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by

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Integrating Monetary Policy and Financial Stability: A New Framework*

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Abstract

Since the aftermath of the Global Financial Crisis during 2007-2008, financial stability (FS) has become top priority for central banks around the world. The conduct of monetary policy (MP) sees no exception. By leveraging on the existing literature, we propose a systematic approach to incorporate FS considerations into MP framework. This starts with calculating a financial cycle (FC) which is a measure of financial imbalances and a predictor of financial crises. We then look at an FS dashboard which consolidates pockets of risks facing the financial sector, and show how it may be used in FS surveillance. Next, we discuss the concept of model development and introduce an example of a model platform to facilitate MP formulation. Nevertheless, when implementing MP to address FS risks, policymakers encounter an inter-temporal trade-off between financial and price stability. A key challenge towards MP decision-making is, therefore, to strike a balance between both mandates by designing the appropriate policy mix between monetary and macroprudential policies. As a demonstration of our approach, we discuss, in each section, an on-going attempt at the Bank of Thailand to systematically incorporate FS into flexible inflation targeting.

JEL classification: E52, G01, C54.

Keywords: Monetary Policy Framework, Financial Stability, Policy Trade-off.

Disclaimer: The views expressed herein are those of the authors, and do not necessarily represent those of the Bank of Thailand.

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1. Introduction

Since the aftermath of the Global Financial Crisis during 2007-2008, financial stability (FS) has become top priority for central banks around the world. The conduct of monetary policy (MP) sees no exception. While the conventional monetary policy framework concentrated on maintaining price stability (PS) – commonly known as the ‘Jackson Hole consensus’ – it is now widely recognized that financial instability, when it break outs, is likely to be severely detrimental to PS. Indeed, as Minsky (1992) hypothesizes, financial sector imbalances could build up even under low and stable inflation, and closed output gaps. For many central banks, including the Bank of Thailand (BOT), FS has become one of the [explicit] MP objectives.

The emerging MP framework that ensures both price and financial stability takes into account several ‘interactions’ that were not acknowledged in the conventional framework such as the interaction between monetary policy mandates mentioned above. The implications of financial market movements on economic fluctuations, also known as the macro-financial linkage (e.g. Schularick and Taylor, 2012; Juselius et al., 2017), should also be taken into consideration as well. Undoubtedly, MP alone cannot sufficiently safeguard FS due to its multi-dimensionality.¹ Increasingly popular as major tools to mitigate systemic risks, macroprudential policies (MaP) have been experimented at a large number of central banks. MaP could simply be defined as the use of primarily prudential tools to safeguard financial stability.² The framework should, therefore, consider interactions between MP and MaP, that could work together to satisfy PS and FS mandates. Figure 1 illustrates the conceptual framework of this endeavor.

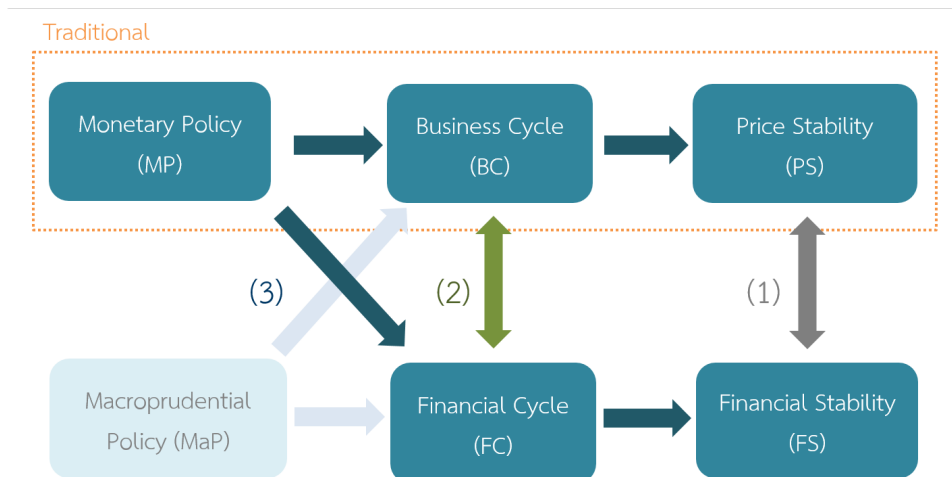
There is, indeed, no consensus regarding the definition of ‘financial stability’ both in the literature and in the central banking community. Some may put it as a state in which financial institutions, markets and market infrastructures facilitate the smooth flow of funds between savers and investors. This helps to promote growth in economic activity. Others may define FS as a state whereby the build-up of systemic risk is prevented and the financial system is able to withstand shocks without large-scale disruption. Unlike PS which is usually

¹The public should also be acknowledged that FS objective is not a sole responsibility of MP, it can be achieved only by effective collaboration among policymakers (e.g. central bank, other regulatory and supervisory agencies, and government) as well as participants in the financial system.

²IMF-FSB-BIS (2016) summarizes three objectives of MaP: (1) to increase the resilience of the financial system to aggregate shocks, (2) to contain the build-up of systemic vulnerabilities over time, and (3) to control structural vulnerabilities within the financial system that arise through interlinkages, common exposures, and the critical role of individual intermediaries in keys markets.

gauged by movements of inflation, FS – or ‘FS risks’ to be more precisely – is likely to be measured with less precision, a complication to policy making.

Figure 1. The Emerging MP Framework



This figure provides an illustration of the emerging monetary policy framework which accounts for financial stability considerations, in comparison with the traditional approach in the dotted box. The new framework acknowledges a number of ‘interactions’ as follows. Link (1): PS and FS are mutually beneficial and re-enforcing; Link (2): FC and BC are related; and Link (3): There is an interaction between MP and MaP which affects their objectives.

By leveraging on the existing literature, we propose a systematic approach to incorporate FS considerations into MP framework. This starts with calculating financial cycle (FC) which is a measure of financial imbalances and a predictor of financial crises (Claessens et al., 2011; Drehmann et al., 2012; Borio, 2014). Despite its potential usefulness in detecting systemic risks, FC does not capture all FS risks, and might miss certain pockets that are not direct input to the FC calculation. We thus turn to sectoral indicators, and compile an FS dashboard which consolidates risks across key sectors of the economy. Being a key tool in MP decision-makings, macroeconomic models at the central bank also need improvements to better serve their roles in both forecasting and policy analysis. This paper, hence, explores the concept of model development and gives an example of a model platform to facilitate monetary policy formulation and implementation.

The interaction between FC and business cycle variables such as output gap provides important information for policy making, for it could stipulate an inter-temporal trade-off between financial and price stability, especially when those variables are moving in the opposite directions. We, therefore, propose a systematic process for MP deliberation, which aims at striking a right balance between PS and FS. Finally, we consider the calibration of monetary and macroprudential policies in order to design the optimal policy mix. This topic is a

paper in its own right, and hence, for tractability, we only present key concepts that should be considered in decision making.

As a demonstration of our approach, we discuss, in each section, an on-going attempt at the Bank of Thailand (BOT) to systematically incorporate FS into its monetary policy framework. The BOT conducts monetary policy under flexible inflation targeting, which allows for a balancing act of multiple objectives. The central bank explicitly acknowledges FS as one of the monetary policy objectives along with PS and economic growth. Moreover, FS risks have been regularly cited by the Monetary Policy Committee (MPC), the rate setting panel, as one of the main reasons that justify their decisions.

FS surveillance at BOT has been constant depending on issues of worry. Even though the approach serves the MPC well, it does not fully facilitates policy debate as the link between FS risks and the real economy is yet to be established. Without a quantitative measure and analysis of FS risks, moreover, policy communication is complicated to the extent that FS might be perceived by the public as a superior objective to PS. In the longer term, such perception may be harmful to the inflation targeting framework – which advocates the primacy of price stability – and to the conduct of monetary policy in general.

Our contribution to the literature is thus two-folded. First, we propose a set of procedure that enables a more FS-oriented monetary policy framework. This allows FS-related matters to be considered and communicated in a systematic manner. Second, we document a country’s experience, including challenges facing the central bank staff, of implementing such a procedure. Hopefully, the experience would aid in the implementation of a similar framework elsewhere. The rest of the paper is organized in the similar structure to the ordering of topics outlined above.

2. Measures of Financial Stability

The soundness of financial sector is one of the key factors to sustain economic growth. Nevertheless, FS risks are diverse in nature, ranging from volatility in financial markets to insolvency of financial institutions. For example, Thailand’s financial stability issues currently concern underpricing of risks that stemmed from the search-for-yield behavior in the prolonged low interest rate environment. To systematically assess FS risks, it is helpful to distinguish between ‘shock’ and ‘vulnerability’. Financial instability materializes when vulnerabilities in the financial system amplify and propagate shocks throughout the financial

system. The triggering event could be an exogenous shock from outside the financial system such as an economic downturn. Alternatively, it could be an asset price correction or an insolvency of systemically important financial institution (SIFI) that endogenously unwind from within the financial system. Adrian et al. (2015) points out, however, that it is more difficult to predict and prevent shocks than vulnerabilities. Our analysis will hence focus mainly on measuring vulnerabilities at this stage.

Without an appropriate measure of vulnerabilities in the financial system, proper policy formulation will be extremely difficult, if not impossible. How does one measure the overall health of the financial system then? The literature suggests a candidate indicator called ‘financial cycle’ (FC) which mainly reflects the cycle of expansions and contractions of financial variables. However, being an aggregate measure, FC can at best reflect the overall financial imbalances, therefore it should be coupled with FS dashboard that provides more granular views of vulnerability; see Section 2.2.

2.1. Financial Cycle and Its Implications

Despite the lack of a commonly agreed definition, FC may be defined as ‘self-reinforcing interactions between perceptions of value and risk, attitudes towards risk and financing constraints, which translate into booms and followed by busts’ (Drehmann et al., 2012). As discussed in Claessens et al. (2011, 2012) and Drehmann et al. (2012), the determinants of FC are primarily cycles of credit and of asset prices, both of which reflect the accumulation of vulnerabilities in the financial system. These cycles are potentially self-re-enforcing. During economic expansion, for instance, accelerating demand for housing credit will push up house price; the rise in collateral value will in turn fuel credit. More importantly, FC is recognized as a predictor of financial crises. The above authors also found strong association between previous peaks and subsequent systemic financial crises. This property makes FC a desirable core indicator for our framework, and the main subject of this subsection.

2.1.1. Characterizing FC

The seminal work of Drehmann et al. (2012) suggests applying Christiano-Fitzgerald filter (CF-filter) to financial variables of interest in order to extract their cyclical components, which are deviations from the long-run trend. The length of FC is prescribed at 8 to 30 years, a significantly longer time than that usually assumed for business cycle (BC) of around $1\frac{1}{2}$ to 8 years. The amplitude, on the other hand, is empirically estimated and associated with the size of financial imbalance. In contrast to the well-known Hodrick-Prescott filter (HP-filter),

CF-filter is a linear band-pass filter making use of a two-sided weighted moving average of the data. Applying this filter with a lower frequency band –as the above construction of FC– provides a much smoother cycle, therefore less susceptible to short-term fluctuations.³

For our purpose, we construct ‘financial cycle composite index’ (simply abbreviated as FC) by applying CF-filter to four financial variables, namely credit aggregates, credit-to-GDP ratio, single-detached house (including land) price index, and land price index.⁴ The first two components reflect ‘credit cycle’, and the others ‘asset price cycle’.⁵ The data series are quarterly collected over the period from 1994 Q1 to 2017 Q4. The configuration of the smoothing parameter follows Drehmann et al. (2012), where FC completes in 8 to 30 years. The composite index is finally obtained from a simple average of the four sub-indices. Figure 2 illustrates the result.

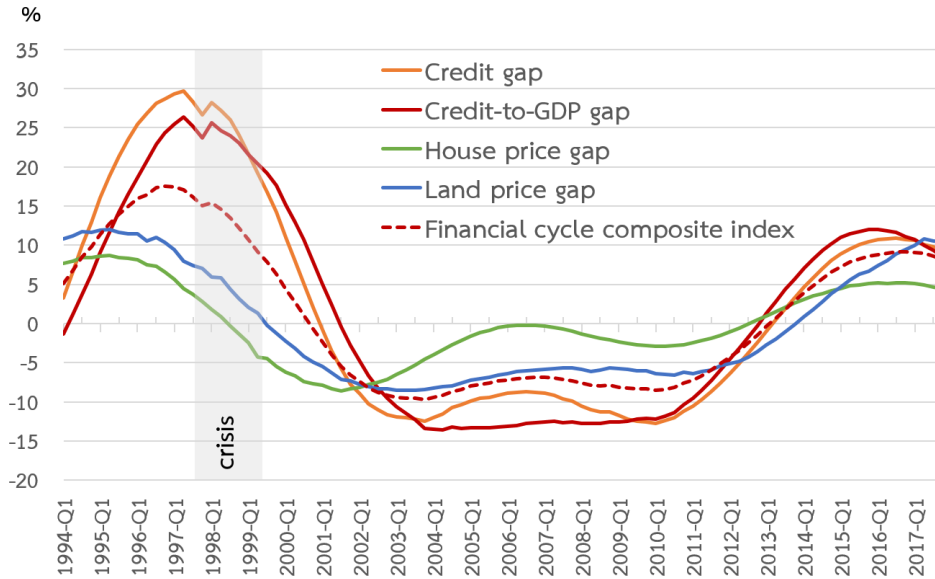
The generated cycles appear to move slowly, extending several years’ time. We note in addition that our FC peaked in the eve of the 1997 Asian financial crisis, providing some evidence in support of the use of FC as a measure of financial imbalance. This issue will be further discussed in Section 2.1.4. The filtered cycles also pass our qualitative and quantitative evaluation criteria. More precisely, (1) the series are long enough and have predictive power for Thailand’s financial crisis in the past; (2) all of them have consistent cyclical patterns making the aggregation sensible and (3) the standard deviation (volatility) of medium-term component is much higher than that of the short-term component – which is interpreted in

³To analyze cyclical movements of financial variables, alternatively, one may employ ‘turning point analysis’ to date the cyclical peaks and troughs in financial variables; see Claessens et al. (2011), Drehmann et al. (2012). However, this method can only specify the periods of expansions or recessions but cannot deliver the magnitude or the severity of the cycle at different stages, all of which are especially desirable for policymakers in order to gauge financial risks. Besides, the estimated dates are less reliable when the data span a relatively short horizon.

