



**BANK NEGARA MALAYSIA**  
CENTRAL BANK OF MALAYSIA

Bank Negara Malaysia Working Papers  
WP6/2015

**The Transmission of Financial Stress and its  
Interactions with Monetary Policy Responses in the  
ASEAN-5 Economies**

By Tng Boon Hwa

July 2015

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# **The Transmission of Financial Stress and its Interactions with Monetary Policy Responses in the ASEAN-5 Economies**

**Tng Boon Hwa<sup>1</sup>**  
Bank Negara Malaysia

## **Abstract**

This study aims to analyse the determinants of financial stress, the impact of financial stress on the real economy and the interactions between monetary policy and financial stress in the ASEAN-5 economies. Results from a panel model of the determinants of financial stress indicates the significance of 3 global and regional variables - US financial stress, world GDP, regional financial contagion – and one domestic variable, bank credit, as important sources of financial stress. Through a subsequent SVAR analysis, financial stress is found to have adverse effects on the real economy, with large initial effects followed by a gradual dissipation. The results also suggest that the central banks in Malaysia, the Philippines and Thailand tend to lower their policy interest rates when financial stress increases. This leads to improvements in economic activity, albeit often with different time dynamics compared to the impact of financial stress on economic activity. Compared to financial stress, monetary policy shocks tend to affect output more gradually over longer lags. Lower policy interest rates are found to have a limited effect in alleviating financial stress, but can stimulate economic activity through other channels.

JEL Classification: E44, E52, G10

Key Words: Financial stress; Financial spillovers; Monetary policy

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<sup>1</sup> Earlier drafts were presented at the Bank of Thailand and Bank for International Settlements (BoT-BIS) 8th Annual Workshop of the Asian Research Networks 2015, the ISI Regional Statistics Conference 2014 in Malaysia and the joint meetings of the Econometric Society Australasian Meeting (ESAM) and Australian Conference of Economists (ACE) 2014. This paper benefitted from comments made by the conference participants. I am also grateful to Mohamad Hasni Sha'ari, Mala Raghavan, Kwek Kian Teng, Fraziali Ismail, Norhana Endut and Sharmila Devadas for feedback and helpful comments. Correspondence: boonhwa@bmn.gov.my

## 1. Introduction

There has been a resurgence of interest in the interconnections between macroeconomic stability and financial stability since the 2008 Global Financial Crisis (GFC) and the euro debt crisis. This renewed attention is no doubt attributable to the large scale and depth of the crises. These episodes were, however, not historically unprecedented as financial crises have occurred often enough for studies to document empirical regularities<sup>2</sup>. For instance, the literature on early warning systems of financial crises finds that crises tend to follow from periods of sustained high growth in credit and asset prices<sup>3</sup>. Another literature on growth experiences after crises, best exemplified by Reinhart and Rogoff (2009, 2014), finds that recoveries from financial crises are often prolonged compared to those from other recessions.

Nevertheless, these empirical commonalities pertain only to crisis periods and are less suited to provide a complete explanation of the entire financial cycle and of macro-financial linkages. This is especially true for small-open economies where in addition to crises that result from the unwinding of domestic financial imbalances (which early warning system studies focus on), adverse financial episodes are often also attributable to spillovers from external sources. While the financial market disruption caused by external financial spillovers does not always reach the scale of crises, they are often severe enough to have material adverse growth effects. Hong, Lee and Tang (2010) illustrate this for 21 Asian economies over the period 1961-2007, by showing that episodes of financial market stress in these economies often coincided with stress in major financial centres and that all their financial episodes were associated with growth slowdowns.

The objective of this paper is to investigate the sources of financial stress beyond just crisis periods and assess how financial stress affects the real economy in small-open economies. This information can guide regulators and policymakers to focus on indicators that potentially portend impending episodes of financial stress. For central banks, this area of inquiry also raises the question of whether financial stress alters the transmission of monetary policy. These findings, together with knowledge of the time profile of how financial shocks affect the real economy, can help guide the formulation of a policy strategy that is consistent with monetary and financial stability.

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<sup>2</sup> See for instance, Kindleberger, Aliber and Solow (2005)

<sup>3</sup> Kaminsky and Reinhart (1999) and Borio and Lowe (2002) are early influential studies.

