



Measuring Financial Stress Index for Malaysian Economy

Jauhari Dahalan¹, Hussin Bin Abdullah², Mohammed Umar^{3*}

¹Department of Economics and Agribusiness, School of Economics, Finance and Banking, Universiti Utara Malaysia, Kedah, Malaysia, ²Department of Economics and Agribusiness, School of Economics, Finance and Banking, Universiti Utara Malaysia, Kedah, Malaysia, ³Department of Economics and Development Studies, Federal University Kashere, Nigeria.

*Email: mumar@fukashere.edu.ng

ABSTRACT

The study measures financial stress index for Malaysian economy. We aggregate the identified financial and economic factors into a single index using the principal component analysis. The result shows that Malaysian Financial Stress Index (MFSI) increases as a result of increase in Banking Sector Fragility Index, credit stress, external debt, stock market volatility and Exchange Market Pressure Index. Moreover, the weights of the variables reveal that the magnitude of the Malaysian financial stress is mainly driven by the fragility of the banking sector. The combine variables explain about 53% of the total variation in the MFSI. Thus, the financial stress is determined to be the key player in the co-movement of the components used in the construction process. Furthermore, the aggregated components practically capture the known key aspects of financial stress in Malaysia. The implication of the finding is that authorities should focus more on banking sector stability than other components of the financial stress. This will help to reduce the overheating of the Malaysian financial stress.

Keywords: Economic Indicators, Financial Crisis, Financial Stress Index, Malaysia

JEL Classifications: C43, G01

1. INTRODUCTION

This study focuses on the construction of financial stress index in an emerging economy. This becomes imperative as a result of the repeated episodes of financial crises. In emerging economies like Malaysia, the episodes of the financial crises occurred often enough (Tng and Kwek, 2015). It is also argued that the episode of financial crises are associated with prolonged process of recovery compared to other forms of recessions (Reinhart and Rogoff, 2014). The most recent obvious episode is the capital market liberalization of the early 1990s as well as the domestic credits accumulated by the Malaysian banking sector (Athukorala, 2010). However, the most significant financial crises in the history of Malaysian economy is the 1997 Asian financial crisis which raises the Malaysia's financial stress to reach its highest level starting from the early 1996 to 1997.

Furthermore, the economy is said to be affected in 2007 when share prices decline as a result of the global financial crisis. This affects export and other financial sectors of the economy which

dragged down the economic growth and raises the financial stress in the country. Nevertheless, the menace of the 2007-2009 financial crisis was not as severe as that of 1997-1998 Asian financial crisis at least for Malaysia. This is due to the improved resilience of the Malaysia's financial sector and its limited exposure to the US collateral debt obligations coupled with the immediate response of the Malaysian monetary policy to the shock. Moreover, the current Malaysia's currency depreciation leads to declining consumer and investors' confidence thereby raising capital flight. This also raises the Malaysia's financial stress.

Previous studies such as Kaminsky and Reinhart (1999), Berg and Pattillo (1999) and Disyatat (2001) identify common factors from the episode of the historic crisis to determine the factors that may cause financial instability. However, the continues nature of the financial stress is beyond the employed binary variables of zero-one to measure the magnitude of the financial stress and such a methodology does not take account of near-miss events. Furthermore, these studies basically focus on banking, currency

and debt crises, without concern about securities-market stress (Balakrishnan et al., 2011; Cevik et al., 2013).

The uniqueness of this study is that unlike the study of Tng and Kwek (2015) who followed Illing and Liu (2006) measurement of financial stress index, our study is carried out using other economic measures such as external debt as emphasized in Cevik et al. (2013) in addition to most of the measures used in Illing and Liu (2006). The significance of including the economic indicators include addressing various aspects of financial stress especially those related to external debt in emerging and developing economies. This is similarly emphasized in Cevik et al. (2013). Moreover, the study uses longer sample data which covers the renowned financial episodes especially in Asia. This gives the true representation of the financial stress episodes for Malaysia. Furthermore, the study to the best of our knowledge is among the very few studies if any that construct financial stress index for Malaysian economy in isolation.

The remaining sections are structured as follows; Section 2 deals with construction of financial stress index for Malaysia, Section 3 describes data and empirical results, Section 4 contains the conclusion of the paper and finally offers policy implications based on the behavior of the index.

