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Assessing Thailand's financial vulnerability: An early warning approach

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Abstract:

This paper intends to assess financial vulnerability in Thailand through the construction of a financial vulnerability indicator (FVI). This early warning system has been developed using the signals approach proposed by Kaminsky and Reinhart (1999), followed by composite indicator construction. The period under study spans from January 2000 through to December 2016. Our empirical findings indicate that exports has the lowest noise-to-signal ratio (0.13), followed by real GDP (0.15) and house price index (0.20). These suggest that financial crises are usually preceded by a weakening in exports, a slowdown in the economy and a decline in house price. For Thailand, four major financial episodes are successfully outlined during the study period, demonstrating the effectiveness of an early warning system in financial vulnerability forecasting.

JEL Classifications: E17, G01, G28

Keywords: Financial vulnerability indicator, early warning, signals approach

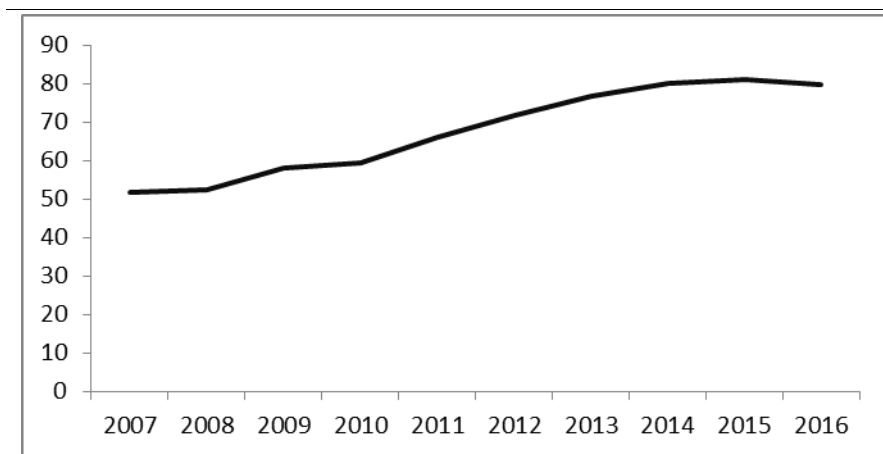
Citation: Puah, C. H., Kuek, T. H., Arip, M. A. (2017). Assessing Thailand's financial vulnerability: An early warning approach. *Business and Economic Horizons*, 13(4), 496-505, <http://dx.doi.org/10.15208/beh.2017.34>

1. Introduction

Over the past decade, the financial sector in Thailand has expanded rapidly, particularly, since the subprime mortgage crisis in 2008. A low-interest rate setting coupled with advances in financial services has triggered the demand for consumer-based financial products which in turn has driven the growth of the financial sector. Predominantly, the recent property boom and favourable macroeconomic conditions in Thailand have stimulated property demand and encouraged home ownership, particularly in the market for residential properties. With the rapid appreciation in the value of certain housing markets in Thailand, this has further supported household net worth and credit demand (International Monetary Fund, 2016).

Along with the rapid development of the financial sector, domestic credit to the private sector has amplified remarkably, hitting 151 percent of gross domestic product (GDP) in 2016, the highest level seen after the subprime mortgage crisis. According to a report by the International Monetary Fund (2016), credit to the household sector has contributed over 80 percent to the increase in the credit-to-GDP ratio in Thailand. Based on the statistics published by the Bank of Thailand, the household debt to GDP ratio hit 81.2 percent in 2015 and remained sticky at around 80.0 percent in 2016 (See Figure 1). Though the credit cycle has shown signs of slowing down, the rapid pace of escalation in household debt relative to income remains a key concern of vulnerability.

FIGURE 1. HOUSEHOLD DEBT TO GDP RATIO IN THAILAND, 2007-2016



Source: Bank of Thailand, various issues.