Within this context, this paper attempts to investigate the transmission of financial stress, how it affects the real economy and to characterise how financial stress influences the behaviour and transmission of monetary policy. I use the ASEAN-5 – Indonesia, Malaysia, Philippines, Singapore and Thailand – as my sample countries to give insight to the following questions:

- i. First, what are the determinants of financial stress? Drawing on recent efforts from Balakrishnan, Danninger, Elekdag, and Tytell (2009), Duca and Peltonen (2011) and Park and Mercado Jr (2014), I estimate a panel model with financial stress modelled as a function of common global/regional variables and country-specific indicators of vulnerabilities.
- ii. Second, how does financial stress affect the real economy? I estimate a time profile of the impact of higher financial stress on real economic activity through impulse response functions from the SVAR model developed in Tng (2013). This methodology allows for an examination of the speed and depth of the economic downturn in response to adverse financial shocks, while remaining agnostic about the sources of financial stress.
- iii. Third, how does financial stress feature in monetary policy considerations and in the transmission of monetary policy to the real economy? I estimate monetary policy movements when financial stress increases and attempt to quantify the role of financial stress in the transmission of monetary policy to the real economy. The latter is of particular policy relevance as it provides a gauge of how effective monetary policy is during periods of financial stress. I also rely on impulse response functions from the SVAR models from Tng (2013) to give insight to these questions.

The methodologies in this paper rely on the use of Financial Stress Indices (FSIs) pioneered by Illing and Liu (2006) as a synthetic measure of financial stability. Using the FSIs offer two advantages: First, the FSIs facilitate an analysis of the financial cycle during tranquil and stressful periods in financial markets, as they are continuous measures of financial stress. This offers an advantage over the approach used in the Early Warning Study (EWS) literature, where judgement is required to date and identify crises, which then take on binary states – crisis or no crisis. As such, the FSIs are useful for analysing the determinants of financial stress in countries with few historical incidences of financial crises. Second, the FSIs summarize financial conditions across all major asset markets, hence sidestepping potential pitfalls from analysing financial spillovers within specific asset markets.

The panel estimations show that both external and domestic variables drive financial stress in the ASEAN-5 economies. World GDP and US financial stress emerge as significant global determinants, which likely reflects the ASEAN-5's high trade and financial linkages to global markets. Regional financial contagion among the ASEAN economies also emerges as a significant variable. For country-specific variables, bank credit is the only determinant that consistently tested significant. A positive bank credit gap portends higher financial stress. Meanwhile, the country-level SVAR estimations show that higher financial stress leads to lower economic activity in all five countries, with output displaying a rapid drop and a gradual recovery back to trend. The SVAR results suggests that when financial stress increases, the central banks in Malaysia, the Philippines and Thailand tend to reduce their policy interest rates, which subsequently lead to improvements in economic activity. This result is consistent with these central banks acting to achieve macroeconomic stability, as the lower interest rates act to offset the contractionary impact of higher financial stress on economic activity.

The remaining sections proceed as follows. Section 2 presents the panel data analysis of the sources of financial stress for the ASEAN-5 economies. The section begins with a brief overview of the transmission channels, followed by the panel estimation methodology and results. Section 3 presents the SVAR analysis of the impact of financial stress on the real economy and its interactions with monetary policy. The final section concludes with the main findings.

## **2. Sources of Financial Stress in the ASEAN-5 Economies**

### **2.1 Early Warning Indicators of Financial Crisis**

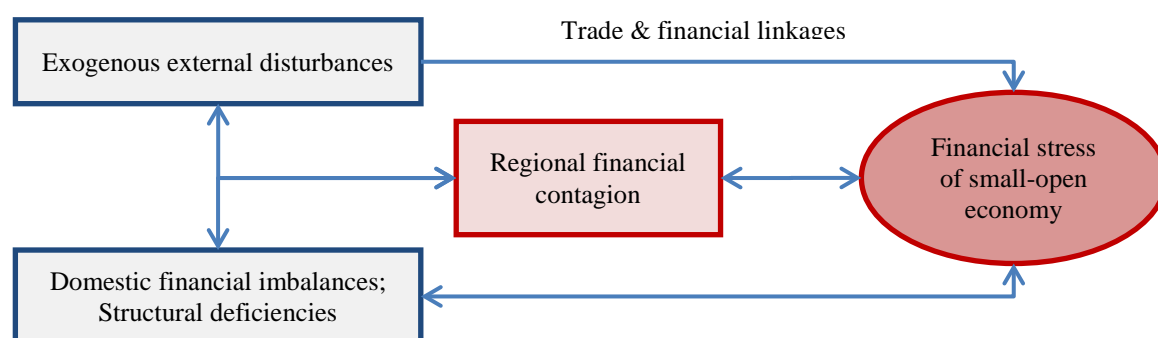
Figure 1 presents a schematic of broad factors that can cause movements in financial stress in small-open economies. First, accumulated financial imbalances and structural vulnerabilities in the domestic economy tend to be precursors of financial crisis. Some typical signs of such imbalances and vulnerabilities include high leverage, high asset prices, current account deficits, large capital inflows and overvalued exchange rates<sup>4</sup>. A key finding is that