⁴The credit aggregate is the total credit (loan and debt securities) to private non-financial sector including non-financial corporations, households and non-profit institutions, collected by Bank of Thailand. It also covers loans and debt securities from both financial institutions: banks and non-banks. The single-detached house (including land) price index and land price index are combined from several sources; the series of 1994-2008 are from Government Housing Bank while the series of 2008-2017 are from the Bank of Thailand. Condominium price is not included in the FC as the series are not long enough. Nevertheless, they may be proxied by land prices, which are major costs of launching condominium. All variables are in real terms (deflating by CPI), except for credit-to-GDP ratio. Moreover, before applying the filter, they are first normalized by their initial values in 1994 Q1. The resulting gaps obtained by the CF-filter are finally scaled by their trends for comparability of the results.

⁵We do not include equity price cycle here as it has shown relatively large volatility compared to that of other financial variables, particularly credit-to-GDP cycle, which is consensually the main indicator in financial cycle literature. Incorporating equity price cycle could therefore distort FC. This result complies with the study of Drehmann et al. (2012) that equity price cycles of many advanced economy seem to be more fluctuated.

Figure 2. Financial Cycle Composite Index and Its Components



FC is an aggregate measure comprising of four cycles: credit cycle, credit-to-GDP cycle, land price index cycle and house price index cycle. Its peak is used as a predictor for financial crises. As shown here, Thailand’s FC peaked in the eve of the 1997 crisis period in the shaded area.

the similar way to signal-to-noise ratios –i.e. the influence of medium-term factors in the variables differs from their short-term counterpart; refer to Drehmann et al. (2012) for detail of this final criterion.

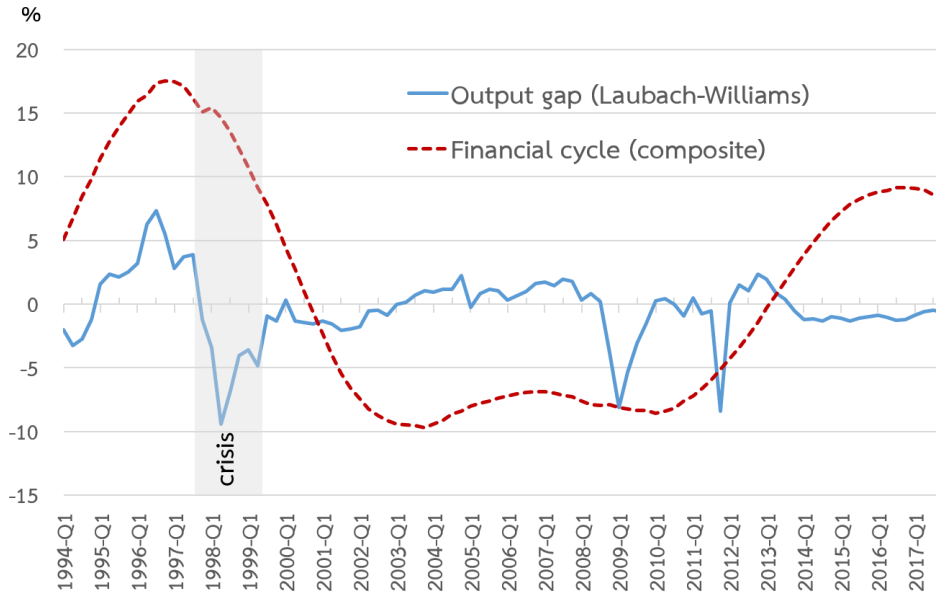
2.1.2. Interactions between financial and business cycles

Information on the relationship between FC and BC variables such as output gap provides policymakers with a key ingredient for assessing the state of the economy. Figure 3 depicts Thailand’s FC in comparison with the corresponding BC as measured by output gap.⁶ The following stylized facts can be seen:

Stylized fact 1: In line with Borio (2014), our FC moves more slowly than BC. The duration and amplitude of the former are higher than those of the latter. Although this may be an artifact of our methodology, it has a crucial interpretation: the slow swing in FC represents vulnerabilities which tend to build up slowly, and are not influenced by other more volatile short-term factors. Indeed, financial crises, being the major driver of FC, do not occur fre-

⁶The series is obtained from the application of Laubach-Williams’s method to real GDP (Laubach and Williams, 2003).

Figure 3. Financial Cycle vs. Business Cycle



At first glance, the correlation between FC and BC is weak. In line with the literature, the former appears to be moving at a much slower pace than the latter. However, there seems to be a non-linear relationship between the two variables. In particular, economic recessions tend to be more intense during financial crisis period.

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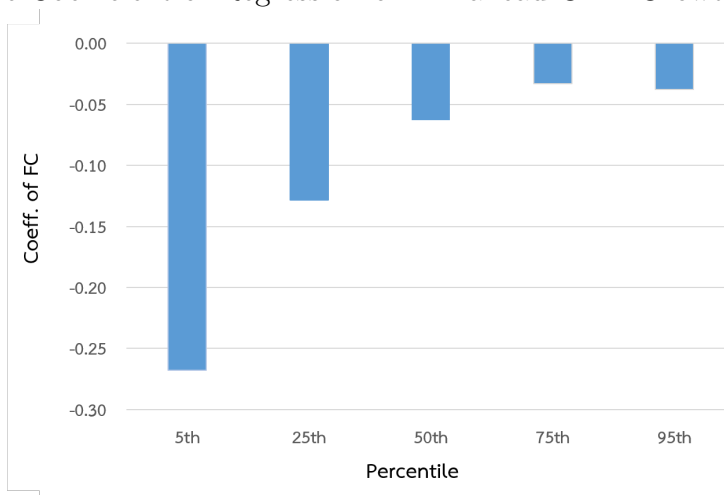
Stylized fact 2: The interaction between FC and BC is more pronounced during downturns. To put it differently, economic recessions are more severe if they occur at the same time as financial crises. An intuition is that, during crises, financial institutions tend to face more difficulties in obtaining liquidity, putting a limit on credit extended to households and corporates. This type of distress makes recovery even harder. See detailed discussion in Jordá et al. (2013), who argue that recessions associated with crises lead to deeper recessions than during normal recessions. In the case of Thailand, the economy took almost two years to recover from the Asian financial crisis, while other recessions spent significantly shorter time.

2.1.3. FC and consequences on the economy

The above graphic (Figure 3) raises the question whether the higher magnitude of financial cycles, the more severe economic downturn. We verify this relationship by mean of quantile regression for panel data (with a country dummy variable) of 9 countries over the period

1993 Q1 - 2017 Q4.⁷ In the analysis, the dependent variable is the one-year ahead GDP growth, while the regressor is the financial cycle constructed by the applying CF-filter on credit-to-GDP ratios and property prices (see Subsection 2.1.1). In Figure 4, our analysis reveals the negative impact of an increase in FC on future economic growth. During economic downturns (roughly around the 5th percentile of historical GDP growth⁸) a one-percentage-point increase in FC will dampen growth in the following year by 0.27 percentage points. The size of the impact is inversely related to the size of GDP growth. Crucially, these numbers establish a novel trade-off between activities in financial and real sectors, in particular one which is inter-temporal. Further discussion of its implication on monetary policy decisions is postponed to Section 4.

Figure 4. Quantile Coefficient of Regression of 1Yr-ahead GDP Growth on Financial Cycle



This figure shows coefficient values of regressions of one-year-ahead GDP growth on FC with respect to percentiles of the dependent variable. There appears to be an inverse relationship between the impact of FC and the percentile level of GDP growth. In particular, the negative impact of FC is more pronounced when GDP growth is relatively weak.

2.1.4. FC and crisis probability

Another dimension where FC can be used to inform monetary policy decisions is its relationship with the probability of financial crises. As mentioned earlier, peaks in FC could signal systemic risks. On a closer inspection, however, the magnitude of the cycle is also

⁷Data comprises two groups, namely (1) emerging economies: Thailand and Malaysia, and (2) advanced economies: France, Italy, Netherlands, Spain, Sweden, United Kingdom and United States. For comparability, each cross-country data is gathered from the same source: credit-to-GDP ratios and residential property prices from BIS and GDP annual growth rate from OECD and CEIC. Especially, the proxy for asset prices is now the residential property prices, see the Handbook on Residential Property Prices Indices (RPPIs).

⁸The 5th percentile of Thailand's GDP annual growth rate over the period of 1994-2017 was -4.3% while its median was 4%.

likely to play an important role. As shown in Figure 3, for instance, the peak in 2016 may not give us a straightforward sign of crises as its size was considerably small compared to the pre-crisis peak in 1995. This problem calls for a more accurate assessment of the probability of future crises in relation to the current level of FC. Nevertheless, one inevitably faces data limitations since crises are rare events.⁹ As a result, we have to employ a different identification strategy, and resort to a cross-country panel data to ensure adequate observations of financial crises for predictive analysis.

Following Anundsen et al. (2016), Bauer and Granziera (2017) and Gourinchas and Obstfeld (2012), we estimate a panel logistic regression using a cross-country dataset. The data used in this analysis were quarterly credit-to-GDP ratios and residential property prices of emerging and advanced economies.¹⁰ Each data series is mapped individually to systemic crises identified by IMF staff as in Laeven and Valencia (2013) which covers both the Asian financial crisis in 1997 and the Global financial crisis in 2007-2008.

In order to provide policymakers time to put in place measures to prevent financial crises, the probability that a country will be in a pre-crisis state is defined to be 1 to 3 years prior to the crisis event. Therefore, the dependent binary variable of country i , $Y_{i,t}$, is 1 if the outbreak of systemic crisis occurred at time $t + k$, where $k \in [5, 12]$, and to be 0 otherwise. In the estimation, we omit observations lying on the crisis period, which is classified to be 4 quarters before and 6 quarters succeeding the crisis date. This crisis probability can then be used as an early warning signal (up to 1-3 years ahead). The forward-looking probability of a crisis is calculated according to the following logistic function:

$$\mathbb{P}(Y_{i,t} = 1) = \frac{\exp(a_i + bx_{i,t})}{1 + \exp(a_i + bx_{i,t})} \quad (1)$$

where a_i is a country-specific fixed effect; b is the coefficients of $x_{i,t}$ – FC of country i .¹¹ Figure 5 shows historical estimates of the likelihood of a crisis in Thailand. In 2017 Q4, the probability is around 0.07 which is significantly lower than 0.90 in the eve of the 1997 crisis.

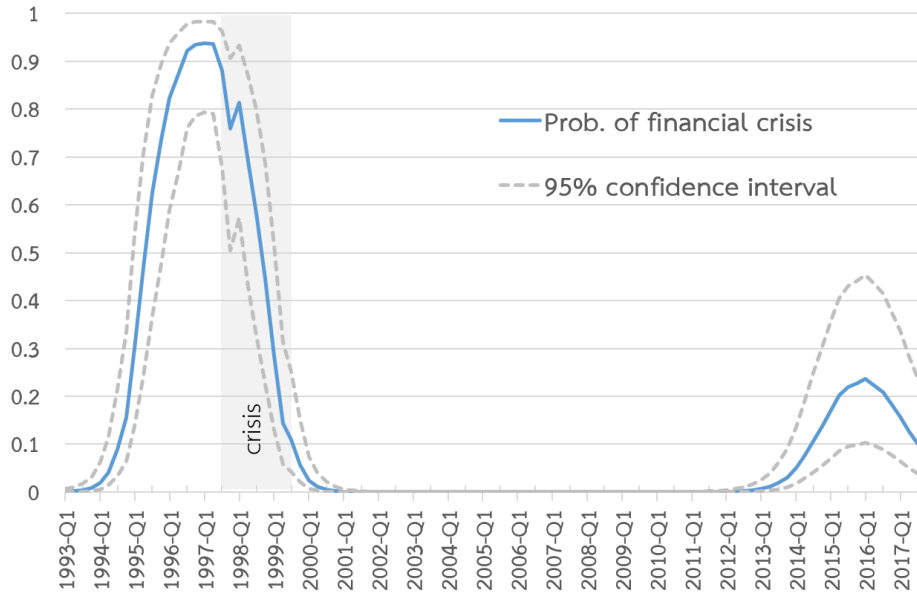
In addition to the financial cycle, such a probabilistic evaluation facilitates policy discussion

⁹In Thailand, there have been only two financial crises in its history, the first one was in 1983 (historical data is not available for the financial cycle analysis) and the latest one was the Asian financial crisis in 1997, see systemic crises database in Laeven and Valencia (2013)

¹⁰These are the same data set as in the quantile regression analysis above.

¹¹The CF-filter is applied to the credit-to-GDP ratio and residential property price index so as to get the deviation from their trend, analogously to the calculation of FC. The individual financial cycle is then the simple average of these two components.

Figure 5. Forward-looking Crisis Probability in Thailand (1-3 Years Ahead)



Thailand’s crisis probability is calculated by a panel logistic regression based on cross-country credit-to-GDP and residential property price data. This likelihood is used as an early warning indicator for systemic crisis up to 1-3 years ahead.

in terms of risk assessments, and should supplement the impact assessment on baseline economic growth discussed later. This result will fit comfortably into a risk management approach to monetary policy á la Greenspan (2004) where decision makers seek to understand the many sources of risks, and quantify them when possible.

2.2. FS Dashboard for Comprehensive Risk Surveillance

To successfully incorporate FS into monetary policy formulation, a set of tools to continually evaluate and monitor FS risks is indispensable. So far, our attention has centered around FC. However, being an aggregate measure, FC can at best reflect the overall financial imbalances – it does not offer granular views of the country’s financial stability. To comprehensively capture all pockets of vulnerabilities therefore requires a look into disaggregate indicators.

At the BOT, a working group brings together experts from various departments across the bank to explore and prototype a sectoral dashboard which would complement FC in risk surveillance. The dashboard aims to serve three main objectives: (1) to ensure that all pockets of risks are on the radar; (2) to shed some light on which sectors are at risk and which types

of vulnerabilities are building up. This will facilitate an appropriate policy mix between monetary and macroprudential policies ¹²; (3) to systematize and improve an existing FS monitoring process which tends to rely rather substantially on expert judgment. Our design follows four steps below.

Step 1 Indicator selection. Since the adoption of flexible inflation targeting in 2000, BOT staff have regularly monitored FS risks in seven key sectors, namely households, corporates, financial institutions, fiscal sector, real estate, financial markets, and external sector. The working group decided not to include fiscal sector in the dashboard as fiscal sustainability assessment has a separate process at the bank, while financial institutions are sub-categorized into banks and non-banks due to the different natures of their businesses. Non-bank financial institutions have recently played more prominent role in our credit markets, especially in low-income groups who are more susceptible to macroeconomic shocks. Candidate indicators for each sector were proposed and debated by the experts. For instance, households' debt to GDP could be easily agreed upon as a prime risk indicator for household sector. On the contrary, the validity of certain financial market indicators were challenged on grounds of the lack of depth in the relevant segments. All in all, the chosen set of indicators conforms to the literature on an early warning system, see IMF (2014), BIS (2017).

