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Article

Financial vulnerability and economic dynamics in Malaysia

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Financial Vulnerability and Economic Dynamics in Malaysia

Abstract: This study attempts to develop a financial vulnerability indicator serving as a composite indicator for the state of financial vulnerability. The indicator was constructed from 10 variables of macroeconomic, financial and property market by extracting a common vulnerability component through the dynamic approximate factor model. On the feedback and amplification effects, the outcome revealed that financial vulnerability shock catalysed significant negative effects on economic activity in a high-vulnerability regime, while the impact was negligible in periods of low vulnerability. This study highlighted the usefulness of composite indicators as an early warning mechanism to gauge vulnerabilities in the Malaysian financial system.

Keywords: Financial Vulnerability Indicator, Financial Crises, Macro-financial Linkages, Markov-switching Bayesian VAR.

JEL Code: C11, C32, C58, E44, G01

1. Introduction

The global financial crisis in 2008 shed light on the importance in monitoring the state of financial vulnerability for policy makers to provide a buffer for a macroprudential shock. Particularly, the spill-over effect of the global financial crisis was substantial on the real sector for most countries in the world. Before the crisis, the impending impacts of the financial vulnerabilities had been severely underestimated thus resulted in renewed research interest in early warning indicators.

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In Malaysia, recent property price hikes coupled with a huge demand for property, especially residential property, has raised growing concern on the issue of mounting household debt; the booming property sector represents a vulnerability.¹ The problems begin when household loans are disproportional to the means of the household. Household debt related to the gross domestic product (GDP) ratio in Malaysia was recorded as the highest among developing economies in Asia, hitting 89.1 percent in 2015 with an increase of 19.6 percent in 2009. Research conducted by the International Monetary Fund (2012) revealed that a higher level of household debt will result in more severe downturns, and Cecchetti et al. (2011) argued that although debt has a huge contribution to economic growth, it could also bring about an economic slump.

The interlinkages between financial market and economies have strengthened as a result of globalisation. Though integration promotes diversification and risk redistribution, extensive interlinkages could also increase contagion vulnerabilities (Organisation for Economic Co-operation and Development, 2012). As experienced through the financial crisis in 2008-2009, increasingly complex networks of integration have further intensified the potential for idiosyncratic shocks on an integrated financial market and even cause amplified spill-over to others (Bank Negara Malaysia, 2013). Contagion vulnerabilities are usually transmitted through the financial market, particularly the stock market during the Asian financial crisis, particularly the export performance during the bursting of the dot-com bubble.

Since the global economic meltdown in 2015, the oversupply of crude oil, coupled with declining demand, hit the global market at a time when economies of Europe and some developing countries were weakening due to sovereign debt and political issues. In particular, the spill-over effect from China with its sluggish growth impacted negatively on emerging market economies.² These emerging market economies with a declining currency value, including Malaysia, became less attractive for investment and thus suffered capital outflows. As a highly open and diversified economy, Malaysia is vulnerable to rising protectionism and weaker growth of trading partners, particularly China and other developed economies (IMF, 2019). Such vulnerabilities only bring about adverse impact to the growth of its real sector. In the event of unfavourable macroeconomic conditions, financial vulnerabilities would only lead to the cost of a substantial financial market downturn and certainly spill over into other economic sectors.

With the substantial spill-over effect of financial vulnerability on economic activity experienced in previous crises, research interest has renewed on the impacts of crises towards economic dynamics. Cardarelli et al. (2011), Cevik et al. (2013a; 2013b) and

¹ See Daud, Marzuki, Ahmad, and Kefeli (2019) for evidence from Malaysian households.

² See related literature on the effect of changes in oil price on country's growth and financial markets (Iyke, 2019a; Narayan, Falianty and Tobing, 2019).

van Roye (2014) came out with a stress index for the financial markets of different countries and regions.³ By means of Markov-switching Bayesian vector autoregression and wavelet procedure, respectively, Aboura and van Roye (2017) and Ferrer et al. (2018) testified that the impact of financial stress brings about significant negative effect on the economic dynamics during episodes of major financial turmoil.⁴ While most early warning studies have focused on developed economies (see for instance, Apergis, 2019), only a few has focused on developing nations, namely, Tng and Kwek (2015) and Cevik et al. (2016). Existing studies mainly focus on financial stress through banking sector which motivates research to be conducted on financial vulnerability from a macroeconomic perspective, see Tng and Kwek (2015) and Dahalan et al. (2016), where dynamic modelling is of crucial in forecasting financial crisis with the ever-changing financial environment.