2. CONSTRUCTION OF FINANCIAL STRESS INDEX FOR MALAYSIA

The paper constructs the Malaysian financial stress index (MFSI) following Hakkio and Keeton (2009), Cevik et al. (2013) and Cevik et al. (2013). The index is measured using financial stress variables. These variables involve both financial and economic indicators that approximately proxy the features of financial stress. It is argued that the characteristics of financial stress must include at least one of these features; rise in uncertainty about the fundamental asset value, increase substitution of illiquid with liquid assets, high asymmetry of information and decrease in the interest to own risky commodities/asset (Hakkio and Keeton, 2009). Despite the emphasis to measure financial stress using purely financial indicators, Rey (2009) suggests using other economic factors such as trade credit, especially in the developing economies. This is because using only financial market prices to measure financial stress in emerging and developing countries might not be sufficient in explaining the abnormal behavior of the financial sector. Thus, in a more recent study, Cevik et al. (2013) consider other variables such as external debt and financial sovereign risk in measuring financial stress for five emerging economies. Based on the previous literature, especially related to emerging economies, the study uses the following components to construct the financial stress index for Malaysia.

2.1. Banking Sector Risk

Banking sector crises is an inability of banks to meet their internal obligations due to actual or incipient bank failure (Bordo, 1986). It is also related to bank failures that lead to systemic exhaustion of either all or most part of its capital (Caprio and Kilvingbiel, 1996). Financial stability of a country can be assessed based on

the soundness of its banking system. This variable is employed in many studies to measure financial stress. However, previous studies basically used either banking sector stock market index volatility or the standard Capital Market Asset Pricing Model (Balakrishnan et al., 2011; Cevik et al., 2013; Cevik et al., 2013). Following Cevik et al. (2013), Kibritçioğlu (2003), we employ Banking Sector Fragility Index (*BSFI*) to measure the banking sector crises. The BSFI is constructed using data on assets and liabilities of banking sector. This includes data on real commercial bank deposit (*CBD*), real claims on domestic private sector (*CDP*) and real foreign liabilities of banks (*FLB*). The index is constructed based on Equation (1) as follows:

$$BSFI_t = \frac{\left[\frac{(\Delta CBD_t - \mu \Delta CBD)}{\sigma \Delta CBD} \right] + \left[\frac{(\Delta CDP_t - \mu \Delta CDP)}{\sigma \Delta CDP} \right] + \left[\frac{(\Delta FLB_t - \mu \Delta FLB)}{\sigma \Delta FLB} \right]}{3} \quad (1)$$

Where, Δ represents a difference operator denoting changes in the series over 12-months period. The symbols μ and σ represent mean and standard deviation of the series under consideration. It is hypothesized that a decrease in the index shows increase in the banking sector riskiness (Balakrishnan et al., 2011; Cevik et al., 2013). This might arise from high level of money withdrawals, decrease in deposit, increase in non-performing loans and exchange rate depreciation.

2.2. Stock Market Risk

Stock market risk is another vital components of financial stress, especially in developing countries. Stock market crisis is popularly measured as the stock market volatility using generalized autoregressive conditional heteroskedasticity (ARCH) (1, 1) model proposed by Bollerslev (1986). The advantage of using the stock market return risk is that its conditional variance is used in pricing derivatives, hedging and calculating risk measures (Cevik et al., 2013). The volatility is measured based on Equations (2) and (3) below:

$$SMR_t = Y_t' \theta + \varepsilon_t \quad (2)$$

$$\sigma_t^2 = \omega + \alpha \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 \quad (3)$$

Where, SMR_t is the stock market index for time t , Y' includes a vector of constant and autoregressive terms of the stock market return. σ^2 is the conditional variance and ε^2 represents the ARCH term.