Step 2 Risk classification. To articulate meaning out of the pre-selected indicators, we follow the FRBNY FS monitoring framework (Adrian et al., 2015) that classifies vulnerability into four types, namely 'price of risk', 'leverage', 'mismatch', and 'interconnectedness'. Some of them share the same rationale as FC, where overleverage could lead to default, while underpricing of risk could result in asset price bubbles which are prone to sharp corrections. In addition, risk underpricing tends to weaken credit standards and lead to low risk premium. Mismatch in terms of liquidity, maturity, and currency could also be a source of financial instability. Excessive mismatch exposes banks to liquidity risk that could trigger bank runs and fire sales. Furthermore, structural features of the financial system itself could generate vulnerabilities. Coupled with complexity to assess information and insufficient transparency, interconnection between entities could cascade and amplify shocks on much larger scales.

The working group also proposed two more vulnerability types, viz. 'risk appetite' which captures behavior that may lead to underpricing of risk, and 'vulnerability in debt serviceability and cushion' which helps identify borrowers' propensity to default and lenders' shock-absorption capacity. They are particularly relevant to Thailand in the current context

¹²Discussed later in Section 5

as search-for-yield behavior in the prolonged low rate environment warrants continued monitoring. Finally, the indicators are compiled into a FS risk matrix of sectoral risks as shown in Appendix B

Step 3 Risk scoring. The next step is to come up with a systematic approach to assess the degree of riskiness. In so doing, we adopt ‘Ms.Muffet’ (Cervantes et al., 2014) – which is a simple yet robust methodology – to calculate risk scores. It begins with computing z -score for each indicator from 5-year historical rolling window. Next, the numerical ranking from 1 to 10 is assigned to each normalized variable. A score ranging from 0 to 10 represents the lowest to the highest level of risk respectively. The last step is to equally weigh each numerical ranking to get the final score. The consolidation by type of risks is also permissible.¹³ (See Figure 6 for an example of FS Dashboard) While the use of statistical techniques should make risk assessment more consistent over time, there is room to incorporate expert opinions, for instance, by fine-tuning the relevant window, or by leaving some remarks to policymakers. Indeed, the selection of appropriate benchmarks – instead of using historical average – as well as reference period is an empirical issue which bank staff could explore further.

Step 4 Robustness check. Since Normality is the critical underlying assumption of Ms. Muffet, we validate the final scores by using average probabilities based on empirical distributions (for detail see e.g. Lichtendahl et al., 2013). This method yields a similar result to Ms.Muffet, but the new scores show greater degree of dispersion due to the relaxation of normality assumption. Overall, the working group concluded that the dashboard produced by Ms.Muffet methodology provided satisfactory results.

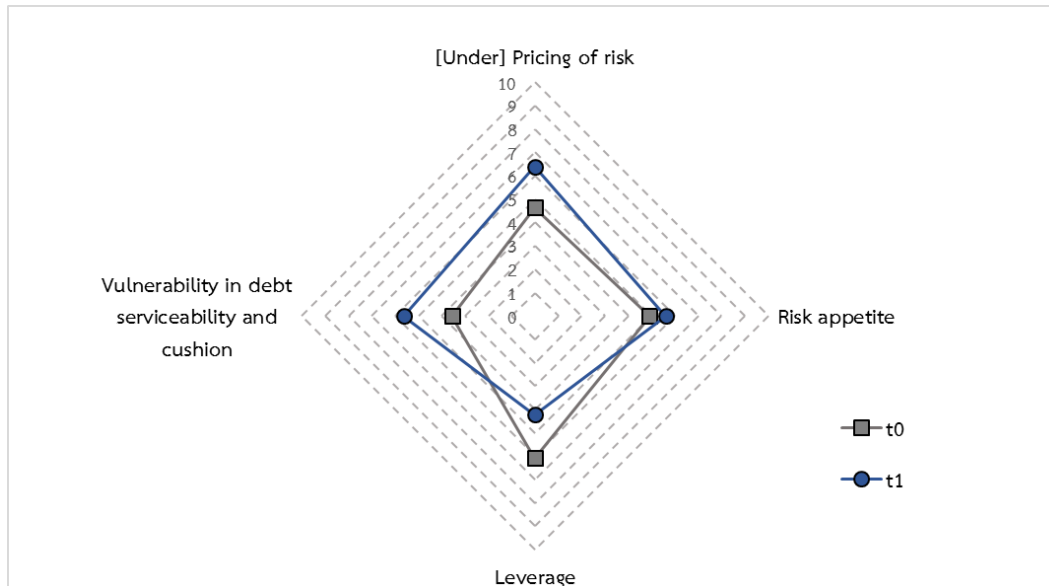
¹³The working group later changed the name from ‘price of risk’ to ‘[under] price of risk’ to better indicate the direction of concern.

Figure 6. Final Scores Illustrated by Two Formats:

a) FS risk matrix

t1		Type of Risk			
		[Under] Pricing of risk	Risk appetite	Leverage	Vulnerability in debt serviceability and cushion
Entity	Household				
	Corporate				
	Bank + SFIs				
	Non-bank FIs				
Market	Real Estate				
	Monetary and Financial Market				
	External				

b) Spidergram of FS risks



Panel a) shows risk scores in matrix format (a score ranging from 0 to 10 is converted into a heatmap for better visualization). While financial stability appears sound overall, [under] pricing of risk seems prevalent in many sectors. This risk type, along with vulnerability in debt serviceability and cushion, warranted close monitoring. **Panel b)** shows the consolidation by type of risks that allows for comparison across time. In fact, both issues exacerbated from the previous period.

3. Model Development

Macroeconomic models are a key tool the central banks employ in the formulation of MP. Given lags in MP transmission, those models help produce forecasts of future economic growth and inflation, which are important inputs into the decision-makings. However, the GFC has shown the failure of macro models, both at the central banks and in the academia, in several dimensions. Not only did they fail to predict the crisis to come, they are also relatively silent in how policymakers should respond to the crisis in terms of both the resolution and prevention. In order to integrate financial stability considerations into MP framework, macro models hence need improvements

3.1. Roles and Features of the Model for FS Analysis

To facilitate FS-oriented monetary policy decisions, we argue that roles of macro models should be expanded. First, in terms of forecasting, the model should overcome the failure discussed above by improving its capacity to predict crisis. Ideally, tail-risk events emanating from financial instability should be incorporated into projections of economic growth and inflation, e.g. in the fan chart. This will help facilitate communication of policy decisions to the public. Apart from forecasting exercise, we need macro models for optimal policy analysis, particularly in assessing the effectiveness of MP and MaP in mitigating FS risks and how the two policy tools should interact to achieve both price and financial stability. As will become clear in the following sections, they assist policymakers in the quantification of trade-offs that arise when policies are devised to preserve FS. Given the novelty of MaP, their implementation so far is often well ahead of theoretical justifications. Macro models should, therefore, help identify real and financial distortions the policies intend to address, and ensure that they eventually yield stabilization and welfare benefits.¹⁴

To cater the models for the new roles, financial factors must be embedded. The consensus among economists is that what seems to be missing from the model is a financial friction (Christiano et al., 2018), which in turn contributes to the failure of macro models aforementioned. Before the GFC, the absence of financial frictions may be sensible, as the central banks mainly focus on PS. Furthermore, in periods of the Great Moderation, macroeconomic stability prevailed and financial instability did not entail large repercussions towards the economy. Only a handful of papers attempted to embed financial factors into macro models (See Bernanke et al. (1999) and Kiyotaki and Moore (1997)), but their proposed features are missing from a standard workhorse model in the literature like that of Smets and Wouters (2007).

¹⁴Mendoza and Bianchi (2010) are among early articles that study normative implications of MaP.

Progress has been made in academia, after the GFC, to introduce financial frictions into macro models. These include frictions that lead to borrowing constraints, which usually tie to borrowers financial conditions. However, over the past decade, literature has put more emphasis on modeling frictions originated from financial institutions and markets, which primarily affect the supply of loanable funds. The latter frictions better reflect key aspects of the GFC, which involve runs on wholesale (or interbank) markets. As an example, Gertler and Kiyotaki (2010) modeled agency problems between financial intermediaries and their lenders, which comprise depositors and the interbank markets, and showed how disruptions in financial intermediation can induce a crisis that affects real activity.

Challenges remain on the construction of comprehensive models that capture most of the individual countrys key economic and financial aspects, ones that will also be useful for FS analysis. We argue that the new model for FS-oriented monetary policy framework should incorporate three main features. First, the model should represent the countrys macro-financial linkages. In particular, it should match with the prevailing financial landscape, i.e. include key players, instruments and prices within the financial system. Relevant financial frictions, whether they originate from borrowers or lenders, should then be included, which will allow for realistic macro-financial interactions and hence meaningful shock propagations. Moreover, a few recent articles, e.g. Jermann and Quadrini (2012) and Gerali et al. (2010), have highlighted the importance of financial shocks - ones originated in the financial sector - in explaining business cycle fluctuations. In this regard, the model may incorporate exogenous financial shocks, which could also serve as a trigger for financial instability.

The second necessary feature is that the model captures the notion of FS risks, which are rather abstract. These may include, but not limited to, deleveraging, bank runs, default, fire sales and contagion. Goodhart et al. (2006) and De Walque et al. (2010) are examples of the models, where financial instability is characterized by periods of high default and low bank profitability. More recent papers, meanwhile, model a fire-sale mechanism. They show that the mechanism results in negative externalities on others who hold similar assets during crisis and, given the failure of internalize those externalities into their decisions, agents tend to overborrow (see Bianchi (2011)). Several papers, including Forlati and Lambertini (2011) and Quint and Rabanal (2014), also try shed light on the recent crisis by modeling mortgage default. At the same time, the model should be able to capture risk accumulation during the boom phase of FC, e.g. through credit and/or asset price booms, which in turn contribute to financial sector vulnerabilities.

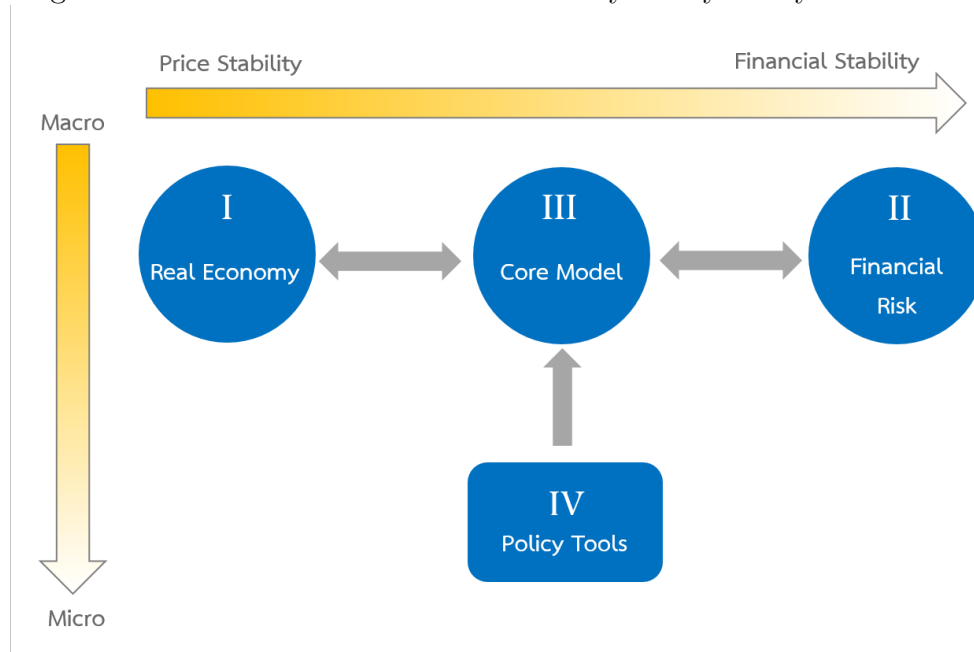
Last, the model should facilitate the assessment of different policy tools, i.e. MP and MaP, and hence provide appropriate policy recommendations. With two tools seeking to achieve PS and FS, we are in need of a unified model that would allow us to study their optimal interactions.

3.2. Model Platform

Our discussion now turns to an attempt at the Bank of Thailand to develop a new model. This illustrates how we put the concept of model development into practice. In order to account for the three features above, there is, nonetheless, no consensus on how the new model should be developed. A new core model in academia, despite substantial progress, is also not agreed upon. Fundamentally, we need to admit that it is extremely difficult to construct a single comprehensive model that features all aspects of the economy. As argued in Blanchard (2018), the central bank may rely on different classes of models to perform different tasks.

Our modeling strategy resorts to a model platform. The ‘platform’ is composed of different classes of models as well as a variety of analytical tools. The models are different, not only on their characteristics and features, but also on their abilities to harness different insights from various types of data, ranging from aggregated macro-level data to individual micro-level data. Pluralism also implies that we can learn from other fields or new innovations in economics such as the modeling of agent heterogeneity by agent-based models, or getting information at the micro level from Big Data and behavioral economics. The platform corresponds to the current practice in a number of central banks that utilizes a core model and multiple satellites to support their policy formulations (e.g. Andersen et al., 2008; Burgess et al., 2013; Burrows et al., 2012; Dees et al., 2017; Gerdrup and Nicolaisen, 2011).

Figure 7. The Bank of Thailand’s Monetary Policy Analysis Platform



This figure shows the model platform and its four modules i.e. core model, real economy, financial risk, and policy tools. The yellow horizontal arrow shows the policy objective of each component, while the yellow vertical arrow points out the type of data requirement for each component. The gray arrow represents the loosely established relationships and linkages amongst modules.

Next, a preview of the platform will be explained. It is composed of four modules: a core model and three satellites; namely, real economy, financial risks, and policy tools.

Module 1: Real economy. This module represents the model Bank of Thailand currently use in producing forecasts and monetary policy analysis. The two main models are the Bank of Thailand Macroeconometric Model (BOTMM) and Monetary Policy Model (MPM). BOTMM is a system of equations that is developed to capture key economic variables and their relationships both in the short and the long run. It covers exhaustively four important sectors; namely, the real sector, the monetary sector, the external sector, and the public sector. On the other hand, MPM is a micro-foundation model, containing optimizing agents with rational expectations. It is a compact model consisting of only a few significant equations, such as the new Keynesian Phillips curve, the dynamic IS curve and the monetary policy rule (Taylor rule).¹⁵ However, the applications of both models to safeguard financial stability is rather limited due to the inadequate role of the financial sector within those models.