To the best of the authors' knowledge, the Malaysian financial market has yet to implement an efficient and innovative early signalling tool that can provide an insightful outlook into the financial market in a timely manner. Hence, the present study was motivated to fill this gap by introducing an indicator-based forecasting instrument that has demonstrated to function well in predicting the majority of the cyclical processes of economic activities. Accordingly, the primary intention of this paper was to construct a financial vulnerability indicator (FVI) that employs leading characteristics to foresee financial market fluctuations in a predictive manner.

In this paper, an FVI has been constructed for Malaysia to act as an early warning mechanism for the state of financial vulnerability. Six major episodes of vulnerability in Malaysian economic history can be identified when analysing the time trend of the indicator. The key empirical findings suggest that high financial vulnerability brings about significant negative effect on economic activity in Malaysia. With that, the outcome of this paper would be useful for macroprudential authorities in mitigating financial vulnerabilities.

2. Literature Review

Research interest in early warning indicators has renewed since the global financial crisis in 2008-2009; the indicators aim to assist in financial crisis forecasting by monitoring key variables. Nevertheless, overall study of early warning systems dates back to Kaminsky and Reinhart (1996; 1999). Using the signals approach, they as-

³ See Cevik, Kirci-Cevik and Dibooglu (2016) construct financial stress index for five emerging economies (Brazil, India, Indonesia, South Africa, and Turkey) and examine the relationship between financial stress and global liquidity.

⁴ See Balakrishnan, Danninger, Elekdag, and Tytell (2011) for evidence of transmission of financial stress from developed economies to emerging economies.

sessed the vulnerability of an economy and developed an early warning system for currency and banking crises. Later, Bruggemann and Linne (2002) extended the signals approach to the Central and Eastern European transition countries. Prior to the recent crisis, financial stress indicator development was primarily for the fluctuation in the financial market. Illing and Liu (2006) employed a combination of survey and econometric methodology in developing a stress index for the Canadian financial system while Bussiere and Fratzscher (2006) proposed the utilisation of a multinomial logit model for crisis forecasting.

With the substantial spill-over effect of financial vulnerability on the economy experienced in previous crises, research interest renewed focusing on the impacts of crises towards economic dynamics. Cardarelli et al. (2011), Cevik et al. (2013a; 2013b) and van Roye (2014) came out with a stress index for the financial market of different countries and regions. They showed that financial stress brings about significant negative impact on economic activity. In particular, Cevik et al. (2013a) and Arip et al. (2019) implemented principal component analysis while van Roye (2014) used a dynamic approximate factor model (DAFM) in developing their respective financial stress indexes. Using the multivariate generalized autoregressive conditional heteroskedasticity (GARCH) model, Louzis and Vouldis (2012) proposed a financial system stress index for Greece and noted that precise prediction regarding the nature of systematic stress is crucial in serving as policy management.

Using a Markov-switching Bayesian vector autoregression and a wavelet procedure, respectively, Aboura and van Roye (2017) and Ferrer et al. (2018) testified that the impact of financial stress brings about significant negative effect on the economic dynamics during episodes of major financial turmoil. While most early warning studies have focused on developed economies, Tng and Kwek (2015) and Cevik et al. (2016), respectively, focused on the Association of Southeast Asian Nations (ASEAN)-5 and emerging Asian economies to assess the influence of financial stress on the economy. As discussed by Kaminsky and Reinhart (1996, 1999) and Pua et al. (2017) using the signals approach, Bussiere and Fratzscher (2006) also noted that economic fundamentals react differently between tranquil and crisis periods. Therefore, more innovative techniques could be emphasized to tackle the significance of nonlinearities during crisis periods.

On the potential indicators of vulnerabilities, Bruggemann and Linne (2002) showed that overvaluation of the exchange rate, weakening of exports and dwindling currency reserves were among the variables that possessed good predictive power in the assessment of crisis vulnerabilities. In addition, Aboura and van Roye (2017) constructed a financial stress index for the French financial market using DAFM methodology consisting of 17 financial variables.⁵ Realising the important role of banking

⁵ See Herceg and Nestić (2014) for household financial vulnerability.

sectors in vulnerabilities build-ups, Tanaka et al. (2018) scrutinised a country's financial vulnerability by accumulating indicators across the banking sector through implementation of the random forests classification model. The review on literature revealed that usage of potential indicators from all sectors is crucial, particularly for the financial market and external sector, due to the effect of financial globalisation.

3. Data and Methodology

The definitions of financial vulnerability differ across the previous works. Generally, financial vulnerability is defined as situation of a greater possibility of causing stress to the future financial system due to exposure to particular risks. Financial vulnerability is not straightforward to measure while changes in a single variable can rarely be used to explain the whole situation. However, construction of one single indicator can serve as a proxy for financial vulnerability, acting as a barometer for the financial system. A wide range of variables from the real sector, financial sector, external sector and capital account is considered for the indicator construction, as financial vulnerabilities may have multiple dimensions. A summary of variables used for the indicator construction is illustrated in Figure 1.