Pertaining to this issue, the Bank of Thailand (2016) warned of the vulnerability of the household sector due to the high level of household debt and weak debt serviceability, particularly for low-income households, agricultural households and SME-operating households. Furthermore, the global insurance giant, Allianz Group, has also warned on the current unhealthy level of Thailand's household debt to GDP ratio, while HSBC's chief Asia economist, Frederic Neumann, has noted the risk exposure of current debt levels towards financial stability if no proper prudent controls are implemented. Excessive debt accumulation by the household sector causes the financial system to be more vulnerable towards another financial crisis. In the situation of sharply plunging property prices or an economic downturn, the highly exposed banking sector will be critically impacted, ensuing in the breakdown of the financial market. A housing bust due to a huge build-up in household debt would eventually lead to a deeper collapse, frailer recovery and more prominent household deleveraging (International Monetary Fund, 2012).

With the current alarming debt levels, an early warning system for any financial vulnerability is crucial for the Thai financial market in order to predict the outlook for the financial market. Such early warning systems are effective as forecasting tools for the financial market and are not entirely new in existing literature, for instance, Nguyen & Duy (2017) developed an early warning system for Vietnam. Hence, the purpose of this paper is to construct a financial vulnerability indicator (FVI) with leading characteristics for the financial market of Thailand.

2. Review of literature

After the subprime mortgage crisis, many studies that focussed on early warning systems have re-emerged as signalling tools for financial crisis monitoring and forecasting. Nevertheless, the development of early warning systems has gained attention since the 1990s. Kaminsky, Lizondo, & Reinhart (1998) and Kaminsky & Reinhart (1999) introduced the signals approach to develop an early warning system for vulnerability assessment towards currency and banking crises where they noted that crises usually happen after a credit and capital driven economic boom. The signals approach was then extended to the approach of indicator construction, for instance, Bruggemann & Linne

(2002), Edison (2003) and Hsing (2004) while Illing & Liu (2006) developed an index of financial stress for the Canadian financial system.

With the pursue by the IMF to develop an early warning system for crisis detection in the wake of the subprime mortgage crisis, studies focusing on early warning system started to re-emerge. For a multiple country perspective, Frankel & Saravelos (2012), Karmarkar & Vani (2014), Feldkircher, Gruber, & Moder (2014) as well as Christensen & Li (2014) developed early warning signal systems across a number of different economies based on the signals approach while Drehmann & Juselius (2014) utilised the receiver operating characteristic (ROC) curve for the development of warning indicators of banking crises for 26 countries. Vesna (2011) discovered that financial crises could be explained using various types of indicators through their early warning system development for three EU countries. Moreover, Duca & Peltonen (2011) and Pasricha, Roberts, Christensen, & Howell (2013) conducted vulnerabilities assessment on the country-specific financial systems of the United States and Canada, respectively. On the other hand, Abu Mansor, Puah, Liew & Wong (2015), Wong, Puah Abu Mansor & Liew (2016) and Puah, Kuek, Arip and Wong (2016) developed early warning systems for different fields, particularly, on economic and property sector. Siedlecki & Papla (2013) and Megersa & Cassimon (2015) revealed the significance of local and international dynamics for crisis forecasting while Nguyen & Duy (2017) established an early warning system for the economy of Vietnam.

3. Methodology and data description

Financial vulnerabilities are circumstances that cause a greater chance of triggering stress to the financial system in the future. The degree of financial vulnerability is determined by the exposure of the financial system towards certain risks which would cause a higher risk of unpredicted correction to the system besides depressing its endurance towards other shocks. Though financial vulnerabilities are elusive, it is believed that their impact is signified through movements in various financial and macroeconomic variables during different episodes of vulnerability.

To capture the abnormal individualities in financial and macroeconomic variables before a crisis, Kaminsky & Reinhart (1999) proposed a signals approach to evaluate the signalling performance of various individual indicators towards an impending crisis. The deviations of individual indicators when surpassing their specific threshold values acted as an early warning of a financial crisis within a certain time period. For crisis identification, the credit-to-GDP ratio was selected as a benchmark for financial vulnerabilities in Thailand. During the period under study, a deviation of 1 time above the measure's mean was identified as a crisis based on the accuracy of the crisis called while a 12-month crisis window was selected for detection of an early signal. Different crisis windows have been employed in previous studies, for instance, Nguyen & Duy (2017) utilised both a 12-month and a 24-month crisis window while Kaminsky & Reinhart (1999) implemented a crisis window of 24 months.

