainable path means that the capital will never reemerge to positive number again.

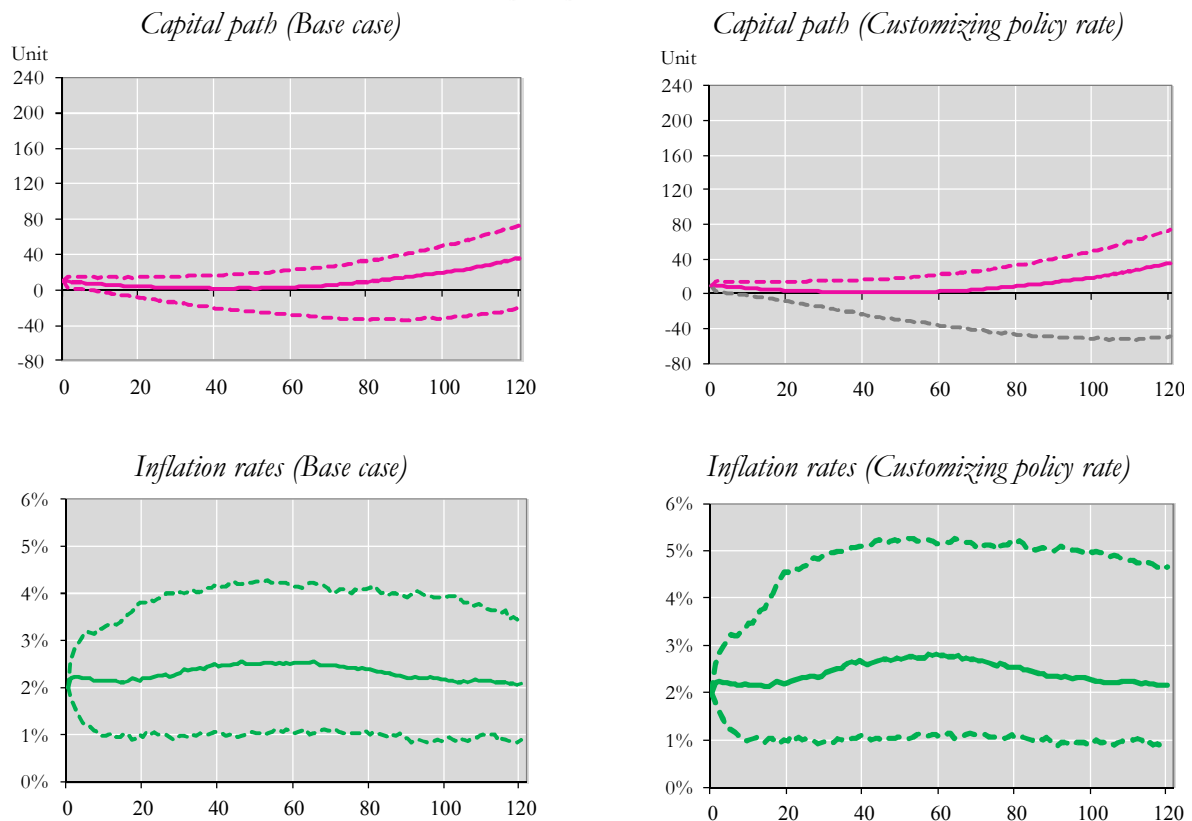
negative level of capital likely to occur even in the case of central bank that operates with the interest rate suggested by the Taylor rule.

The followings are main findings of the results of each balance sheet improvement option of a hypothetical central bank.

Option 1: cost reduction by customizing policy rate: a self defeating problem

A hypothetical central bank may choose to reduce the policy interest rates so as to lessen the interest payment on their liabilities, for the purpose of improving its profit and losses. This option implies that central banks compromise its policy objective for the purpose of improving its financial status. This corresponds to the first channel (in section 3.2), namely the policy decision and implementation, through which the severe financial losses could impair central bank credibility.