Figure 1: Conceptual construction of FVI

Financial Vulnerability Indicator			
Real Sector	External Sector	Financial Sector	Capital Account
<ul style="list-style-type: none"> • Real GDP • Share Price • Housing Approvals • CPI 	<ul style="list-style-type: none"> • Exports • Imports • REER 	<ul style="list-style-type: none"> • M2 • Loans and Advances 	<ul style="list-style-type: none"> • Total Reserve

The indicator construction was initiated with the categorisation of potential indicators of vulnerabilities from the review of previous studies available. The selection of potential indicators was commenced based on the exhibition of leading attributes and country-specific characteristics with respect to the nature of the economy. Subsequently, the composite indicator was developed through the DAFM methodology and the accuracy of the constructed indicator was compared with the actual timeline of previous vulnerability episodes documented by the central bank of Malaysia, Bank Negara Malaysia. The comparison was necessary to also serve as robustness checking on the major vulnerability episodes produced by the indicator besides selecting the best possible potential indicators of vulnerabilities. With that, the economic rationale of the selected variables is as follows:

Variable	Rationale	Descriptive Statistics		
		Min.	Max.	Mean
Real GDP (million)	As the economy experiences slowdown, it increases a country's vulnerability towards crisis.	21550.33	119368.48	58402.02
Share Price	Downturns in the stock market are linked with crises.	24.67	137.06	85.08
Housing Approvals (unit)	With the close connectedness between property market and economic development, low housing approvals signifies economic slowdown.	2374	29627	13867.83
Consumer Price Index	Great inflationary pressure negatively affects the financial sector through numerous channels and it may serve as a proxy for misalignments at the macroeconomic level.	72.61	120.88	94.50
Exports (million)	Dwindling exports affect a country's income from foreign exchange trading.	13564.90	83515.61	46594.67
Imports (million)	Growing imports are an indication of an overvalued exchange rate, which also signals a loss of competitiveness on international market.	13151.84	77224.63	39442.59
Real Effective Exchange Rate	Overvaluation of exchange rates is a driving force to potential build-up of vulnerabilities.	84.33	130.84	97.67
M2 (million)	Expansionary monetary policy is related to the onset of a crisis.	246200	1716651	847880.78
Loans and Advances (million)	Rapid credit expansion exposes the financial system to the menace of balance sheet imbalance.	4551.7	12924.7	9101.22
Total Reserve (million)	A country's total reserve mitigates financial or economic shocks.	34682.9	148121.10	74075.33

3.1. Data Description

In this paper, the dynamic approximate factor model is implemented for indicator construction following the application of Banbura and Modugno (2014) and van Roye (2014), combined with the maximum likelihood and Expectations Maximization algorithm, while the Markov-switching model utilised is similar to the methodology Sims et al. (2008) employed to analyse the impact of financial vulnerability on economic dynamics. The period under study for this research spanned from 1997M01 through 2017M12. The indicator is constructed using real GDP, share price, housing approvals, consumer price index (CPI), exports, imports, real effective

exchange rate, monetary aggregates M2, loans and advances, and total reserve. The GDP data, available on a quarterly basis, are divided by the CPI to obtain the value in real terms. Application of the Chow-Lin (1971) methodology is utilised for interpolation of quarterly data to monthly series. All the financial, property and macroeconomic data are obtained from the CEIC Database.⁶

3.2. Methodology

3.2.1 Dynamic Approximate Factor Model

The dynamic approximate factor model can be presented in state space form. The measurement equation relates the observed data to the state vector of the latent factor, f_t . Following the application of van Roye (2014), a single factor is imposed on the model estimation as inclusion of more factors does not meaningfully change the empirical outcomes.

$$y_t = \Lambda f_t + e_t \quad \text{where } e_t \sim iid N(0, C) \quad (1)$$

where y_t is a vector of stationarity and standardized endogenous variables of financial, property and macroeconomic data, f_t is a single common latent factor and Λ is an $n \times 1$ vector of the factor loadings of each variable. The factor loadings reflect the degree to which each time series is influenced by the common factor. The (FVI) is given by $FVI_t = \Lambda f_t$. The notation of e_t is an $n \times 1$ vector representing the idiosyncratic component, which is allowed to be in low correlation in terms of series and cross-section at all leads and lags to prevent over-restriction. The following transition equation denotes the dynamics of the latent factor f_t ,

$$f_t = A f_{t-1} + \epsilon_t \quad \text{where } \epsilon_t \sim iid N(0, D) \quad (2)$$

where A is the autoregressive coefficients matrix, gauging development of the latent factor f_t in an autoregressive model over time.