¹⁵For details on the economic model at the Bank of Thailand <https://www.bot.or.th/English/MonetaryPolicy/MonetPolicyKnowledge/Pages/MacroModel.aspx>

Module 2: Financial risks. To complement the real economy module, this module plays a role for ‘financial stability’ analysis. It was designed to find vulnerabilities and gauge riskiness in the financial system. Naturally, financial cycle and FS dashboard, discussed in detail earlier as a tool to measure FS risks, fit into this module. The class of models suitable for this particular task could be borrowed from financial literatures, especially from the realm of risk management. For instance, compared to a standard econometric technique, a top-down macroeconomic stress test is likely to perform better for identifying weakest links in the financial system and assessing downside risks to growth and inflation projections produced by the real economy module. Dees et al. (2017) provide an example of a stress test methodology ECB developed and how each module can be linked together. Moreover, many other types of risk models and techniques can also be classified into this category, such as network models, copulas, value-at-risk models, and extreme value theory.

Module 3: Core model. This module is the crux of the matter. Aiming to integrate PS and FS, it helps connect between two previous modules and reconcile any discrepancy. In this endeavor, one requires a ‘core’ economic model that encapsulate linkages between macroeconomic and financial variables. While some progress has been made in this regard – see e.g. Gertler and Kiyotaki (2010); Christiano et al. (2010); Juselius et al. (2017) – to the best of our knowledge there is no consensus on the “standard” model in the literature as yet. We then experiment with the whole spectrum of models starting from a data-driven model such as Vector autoregressive (VAR) and an Unobserved component model (UCM) to a more structural model with theoretical foundations such as Dynamic Stochastic General Equilibrium (DSGE). Box 1 and 2 describe the concept of each model and some examples of how it was utilized in policy analysis at the Bank of Thailand. So far, we are still reluctant to pick a winning model since each has its own comparative advantages. With further research and experiential learning, we may be able to unify these models.

Module 4: Policy tools. Last but not least, this module aims to acquire deeper understanding of policy tools, particularly monetary and macroprudential policies, from granular data. We pay more attention to effectiveness and their interactions. Although economists have been studying these questions with macro-level data for a long time, the availability of big data allows us put them in a new perspective and offer better insights. It is where micro meets macro. For example, crunching loan arrangement data (micro-data), Ratanavararak and Ananchotikul (2018) find some evidences of bank-risk taking channel from a low-for-long

interest rate in Thailand.¹⁶ Tantasith et al. (2018), meanwhile, utilize contract-level data of housing credit in Thailand to evaluate the effectiveness of the Loan-to-Value (LTV) measures implemented in 2009, 2011 and 2013. These findings can help fine-tuning parameters estimated from macro-data in the core model or other modules.

At this stage our model remains a work in progress, yet it should serve as a road map that points towards the direction we are heading and reveals what can be delivered for policy makers. However, one should keep in mind that a major challenge for model platform is to seamlessly integrate and reconcile outputs of each model in order to minimize uncertainties stemming from consolidation processes.

4. Monetary Policy Deliberation

In the preceding sections, we have shown how FC and FS Dashboard can provide necessary information regarding financial imbalances, as well as how the central bank's macro model should be developed to serve forecasting and policy analysis. Now we will discuss their implication on monetary policy, and how these pieces of information may be submitted to the rate setting committee. The bottom line is that the integration of FS into MP framework entails a trade-off between PS and FS. Policymakers, hence, need to carefully weigh benefits and costs of their policy action to address FS risks in order to strike a balance between the two mandates.

4.1. *Lean versus Clean*

Policy actions to counter FS risks are usually termed as leaning against the wind (LAW). Practically, it implies a conduct of a tighter MP than would be justified by developments of inflation and output growth alone. LAW can be applied to both policy rate hikes and cuts. During the tightening cycles, the central bank may raise rates further to control asset price bubbles and/or excessive credit expansion. Meanwhile, in the easing cycles, rates could be cut by less in the view of heightened FS risks. The LAW approach was rather unpopular before the GFC. This is partly owing to (1) the difficulty in timely identifying bubbles or FS risks in general, (2) the belief that FS risks would not cause large economic repercussions, and (3) the fact that MP, being a blunt instrument, can have economy-wide adverse consequences as it is deployed to mitigate risks in certain sectors. Cleaning up after the mess

¹⁶See Ioannidou et al. (2009) and Jiménez et al. (2014) for more studies in Spain and Bolivia on the risk-taking channel of monetary policy using credit registry data .

was at the time a chosen strategy, where MP reacts only after the financial crisis has already occurred.

The LAW approach has gained more attention after the GFC, since the crisis has shown how costly it can be to wait and clean. The crisis was so large that MP encountered the problem of zero lower bound (ZLB). Many central banks resorted to unconventional MP, whose effectiveness remains unclear. Moreover, the current data-rich environment enables better identification of financial imbalances. More emphasis has, consequently, been placed on reducing financial sector vulnerabilities, which would help prevent the financial crisis from occurring in the first place.

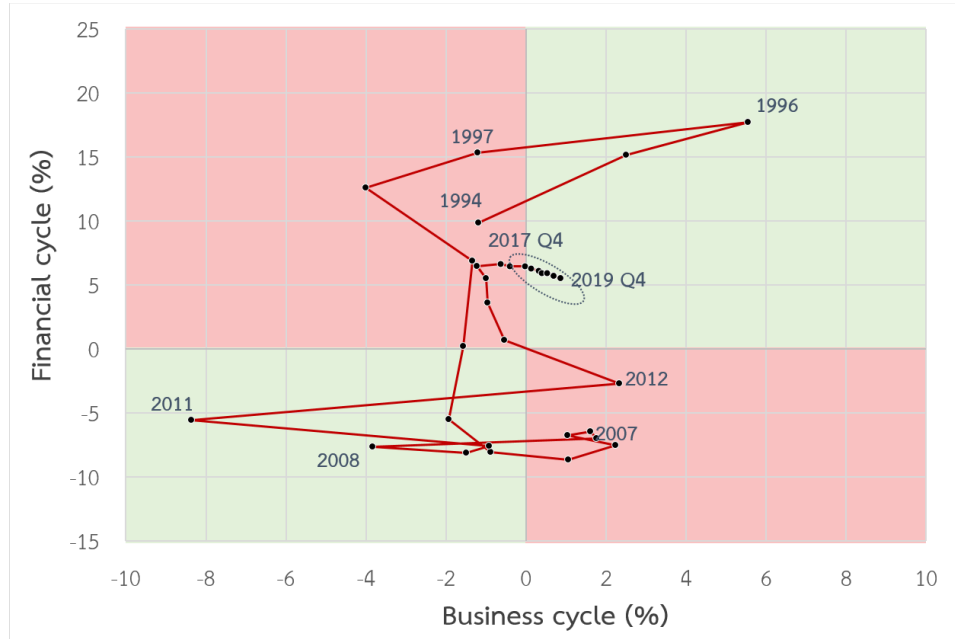
4.2. A Policy Trade-off

A key challenge faced by policymakers, especially those under FIT, is they need to strike a balance between FS and PS mandates. At the heart of the decision to lean against the financial imbalances is an intertemporal trade-off between PS and FS. MP tightening to address FS risks entails benefits by lowering the probability and magnitude of crisis, which results in more stable outcomes for inflation and output in the long run. Nevertheless, the economy encounters a trade-off in terms of worse short-term macroeconomic outcome. In short, the basic idea is to trade-off the output costs of leaning today with the possible output benefits tomorrow. How severe the trade-off is depends crucially on the co-trajectories of BC and FC. A simple illustration for Thailand's case is shown in Figure 8.

The green zone. The trade-off is less an issue when FC and BC are in the same direction [Quadrant I & III], i.e. macro-financial dynamics are complementary. Under such circumstances, a policy action that addresses PS would also benefit FS. For example, when a financial crisis strikes, monetary policy easing will not only stimulate economic growth, but also support credit and asset prices. On the other hand, monetary policy tightening may be desirable when both the economy and the financial sector are showing signs of overheating. Under this circumstance, policymakers may consider whether the normal MP path, one that takes into account merely the outlook for economic growth and inflation, is sufficient to mitigate FS risks. The LAW strategy, if adopted, implies additional tightening and that inflation will undershoot the target, while output grows below potential, for certain periods.

The red zone. The trade-off becomes, nevertheless, severe when FC and BC move in the opposite direction [Quadrant II & IV]. This non-synchronization brings policymakers to

Figure 8. Path of Thailand's Financial Cycle and Business Cycle



This figure shows a contemporaneous plot of FC and BC. The macro-financial dynamics is said to be ‘complementary’ when the two variables are in the same direction (green zone), and there is a strong ‘trade-off’ otherwise (red zone). The densely dotted line represents projection (2018 Q1 to 2019 Q4) based on the same set of information as the economic projection presented to the rate setting committee.

a dilemma. On the one hand, the attempt to stabilize inflation through an eased policy stance could stimulate risk-taking and further accumulation of FS risks. On the other hand, adopting the LAW strategy could exacerbate the economic downturn and/or delay further the recovery of inflation to the target. The latter may derail the central banks credibility in pursuing PS objective. In this case, further analyses are required accordingly so that policymakers can carefully weigh benefits and costs of LAW.

4.3. Inputs into Monetary Policy Decisions

In light of the intertemporal trade-off above, policymakers, at each meeting, must carefully weigh benefits and costs of LAW to arrive at appropriate policy decisions.¹⁷ Staffs, therefore, need to provide necessary information that will assist in an evaluation of the trade-off. In this subsection, we describe the information set that should be submitted to policymakers, which includes:

¹⁷Debates on lean vs clean usually apply cost-benefit analysis to attain the conclusion (See, for example, Svensson (2017) and Adrian and Liang (2018)).

4.3.1. Assessments of Risks to Financial Stability

At the fundamental level, the rate-setting committee shall be presented with data for FC which is a summary measure of financial imbalances in the economy. A monetary policy framework with FS objective should take FC into consideration akin to key indicators of the real economy's health such as inflation, GDP growth, and unemployment rates. Figures 2 and 3 above are examples of time series data for FC that form part of MPC briefing at the BOT. Based on the findings from Section 2, where FC serves as a predictor for crisis probability and magnitude, the extent of FC upswing is thus the main indicator to suggest whether financial imbalances are high. An illustration of FC is to be complemented with FS Dashboard, which should help identify key vulnerabilities within the financial system and also sectors at risk. As argued earlier, the Dashboard also ensures that all pockets of risks are on radar.

A major challenge to policymakers is to decide at what level risks to FS is considered high and may warrant the LAW strategy. One approach is to estimate a threshold for FC, or the corresponding crisis probability, that implies excessive risk accumulation and hence high chances of crisis. Appendix A describes the method employed to estimate such threshold, which relies on maximizing the signal-to-noise ratio aimed at balancing the trade-offs between missed crisis calls and false alarms. The idea is that the threshold should not be so high that it fails to warn against the crisis to come, while not being too low and causes too much leaning against the imbalances. This threshold will serve as a rough guide for the harmful level of FC. Therefore, if there is a tendency that the country's FC is approaching such a level, it should alert policymakers that LAW may be warranted. Nevertheless, the committee should be mindful that the threshold is derived from its ability to predict past crisis in the cross-country perspective. Constantly evolving macro-financial circumstances may have altered each economy's overall risk appetite and tolerance, rendering different alarming levels across countries and times.

Conditional on the committee judging that the degree of financial imbalances is high and may pose risks to FS, further discussions are encouraged to lay the groundwork for monetary policy decisions. These may include the nature and source of financial sector vulnerabilities, their developments going forward, their potential consequences on the economy, and the available and effectiveness of MaP:

(i) What are the Nature and Sources of Financial Imbalances?

Policymakers shall form a view about factors driving the upswing of FC and/or contributing to financial sector vulnerabilities showing up in FS Dashboard. Understanding nature of risks and drivers of a financial upturn is important for prescribing appropriate policy responses. In the following, we list some useful considerations in classifying nature and sources of imbalances.

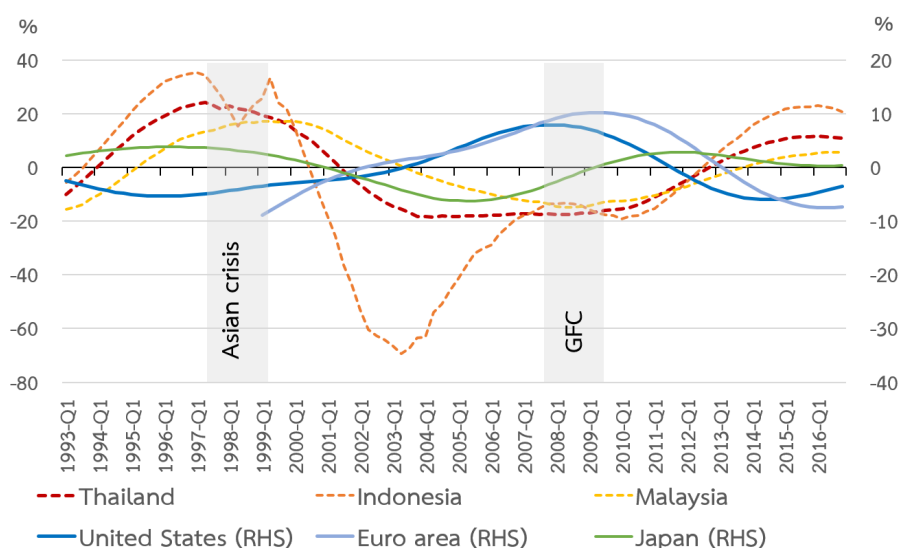
First, are the imbalances of cyclical or structural nature? Literature mostly classifies vulnerabilities, or more precisely the potential for systemic risks, into two dimensions: cross-section (structural) dimension and time-series (cyclical) dimension. The former focuses on the build-up of systemic risks over time, which is usually reflected in risk pricing, leverage conditions, and the degree of maturity and liquidity transformation. The latter, on the other hand, emphasizes the allocations of risk within the financial system, e.g. the degree of interconnectedness and the concentration of risks within particular institutions or assets. The distinction between cyclical and structural dimensions facilitates the choice of optimal policy tools, since MP is more effective in dealing with cyclical than structural risks. Addressing those structural risks is better off by deployment of other policies such as macroprudential, regulatory or supervision policies (for further discussion see Yellen (2014)). FS Dashboard which classifies vulnerabilities into several types can be useful for this purpose.

Second, are the financial imbalances economy-wide or sector-specific? Sources of FS risks are usually sector-specific, e.g. housing and stock market booms, entailing MP a blunt instrument. Decisions to lean against the wind need to carefully consider their negative consequences on the rest of the financial sector and the economy as a whole. However, economy-wide imbalances may take place and support MP actions. A good deal of examples includes the prolonged, low interest rate environment that fosters the search-for-yield behavior across many agents. In addition, the procyclicality between real and financial sectors can lead to heightened risks across several sectors in the financial system. In these circumstances, the ability of MP in getting into all the cracks renders the policy effective in addressing overall FS risks.