The signalling performance of individual indicators was evaluated based on a certain threshold value, where surpassing their specific threshold value acted as an early warning of a financial crisis within a certain time period. Following Kaminsky & Reinhart (1999), different cut-offs ranging from 5 percent to 35 percent and 65 percent to 95 percent were set to determine the suitable threshold values for individual indicators. The optimal threshold was chosen based on the individual indicators holding a minimum noise-to-signal ratio (NTS ratio) so as to select indicators containing more good signals. The NTS

ratio, w_j , is defined as $w_j = \frac{B/(B+D)}{A/(A+C)}$ where the individual indicators were categorised into

four types of signal quality to assess their effectiveness. The classification of these four types of signals quality is illustrated in the following matrix:

| | Crisis (within 12 months) | No crisis (within 12 months) |
|--------------------------|------------------------------|---------------------------------|
| Signal was identified | A | B |
| No signal was identified | C | D |

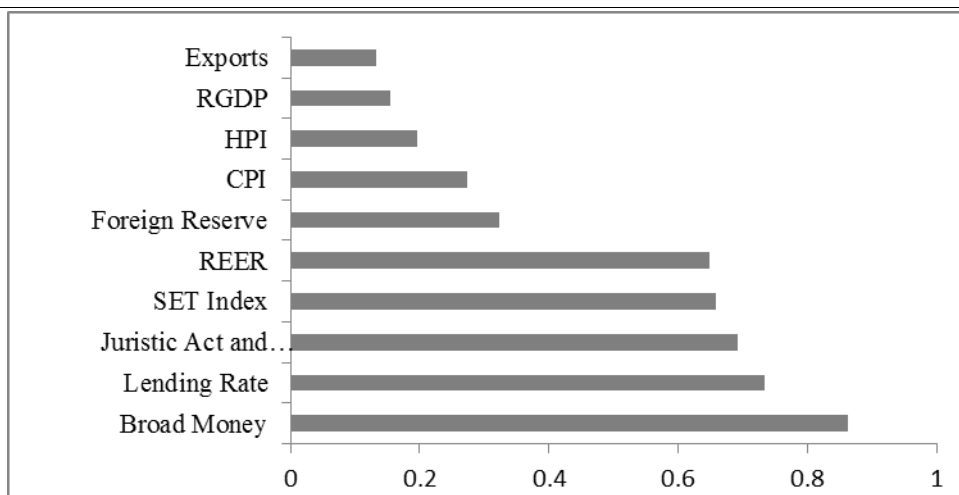
A: The number of months in which the indicator effectively produces a good signal

B: The number of months in which the indicator effectively produces a bad signal

C: The number of months in which the indicator does not effectively produce a good signal

D: The number of months in which no signal is identified

FIGURE 2. NOISE-TO-SIGNAL RATIO OF INDIVIDUAL INDICATORS



Source: Own calculation.

From the selected indicators, all of the indicators contained an NTS ratio lower than 1.0, which means that the indicators have a good forecasting ability for vulnerabilities towards financial crises. The indicator with the lowest NTS ratio is Exports at 0.13, followed by real GDP at 0.15, House Price Index at 0.20, Consumer Price Index at 0.27, Foreign Reserve at 0.32, Real Effective Exchange Rate at 0.65, Stock Exchange of Thailand index at 0.66, Juristic Act and Right Registration Fee for Property at 0.69, Lending Rate at 0.73 and Broad Money at 0.86 (see Figure 2).

Generally, the production of signals from more individual indicators could signify financial vulnerabilities to a crisis. In order to detect the level of financial vulnerabilities in a broader sense, compiling each individual variable into a composite indicator is much more constructive in this case to avoid the loss of essential information. Following the work by Bruggemann & Linne (2002), the indicator construction in this paper utilised this

procedure in view of the signal strength, the signal timing and prognostic quality of an indicator.