2.3. Currency Market Volatility

The currency market crises deals with depreciation in the exchange rate and decline in the international reserve. It is defined based on “its ability to capture both successful and unsuccessful speculative attacks” (Bussiere and Fratzscher, 2006 in Cevik et al., 2013). The manifestation of the foreign exchange stress depends on the exchange rate regime of a country. Volatility of exchange rate leads to uncertainty in the foreign exchange market. This arises due to high illiquidity which affects the foreign exchange market

efficiency. The study calculates the Exchange Market Pressure Index (EMPI) to measure the degree of exchange rate pressure. The EMPI has been proposed by Girton and Roper (1977) and widely used in the literature. The series is calculated following Balakrishnan et al. (2011) and Cevik et al. (2013) among others as follows:

$$EMPI_t = \frac{\Delta exc_t - \mu \Delta exc}{\sigma \Delta exc} - \frac{\Delta frv_t - \mu \Delta frv}{\sigma \Delta frv} \quad (4)$$

Where, Δ denotes 12-months changes in exchange rate and international reserve. exc is the exchange rate series, frv denotes foreign reserve excluding gold. The notations, μ and σ symbolize mean and standard deviation of the exchange rate and international reserve.

2.4. Sovereign Bond Risk

Changes in risk perception by investors especially in an emerging economy like Malaysia usually leads to short-term capital flows. Therefore, following Balakrishnan et al. (2011), Cevik et al. (2013), the study uses 10 years government bond yield and 10 years US Treasury bond yield in constructing the MFSI. The sovereign risk spread can be used as an important measure of risk perception in the economy. This is measured as a difference between 10 years Malaysian government bond and US treasury bond yield as follows:

$$SBR_t = GBY_t - USB_t \quad (5)$$

Where, SBR is the sovereign bond risk, GBY and USB indicate monthly 10 years Malaysian government bond yield and monthly 10 years US Treasury bond yield respectively. The subscript t denotes time period, which represents monthly frequency in this study.

2.5. Credit Stress

According to Cevik et al. (2013) and Rey (2009) the financial stress index should involve a measure of credit stress in the construction. It has been noticed that the calculation of credit stress is not straight forward. However, this study follows the measurement adopted in Cevik et al. (2013) to proxy credit stress. This is the use of rate of growth on claims on the private sector. The growth rate is calculated based on Equation (7), where credit stress is calculated as growth of claims on private sector.

$$Credit\ Stress = \left(\frac{CPS_t - CPS_{t-1}}{CPS_{t-1}} \right) * 100 \quad (6)$$

The terms, CPS_t and CPS_{t-1} are the current and previous claims on private sector respectively. We arrived at the percentage changes by multiplying the fraction by 100.

2.6. External Debt

External debt constitute one of the important financial stress indicators especially in developing economies (Bussiere and Fratzscher, 2006). This plays an important role in economic growth sustainability taking account of the Asian financial crisis (Cevik et al., 2013). Furthermore, Cevik et al. (2013) emphasize that external debt component should be included in the financial

stress index for developing countries. Perhaps, excessive external debts affect the stability of financial system and economic activities via a process of debt overhang effect. This is a phenomenon characterized by decrease in the incentives to invest, impaired international credit access, reduced public investment and heavy constraints on government adjustment (Erbil and Salman, 2006). In this study, we proxy external debt using 12-months growth rate of external liabilities. The rate is calculated as follows:

$$EXDGR = \left(\frac{EXL_t - EXL_{t-1}}{EXL_{t-1}} \right) * 100 \quad (7)$$

Where, $EXDGR$ represents external debt growth rate. EXL_t and EXL_{t-1} are the current and previous external liabilities respectively. The value, 100 is multiplied by the fraction to arrive at the percentage change.

3. DATA AND EMPIRICAL RESULTS

3.1. Data

In order to measure the Financial Stress Index for Malaysia, we collect monthly data from 1995:1 to 2014:12. The data are collected on money market interest rate, international reserve, foreign exchange rate, domestic currency credits, 10 years government bonds yield, external medium and long term debt securities, base currency in circulation, claims on the private sector, external liabilities, commercial banks deposit, foreign liability of banks and interest rate 3-months treasury bills from Bank Negara Malaysia (BNM). Whereas, data on net financial flows, banking sector and stock market indices are collected from the Bank for International Settlement. 10 years US bonds interest rate yields and claims on domestic private sector are generated from the Federal Reserve of US and International Financial Statistic respectively.