Third, are the financial imbalances generated domestically or from abroad? The interest rate policy may be deemed more appropriate for managing such movements arising from domestic factors, as opposed to external ones. Cross-border capital flows, for example, can be an external shock that exacerbates asset price booms and busts, as well as fuels domestic credit. If that is the case, the deployment of capital flow measures may be more effective

than MP in addressing the problem. In this regard, policymakers might consider movements of FC elsewhere. Figure 9 depicts Thailand's credit-to-GDP gap whose movements are quite in line with those of other ASEAN countries (Malaysia, Indonesia and Singapore) in contrast to those of the G3 countries (United States, Euro area and Japan).¹⁸ Policymakers could then debate on the influence of the global factors with more credit inflows fueling domestic FC, together with the bearing on monetary policy in the same fashion as the proposition put forth by Rey (2015).

Figure 9. (De-) Synchronization of Credit-to-GDP gaps



This figure shows evolution of credit-to-GDP gaps for selected economies. Thailand's financial cycle seems to be moving in line with those of other ASEAN countries, but decouples from those of G3 countries.

In addition to the list above, our paper argues that it may also be useful to examine the root causes of financial sector vulnerabilities. FS risks can be born out of structural roots, where LAW does not sustainably address the problem. We can think of the issue of limited liability or some forms of explicit or implicit guarantee that could lead to moral hazard and excessive risk-taking. Recent articles have, moreover, emphasized the failure of agents to internalize pecuniary externalities, which then results in overborrowing and the higher probability of crisis. These structural problem could be better addressed by prudential regulation and supervision.

¹⁸Data source: BIS. We applied Christiano-Fitzgerald-filter with frequency domain of 32-120 quarters to the credit-to-GDP series from 1993 Q1 to 2016 Q4.

(ii) What Will Be the Development of Financial Imbalances Going Forward?

Policymakers should form a view about the trajectory of FC and developments of vulnerabilities going forward. The projected path could base on either the market forecast or the central bank's own macro and econometric models. Such forecasts would enable a forward-looking assessment of the evolving state of financial imbalances, and an appropriate policy response accordingly. Conditional on the traditional MP path, if FC is expected to accumulate further, policymakers may use it as a ground to lean against the wind, since its impact on the economy can be disproportionately larger as the imbalances grow. The committee may, at the same time, assess whether the stance of monetary policy is, in part, contributing to such increased vulnerabilities. Policymakers should be vigilant on the possibility that MP can itself be a source of imbalances, especially when economic recessions call for large monetary expansion. On the other hand, if the financial sector is expected to soon undergo the process of deleveraging, the need to adopt the LAW strategy is lessened.

For Thailand, the latest data (2017 Q4) sees FC and BC in the red zone (Figure 8). The projection, nevertheless, shows the pairs gradually move into the green zone as output gap slowly closes and credit and asset prices moderate.¹⁹ Such developments, hence, signal strengthening economic outlook, with risks to financial stability receding.

(iii) What are the Potential Consequences on the Economy?

Policymakers should consider the potential impact on economic growth once financial imbalances unwind. Fundamentally, the level of FC should give policymakers a rough idea on the prospects of financial crisis, viewing from an aggregate perspective. However, FS risks are various in nature, and hence their effects on the economy may differ both in terms of transmission channels and the extent. While certain types of risks may have large negative repercussions on the whole financial system and the economy, others affect some sectors with limited spillovers onto the rest of the financial system or only lead to mild recessions. The analysis here will help complete the assessment of systemic risk, and give policymakers an idea whether it is worth adopting the LAW strategy and paying a premium in terms of worse near-term macroeconomic outcomes. Marginal benefits from LAW should increase with the anticipated negative effects of financial imbalances on the economy. In this regard, despite the fact that the past GFC showed how deep and severe recessions can be after the bubble burst, some estimates of the potential impact should be another useful input submitted to

¹⁹Credit, house price, and land price are projected to grow by 5%, 2%, and 5% respectively. These are consistent with consensus forecasts. The path for BC, on the contrary, is based on BOT's macroeconomic projection.

policymakers. This is the area where macroeconomic models, or less formal econometric analysis, can again be useful.

(iv) Are macroprudential policies available and effective in reducing financial imbalances?

Discussions so far assume away the role of MaP to take care of financial sector vulnerabilities. After the GFC, MaP is widely proposed as the alternative to safeguard FS. The measure, existing in several forms, can target specific sources of financial imbalances and distortions. Therefore, MP decisions should be made conditional on the reaction of MaP.²⁰ If effective MaP is available and timely implemented, financial imbalances can then be well-managed and there will be less a burden on MP to safeguard FS. Nevertheless, as we will elaborate over the next section, the deployment of MaP is subject to various implementation issues, while empirical evidence on its effectiveness remains limited. There can, hence, be roles for MP to address those vulnerabilities that not or imperfectly targeted by MaP.

4.3.2. Assessments of Monetary Policy Responses

After assessing risks to financial stability, the rate-setting committee should already have a view of whether FS risks are high. In the view of heightened risks, policymakers may decide to adopt the LAW strategy. However, the policy trade-off must be carefully evaluated, particularly when the BC and FC move in the opposite direction. That is, its benefits in preserving FS over the long run need to be weighed against near-term costs to macroeconomic performance. We describe here key considerations that would help policymakers evaluate such a trade-off.

(i) The Effectiveness of Monetary Policy in Addressing FS risks

Benefits of LAW depend, to a large extent, on the effectiveness of MP in mitigating FS risks. Staffs may present how LAW alters the future path of FC (and hence the probability of crisis) or financial risk variables of interest. To the extent that MP has a small impact on FS risks, large interest rate adjustments are required, which can be costly to the economy. Indeed, MP can constrain credit and asset price growth, and hence reduce financial imbalances, through its standard transmission channels. Recent literature also links MP to bank risk-taking incentives, highlighting more channels MP can safeguard FS.²¹ However,

²⁰This amounts to taking the behavior of MaP as exogenous in MP reaction function. However, for some countries, the central bank does have the authority to implement MaP and should give rise to coordinated policy actions.

²¹See, for example, Adrian and Shin (2010) who find that loose MP increases the ability of intermediaries to assume risk

as argued previously, the effectiveness of MP in addressing FS risks will, in part, depend on nature of financial imbalances. Facing with vulnerability of cross-sectional dimension or emanated from abroad, MP may be ineffective.

We hasten to add that the effectiveness of MP also likely depend on the state of financial imbalances. In particular, adopting the LAW strategy could worsen financial instability if committed when FS risks are already too excessive, e.g. when FC almost reaches their peak, or asset price bubbles are on the verge of collapsing. This follows from the findings that MP tightening, while improving FS over the longer horizon, negatively affect financial conditions in the short run (see Altunbasa et al. (2014)). In the short term, interest rate hikes reduce serviceability of existing variable-rate loans. Furthermore, by slowing down economic activities, they depress households and firms income, hence worsening their financial conditions and balance sheets. Default, consequently, rises. When the amount of loans outstanding has already grown excessively large, MP tightening may itself kick off the financial crash, while its LAW benefits in controlling new debt are yet to materialize over the longer horizon. Under this regard, when considering the impact of MP on FS, it is useful to consider balance sheet conditions of households and businesses, as well as how sensitive they are to MP tightening.

(ii) The Sacrifice of Near-term Macroeconomic Performance

On the other hand, costs of LAW are measured in terms of the sacrifice of near-term economic growth and inflation. Staffs may present projected paths for inflation and economic growth over the next 1-3 years conditional on MP reacting to emerging FS risks. Such projections can be obtained from the central banks forecasting models. As argued earlier, costs to macro performance are likely to be large when FC and BC are non-synchronized. Policy actions to mitigate FS risks could exacerbate economic downturn and the problem of low inflation. Policymakers should, hence, be mindful on the potential consequences on the central banks credibility in pursuing PS objective, which in turn risks the de-anchoring of inflation expectations.

As an illustration of how the trade-offs are evaluated, in this paper, we employ the Structural Vector Autoregression (SVAR) model to quantify the trade-offs. Details of the model and results can found in Box 1. We find that, under the baseline case, credit growth is expected to soften by slightly above 1% per annum in response to a one percentage point increase in the policy interest rate. On the other hand, the ‘Effective LAW’ sees the impact of around 4%, while ‘Ineffective LAW’ faces accelerating loan growth.

Based on the above results, we can then calculate the corresponding changes in FC, their impact on future GDP growth, and the probability of financial crises accordingly by using the methodologies described in Section 2.

- In the short run, such monetary policy tightening is expected to cut down GDP growth by 0.60% but adds a non-statistically significant 0.16% to headline inflation [core model].²²
- In the longer run (about 2-4 years), the softer growth of credit and land price is expected to improve future GDP growth by a 0.01% rate [quantile regression], and lower the probability of financial crises by 0.91% [panel logistic regression]. In the Effective LAW case, however, future growth could improve by 0.07%, and the crisis probability drops markedly by 4.62%. Under the Ineffective LAW scenario, on the other hand, the impact is reversed.

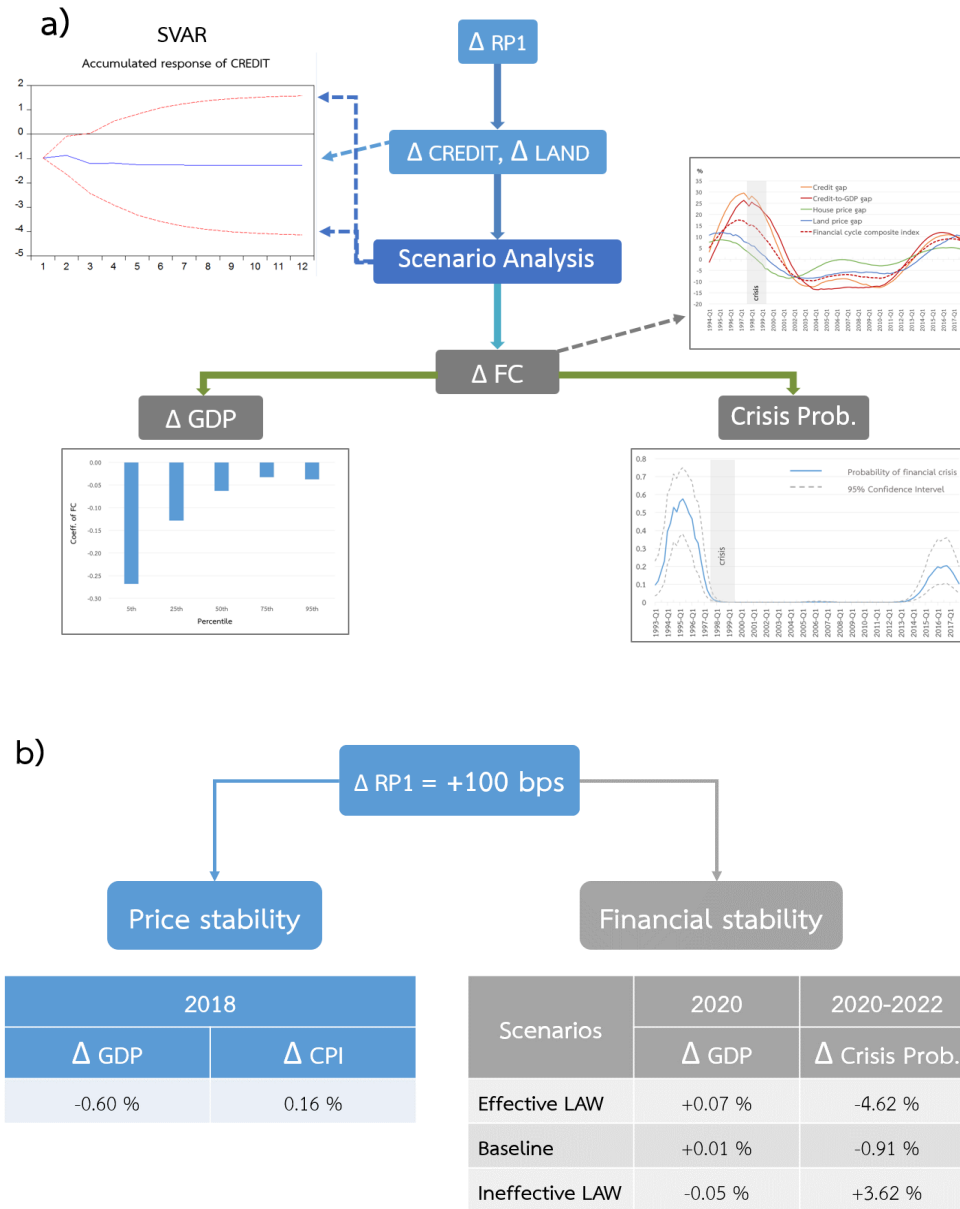
The results confirm an inter-temporal trade-off between using monetary policy to address FS vis-à-vis PS. The exercise, therefore, provides policymakers with quantitative information to carefully weigh the costs and benefits of LAW policy. Our analytical framework is summarized in Figure 10 below. Such a procedure shall be integrated into a monetary policy framework that takes FS considerations into account systematically. Although our framework shares the same spirit as the simple cost-benefit analysis of Svensson (2016) and Pescatori and Laséen (2016), we account for a detailed analysis of macro-financial linkages which gives us an insight into the impact of FC to future economic growth.

4.4. *Decision-making*

Given available information provided by the central banks staffs, the policy committee will weigh benefits and costs of LAW. They, then, decide whether the strategy is appropriate in striking the right balance between policy objectives. It is likely that, when the economy grows far behind its potential or inflation is far below target, marginal costs from LAW can be large and so the LAW strategy may be undesirable. Nevertheless, when the economy operates close to or above potential, there is more room to employ MP to lean against the financial cycles and accept a delay in getting inflation back to target so as not to exacerbate financial vulnerabilities along the way. A necessary condition for LAW is that confidence in the inflation target is firmly rooted and does not risk deteriorating because it takes somewhat longer for inflation to attain the target (Skingsley, 2015). Whether to act is conditional on

²²We humbly acknowledge the presence of ‘price puzzle’, which we have been unsuccessful at resolving.

Figure 10. Analytical Framework for FS-oriented Monetary Policy (a) and Policy Simulation Results (b)



Panel a) shows a procedural diagram to quantify the impact of monetary policy actions on financial cycle (FC), which in turn affects growth dynamics and the probability of financial crises. A change in monetary policy will affect credit and land price growth in the scenario analysis via the ‘core’ SVAR model. In the longer run, an increase in policy rate, leading to a decrease in FC, will also lower the likelihood of a crisis and raise growth as shown by our quantile regression results. However, this interest rate hike will cut down the GDP growth in the short run. We acknowledge the presence of ‘price puzzle’ in our SVAR analysis. **Panel b)** is an example of the quantified trade-off presented to the Monetary Policy Committee.

the extent of financial imbalances and the policy effectiveness in addressing the emerging imbalances weighing carefully against costs to near-term macro performance.