Initially, a second threshold of half of the original percentile of the frequency distribution was introduced for the differentiation of the signal strength. A double weightage was taken for indicators that surpassed their second threshold value while a single weightage was taken for indicators surpassing their original percentile only. Furthermore, no weightage was assigned to indicators which failed to surpass their original threshold value.

Signal timing is essential in defining the vulnerabilities of an economy to a financial crisis. It is assumed that current signals are comparatively more vital for any current crisis potential than previous signals. Hence, a moving 12-month window is compiled with a geometric weighting scheme:

$$z_t^j = \sum_{i=1}^{12} \frac{I_{t+1-i}^j}{i} \quad \text{for } t \geq 12$$

Finally, the indicator was constructed based on its prognostic quality. The prognostic quality was determined through the forecasting performance of individual variables by taking the inverse of the corresponding NTS ratio. Individual variables with lower values of the inverse of the corresponding NTS ratio were assigned with a higher weightage. Consequently, the FVI was constructed by the implementation of the following formula:

$$FVI_t = \sum_{j=1}^k \frac{1}{w^j} (z_t^j)$$

As the constructed indicator serves as an early signalling tool for the vulnerability of an economy to financial crises, the possibility of the occurrence of impending crises remains uncertain. With that, conditional probabilities can be employed to draw conclusions on the probability of a crisis taking place. Thus, the computation of the conditional probabilities in this paper follows the suggestion by Edison (2003):

$$= \frac{\Pr[\text{crisis}_{t,t+12} | FVI_l \leq FVI_t < FVI_u]}{\sum \text{No. of months for } FVI_l \leq FVI_t < FVI_u \text{ and crisis occurs}} \\ \sum \text{No. of months for } FVI_l \leq FVI_t < FVI_u$$

where $\text{crisis}_{t,t+12}$ is the possibility of a crisis happening within 12 months given that the FVI lies between its upper (FVI_u) and lower boundary (FVI_l).

The indicator in this study was constructed based on high-frequency data on a monthly basis for higher accuracy. The period under study covered from January 2000 through to December 2016 to predict financial vulnerabilities in Thailand as financial liberalisation emerges after the Asian financial crisis. Financial and macroeconomic variables were employed for the construction of the indicator, consisting of exports, real GDP, the house price index, the consumer price index, total reserves, the real effective exchange rate, the

Stock Exchange of Thailand (SET) index, the juristic act and the right registration fee for property, the lending rate and broad money. The credit-to-GDP ratio was selected as the benchmark to proxy financial vulnerability. Real GDP was computed by dividing GDP by the consumer price index. The data of GDP, house price index and credit-to-GDP ratio were interpolated using the Gandolfo (1981) and Chow-Lin (1971) interpolation, respectively. All of the data were attained from the CEIC Database and Bank for International Settlements.

4. Results and discussion

Based on the signals approach, ten indicators with leading attributes were identified for financial vulnerabilities in Thailand. All of the selected leading indicators held an NTS ratio lower than 1.0, representing that the indicators were of good forecasting ability. The selected leading indicators covered the real sector, external sector, financial sector and capital account where a financial crisis is regarded as a multidimensional event. The leading indicators from the real sector consisted of real GDP, the SET Index, the Juristic Act and Right Registration Fee (Property), the Consumer Price Index and the House Price Index. As for the external sector, it consisted of Exports and the Real Effective Exchange Rate while Broad Money and the Lending Rate fell under the financial sector. The movement of the capital account was measured through Foreign Reserves. Table 1 represents the risk tail and justification for each of the leading indicators.