3.2. Aggregation of the Components

Due to the relative approximation to various features of financial stress associated with our selected variables, there is a tendency that the variables move together due to changes in the degree of financial stress. However, combining economic and financial variables in the construction may facilitate changes in the variables as a result of other reasons different from financial stress. According to Hakkio and Keeton (2009) financial stress usually works toward variable convergence whereas, other factors lead to deviation of the variables from one another. This scenario is examined using correlation analysis presented in Table 1. Table 1 presents the correlation coefficients among the selected variables over the study period. The coefficients show a maximum of 52% coefficient between BSFI and credit stress. This indicates that although the variables move together within a certain boundary however, they do not move at the same speed. Furthermore, the coefficients are not highly correlated, ranging from 0.04 to 0.54. This further suggests that the series independently contribute to the construction of the financial stress index.

Furthermore, the aggregation of the components into an overall index is carried out following the popular methodology of principal component analysis (PCA) employed in the similar previous studies such as Hakkio and Keenton (2009), Cevik et al.

(2013), Cevik et al. (2013) to combine the identified financial and economic variables into a single financial stress index for Malaysia.

3.3. PCA

This is a descriptive and explanatory method of reducing the original large number of variables collected from a single population into a lower orthogonally synthesized variables. It scientifically visualizes and correlates variables among statistical units. The weights of the variables used in the PCA for this study are presented in Table 2. Prior to the component aggregation, the study standardized all variables by subtracting their mean from the contemporaneous value and dividing by their standard deviation. This is carried out to directly assess the magnitude of the coefficients. Furthermore, the standardization of the data prevents the problems of unit of measurement and variation bias.

The principal components equal to the number of the random vector of variables. The first component specifies the coefficients of the constructed variables to maximize its variance and obtain a unique number subject to the constraint of equating the sum of the squared coefficients to unity. The process is similarly repeated in the second and subsequent components to account for the remaining variation as much as possible, subject to the constraint that the correlation values of the first and second as well as subsequent components are all equal to zero. This ensures that there exist no correlation among the principal components.

We estimate various combinations of the components with numerous groupings in the PCA to arrive at the index with high explanatory power of the total variance. The coefficients of the individual constructs are obtained from the eigenvector of the PCA correlation matrix.

Table 2 presents the results of the standardized PCA coefficients. It indicates the impact of one-standard-deviation shock in the components on the overall MFSI. The result shows that MFSI increases as a result of increase in BSFI, credit stress, external debt, stock market volatility and EMPI. In other words, the result shows that during excessive financial stress, the Malaysian banking sector becomes more fragile; the stock market becomes more volatile; the pressure on the domestic currency increases; external liabilities rises and claims on the private sector (credit stress) grew over time. Moreover, the weights of the variables reveal that the magnitude of the Malaysian financial stress is mainly driven by the fragility of the banking sector. Similar result is found in Cevik et al. (2013) for Bulgaria and Russia. This is followed by claims on the private sector (credit stress) and external debt and stock market volatility. The least component that increases the magnitude of the financial stress in Malaysia is the exchange rate pressure index. This might be as a result of the managed floating exchange rate regime of the country which does not fully allow the currency prices to be solely determined by the interaction of the market forces.

However, increase in the return realized on Malaysian government bonds in relation to US bonds yields and net financial flows tend to reduce the magnitude of financial stress in Malaysia, especially during the period of high financial crises. Therefore, the result

Table 1: Correlation coefficients of MFSI components

	BSFI	SMV	EMPI	SBR	CREDIT	DEBT
BSFI	1.000					
	-					
SMV	0.143** (0.027)	1.000				
		-				
EMPI	0.080 (0.221)	-0.394*** (0.000)	1.000			
			-			
SBR	-0.148** (0.022)	0.113* (0.080)	0.076 (0.244)	1.000		
				-		
CREDIT	0.543*** (0.000)	0.100 (0.122)	0.077 (0.233)	0.002 (0.973)	1.000	
					-	
DEBT	0.293*** (0.000)	0.041 (0.523)	-0.058 (0.367)	-0.126 (0.051)	0.107* (0.097)	1.000
						-

***, ** and * indicate significance level at 1%, 5% and 10% respectively. The values in parenthesis are the probability values of the pairwise correlation coefficients. The notations BSFI, EMPI, SMV, SBR, DEBT, and CREDIT represent the constructed variables, banking sector fragility index, exchange market pressure index, stock market volatility, government bond risk, external debt and credit stress respectively. Source: Authors' computation. MFSI: Malaysian Financial Stress Index

Table 2: PCA results

Components	Coefficients
BSFI	0.630
SMV	0.323
EMPI	0.252
SBS	-0.102
Credit stress	0.560
External debt	0.333
Total variance explained	53.06%

Source: Authors' computation. BSFI: Banking sector fragility index, SMV: Stock market volatility, EMPI: Exchange market pressure index, SBS: Sovereign bond spread

also reveals that changes in the risk perception of the investor measured as government bond spread is the most important source of financial stress reduction in Malaysia.