Another challenge facing policymakers is to decide when to counteract the emerging financial imbalances. Some advocates policymakers to consider LAW when FS risks become excessive, see IMF (2015). However, in doing so, it may be too late and, hence, large and prolonged MP tightening is required. There is also a possibility that such tightening could weaken agents financial conditions and even precipitate the crash. Others, on the other hand, support early, and more systematic, leaning against the wind, to avoid placing large burden on MP (Filardo and Rungcharoenkitkul, 2016). They argue that, if MP does not take action, risks could build up over time and there will be costs to waiting. In addition, benefits of LAW are possible in normal times, i.e. without crises, since financial imbalances, either large or small, bring about resource misallocation. Given these considerations, supporters of this idea suggest that MP should attempt to actively stabilize FC. Nevertheless, we see that such an attempt may result in persistent declines in inflation and economic growth, while ignoring the possibility that the financial upturn may be driven by good causes that do not necessarily result in economic inefficiencies.

Nonetheless, as the Bank of Canada’s governor puts it (Poloz, 2015), “Given all of the uncertainty, it seems that the proper response of the monetary authority is to acknowledge and accept all the things we don’t know, gauge the risks facing the economy as best as we can, and manage those risks as we conduct monetary policy.” Despite how systematic we intend in the integration of FS into MP framework, policy deliberation may ex post be heuristic. Evolving financial landscape, both in terms of participants, markets and instruments, incur unprecedented risks to the financial system that are hard to trace and identify their economic consequences. Policy decisions will, hence, involve considerable uncertainty. The bottom line is policy deliberation will likely be discretionary, and will involve more of expert judgment that makes use of rich information available.

4.5. Challenges to the Pursuit of Price Stability

Deviations of MP to take care of FS risks imply that inflation stays away from the central bank’s target more and longer than usual. At the extreme, MP could lose the primacy of PS and its credibility in the fight against inflation. Some modifications to the MP framework and practices are, hence, needed to ensure the most effective integration of FS.

The most important of all is to enhance flexibility of the inflation target. In particular, the horizon in achieving target needs to be extended. Indeed, the IT framework for many central banks has already supported this feature, given the target set at the medium-term horizon. However, to ensure commitment to PS, the expected time frame inflation returns to target should be communicated whenever MP is devised for the pursuit of FS. Moreover, to comply with the extended targeting horizon, the inflation and growth forecast horizon may need to be longer. As argued by Moenjak et al. (2004), such longer projections will also facilitate the estimation of an adverse impact of FS risks on growth and inflation outturns, which usually take time to materialize.

Communication will have a key role in promoting transparency and accountability under this FS-oriented monetary policy framework. Given several objectives for MP to achieve, policymakers need to clearly justify their agreed policy stance. The publication of FC and FS Dashboard could, in part, facilitate the task. Being rather well-established measures, they support the policy committee's narratives about systemic risk assessments. The committee should, however, make it clear to the public that they do not target FC – as a variable to stabilize – instead of inflation rate. Failing to do so risks losing the primacy of PS, and the credibility of monetary policy in the longer term.

5. Monetary and Macroprudential Policy Coordination

Our discussion will not be complete without considering the optimal policy mix for the MP framework that systematically takes FS considerations into account. As the well-known Tinbergen rule dictates, each policy target requires at least one policy tool. Therefore, preserving both PS and FS simultaneously probably requires, in addition to monetary policy tools like the policy interest rate, other available tools that can address FS concerns such as macroprudential policy (MaP). In the previous section, we suggest appropriate MP deliberation, taking the implementation of MaP as exogenous. This section, instead, argues that the formulation of a suitable policy package should draw on the merits, while acknowledging costs and limitations, of these policies in close coordination. We begin by discussing the rationale for why such policy coordination is preferred and later share an idea on how both policies may interact to achieve both PS and FS.

5.1. *Monetary and Macroprudential Policies: Complements, not Substitutes*

MaP is widely-proposed as a major tool to counter FS risks. Its clear benefit is that it is granular enough to address the growing imbalances where they arise. Furthermore, the deployment of MaP tools is perceived as further removing the need for MP to be concerned with FS. Ideally, if MaP could perfectly preserve FS, MP would be able to retain its pre-crisis role by holding accountable for only PS. In this regard, MaP acts as a substitute for MP in fulfilling FS mandate. Nevertheless, we argue that this separation principle could indeed be a sub-optimal choice. Policymakers, instead, should exploit the complementarity between those tools. Our argument rests on three assumptions.

5.1.1. *Macroprudential Policies are subject to implementation issues, while their effectiveness remains uncertain.*

The ability of the central bank to focus MP on achieving the inflation target is conditional on authorities with FS responsibilities having the will and the policy tools to mitigate financial system vulnerabilities and increase resilience. However, in practice, there are some considerations that preclude the absolute role of MaP in preserving FS.

- **Institutional arrangements** MaP might not be under the jurisdiction of the central bank; or fragmented institutional arrangements might make it difficult for the MPC to deploy such policies. In Thailand, for instance, FS falls under the responsibility of four main agencies, namely the Ministry of Finance, the BOT, the Securities and Exchange Commission, and the Office of Insurance Commission. Although these regulators do meet regularly, not all MaP measures will be promptly available.²³
- **Availability of MaP** There is no MaP available for certain segments of the economy. Non-banks such as credit cooperatives tend to be more loosely regulated than banks which means that MaP to target this particular businesses may not exist. In the extreme, the gray economy requires structural policies and appropriate interventions.
- **Implementation concerns** MaP tightening is usually an unpopular directive, and might have some political repercussion. This not only makes the implementation itself challenging, but also the right timing difficult to gauge.

Apart from the above implementation issues, whenever MaP tools are available, there are uncertainties surrounding their effectiveness. As argued by Smets (2014), assessing the effectiveness of MaP can be difficult, because (1) there is a wide variety of possible MaP tools,

²³Svensson (2018) argues that, under such circumstances, achieving FS requires consolidated actions among related parties. The efficacy of and accountability for MaP would be enhanced if one authority controlled all MaP instruments.

(2) there is as yet no widely agreed upon and comprehensive theoretical framework for the optimal choice and calibration of those tools, and (3) there is only scant experience with them for each country. The empirical literature, e.g. Lim et al. (2011) and Crowe et al. (2013) mostly argue in favor of MaP in dampening procyclicality of credit and leverage, particularly those related to housing. To what extent such measures are effective enough to significantly reduce systemic risk is, however, as yet unclear. In addition, there is less evidence on their impact on certain sources of financial sector vulnerabilities such as liquidity mismatch or on the overall price of risk.

MaP is also subject to regulatory arbitrage. Goodhart (2008) coined this issue the boundary problem of financial regulation. Effective regulation is likely to penalize those within the regulated sector, relative to those just outside, causing substitution flows towards the unregulated. There are, therefore, tight incentives for circumvention, with risk of vulnerabilities building up outside of the regulatory perimeter and policymakers sight. All these imperfections make MaP an imperfectly targeted policy with uncertain benefits and potential spillovers onto other parts of the financial system. It is, therefore, desirable for MP to lend a hand in achieving FS, rendering MaP a complement rather than a substitute in the fight against FS risks.

5.1.2. Policymakers could reap benefits from the specificity of each policy tool

Fundamentally, the integration of MP and MaP helps promote some division of labor in the fight against financial imbalances, allowing policymakers to devise the tools that are the most effective in tackling the problem.²⁴ Clearly, the main comparative advantage of MP is its ability to ‘get in all the cracks’, as Stein (2013) puts it. The policy could, hence, directly address implementation issues of MaP aforementioned. In addition, it influences the behavior of institutions that escape the regulatory perimeter, thereby alleviating concerns over the effectiveness of MaP, particularly those stemmed from regulatory arbitrage. On the other hand, the huge variety of MaP makes possible the design of tailored policy for specific purposes. It can either assume a time series or a cross-section dimension, therefore being able to address various forms of vulnerabilities, including ones that could not be effectively managed by MP. Importantly, it does so with little or no costs to the economy, at least from the macroeconomic perspective.

²⁴An appropriate policy sequencing is, indeed, still a hotly debated topic among academics and central bankers (for detail see Smets (2014)). A camp led by the BIS supports the use of MP to addresses financial imbalance, while the other led by the IMF believes that MP should be the last line of defense against FS risks.

Earlier, we have also argued that the nature and sources of financial imbalances may matter for the appropriate choices of policies. In particular, MaP is well-suited to mitigate FS risks of cross-sectional dimension. Given its specificity, it is also usually viewed as a prime candidate to counter pockets of FS risk. For example, tightening the loan-to-value ratio is likely to deter financing activities in the real estate sector, but shall not, at least in theory, deter other types of activities. On the other hand, MP, given its ability to reach into corners of the financial system, may be more effective in dealing with an economy-wide emergence of financial imbalances, such as those caused by the procyclicality between the real and financial sectors. In this case, MaP tightening in multiple sectors may be required, and hence could be subject to implementation issues and challenges in the joint calibration of several tools.

5.1.3. Policy coordination helps avoid over-burden on a particular policy

This argument is particularly relevant to MP, which is mandated to achieve several objectives. Being a blunt instrument, large interest rate adjustments, particularly when leaning against overly optimistic expectations, may be warranted, which in turn incur huge costs to the economy. Placing excessive burden on MP in addressing FS issues risks throwing away its credibility in maintaining PS. Moreover, given the high persistence of policy interest rates and concerns over the policy trade-off, MP reaction to address heightened FS risks is likely to be inadequate. Therefore, it is necessary that MaP shares the burden in preserving FS, particularly when the LAW strategy could result in strong tensions between PS and FS.

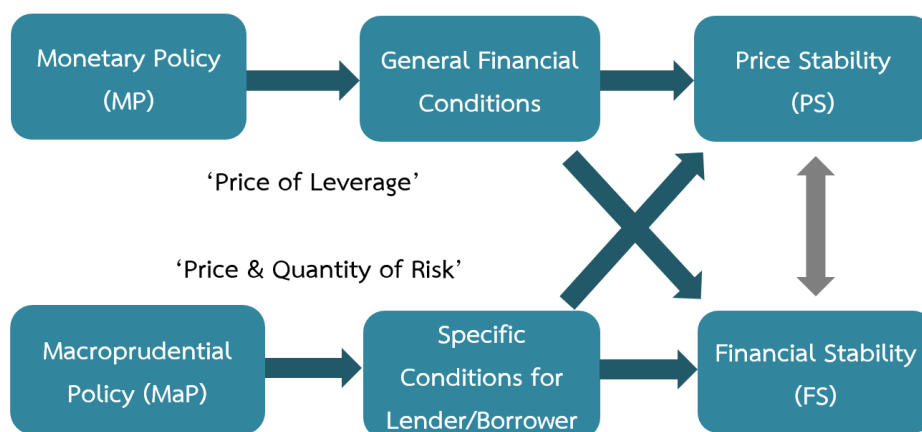
Nevertheless, the bottom line is that we, the central bank and financial regulators, still have a lot to understand about the transmission and impact of both policies on FS. This is, particularly, the case for MaP, which has yet to be fully-developed, and thus several tools remain unproven with respect to their ability to curtail financial imbalances, let alone their potential implementation issues. Therefore, relying solely on one particular policy risks failing to satisfy the FS objective.

5.2. A High-level Framework for Policy Coordination

The high-level framework, therefore, involves two objectives with two policy tools. Figure 11 illustrates the standard transmission mechanism of these policies. MP influences economic activities by affecting general financial conditions. An increase in the benchmark rate raises costs of borrowing ('price of leverage'), and the economy's overall financial activities are likely to be dented. MaP, on the contrary, targets financing activities of a particular group of borrowers and lender, where transmission is made via balance sheet components of eco-

conomic agents. The formulation of a suitable policy package, i.e. the right combination of policy tools, should draw on the merits of these policies in close coordination while taking into account their limitations and trade-offs. The economy will benefit from the right policy mix that gears towards ensuring both price and financial stability.

Figure 11. Transmission of Monetary and Macroprudential Policies



MP sets a benchmark domestic interest rates, which determine costs of borrowing (‘price of leverage’). The impact of MaP, on the contrary, is transmitted via balance sheet components of banks/companies/households. These tools could influence both PS and FS objectives.

MP and MaP may, indeed, coordinate in dealing with FS risks, and strike a balance between FS and PS. Roughly, there can be two approaches.

In some occasions, MP and MaP may be simultaneously devised to lean against financial cycles, i.e. both policies will be in the same tightening direction. This ‘reinforcement’ strategy can be useful, for example, when the buildup of imbalances is massive and/or when costs to the macroeconomy constrains large interest rate adjustments. In addition, an incomplete MaP may urge MP to help lean against the imbalances. Collard et al. (2017) study the economy with excessive risk-taking stemmed from limited liability and deposit insurance, and find that a positive productivity shock leads to an optimal joint tightening of the capital requirement and the interest rate. This complementarity means that the optimal interest rate adjustment can be smaller given the already-tightened capital requirements.

In other situations, both tools may be deployed in the opposite direction, with an aim to address potential side-effects from their counterparts. This is usually the case when BC and FC are in the opposite directions, when MP easing is required to shore up the economy and MaP reacts to curtail risks to FS. The negative side-effects of monetary expansion on FS can

be offsetted by MaP tightening. This ‘counterbalancing’ strategy allows one policy, usually MP, to focus exclusively on inflation or economic growth, while the other policy mops up any externalities on FS. In case of Thailand, even though FC has recently peaked – which signals subsiding systemic risk – [under] pricing of risk still seems prevalent in many sectors according to disaggregate data. In such circumstances, MP easing to shore up output should be accompanied by MaP tightening in multiple sectors to contain FS risks. Even in the presence of effective MaP, such a policy strategy may be most costly than using MP to LAW so as to manage the ‘price of leverage’ in general.

To illustrate how policymakers evaluate the optimal policy mix, we employ a Dynamic Stochastic General Equilibrium (DSGE) model to quantify benefits and costs from formulating each policy instrument. A brief account of the model and the results are shown in Box 2. In the model, we consider FS risks emanated from the housing sector, where increased demand for houses raises mortgage and house price growth. The existence of mortgage default serves as key risks to the financial sector. Both MP and MaP are available to contain imbalances in this sector. The choice of MaP tools includes countercyclical capital buffers (CCyB) and caps on LTV ratio. For the latter, we consider both through-the-cycle and state-contingent types. Given a variety of tools policymakers can resort to, they should, therefore, carefully assess their effectiveness and potential costs so as to implement the appropriate policy package.