The estimation of the dynamic approximate model in this paper follows the work of Banbura and Modugno (2014) and van Roye (2014) through combination of the maximum-likelihood approach and the expectation maximization algorithm initially suggested by Dempster et al. (1977). The dynamic model discussed allows for an efficient treatment of ragged edges, mixed-frequency data and a random pattern of missing data. Prior to the estimation, the time series are de-meaned and standardised.

⁶ All variables are subjected to the Narayan and Popp (2010, 2013) structural break unit root tests. Break dates were statistically insignificant. Results are available upon request.

3.2.2 Markov-switching Bayesian Vector Autoregression Model

The Markov-switching framework implemented in this paper follows the Bayesian econometric tools developed by Sim et al. (2008). The Markov-switching Bayesian vector autoregression (MSBVAR) model contains several advantages for estimation, including assessment on the presence of nonlinearities, differentiation between variance switching and coefficient switching and investigation on the feedback and amplification effects between the real and financial sectors. Coefficient switching would indicate either a change in agents' behaviours during high financial vulnerability or a substantially dissimilar environment, whereas switching in variance indicates that the occurrence of the financial crises is by happenstance.

Financial vulnerability can be considered a tail event where two regimes are assumed a priori, particularly a low-vulnerability regime and high-vulnerability regime. The model is set up with four endogenous variables, comprising the financial vulnerability indicator, the inflation rate, growth of industrial production and the change in the short-term interest rate (3-month KLIBOR). Following Sims et al. (2008), the MSBVAR model is set up as follows:

$$y_t' A_0(s_t) = \sum_{j=1}^l y_{t-j}' A_j(s_t) + z_t' C(s_t) + \varepsilon_t' \theta^{-1}(s_t) \quad t = 1, 2, \dots, T \quad (3)$$

where y_t is an $n \times 1$ vector of endogenous variables; are unobservable (latent) state variables at time t . l is the vector autoregression's (VAR's) lag length while ε_t is the $n \times 1$ vector of random shocks. z_t is a matrix of exogenous variables, which are set to a column vector of constant 1_n (e.g., one intercept per equation). $A_0(s_t)$ is an $n \times n$ matrix of parameters describing contemporaneous relationships between the elements of y_t , $C(s_t)$ is a $1 \times n$ vector of parameters of the exogenous variables, $A_j(s_t)$ is an $n \times n$ matrix of parameters of the endogenous variables and sample size is denoted by T . The diagonal $n \times n$ matrix $\theta^{-1}(s_t)$ comprises the standard deviations of ε_t where the structural shocks are epitomized through $\varepsilon_t' \theta^{-1}(s_t)$. The values of s_t are elements of $\{1, 2, \dots, h^m\}$ and change according to a first-order Markov process with the following state probabilities:

$$\Pr(s_t^m = i | s_{t-1}^m = k) = p_{ik}^m, \quad i, k = 1, 2, \dots, h^m. \quad (4)$$

Let us designate $Y_t = \{y_0, y_1, \dots, y_t\}$ as the vector y stacked in the time dimension. We assume that ε_t is conditionally standard normal:

$$p(\varepsilon_t | Y_{t-1}, S_t, A_j) \sim N(0_{n \times 1}, I_n). \quad (5)$$

The variance-covariance matrix $\Sigma(s_t^m)$ of the correlated reduced-form regression errors can be recovered as follows:

$$\Sigma(s_t^m) = (A_0(s_t^c) \theta^2(s_t^v) A_0'(s_t^c))^{-1}. \quad (6)$$

Since the matrix A_0 varies across coefficient regimes, s_ξ^c , the number of regimes of the correlated shocks is obtained as a multiple of the number of variance regimes of the structural shocks s_ξ^v since the coefficients and variances are presumed to switch stochastically and independently.

The estimation of the model is initiated with the block-wise optimization algorithm for searching of posterior mode, particularly efficient for systems with large dimensions. The algorithm includes parameters divided into blocks and the initial parameter estimates undergo a hill-climbing quasi-Newton optimization routine. Priors are set for the VAR parameters and the state transition matrix as presented in Table 1. An efficient prior for the problem under study is those produced with less variance switching than coefficient switching.