The coefficients of the components are in most cases in line with a prior expectations. However, the result on the external debt component contradicts the findings of Cevik et al. (2013) and Cevik et al. (2013) who found that short term debt is negatively related to financial stress index for Turkey, Bulgaria, Czech Republic, Hungary, Poland and Russia. The present study proxies external debt by external liabilities and found a positive relationship for Malaysia. Perhaps, this might be related to the perception and concern of the market participants about Malaysia's debt sustainability which is anticipated to affect the solvency of the country's financial sector, thereby increase in the abnormal workings of the financial system. Moreover, the result is in line with the findings of Reinhart et al. (2012) who conclude that external debt is one of the factors that retard economic growth.

The tendency of the financial variables to move together in explaining the overall financial stress index is investigated using the explanation of the total variance. The components jointly explained 53.06% of the total variation in the financial stress index. Thus, the financial stress is determined to be the key player in the co-movement of the components used in the construction process. Furthermore, the performance of the constructed index is assessed by its ability to indicate the established episodes of

financial stress. Figure 1 shows the plots of the MFSI and possible events that occurred during the period under study.

We use the famous Harding and Pagan (2002) business cycle algorithms based on monthly data specification to identify the potential turning points, ensure alternation in peaks and troughs among others. This helps to avoid the possibility of ad hoc subjective selection of the recession regimes. The graph of the MFSI (Figure 1) indicates the historic recessions that occurred in the economy from the period of 1995M1 to 2014M12. In emerging economies like Malaysia, the episodes of the financial crises occurred often enough (Hong et al., 2010; Tng and Kwek, 2015). It is also argued that there is always a prolonged process of recovery from financial crises episodes compared to other forms of recessions (Reinhart and Rogoff, 2014). Therefore, presenting all the indicated financial stresses on a single graph might not be appealing, instead the algorithm plots only episodes with a threshold parameter of at least 25 per cent and above. It has also been emphasized in Hakkio and Keeton (2009) that a certain threshold is required rather than casual determination of the financial stress's events. This ensures identification of high episodes of financial stress in Malaysia.

The plot shows that the MFSI has been consistently volatile over the period of our study. The first obvious shock that is captured in the sample period is the spillover effect of the capital market liberalization of the early 1990s as well as the domestic credits accumulated by the Malaysian banking sector (Athukorala, 2010). However, the most significant episode in the history of Malaysian economy is the renowned Asian financial crisis. This is significantly captured in Figure 1. The event started in 1996 which leads to shrink in the Malaysian economic growth as a result of the speculative deals in the exchange rate market, fell in foreign inflow of investments, excessive capital outflows, reasonable decrease in the Kuala Lumpur Stock Exchange's composite index and low external debt exposure of banking sector. This contracts the economic activities by a very sharp decline which raises the Malaysia's financial stress to reach its highest level sometimes in the early 1996 up to 1997.

Additionally, the MFSI also captured the Malaysia's ability to absorb the shocks of the Asian financial crisis which started from the last part of 1998 to the early part of 1999. This is not unrelated to the implementation of pegged exchange rate, capital control measures, suspension of central limit order book trading, budget deficits, low interest rate and export orientation adopted by the BNM. These measures kept the MFSI mostly below zero with deviations within the same regime until 2007 when share prices declined as a result of the global financial crisis. This affects export and other financial sectors of the economy which dragged down the economic growth and raises the financial stress in the country. Nevertheless, the menace of the 2007-2009 financial crisis was not as severe as that of 1997-1998 Asian financial crisis at least for Malaysia. This is due to the improved resilience of the Malaysia's financial sector and its limited exposure to the U.S collateral debt obligations coupled with the immediate response of the Malaysian monetary policy to the shock.