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<sup>4</sup> Early influential studies in this strand include Eichengreen, Rose, Wyplosz, Dumas, and Weber (1995) and Kaminsky, Lizondo and Reinhart (1998), Kaminsky and Reinhart (1999) and Borio and Lowe (2002, 2004). See Frankel and Saravelos (2012) and Gourinchas and Obstfeld (2012) for recent discussions and further references on the early warning literature. Alessi and Detken (2011) is an exception as they also include global measures of liquidity in their assessment of early warning indicators.

financial crises have a higher probability of occurring just after the boom phase of the business cycle against the backdrop of worsening macroeconomic fundamentals, with credit/monetary conditions looser on the eve of crises. A typical scenario depicts an overheating real economy financed by foreign credit and capital (portfolio and direct investment) inflows, as well as high domestic credit and asset prices during the boom phase. Real economic activity subsequently peaks and starts to moderate. An event then triggers a “sudden stop” in capital inflows causing the current account deficit to be no longer sustainable. This development, together with a credit crunch in domestic financial institutions and falling asset prices, causes real economic activity to slow substantially, usually due to a large prolonged investment slump to restore the internal-external balance<sup>5</sup>.

**Figure 1. Schematic of the Determinants of Financial Stress in Small-Open Economies**



## 2.2 Spillovers from External Financial Episodes

In addition to domestic financial imbalances, financial cycles in small-open economies are also influenced by external developments especially from major financial centres. In cases when financial shocks originate externally, the degree of spillover to other markets depends in part on trade and financial linkages between the economies<sup>6</sup>. Higher integration to the origin of the financial shock potentially increases the degree of stress transmission. Financial spillovers can also occur from non-fundamental reasons, such as herd behaviour among market participants.

<sup>5</sup> See Reinhart and Tashiro (2013) for a discussion of the role of investment as an adjustment mechanism and its prolonged drag post-financial crisis. See Calvo (1998) for an initial detailed description of sudden stops.

<sup>6</sup> See Cheung, Tam and Szeto (2009) for a review of the contagion literature.

### **2.2.1 Trade Linkages**

The trade channel in driving financial spillovers has been extensively studied in existing literature. Chui, Hall, and Taylor (2004) and Balakrishnan et al. (2009) note that when trade shocks occur, the spillover effects in financial markets can occur before the real economy effects are visible. This is because the financial market effects reflect changing expectations by market participants of the real economy effects, while the direct effect of lower trade on growth occurs with a lag. The trade channel operates in two ways: First, an adverse external demand shock reduces the external economy's income, which lowers its import demand and hence adversely affects its trade partners. Second, the trade channel may operate indirectly through competition with common export markets. For example, an exchange rate depreciation increases the economy's export competitiveness relative to its competing exporters to common export destinations. Eichengreen and Rose (1999), Glick and Rose (1999), Forbes (2002) and Forbes (2004) find a significance for these direct and indirect trade linkages.

### **2.2.2 Financial Linkages**

Financial spillovers may also occur through linkages in financial markets, of which there are three major channels – bank, portfolio and direct investment. Essentially, a financial crisis in an economy causes a reduction in the supply of credit and capital to its destination economies. Garber and Grilli (1989), Valdes (1997) and Allen and Gale (2000) analyse international financial spillovers when financial institutions (e.g. banks and hedge funds) face liquidity shortages during crises. In efforts to raise liquidity within a short time span, many financial institutions are forced to sell assets from other countries at the same time. This triggers capital outflows in both portfolio securities and direct investments, and depresses asset prices and economic activity in the host countries. Similarly, banks facing crises are likely to reduce their exposures to higher risk loans, including loans to other countries. Another channel is through portfolio rebalancing by financial market participants where leveraged funds sell assets from other markets to raise funds to meet margin calls if the value of their collateral is sufficiently affected. In these scenarios, the participants often choose to reduce their portfolio risk exposures to emerging economies.