Figure 19: Capital paths and inflation rates



The first scenario in the simulation model allows the policy interest rate to be slightly below the optimal interest rate as suggested by the Taylor rule, under the condition of negative capital. The simulation results show that the reduction of the policy rate below its optimal level results in the higher inflation outcome, as presented by the higher mean value of inflation in figure 19. The upside risk of inflation, as stated in the percentile 95, is also increasing. The initial intention to improve financial condition by reducing interest expense is also futile; the higher level of inflation necessitates the central bank to consequently tighten its policy rate. This also results in the further reduction in the downside risk of the equity level, in other words, policy compromising does not help resolve the central bank financial problem reflecting in the higher risk to worsen its equity.

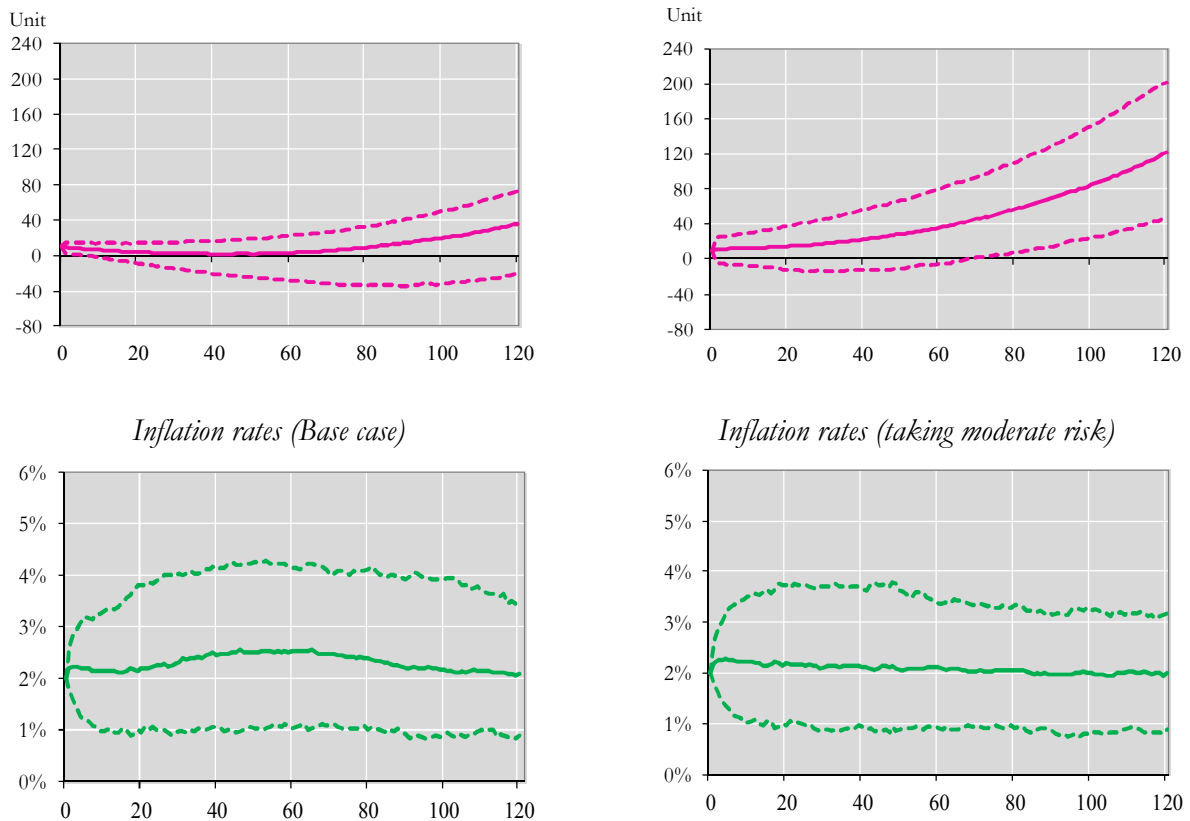
Option 2: profit enhancement by seeking more risk on the foreign reserve management: high-risk-high return

Besides cost reduction, an alternative financial solution for the hypothetical central bank is to increase profitability. The central bank could enhance return on the net foreign reserve via investment in higher risk assets with the expectation to improve the return and recover the existing loss.