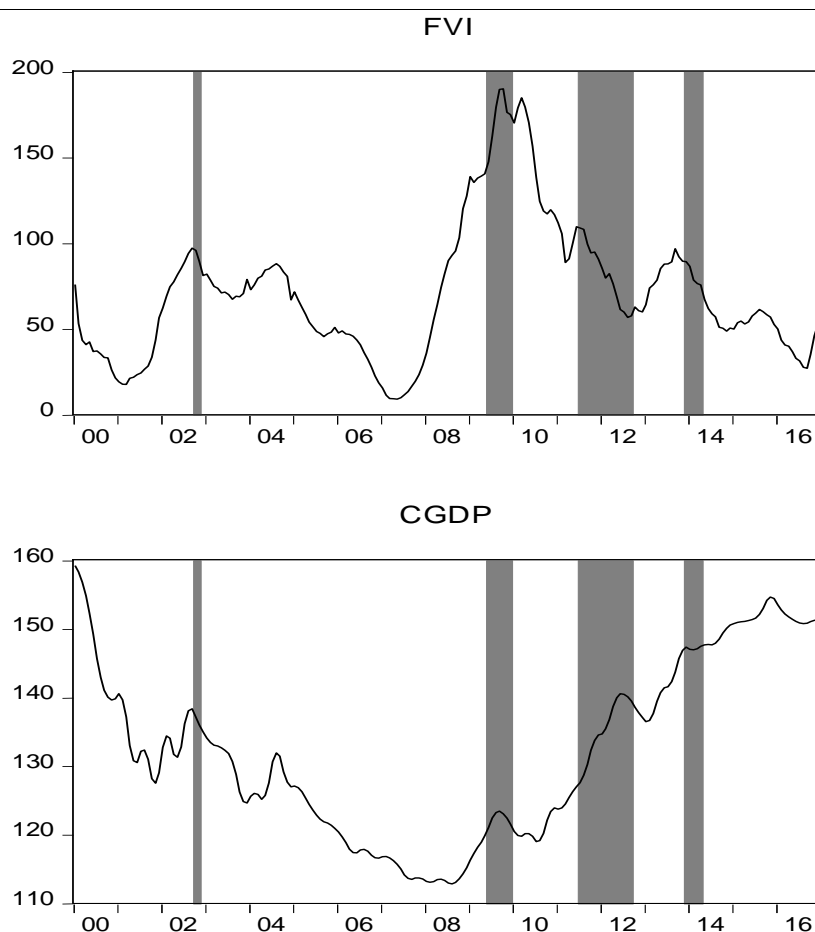
TABLE 1. RISK TAIL AND JUSTIFICATION FOR LEADING INDICATORS

| Leading Indicator | Risk Tail | Justification |
|--|------------|---|
| <i>REAL SECTOR</i> | | |
| Real GDP | Lower Tail | Economic recession is associated with the onset of a crisis where the vulnerability of a country to financial crisis increases as the economy slumps further. |
| SET Index | Lower Tail | Downturns in the stock market are associated with the onset of a crisis. |
| Juristic Act and Right Registration Fee (Property) | Lower Tail | The property sector is closely linked to the economy as a whole. Decreasing juristic act and right registration fees for property signify an economic slowdown. |
| CPI | Upper Tail | The financial sector could be adversely impacted by high inflationary pressure where it may also act as a proxy for misalignments at the macroeconomic level. |
| HPI | Lower Tail | A decrease in property prices would cause devaluation in asset prices and an imbalance in banks' balance sheets. |
| <i>EXTERNAL SECTOR</i> | | |
| Exports | Lower Tail | Weak exports are adverse to the income of an economy through loss of foreign exchange earnings. |
| Real Effective Exchange Rate | Lower Tail | Overvaluation of exchange rates is a trigger to impending crisis build-up. |
| <i>FINANCIAL SECTOR</i> | | |
| Broad Money | Upper Tail | An expansionary monetary policy leads to the deterioration of the domestic currency prior to a crisis. |
| Lending Rate | Upper Tail | An increment in the lending rate could indicate dwindling liquidity in the financial system. |
| <i>CAPITAL ACCOUNT</i> | | |
| Foreign Reserve | Lower Tail | Foreign reserve functions to mitigate internal and external vulnerability. |

Source: Own elaboration.

The construction of the financial vulnerability indicator was conducted based on the selected leading indicators. By employing the work of Bruggemann & Linne (2002), the financial vulnerability indicator was constructed to serve as an early warning signalling tool for the financial market in Thailand. The vulnerability to financial crisis surges along with the upward trends of the constructed indicator and vice versa. Figure 3 illustrates the graphical representation of the FVI and the credit-to-GDP ratio of Thailand. Based on the signalling analysis, four major financial episodes were successfully traced by the constructed indicator. During the period of study, the financial market in Thailand experienced four major episodes, namely, the dotcom bubble in 2002, the subprime mortgage crisis in 2008-2009, the property price hike in 2010 and Thailand's political turmoil in 2013-2014.