Our results show that MP can be a useful tool to deal with imbalances in the housing sector. However, a trade-off in terms of short-term output losses is also evident. Policymakers, as a result, need to be mindful of these adverse consequences on the economy, particularly when the economy does not exhibit a good strength. Meanwhile, CCyB can slow down mortgage booms to some extent, but is not as effective as MP. Indeed, the primary aim of CCyB is to buildup capital buffers, where we find that the measure serves its role relatively well. The most effective tool to lean against housing booms is evidently the LTV regulations. Given their well-targeted nature, they do not entail costs on the overall economy. However, the LTV caps need to be stringent enough for them to be able to soften mortgage growth. With these information, policymakers can then design a policy package.

Many challenges remain in the policy coordination. Not only is the literature on interactions between MP and MaP in an early stage, but policymakers also lack practical experience. A more daunting task is that institutional arrangement may need an overhaul.²⁵ For instance,

²⁵See Shakir and Tong (2014) for an example of institutional setup at the Bank of England to facilitate the

assigned objective and accountability to preserve both PS and FS should be shared among authorities responsible for each policy tools. Policy committees, high-level executives and staffs should be incentivized for joint decision-making and cross-organizational collaboration. Effective coordination mechanism e.g. information sharing channel among entities should also be established. It is already hard to get a right institutional design, but even harder to successfully implement it.

6. Conclusion

In this paper, we consider a systematic approach to incorporate financial stability considerations into monetary policy framework, and supports our case by looking at the experience at the Bank of Thailand. In summary, our attempt is not to propose a new monetary policy framework, but to make some modifications to the flexible inflation targeting framework.

As an initial step, the conduct of monetary policy can be made more oriented toward financial stability. First, appropriate measures of FS risks should be included in the information pack for the rate setting committee. FC and FS dashboard data are one way of doing so. While FC serves as a candidate indicator to assess the overall health of financial system, FS Dashboard, compiled from more than 50 sectoral indicators, helps ensure all pockets of risks are on the radar screen. Second, macro model need improvements –at least not to repeat the same failure during the GFC. It should capture the notion of macro-financial linkages, able to forecast FS risks, and facilitate proper choice of policy tools. We propose an example of model platform to perform all these challenging tasks.

The final step is to expand the scope of monetary policy deliberation to strike a balance between PS and FS. We suggest how it proceeds step-by-step. The extent of FS risks, and the quantification of the intertemporal trade-off between PS and FS, are some vital issues that should be comprehensively analyzed and debated within the monetary policy committee. At a higher level, we propose that a suitable policy package, including both MP and MaP, should draw on the merits of these policies in close coordination, while taking into account their limitations and trade-offs.

While the proposed analytical framework is rather generic, more works need to be done to ensure successful implementation. Obviously, the applicability of our approach will also depend largely on the country context such as the economic and financial structure, the interaction between the Monetary Policy Committee (MPC) and the Financial Policy Committee (FPC).

suitable measurement of financial imbalance, and institutional setups of different policy tools. Nevertheless, we believe that technical research and model development are key to enhance quantitative policy analysis. The analysis of macro-financial dynamics could be strengthened by utilizing micro and balance sheet data. More understanding regarding the ability of MP and MaP, is also needed. Moreover, a platform of model should be developed to facilitate realistic policy simulation.

Box 1: Structural Vector Autoregression

Structural vector autoregression (SVAR) is a data-driven model that estimates a linear relationship of multiple time series. Each endogenous variable in the system is assumed to depend on its own lagged values, lags of other variables and contemporaneous exogenous variables. From the economic perspective, SVAR is used to interpret the joint dynamics between variables of interest. To identify structural shocks, SVAR resorts to many available identification techniques such as Cholesky decomposition, long-run zero restrictions and sign restrictions. The impulse response functions (IRFs) summarize the effects of temporary shocks to the system.

In the study of macro-financial linkages, we follow a VAR approach of Disyatat and Vongsinsirikul (2003) which is prior work on monetary policy transmission in Thailand. We construct SVAR in a compact system, comprising real output (GDP), headline consumer price index (CPI), private credit (CREDIT), land price index (LAND), and the policy rate or 1-day repurchase rate (RP1). Based on a literature survey, the ordering of endogenous variables is as follows: CPI, GDP, RP1, LAND and CREDIT, which implies that financial variables have lagged implications on rate-setting decisions, but they respond contemporaneously to an interest rate shock. We also include two exogenous variables: Dubai Crude Oil Price (DUBAI) and Real Effective Exchange Rate (REER) in order to capture effects from external sectors. All data are quarterly from 2000 Q1 to 2017 Q4,^a and are transformed to quarter-on-quarter growth in order to achieve stationarity (except the policy rate which is its first-difference). The optimal lag length of two was chosen based on information criteria. Cholesky decomposition is employed to identify structural shocks based on the ordering above.^b

Figure A shows the impulse response of real GDP and credit to a MP tightening shock. A policy interest rate hike of roughly 1 percent in 4 quarters results in a fall of GDP, with 8 quarter-ahead response, of roughly 0.6 percent below baseline, while real credit, with 8 quarter-ahead response, falls roughly 1.0 percent below baseline. This means an interest rate hike will result in the reduction in both the real economy (GDP) and the financial markets (represented by real credit), so the increasing interest rate faced trade-off between the benefit in decreasing financial imbalances and the cost in economic slowdown.

Moreover, the IRFs conveniently enable scenario-based policy simulations, for instance,

when we evaluated the cost of leaning against the wind (LAW) from tightening policy rate 100 basis point, we report the reduction in credit growth as baseline and present additionally the confidence interval (e.g. $\pm 2SD$) as effectiveness of LAW scenarios. We assigned the lower bound of the IRF could correspond to ‘Effective LAW’ scenario (reduction in credit growth is larger than baseline), and the upper bound ‘Ineffective LAW’ (reduction in credit growth is smaller than baseline). As a consequence, policymakers can fully appreciate a range of possible outcomes.

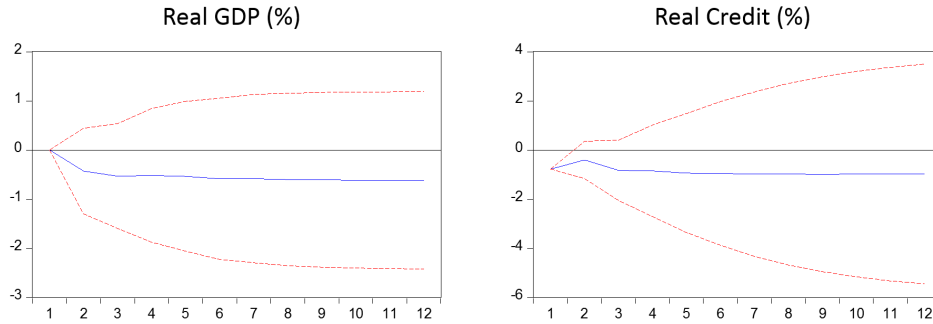


Figure A. Effects of policy rate shock on real GDP and real credit growth

For Thailand’s policy simulation, we assume that credit and land price will grow by about 7% and 5% per annum, respectively, during the next few years [market forecasts]. Under the baseline scenario, credit growth is expected to slow down by slightly above 1% per annum in response to a one percentage point increase in the policy interest rate. On the other hand, the ‘Effective LAW’ sees the impact of around 4%, while ‘Ineffective LAW’ faces accelerating loan growth. The latter might arise because of a shift in expectations where agents perceive the rate hike as a sign of robust growth outlook.

In conclusion, we tried to build the SVAR incorporating both macroeconomic and financial variables and simulated the responses from shocks, especially policy shocks, to obtain the effectiveness of LAW scenarios. This model is an example that quantitatively predict impacts of different scenarios for policy makers to formulate their decisions.

^aWe use the same data set as in Section 2.1.1

^bWe also experimented with time-varying parameters(Primiceri, 2005; Aastveit et al., 2017), and coefficient restrictions (Arias et al., 2017). However, such variation in core models does not pose any departure from the main analytical framework

Box 2 Dynamic Stochastic General Equilibrium

Dynamic Stochastic General Equilibrium (DSGE) model is a type of model usually applied in monetary economics researches and at many central banks. It is rather deep in theoretical microfoundations, but can as well match key moments of the data through calibration and Bayesian estimation. The model, though, is often being criticized with its strong assumption of rational expectations and an ability to perform forecasting. However, given its structural approach to modeling, the DSGE model is beneficial for conducting policy analysis. In particular, it offers a unified macro-financial framework to analyze different tools. New tools, or policy regime shifts in general, can be assessed in the way that is less subject to Lucas Critique. Furthermore, as agents' behavior is based on optimization, the model allows for a proper welfare analysis and hence can offer optimal policy recommendations.

This paper employs a DSGE model to analyze interactions between monetary and macroprudential policies in the context of the Thai economy. We propose the model that features the country's macro-financial linkages. To shed light on the issue of high household debt, mainly driven by housing loans, we embed housing and banking sectors into an otherwise standard New-Keynesian DSGE model à la Smets and Wouters (2007). In the model economy, households consist of two types, patient and impatient ones. Impatient households have incentives to borrow from banks, the only source of funds, to consume and accumulate houses. One type of loans is available, including secured mortgages tied to housing value. Banks obtain deposits from patient households, and use them in conjunction with retained earnings to lend to both impatient households and entrepreneurs. The latter require business loans to accumulate capital. Monetary policy, meanwhile, is modeled as a simple Taylor rule.

Two financial frictions are included into the model. To capture the emergence of financial instability, impatient households may default on mortgages. We follow Bernanke et al. (1999) and Forlati and Lambertini (2011), which assume costly state verification, in the modeling of default. In compensation for default, banks can seize houses. Default, hence, represents key FS risks in this economy. Furthermore, bank loans are subject to capital regulations. This incurs another friction to financial intermediation and could amplify and propagate the impact of shocks to the rest of the financial system and the economy. In particular, any shocks that drive bank profits and capital down lead to the shrinkage of bank assets and the tightening of loan standards, with adverse implications

on the real economy.

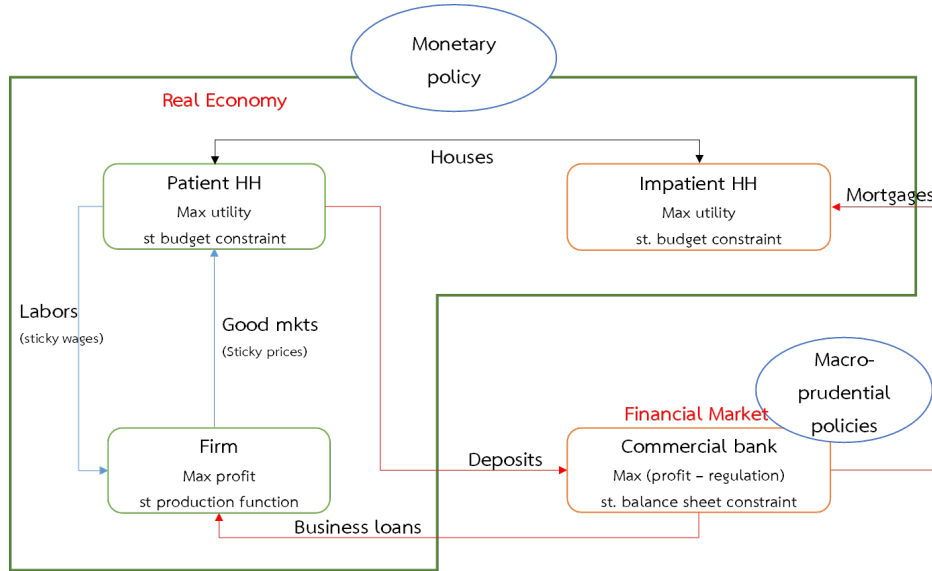


Figure B1. Model Structure

As an illustration, we experiment with positive housing demand shocks and housing risk shocks to model the boom and bust of housing cycles, respectively. During the boom, a housing demand shock generates rising house prices and mortgages, implying greater financial sector vulnerabilities as suggested by FC (Figure B2). Banks grant loans with higher loan-to-value (LTV) ratios, which trigger some default on mortgages in later periods. GDP, however, barely moves. Against this background, policymakers will have incentives to counteract this mortgage upswing, e.g. by adopting the LAW strategy, despite the economy growing close to potential. In the bust, a housing risk shock serves as a trigger for households' incentive to default, which subsequently leads to periods of financial turmoil, as shown in lower bank profits, heightened credit spreads that result from both greater default risk and falling bank capital, and subdued loans growth (Figure B3). We observe worse economic activities, both in consumption and investment. The finding illustrates that specific shocks originated in the financial sector can have wide-spreading effects on the economy, and hence warrants any preemptive actions to relieve the shock impact.