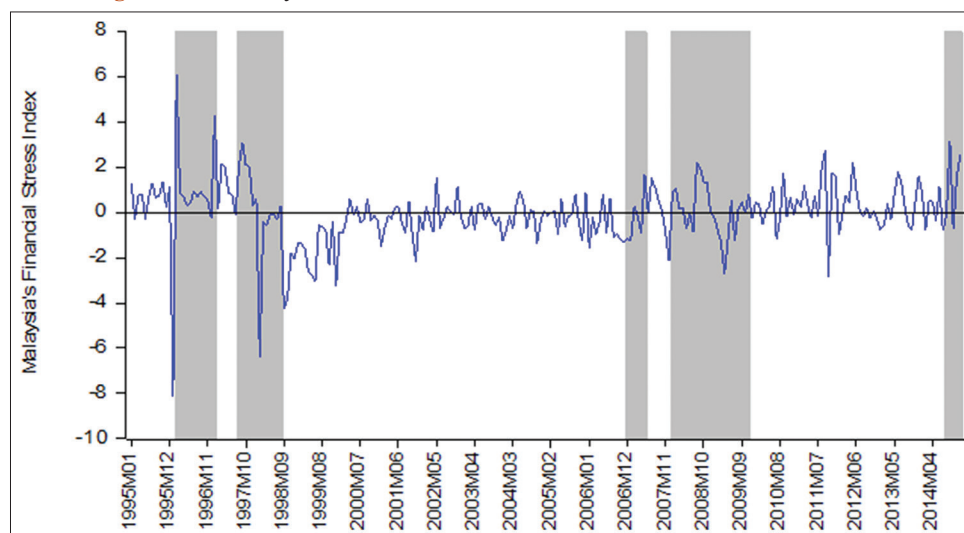
Moreover, the current Malaysia's currency depreciation leads to declining consumer and investors' confidence thereby raising capital flight. This also raises the financial stress index above the threshold starting from the last part of 2014 and contracts the recorded sustainable economic growth.

4. CONCLUSIONS AND POLICY IMPLICATION

We construct financial stress index for Malaysian using both financial and economic variables for the period spanning 1995:1 to 2014:12. The variables include financial, such as BSFI, stock market volatility, EMPI, money market spread, government bond spread, and credit stress as well as, economic factors like the 12 months growth rates of external debt. The study applies PCA to aggregate the MFSI. The plots of the index indicate that the MFSI captured the historic financial stress episodes that exist in the sample. This makes the MFSI a vital indicator of the real economic activity in the country.

The implication of the result is that increase in banks failure to meet up their internal obligations due to excess insolvency, increase

Figure 1: The Malaysia's Financial Stress Index. Note: Shaded areas are recessions



non-performing loans and high money withdrawals will lead to procyclicality of debt stocks which reduces the credit facility of the financial sector and greatly affect the economic activity. On the other hand, the prolonged manage floating exchange rate regime also leads to a significant loss in international reserve, rise in interest rate and domestic currency overheating in the exchange rate market. More so, perception and concern of the market participants about Malaysia's debt sustainability which is anticipated to affect the solvency of the country's financial sector, also increase the abnormal workings of the financial system. Likewise, the current Malaysia's currency depreciation leads to declining consumer and investors' confidence thereby raising capital flight. Furthermore, the increasing stock market risk, growth rate of external liabilities and claims on the private sector can also affect the financial stability which in turn deteriorate the level of economic activity in Malaysia.

Thus, the study suggests that the monetary authority should directly deals with creditworthiness of the financial sector through providing sufficient credits to solve the usual problem of insolvency in the financial sector. Policies should be tailored towards export orientation especially when the financial stress is related to external sources. This will lead to more demand for the domestic currency and increase in the external reserves. The result of this study particularly reveals that authorities should focus more on banking sector stability than other components of the financial stress. This will help to reduce the overheating of the Malaysian financial stress.

5. ACKNOWLEDGMENT

We wish to acknowledge the effort of the Research and Innovation Management Centre, Universiti Utara Malaysia and the Ministry of Higher Education, Malaysia for awarding us with the Fundamental Research Grant Scheme to carry out this research project.

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