FIGURE 3. GRAPHS OF FVI AND CGDP, 2000-2016



Source: Own elaboration.

Based on the constructed FVI, the conclusion on the possibility of a crisis occurrence can be drawn through the computation of conditional probabilities. Table 2 summarises the conditional probabilities of a financial crisis. An upswing in the indicator signifies a higher probability of a financial crisis happening. Where the level of the indicator was more than

90, the conditional probability of a crisis occurring hit 86.67 percent while where the level of the indicator was less than 30 there was no chance for a crisis to occur.

TABLE 2. CONDITIONAL PROBABILITIES OF A FINANCIAL CRISIS

| Financial vulnerability indicator | Probability of a crisis (%) |
|-----------------------------------|-----------------------------|
| 0 - 30 | 0 |
| 31 - 60 | 10.94 |
| 61 - 90 | 46.27 |
| > 90 | 86.67 |
| Unconditional Probability: 21.47% | |

Source: Own calculation.

5. Conclusions

This paper intends to assess the financial vulnerability in Thailand through the construction of a financial vulnerability indicator. Its main difference from most early warning systems lies in its development which is based on country-specific approach, where the nature of a specific economy is taken into account. The constructed indicator reveals the prominence of an early warning system in forecasting vulnerabilities to a financial crisis. By employing the signals approach, the selected leading indicators of financial vulnerabilities provide an outlook of the financial market in a timely manner. Using the proven signals approach to monitor individual indicators, vulnerable areas of the economy can be effectively determined which can make way for better policy establishment.

The empirical outcomes suggest that a weakening in exports, a slowdown in the economy, and a decline in house price are the common crisis activators, as such circumstances are experienced prior to crisis occurrence. The leading indicators identified are robust with the findings from other early warning systems. A weakening in exports is adverse to the income of an economy while an abrupt waning in property prices is stressful to the financial market where a major credit crunch and capital flight could trail thereafter, ensuing in the breakdown of the financial market and even economic downturns. Using the constructed indicator of financial vulnerability, four previous major financial episodes were successfully traced in advance, revealing the effectiveness of the indicator in predicting the development of the financial market in Thailand. With that knowledge, precautionary measures could be taken in the case of a crisis occurring to at least reduce the detrimental impacts.

Based on this study, two recommendations can be drawn for the purpose of policy development. Firstly, exports are one of the main income generators from the foreign exchange market for an economy. Promoting attractive exports on foreign market ensures solid income to protect a nation's vulnerability. By utilising the exchange rate policy, its key role is to avert a high appreciation of the real exchange rate, where its overvaluation could be a trigger to an impending crisis build-up. With proper monitoring on exchange rate fluctuations, goods and services from the domestic market would ensure its competitiveness internationally and generate better foreign earnings for the economy.

Secondly, as in most economies, the property sector has a close interdependency with the financial sector and the economy as a whole. With the attractiveness of the property sector as a form of investment, domestic and foreign investment in property has to be closely monitored. Effective housing and investment policy is necessary to prevent undue speculation in the property sector, where a sudden sell-off could eventually lead to a credit crunch and capital flight, ensuing in the collapse of the financial market and the economy.

Particularly, for foreign investors, frontier policy to invest in certain property segment only can be enforced. In addition, proper monitoring of property prices and investment could offer resilient economic growth for a country.

Though previous studies have demonstrated the effectiveness of early warning systems, there are still certain constraints that lie in any such warning system. For instance, information regarding certain issues might be neglected in developing such a system due to lack of data availability, for example, natural catastrophes. Furthermore, the development of such a mechanism could be enhanced with more innovative procedures in the future.

Acknowledgement

Financial supports from Universiti Malaysia Sarawak (UNIMAS) and Fundamental Research Grant Scheme [F01/FRGS/1493/2016] are gratefully acknowledged.

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