Table 1: Prior Selection for Hyperparameters

Type of Prior	Value
Overall tightness for A and F	0.65
Relative tightness for F	0.13
Relative tightness for the constant term	0.10
Tightness of lag decay	12

The MSBVAR model is set up with four endogenous variables. Let $y_t = [FVI \ IPI \ P \ I]'$ where *FVI* represents the financial vulnerability indicator; *IPI* is the growth of industrial production; *P* is the inflation rate; and *I* denotes the change in the short-term interest rate (3-month KLIBOR). All variables are on a monthly basis and expressed at annual rates, spanning from 1997M01 to 2017M12.

3.2.3 Diebold-Mariano Test

The Diebold-Mariano (2012) test is a test on two competing forecasts if they contain equal forecasting accuracy. The computation of the test statistic for one-step ahead forecasts is as follows:

$$s = \bar{d}/s_d \quad (7)$$

where $d = L_1 - L_2$ and $L_i, i = 1, 2$ is either a squared or absolute difference between the forecast and the actual,

$$L_i = (\hat{y}_i - y)^2 \text{ or } L_i = |\hat{y}_i - y| \quad (8)$$

where \bar{d} and s_d are the mean and sample standard deviation of d .

For the matter of robustness check, the Diebold-Mariano (2012) test is implemented on the constructed indicator and a conventionally used credit-to-GDP gap to determine their forecasting accuracy. Both of the indicators are benchmarked against credit-to-GDP ratio where the credit data is available and published by the Bank for International Settlements (BIS). The BIS discovered the usefulness in credit-to-GDP gap in signalling vulnerabilities build-up (BIS, 2018). Furthermore, Giese et al. (2014) also noted the practicality of the credit gap for countercyclical capital buffer.

4. Results and Discussion

Following the factor modelling proposed above, the FVI was constructed according to the factor loadings of the DAFM presented in Table 2. The selected indicators are from the macroeconomy, the financial and property markets comprised of imports, the real GDP, exports, M2, total reserves, share prices, loans and advances, the consumer price index, housing approvals and the real effective exchange rate. The top three indicators with the highest factor loadings of the DAFM, contributing largely to the FVI, were imports, the real GDP and exports with loadings of 0.897, 0.894 and 0.819, respectively. The empirical findings of the constructed FVI based on the DAFM showed that a weakening of the international trading market would eventually lead to an economic downturn as the source of the fundamental driver became affected. This also highlighted the importance of both internal and external macroeconomic environments in defining the financial vulnerability of an economy.

Table 2: Factor Loadings of DAFM

Indicator	λ_i
Imports	0.897
Real GDP	0.894
Exports	0.819
M2	0.526
Total Reserve	0.405
Share Price	0.345
Loans and Advances	0.235
Consumer Price Index	0.155
Housing Approvals	0.118
Real Effective Exchange Rate	-0.159

Note: The values are extracted from the loading matrix Λ of the DAFM.

The development of the FVI is illustrated in Figure 2. Several major episodes of vulnerability in Malaysian economic history can be identified when analysing the time trend of the indicator. Based on the period under study, the initial significant surge

in financial vulnerability happened before the Asian financial crisis in 1997-1998. The main contributor of financial vulnerabilities build-up was from the financial sector, spilling over to the external and real sector. Thai currency depreciated sharply in July 1997, causing an abrupt withdrawal of short-term capital out of the country, particularly affecting the property market. The Asian financial crisis was closely associated with the vulnerabilities of short-term capital flows into the country's economy and the abnormalities in currency trading. In September 1998, the Malaysian government implemented an exchange control measure and restructured the financial sector extensively.⁷

The subsequent increase in vulnerability was due to the bursting of the dot-com bubble in the US in 2001, which adversely affected the Malaysian external and real sector. The bursting of the bubble in the US triggered sell-off in the Malaysian financial market; the stock market index fell nearly 45 percent between February 2000 and April 2001. As Malaysia was one of the Asian economies that engaged in subordinate activities for dot-com companies in the US, the manufacturing sector was affected the most due to the low demand for electronic products after the bursting of the dot-com bubble, especially from the export markets of Europe and Japan.

As a net oil-exporting economy, the spike in oil prices in 2005-2006 pressured the overall price to a significantly higher level in the nation, which in turn brought about adverse effects on the economy besides setting inflationary pressures on consumers. A period of comparatively low vulnerability thereafter was upset with the global financial crisis in 2008, triggered by the collapse of subprime mortgages in the US. The crisis spread to other parts of the globe through capital flows, trade flows and commodity prices. The global financial crisis impacted Malaysia through the financial and trade channels. This crisis also exposed the vulnerability of Malaysia's export-dependent growth where merchandise exports earnings recorded a contraction of 9.5 percent in 2009 due to poor demand in the world market, contributed to by contracted manufacturing exports and reduced earnings from the primary commodity products of crude oil, rubber and palm oil.