In practice, central banks may consider expanding their asset universe to incorporate any higher risk/return asset classes such as equity, commodity, and real estate. It is still debatable how volatile the level of capital a central bank can tolerate and how much credit and liquidity risk a central bank should opt to. The simulation exercise presumes the high risk high return basis, where higher expected return associated with greater risk in the foreign reserve earning.

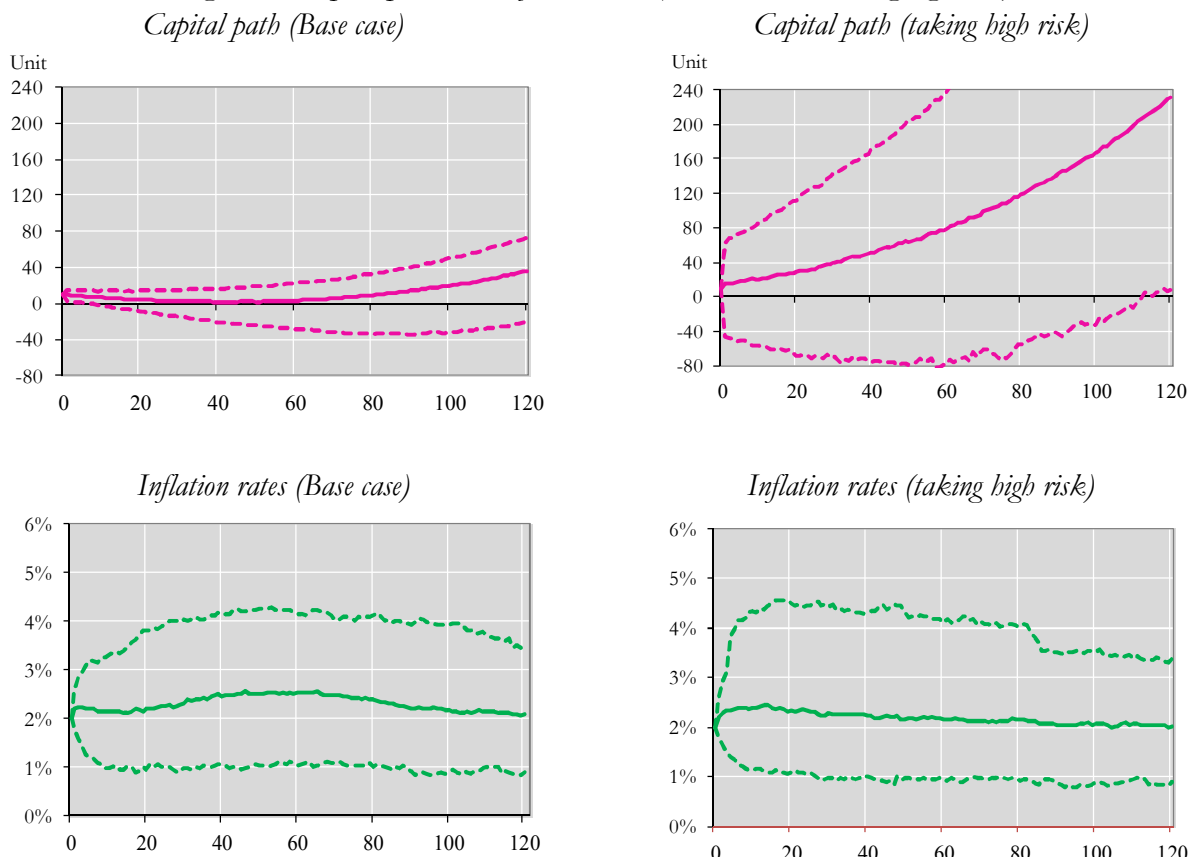
The simulation results suggest that moderately expanding the asset universe to allow higher risk return profile could possibly improve the level of central bank capital, while achieving more favorable the inflation outcome (figure 20). From the figure, the slightly improving the returns by taking moderate risk could result in higher median of central bank capital. The probability of severely distressed equity was also reduced, as illustrated by the 5th percentile of the capital level. This also helps improve monetary policy efficiency, as it may help reassure public about better financial sustainability and the lesser chance for central bank to incorporate their financial weakness into their policy formulation.