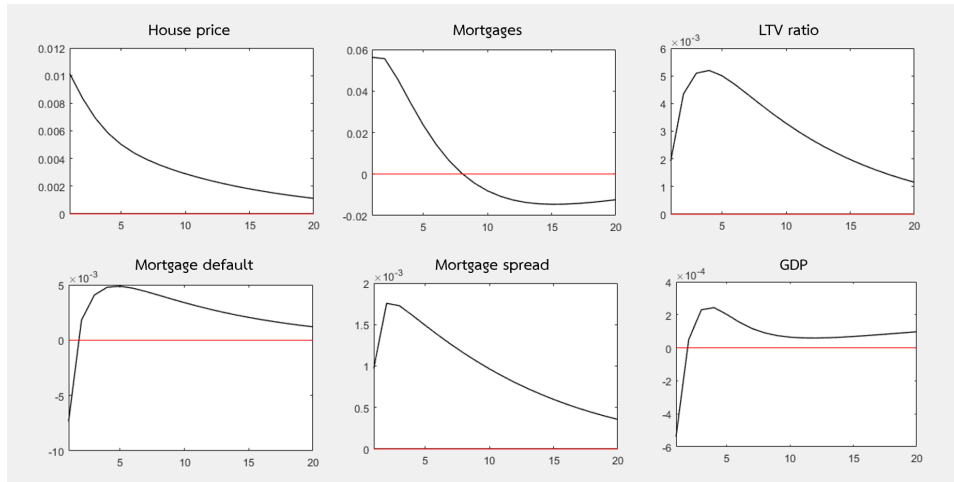


Figure B2. The effects of a housing demand shock on the economy

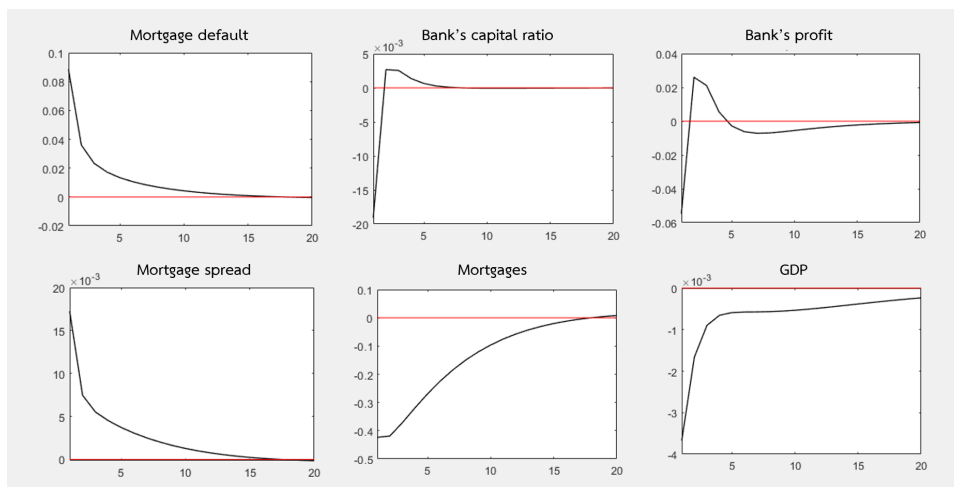


Figure B3. The effects of a housing risk shock on the economy

We, next, assess the roles of MP and MaP in stabilizing housing cycles. For MP, policy interest rates, not only respond to output growth and inflation but the credit-to-GDP ratio. We call it the modified Taylor rule (MTR). For MaP, a wide range of tools is considered, ranging from countercyclical capital buffers (CCyB) to caps on the LTV ratio. CCyB, which increase with the credit-to-GDP ratio, force banks to hold more capital during the boom. Given that bank capital is more costly than deposits, the measure can indirectly curb excessive bank lending. Meanwhile, there are two forms of LTV regulations, i.e. through-the-cycle and state-contingent LTV caps. For the former, caps are set at the steady state and do not vary over time. In contrast, for the latter, caps vary with the ratio of mortgages to GDP. During housing booms, regulators may lower caps on LTV to tame down mortgage growth.

Our results benefit the quantification of trade-offs from formulating each policy tool aimed at addressing growing FS risks and the understanding of how they help preserve financial stability, which should help policymakers decide on an appropriate policy mix. Figure B4 shows the cumulative effects over 4 quarters in slowing mortgage growth, as well as the associated output losses, compared to the benchmark case shown in Figure B2 above. First, MP yields significant benefits in slowing mortgage growth. The trade-offs on short-term economic growth can be clearly observed, though not to a large extent. It is to note that the recessionary effects on lending activities are broad-based. That is, personal and business loan growth decline relative to the benchmark case. Given the trade-offs on output growth exists, policymakers should be mindful when employing MP to lean against housing cycles.

Second, CCyB, not only raise banks' capital ratio during the housing boom, but can effectively reduce their risk-taking. Mortgages fall immensely as more capital buffers are required by regulators. However, negative effects on loan supply and output are also inevitable and found to be broad-based since banks can choose to reduce any loans to satisfy capital requirements. Compared to MP, benefits of CCyB in leaning against mortgage growth relative to its costs are smaller. Nevertheless, higher capital buffers should make banks more susceptible to upcoming shocks.

Last, caps on LTV ratios can be an effective tool in dealing with excessive mortgage growth, particularly as they do not entail costs on overall output growth. In the simulation, we assume that initially the equilibrium LTV ratio is at 0.87. For through-the-cycle LTV caps, their benefits in taming down the booms are significant if and only if caps are stringent enough, for example when they are set as low as 0.80. For state-contingent LTV caps, higher mortgage-to-GDP ratios would urge regulators to tighten LTV caps. They are also shown to be effective in slowing down mortgage growth. As a result, LTV regulations can be a useful measure to target imbalances in the housing sector. When there is high costs from implementing MP, this MaP tool can be an effective first line of defense against such imbalances.

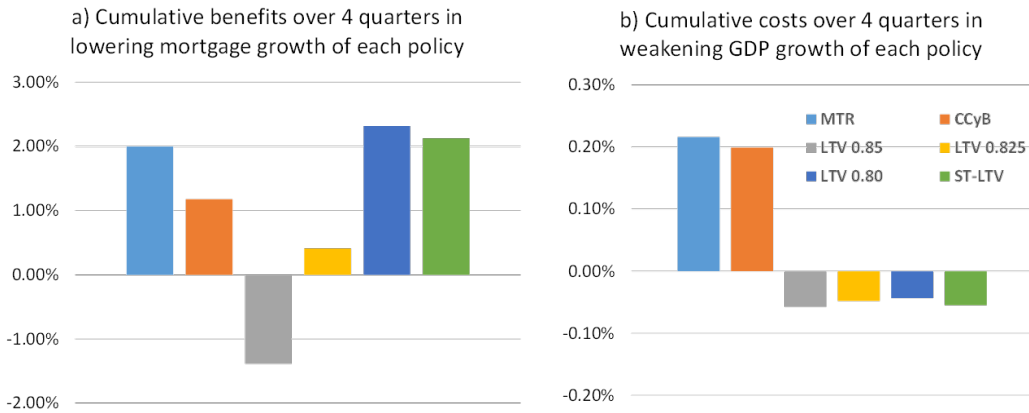


Figure B4. Quantification of benefits and costs from leaning against the housing booms triggered by a housing demand shock^a

To conclude, we have shown how the DSGE model, or structural models in general, can be useful in the optimal policy analysis. Here, we focus on one particular source of FS risks, namely a housing boom and bust. Several policy tools are, then, evaluated to help policymakers understand their benefits and costs if they are to be implemented to lean against the boom. Our model, therefore, offers a unified framework to aid the decision-makings.

^aIn this figure, we explore four alternative policy options, namely (1) a modified Taylor rule (MTR), where policy interest rates also respond to mortgages; (2) through-the-cycle caps on the LTV ratio (from 0.8 to 0.85); (3) state-contingent LTV caps (ST-LTV); and (4) countercyclical capital buffers (CCyB). Benefits and costs are computed in relative to the impulse responses from the benchmark Taylor-rule case.

Appendix

(A) A Derivation of Early Warning State for Crisis Probability

The forward-looking probability of financial crisis derived in Section 2 facilitates policymakers in assessing financial stability risk. However, one might ask what level of crisis probability should trigger policy makers to start implementing measures to prevent significant economic slowdowns. Based on historical data, we apply a statistical method to set a threshold for an early warning state.

By specifying a threshold, two types of errors occur: (i) missed crisis calls (type I error) and (ii) false alarms (type II error). If the threshold is set too high, the former will increase whereas the latter will decline, i.e. setting too high threshold will increase missed crisis chance, but signal less false alarm, and vice versa.

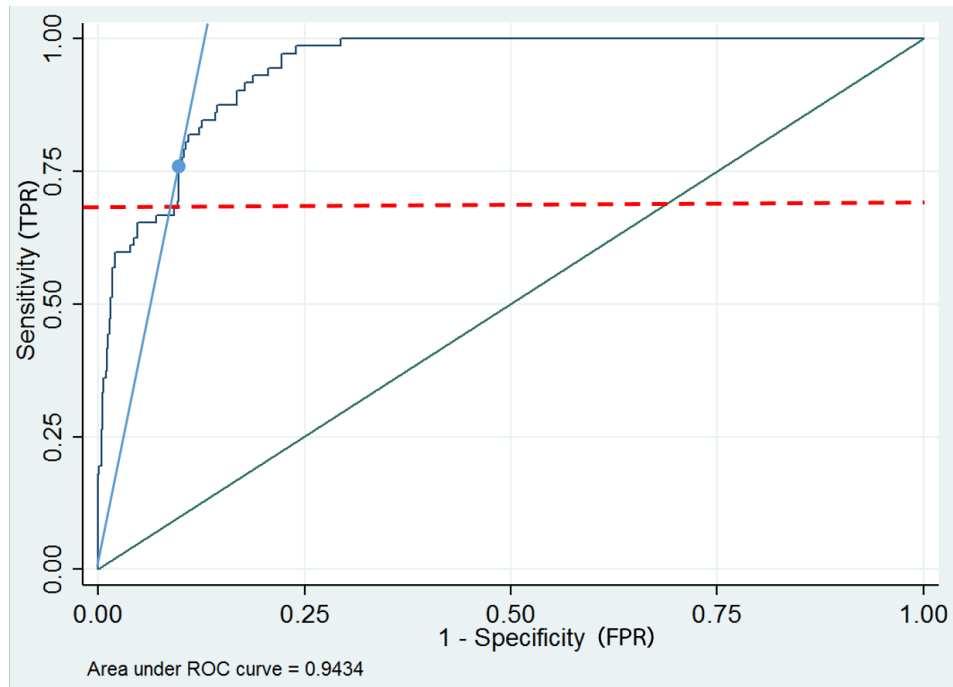
Therefore we need to deal with the trade-off between these two type of errors by adjusting the threshold such that the so-called noise-to-signal ratio –defined to be the ratio of a false positive rate (FPR) and a true positive rate (TPR)– is minimized.²⁶ Moreover, the desired threshold should historically predict at least two thirds of the occurrence of crises correctly. See Aldasoro et al. (2018).

Figure 12 shows the mapping between TPR and FPR by adjusting the threshold ranging from 0 to 1. In fact, this curve is called a Receiver Operating Characteristic (ROC) curve which contains information about signaling quality for an indicator. Intuitively, it shows whether the distributions of the two samples –crisis group sample and non-crisis group sample– are well separated. Under our criteria the point of interest is the one which is lying above the dashed red horizontal line (predicting at least two thirds of crisis events) and has the steepest slope from the origin (maximizing signal-to-noise ratio).²⁷ The optimal threshold given by our analysis is equal to 0.24 which gives the minimum noise-to-signal ratio.

²⁶We define FPR to be the ratio of false alarm, i.e. the number of negative (non-crisis) events wrongly categorized as positive (crisis) group, while TPR is denoted to be the ratio of correctly predicted crises.

²⁷The slope is the ratio of TPR and FPR, therefore maximizing this slope is equivalent to minimizing noise-to-signal ratio.

Figure 12. Receiver Operating Characteristic (ROC) Curve



We evaluated the performance of this early warning indicator in the case of Thailand. The threshold of 0.24 performs well since it signals a pre-crisis state in 1995 Q1, about 2 years before the Asian financial crisis in 1997. The threshold enables policymaker to get an idea of early warning state of financial booms.

(B) Example of Core Indicators by Sector and Type of Vulnerability

Sector/ Vulnerability	[Under] Pricing of risk	Risk appetite	Leverage	Vulnerability in debt serviceability and cushion	
Entity	Household	<ul style="list-style-type: none"> % of risky financial asset to total financial asset 	<ul style="list-style-type: none"> Household debt to GDP Household debt growth 	<ul style="list-style-type: none"> Debt service ratio (DSR) New entry NPL rate (retail loan) % Special mention loans (SIM) + NPL (retail loan) 	
	Corporate	<ul style="list-style-type: none"> Hurdle rate (proxy by Weighted Average Cost of Capital: WACC) Change in new loan rate* - Change in policy rate <ul style="list-style-type: none"> > 1,000 mn THB < 1,000 mn THB 	<ul style="list-style-type: none"> Corporate debt to GDP D/E ratio of The Stock Exchange of Thailand (SET) Corporate debt growth 	<ul style="list-style-type: none"> Interest coverage ratio (ICR) New entry NPL rate (business loan) % SIM + NPL (business loan) 	
	Bank + Specialized financial institutions (SFIs)	<ul style="list-style-type: none"> Average cooperatives' loan rate - Average cooperatives' deposit rate 	<ul style="list-style-type: none"> Risk-weighted asset growth Loan to deposit + borrowing Credit to GDP gap Credit standard from senior loan officer survey (SLOS) 	<ul style="list-style-type: none"> Bank D/E ratio SFI leverage (D/E ratio) 	<ul style="list-style-type: none"> Liquidity coverage ratio Capital adequacy ratio (CAR) Actual to regulatory loan loss provision
Market	Non-bank financial institutions	<ul style="list-style-type: none"> Average cooperatives' loan rate - Average cooperatives' deposit rate 	<ul style="list-style-type: none"> Non-bank FI's loan growth Saving cooperatives' deposit growth Money market fund -daily fixed income / Saving commercial banks' deposit + SFI Foreign investment fund growth 	<ul style="list-style-type: none"> Non-bank FI's leverage (D/E ratio) Saving cooperatives' Leverage (D/E ratio) Insurance D/E ratio 	<ul style="list-style-type: none"> Non-bank FI's ICR (listed company only)
	Real Estate	<ul style="list-style-type: none"> Housing price growth Land price growth 	<ul style="list-style-type: none"> Loan-to-value ratio (LTV) Condominium's reservations (average of the past 20 months) to transferred properties by unit (latest month) 	<ul style="list-style-type: none"> Pre-finance loan + bond (% growth) Pre-finance loan + bond (% to GDP) Post-finance loan (% growth) Post-finance loan (% to GDP) 	<ul style="list-style-type: none"> ICR of SET's developers <ul style="list-style-type: none"> ICR P25 ICR P75 Mortgage borrowers' debt service ratio % SIM + NPL pre finance % SIM + NPL post finance
	Monetary and Financial Market	<ul style="list-style-type: none"> 12-month forward P/E ratio 2-10 spread of govt bond 1-3Y corporate bond spread by rating <ul style="list-style-type: none"> A group B group 	<ul style="list-style-type: none"> VIX Index Outs of unrated + non-investment grade bonds to total bond outstanding SET turnover ratio % Non-resident (NR) bond holding % NR stock holding % margin loan to SET total market value 		
External	<ul style="list-style-type: none"> 5Y CDS premium 10Y govt bond spread over G3 		<ul style="list-style-type: none"> External debt growth External debt to annualized export External debt to foreign reserve 	<ul style="list-style-type: none"> DSR (foreign debt to export's income (goods & services)) ST debt to foreign reserve 	

This dashboard is an attempt on classifying our core indicators into a 7 × 6 table—seven key sectors and six types of vulnerabilities—which enables us to comprehensively monitor all pockets of FS risks. However, the measurement of ‘mismatch’ and ‘interconnectedness’ probably requires different methodologies which are still under investigation by the working group. See Adrian et al. (2015) for an example of indicators in these two categories.

*New loan rate is calculated from interest payments on new loan contracts by 14 Thai commercial banks excluding loans to households and financial intermediaries and is weighted by loan size.

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