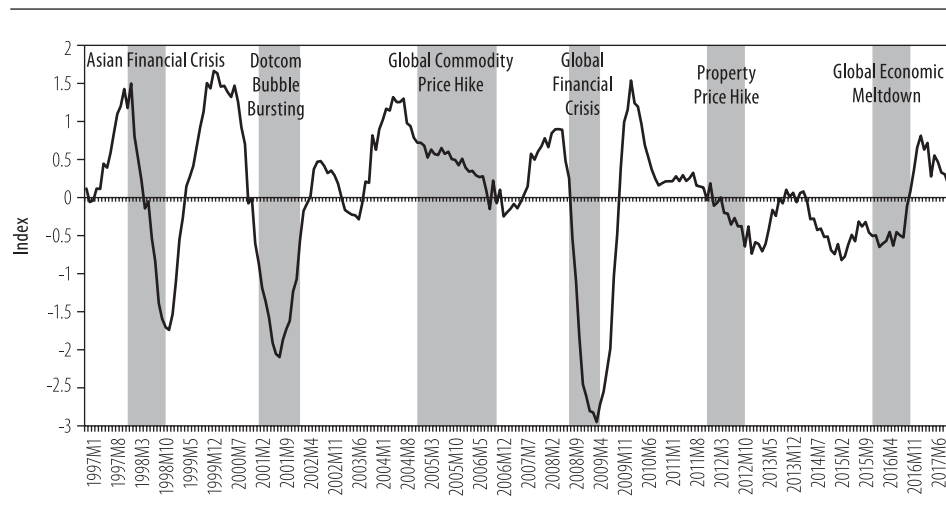
After 2009, demand and investment in the Malaysian property market surged due to massive investment inflows to emerging markets, causing high vulnerability and concern about an unsustainable property bubble. Towards the end of 2011, the household debt-to-GDP ratio was recorded at 74 percent, with a huge portion accounting for residential property loans (International Monetary Fund, 2014). Unsustainable housing price escalation, which is unsupported by economic fundamentals, could be a source of risk for financial stability.

⁷ For more detail on efficiency of the foreign exchange market, see Iyke (2019b) and Golit et al. (2019).

A slight increase of vulnerability in 2014 was triggered by the global economic meltdown due to plunging crude oil prices, coupled with declining demand, which hit the global market at a time when economies of Europe and some developing countries were weakening. The spill-overs from China's sluggish growth impacted negatively on emerging market economies. Emerging market economies with a declining currency value, including Malaysia, became less attractive for investment and thus capital outflows from the Malaysian financial market suffered. These factors dragged down the broader market and took a toll on economic growth as a whole.

The decomposition of the FVI into four sub-groups enables tracking of the source of financial vulnerability in different episodes, as depicted in Figure 3. All the variables can be categorised into four different sub-groups: real sector, external sector, financial sector and capital account. Variables for the real sector sub-group include real GDP, consumer price index, share price and housing approvals. The external sector sub-group comprises exports, imports and the real effective exchange rate. In addition, the monetary aggregate M2, and loans and advances are categorised as the financial sector sub-group while the capital account sub-group is measured by total reserve.

Figure 2: Financial Vulnerability Indicator for Malaysia



Note: Shaded areas indicate vulnerability based on reports of various issues on Malaysia by Bank Negara Malaysia.

Through the Asian financial Crisis in 1998, the main contributor of financial vulnerabilities build-up was from the financial sector, spilling over to the external and real sector while the dot-com bubble bursting in 2001 contributed significantly via both a weak external sector and real sector. Moreover, the weak external factor, the spill-over effect of the bubble burst in the US housing market, led to a meltdown of the real sector in Malaysia during the subprime mortgage crisis in 2008-2009. As for the property cooling in Malaysia in 2013 and the global economic meltdown in 2015, the slowdown in real sector and the weak external environment contributed to the vulnerabilities in the Malaysian financial market, respectively.