Figure 20: Capital paths and inflation rates (Base case VS Taking moderate risk)



Nevertheless, aggressive investment strategy could result in adverse financial outcome. Although taking substantially higher risk could result in higher average return, the probability of turning to severe negative capital has raised sharply either. Figure 21 illustrates that the 5th percentile of capital has reduced drastically, which corresponds to higher risk to inflation.

Figure 21: Capital paths and inflation rates (Base case VS Taking high risk)



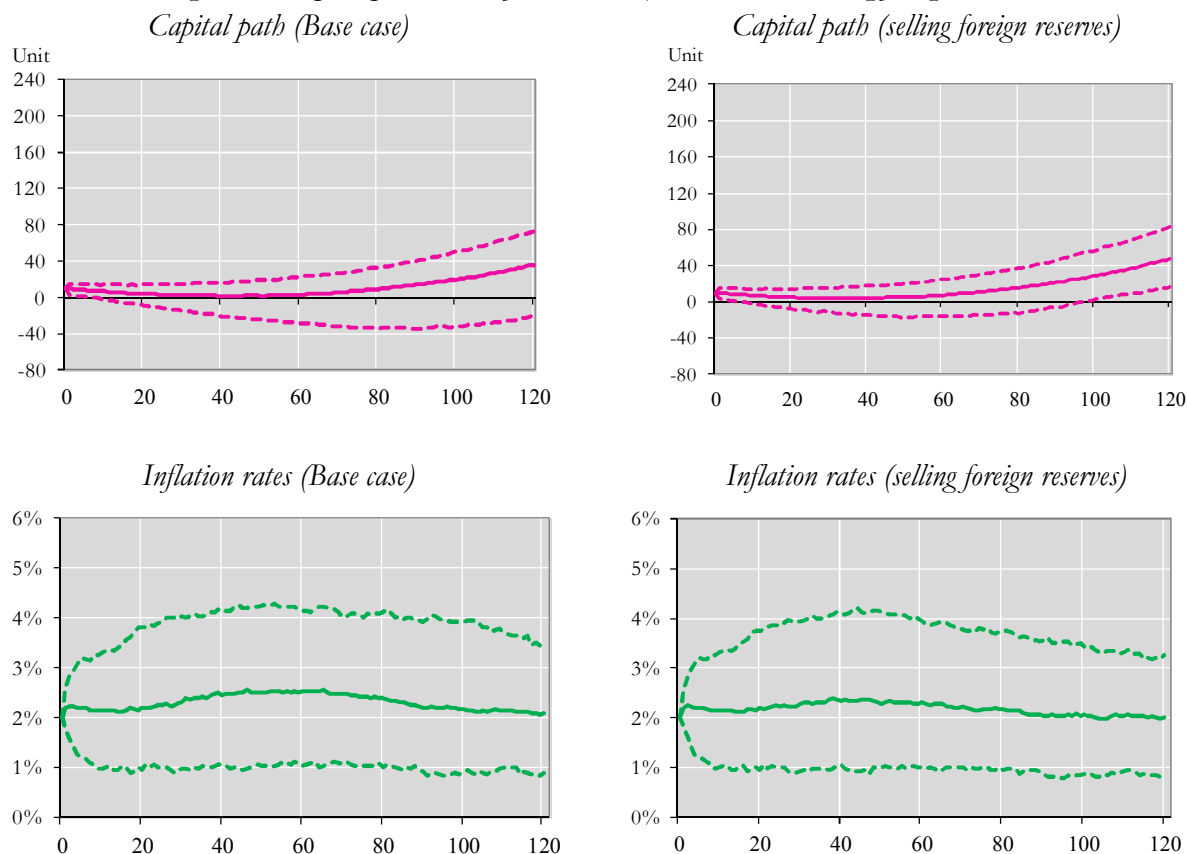
Choice (3): balance sheet structure improvement by minimizing its mismatch: complicate in practice

In case of central banks in developing countries, the currency and the interest rate mismatch relates to the ratio between net foreign reserves assets and non-monetary liability in local currency. The net foreign reserves tend to earn lower interest return and have longer maturity, comparing to the interest cost of financing domestic liability. The mismatches actually reflect risks embedded in the balance sheet structure. One way to minimize them is to reduce the size of net foreign reserve assets. Selling foreign reserves may be the direct way to solve the problem of high balance sheet exposure.

In practice, reducing central bank foreign reserves can be difficult, as it depends on the balance of the capital flows in an economy. This is especially true in case of emerging economies where the capital market is relatively thin and need far more level of development. Selling a substantial amount of reserve into the system can significantly affect the balance of capital flows and put pressure on the currency. Central banks deem to do market neutral operations in order not to conflict with their roles in maintaining price and exchange rate stability. Selling small

amount in the market neutral manner can be possible, but central banks need to allow time and occasion to do so. The actual implementation could be highly uncertain with respect to the international capital mobility, as mentioned earlier. In addition, the determination of excess reserves or the optimal reserves might be controversial. Thus, it is usually difficult to justify whether the country hold excess amount of foreign reserves, unless it is in an extreme case.

Figure 22: Capital paths and inflation rates (Base case VS Selling foreign reserves)



The simulation model assumes that the hypothetical central bank opt for the market neutral strategy by gradually selling foreign reserves without any influence on the foreign exchange market. The results are found to be satisfactory, as illustrated in figure 22. The probability for equity to turn into negative level has declined. The upside risk of inflation has also declined in the long run.

5.2 The case for the Bank of Thailand

The discussion of the solution to financial weakness in section 5.1 was to address the stock basis of the balance sheet exposure. **Stock problem** refers to the existing amount of losses due to the past operation. This refers to the foreign currency reserve accumulation in case of the Bank of Thailand. As mentioned earlier, the reserve accumulation coupled with the sterilization results in the losses from ‘negative carry’ and ‘valuation losses’. Factors determining the size of losses are the interest rate gap between returns from holding international reserves and domestic interest rate cost of sterilization, outstanding amount of international reserves and the exchange rate volatility.

The solutions to the stock problem are widely discussed. Public suggestion includes (1) improving the return on investment in the foreign reserve assets, (2) reducing the policy interest rates, and (3) reducing foreign currency reserves holding. For the first approach, the Bank of Thailand has expanded the asset universe by increasing investment in Asian government bond market. This helps reduce interest rates mismatch by increasing return from foreign reserves. However, investment in other asset class needs careful considerations, as it need to be under the scope that stated by the law. In addition, liquidity and credit risk should also be concerned. It should be noted that investing in risky assets could increase the probability of financial losses, which in turn worsen the capital condition and could consequently affect the central bank credibility.

Interest rate reduction was formerly suggested by an outsider; however, this could not actually solve the problem but rather worsen central bank financial status. If the interest rate is reduced to the level that is not consistent with economic fundamental, the policy will lose trust from public. Consequently, central bank ability to curb inflation expectation is also affected, which result in the ineffectiveness of the monetary policy. Once the financial status involves in the policy decision, credibility will also be destroyed. Consequently, the central banks need to exercise more tools, i.e. increasing more interest rates, in order to curb inflation. One would observe that credibility is important. Therefore, solving the financial position by compromising the policy is not a wise solution. The last suggestion is to reduce amount of foreign reserve holding, by selling it. This gives favorable results, however implementation is not easy in practice, as it depends on several factors especially international capital flows.

Another important aspect of the balance sheet exposure is the **flow problem**, which depends on the additional foreign currency reserve accumulation, in other words, the degree of intervention in the foreign exchange market going forward. In fact, allowing more flexibility in the foreign exchange market could create advantageous to the economy as follows: (1) it stimulate an adjustment in the economic structures to a more volatile exchange rate, which help increase their ability to absorb shocks, (2) it encourage private sectors to use more foreign exchange hedging tools and to improve their production efficiency to produce higher value added products, and (3) it encourage a more investment domestically and internationally.