Figure 3: Contribution of indicator sub-groups

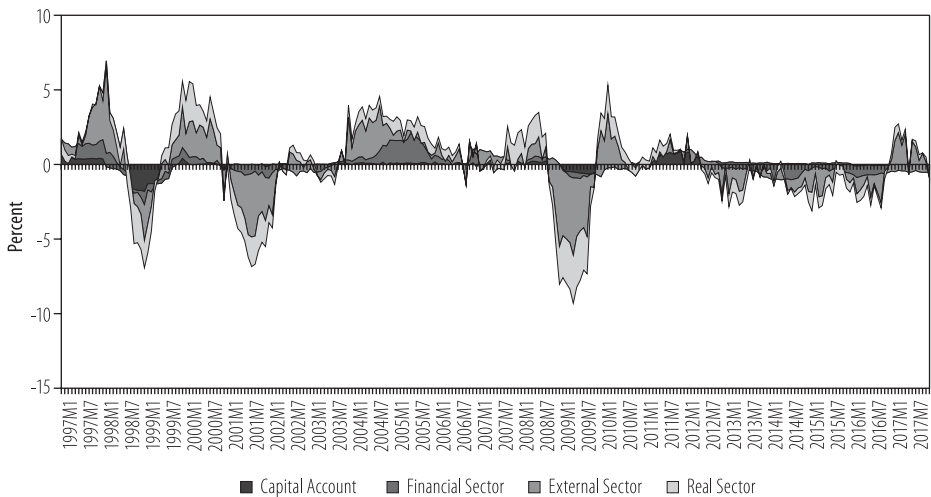


Figure 4 illustrates the FVI, its conditional standard deviation and the smoothed state probabilities over the period of study. The model reveals that the probability of the Malaysian economy to be in a high-vulnerability regime (state 2) was very high during the Asian financial crisis, the dot-com bubble burst and the subprime mortgage crisis. On the other hand, the high probability of regime switching was detected during the period of the property price hike in 2011 and the global economic meltdown in 2015. As for the variance switching, the empirical findings indicate a short period of switching in variance after the Asian financial crisis and before the subprime mortgage crisis, serving as a robust check for coefficient switching.

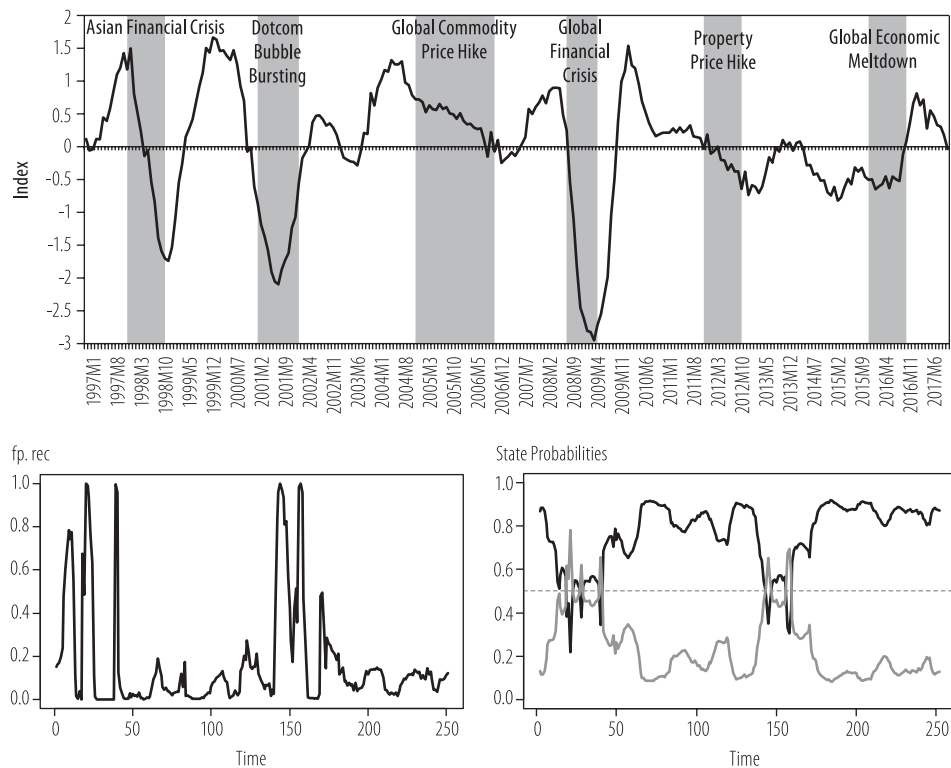
Figure 4: Markov Switching Model for the FVI Malaysia

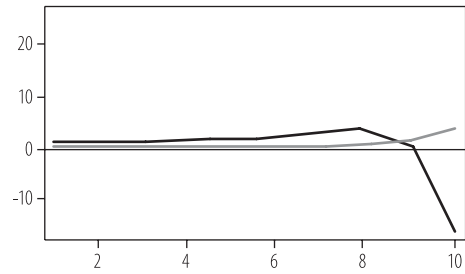
Figure 5 illustrates the functions of impulse response for the variation in economic activity to a shock in the financial vulnerability indicator. The feedback of financial vulnerability varies substantially between the low-vulnerability regime and high-vulnerability regime. During a period of low vulnerability, the shock in financial vulnerability has no significant impact on economic activity. On the other hand, a significant alteration in economic dynamics in response to financial vulnerability shocks ensues during a period of high vulnerability, whereby the change in industrial production is extensively negative. This signifies a slowdown in economic activity during a period of high vulnerability. The empirical findings highlight the prominence of nonlinearities in a crisis situation.