The degree of intervention in the foreign exchange market going forward depend very much on the foreign exchange policy design which take into account challenges from economic environment and the readiness of the economy and business operators to adjust for shocks and foreign exchange rate volatility. With this, a more flexible foreign exchange rate is suitable for current situation, because of the three main reasons. First, recently, private sectors have more capability to cope with shocks and more volatile exchange rates, and increase their usage of foreign exchange hedging tools. Second, there is greater need for the economy to push ahead with improving industrial and manufacturing competitiveness due to higher competition in the global trade. Relying on the price competitiveness through the weaker foreign exchange rate is not a way to achieve sustainable growth. Lastly, the international capital flows become more balanced. The outward direct investment has increased gradually after the capital account

liberalization³⁹. The challenge to volatile capital flows in the near term is the continuation of the quantitative easing measures of advanced economies; however, impacts on the economy tend to be less severe. During 2009-2010, the surges of the international capital flows into Thailand and other EMEs are from both push and pull factors. The monetary policy easing measure in advanced economies resulted in the influx of liquidity to search for higher yield and currency gain in the economies with better economic growth prospects. Currencies in EMEs were proxy of the Yuan, which was expected to appreciate following China's impressive economic growth performance. However, the disparity in the growth momentum between advanced and EMEs is less sharp currently, the huge and sudden capital inflows may be less likely observed. With the combination of the economy's greater resiliency to shock, the better adjustment of the private sector and the higher effectiveness of measures to restore the balance in the capital flows, it would necessitate less foreign exchange intervention in an anomaly period.

The Bank of Thailand should gradually allow more flexibility in the foreign exchange rate and intervene occasionally when the baht deviate from its fundamental. Eventually, the role of the Bank of Thailand as an exchange rate stabilizer will be faded out, and the BOT's financial vulnerabilities will not be aggravated.

Conclusion

This study set out to determine whether central banks' financial weakness adversely affect their policy performance. The most obvious finding to emerge from this study is that the continued policy success does not depend on the central banks' financial status, but rather on the ability to maintain credibility. The financial status can instead be treated as one of the credibility factors. This study contributes to the literatures by identifying credibility factors and found a statistically significant relationship with the policy effectiveness.

The empirical results also suggest that the Bank of Thailand and other emerging market economies have higher vulnerability to credibility comparing to central banks in advanced economies. They are thus recommended to improve the area of transparency and financial sustainability, especially in face of financial loss. This brings in another important practical implication of this paper; to maintain credibility in face of financial loss, central bank should provide guideline for restoring long term financial strength. However, the solution to financial weakness must not conflict with the core policy objective. An analysis of alternative solutions to financial weakness through an assessment of impact on macroeconomic and financial outcome was the second contributions to the literatures. Nevertheless, it was not specifically designed to evaluate factors related to the real economic sector. This can be recommendation for future research.

³⁹ The Bank of Thailand attempted to create the more balanced flow environment by introducing the Capital Account Liberalization Master Plan in 2011. The objective of the plan is to mitigate the risks related to the impact of capital flow volatility on exchange rate and domestic asset prices as well as to strengthen the country's long-term international financial capability. The first phase of the plan is to liberalize the capital flows by relaxing regulations that create obstacles for investors who seek higher returns and diversification benefits from investment abroad. This will help strengthen our International Investment Position (IIP). The plan is expected to deliver more balanced capital flows, enhance capital and foreign exchange markets development in the long term. This will consequently aid Thai business in gaining competitiveness in international trade and investments, and get ready to the integration of the regional financial markets by ASEAN Economic Community in 2015

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Appendix I Data details and sources

Variable	Details and Sources	
Central bank asset	Ratio to GDP	Central banks annual report
Central bank equity	Ratio to GDP	Central banks annual report
GDP	Nominal value at local currency	IMF, IFS
Inflation	% change YOY of consumer price index	World development indicator
Real GDP per capita	PPP Converted GDP Per Capita (Laspeyres), derived from growth rates of c, g, i, at 2005 constant prices	Penn World Table
Trade openness	Trade Openness at 2005 constant prices (%)	Penn World Table
Capital account openness	Chin-Ito de jure measure of financial openness	Chin and Ito (2008)
Inflation targeting	Dummy variable	IMF, IFS
Transparency	Political, Economic Procedural, Policy, and Operational aspects, 2005	Dincer and Eichengreen (2007)
Scope of central bank function	Index of central bank function, 2009	Central bank governance group, BIS
Central bank autonomy	Political and economic score, 2003	Arnone et al. (2007)
Financial development	Financial development report, 2011	World Bank
Institutional quality	Regulatory quality and government effectiveness dimension, 2011	The Worldwide governance indicators (WGI), World Bank
Government balance	Government cash balance (%GDP)	World Economic Outlook, IMF