During the period of high vulnerability, financial vulnerability shock brings about a significant negative effect on industrial production. Based on the chronology of high financial vulnerabilities in Malaysia, this phenomenon is significant with the slowdown in industrial production. The weak global condition and demand during the subprime mortgage crisis in 2008-09 adversely impacted economic development

in Malaysia, indicated by the rapid dwindling in export performance and industrial production (Bank Negara Malaysia, 2008).

To evaluate the forecasting ability of the constructed FVI, the indicator is benchmarking against credit-to-GDP ratio as a proxy to financial vulnerabilities and compared with the conventionally used credit-to-GDP gap. Table 3 shows the forecast evaluation of credit-to-GDP gap and the constructed FVI, whereas Figure 6 illustrates the forecast comparison graph of both indicators. With the lower values in forecast evaluation signifying better forecasting accuracy, the empirical outcomes reveal that the constructed FVI contains higher predictive power from 5 out of 6 evaluation indicators. The forecast evaluation analysis also serves as a robustness check for the constructed indicator of FVI.

Figure 5: Impulses responses for change in IPI to shock in FVI

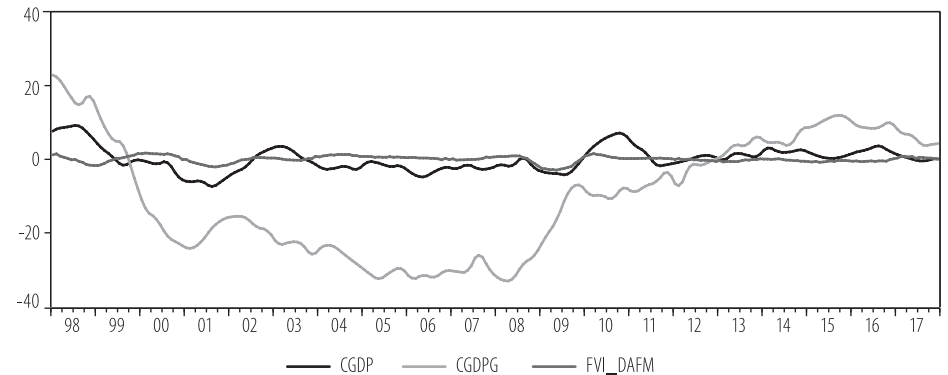


Note: Gray line denotes impulse response in low-vulnerability regime while black line denotes impulse response in high-vulnerability regime.

Table 3: Forecast Evaluation of Credit-to-GDP Gap and FVI

Forecast	RMSE	MAE	MAPE	SMAPE	Theil U1	Theil U2
CGDP Gap	17.210	14.315	2175.176	153.370	0.780	33.852
FVI	3.291	2.647	153.420	173.077	0.779	1.411

Figure 6: Forecast Comparison Graph



5. Conclusion

Ever since the global financial crisis in 2008, monitoring the state of financial vulnerability has become a top concern for policymakers to provide a buffer for a macroprudential shock. In this paper, an FVI has been constructed for Malaysia to act as an early warning mechanism for the state of financial vulnerability, using a sophisticated modelling approach. With the implementation of the dynamic approximate factor model, the indicator is developed using 10 variables from the financial market, property market and macroeconomic data from 1997 to 2017. The model estimation, which is based on the combination of maximum likelihood and Expectation Maximisation algorithm, permits mixed frequencies and an arbitrary pattern of missing statistics.

Assessment of the effects of financial vulnerability on economic dynamics is accomplished through the MSBVAR modelling. Precisely, two regimes of low-vulnerability and high-vulnerability are imposed on the model to capture the variation in the transmission of financial vulnerability on economic activity in different regimes. The empirical outcomes indicate that a single regime is insufficient to model economic activity within the model whereby two regimes model are significantly more suitable to capture nonlinearities in the model. In a high-vulnerability regime, financial vulnerability transmits significantly to economic activity while economic activity is barely affected in a low-vulnerability regime. The empirical results suggest the prominence of nonlinearities when scrutinising financial vulnerability shocks.

Consistent with the outcomes from other similar studies, the key findings of this paper suggest that high financial vulnerability brings about significant negative effect on economic activity in Malaysia. Therefore, macroprudential authorities should consider the implementation of the constructed FVI and MSBVAR modelling as a barometer on the state of financial vulnerability so as to monitor and mitigate macroprudential vulnerabilities that threaten the economic dynamics in Malaysia.

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