Appendix II Principal Component analysis

Sample: 43 countries, average value over 2006-2011

Principal components/correlations:

Component	Eigen value	Difference	Proportion	Cumulative
Component 1	3.40	1.96	0.49	0.49
Component 2	1.43	0.57	0.20	0.69
Component 3	0.87	0.37	0.12	0.81
Component 4	0.50	0.10	0.07	0.89
Component 5	0.40	0.09	0.06	0.94
Component 6	0.31	0.22	0.04	0.99
Component 7	0.09		0.01	1.00

Eigenvectors (loadings):

Variable	Comp1	Comp2	Comp3	Comp4	Comp5	Comp6	Comp7	Unexplained
Transparency	0.46	-0.20	0.00	0.02	-0.25	0.83	0.08	0.00
Financial development	0.44	0.34	-0.30	-0.15	0.28	-0.15	0.69	0.00
Autonomy	0.24	-0.40	0.78	-0.14	0.33	-0.14	0.19	0.00
Institutional quality	0.47	0.24	-0.09	-0.21	0.45	0.00	-0.68	0.00
Cash balance	0.10	0.65	0.46	0.59	-0.09	0.07	0.00	0.00
Function	-0.45	-0.01	-0.08	0.21	0.73	0.45	0.11	0.00
Sustainability	0.32	-0.46	-0.28	0.72	0.12	-0.26	-0.05	0.00

Appendix III Simulation models and equations

- i. *Central Bank Balance Sheet:* The asset side has a single item i.e. the net foreign reserve (F), while the liability comprises three items, the monetary base (B), the non-monetary base (M), and the capital (C). The monetary base includes the currency in circulation and banks' reserve. Non-monetary liability is the debt instruments employed in open market operations such as repurchasing agreements, discount window, central bank's securities as well as swap.

A simplified central bank balance sheet

Assets	Liabilities
F Net Foreign Reserves	B Monetary Base
	M Non-Monetary Liability (OMOs)
	C Capital

- ii. *Central Bank Policy Operations:* In this setting, a central bank performs only two tasks, setting short-term rates to curb inflation and managing net foreign reserve. It adjusts policy rate (i_m) according to a simplified Taylor rule (STR) and pockets the foreign reserve's return (i_f) which assumed to be normally distributed.

$$i_{m,t} = \max(4 + 1.5(\pi_{t-1} - \pi_{target}), 0)$$

$$i_f \sim N(\mu_F, \sigma_F)$$

[Definition: inflation (π), inflation target (π_{target}), time index (t)]

- iii. *Inflation Dynamics:* The simulations adopt the Wicksellian relationship to describe the inflationary process. It is important to emphasize that a central bank could not fully control the inflation so the error term (γ) is introduced.

$$\pi_t = \pi_{t-1} + \beta(i_{real} + \pi_{t-1} - i_{m,t-1}) + \gamma \quad ; \gamma \sim N(0, \sigma_\gamma)$$

[Definition: real interest rates (i_{real}), inflation coefficient (β)]

- iv. *Exchange Rate Dynamics:* Exchange rate is assumed constant, but we would argue that it is not too simplistic. The result should be the same as applying a famous exchange rate model, the random walk process. The random walk model would simply boost the uncertainty in the system without altering the average level or the shape of the capital and inflation paths. However, it will be more fanciful if we could model both the exchange rate process and its intervention rule.
- v. *Net Foreign Reserve Dynamics:* The amount of foreign reserve remains unchanged unless a central bank does foreign exchange intervention (I) i.e. buy/sell foreign currency. For simplicity, our model ignores any foreign exchange interventions, except the case of choice (3).

$$F_t = F_{t-1} + I_{t-1}$$

- vi. *Bank Note Dynamics:* The bank note growth rate will normally follow the growth of nominal GDP. It fluctuates around the long-term trend due to the uncertainty demand for money (ε).

$$B_t = B_{t-1} + B_{t-1}(i_{real} + \frac{\pi_t}{100}) + \varepsilon \quad ; \varepsilon \sim N(\mu_\varepsilon, \sigma_\varepsilon)$$

- vii. *Administrative Cost Dynamics:* The general administrative expense (q) such as central bankers' salary, and note printing cost etc. is assumed to inflate by the inflation rate.

$$q_t = (1 + \frac{\pi_t}{100}) \times q_{t-1}$$

- viii. *Profit Distribution Scheme:* A constant rule is applied. If a central bank makes profit, it must distribute certain portion to treasury (α). On the contrary, any losses will be absorbed by central bank individually.

$$\text{if } P_{t-1} > 0 \text{ then } C_t = C_{t-1} + \alpha P_{t-1} \text{ else } C_t = C_{t-1} + P_{t-1}$$

[Definition: profit (P)]

- ix. *Liquidity Absorption:* The amount of open market operations (OMOs) derives by equating the asset and liability side. Simply put, it is a residual of balance sheet.

$$M_t = e_t \times F_t - (B_t + C_t)$$

[Definition: exchange rate (e)]

- x. *Profit and Loss:* The way profit and loss being recognized is straightforward. The profit comes from the interest earned on the foreign asset, and the expense comes from the interest paid on the OMOs and other administrative cost. It should be noted that the monetary base bear no interest and is irredeemable, so it is irrelevant here.

$$P_t = \left(\frac{i_f}{n} + \ln\left(\frac{e_t}{e_{t-1}}\right) \right) F_t - \frac{i_{m,t}}{n} M_t - \frac{q_t}{n}$$

[Definition: simulating frequency (n)]

- xi. *The Adverse Feedback Mechanism:* As we mentioned earlier, the credibility is the linchpin. Here we take or granted that a low credible central bank with negative capital would raise the public's inflation expectation (θ). In a modeling perspective, it shifts up the mean of the error term in the inflationary process.

$$\pi_t = \pi_{t-1} + \beta(i_{real} + \pi_{t-1} - i_{m,t-1}) + \gamma \quad ; \gamma \sim N(\theta, \sigma_\gamma) \text{ when } C_t < 0$$

- xii. *Exception:* The simulations ignore the detail of accounting policy as its modeling is quite convoluted. For example, it has a big flaw on how to separate between realized and unrealized gain/loss.

Appendix IV Parameters used in the simulation model

	Parameters	Baseline	Unsustainable Case	Choice (1)	Choice (2)		Choice (3)
				Customizing policy rate	Taking moderate risk	Taking high risk	Minimizing its mismatch
i. Central Bank Balance Sheet	F_0	100	100	100	100	100	100
	B_0	30	30	30	30	30	30
	M_0	60	60	60	60	60	60
	C_0	10	10	10	10	10	10
ii. Central Bank Policy Operations	i_m	STR	STR	0.5% lower than STF*	STR	STR	STR
	μ_F	2.50%	2.50%	2.50%	5.00%	10.00%	2.50%
	σ_F	4.00%	4.00%	4.00%	10.00%	30.00%	4.00%
	π_{target}	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
iii. Inflation Dynamics	σ_γ	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%
	i_{real}	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
	β	0.20	0.20	0.20	0.20	0.20	0.20
iv. Exchange Rate Dynamics	e	1	1	1	1	1	1
v. Net Foreign Reserves Dynamics	I	0	0	0	0	0	0.5/quarter for 10 years
vi. Banknote Dynamics	μ_ε	1	0	1	1	1	1
	σ_ε	1	1	1	1	1	1
vii. Administrative Cost Dynamics	q_0	1	1	1	1	1	1
viii. Profit Distribution Scheme	a	0.75	0.75	0.75	0.75	0.75	0.75
ix. Liquidity Absorption							
x. Profit and Loss	n	4	4	4	4	4	4
xi. The Adverse Feedback Mechanism	θ	0.15%	0.15%	0.15%	0.15%	0.15%	0.15%

* When the central bank capital is negative.