### **2.2.3 Other Explanations**

Although trade and financial linkages have been studied extensively, they are insufficient to fully explain the propensity for financial crises to spread, as crises often trigger crises elsewhere despite weak trade and financial linkages (Cheung et al., 2009). For instance, Rose and Spiegel (2011) focus on the recent GFC episode and fail to find systematic evidence that trade and financial linkages with the US economy, the origin of the crisis, explain how the crisis spread from the US to other economies. One explanation is that cross-country financial spillovers result from expectations formation and herd behaviour in financial markets. In an environment of asymmetric information in which some investors possess more private information than others, it is optimal for the less informed investors to follow those perceived to be better informed.

### **2.3 Regional Contagion**

Financial stress can also manifest through contagion at the regional level. Park and Mercado (2014) find significant regional effects in the transmission of financial stress in emerging economies. This may be attributable to regional economies sharing common creditors or being viewed as a cluster with similar macroeconomic risk profiles. Thus, a shock that triggers deleveraging by financial institutions, asset sell-offs and portfolio rebalancing by funds has regional, as opposed to country effects. Kaminsky, Reinhart and Végh (2003) and Kaminsky and Reinhart (2000) study the financial crises in Latin American and Asian economies during the 1980s and 1990s, in particular, which episodes were contagious to other economies and why some crises were contagious and some were not. They find that financial crises tend to spread to other economies who shared a leveraged common creditor, including commercial banks, hedge funds and mutual funds. This is consistent with Frankel and Schmukler (1998) and Kaminsky, Lyons and Schmukler (2004) who find that mutual funds were common actors in propagating the financial crises triggered by the currency devaluation in Mexico in 1994, which subsequently spread to Argentina and Brazil. Meanwhile, Kaminsky and Reinhart (2000) and Van Rijckeghem and Weder (2001) find that commercial banks were common creditors to the affected countries during the AFC, as well as the subsequent Mexican and Russian crises for the latter study. Thus, regional financial contagion can arise when the source of the financial disturbance comes from a



major financial centre, such as the GFC, or from an economy within the region, such as the AFC.

## 2.4 Recent Investigations of Financial Spillovers using Financial Stress Indices

A majority of the empirical studies in the early warning literature rely on identifying crisis episodes, then testing the ability of trade and financial linkages, vulnerabilities and other country-specific factors to predict them. One common feature is that the identification of crisis episodes is event driven, with the “crisis” variable indicating either crisis or no crisis. For example, Laeven and Valencia (2012) date the onset of systemic banking crisis when there is “*significant signs of financial distress in the banking system*” and “*significant banking policy intervention measures in response to significant losses in the banking system.*” A consequence of this event driven method of identifying financial episodes is that it misses periods marked by higher stress in financial markets but without systemic failures of financial institutions, currency runs or sovereign debt defaults. While not fitting the traditional definition of crises, such episodes are nonetheless significant if they had large adverse macroeconomic effects (Borio & Lowe, 2002). For instance, the US tech bubble burst in 2000-2001 had adverse macroeconomic effects domestically and to the US economy’s trade/financial partners, but it is not considered a financial crisis in most financial crisis databases<sup>7</sup>. Thus, dating and identifying financial crises in the traditional manner limits country-level analysis of financial spillovers in countries where crises have been rare, but still experience adverse financial episodes (Misina & Tkacz, 2009).

To address this shortcoming, Balakrishnan et al. (2009), Misina and Tkacz (2009), Duca and Peltonen (2011) and Park and Mercado Jr (2014) use Financial Stress Indices (FSIs), composite indices of stress, instead of the binary crisis indicator to analyse the determinants of financial stress. Balakrishnan et al. (2009) construct FSIs for 26 emerging economies to investigate the transmission of financial stress from advanced to emerging economies. Using aggregated measures of financial stress in the advanced and emerging economies, they estimate a panel model of emerging market FSIs. Their panel model includes an advanced economy FSI, a set of common global determinants, financial stress in other emerging economies, trade and financial openness, and three variables that capture country-specific

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<sup>7</sup> See Laeven and Valencia (2012) and Reinhart and Rogoff (2009) for recent examples of databases of banking, debt and currency crisis.

vulnerabilities to financial crisis, namely, the current account balance, fiscal balance and the level of foreign reserves. Overall, the authors find that common global financial and economic conditions play an important role in driving financial stress in emerging economies. Park and Mercado Jr (2014) extend Balakrishnan et al.'s (2009) panel analysis, by adding variables to capture regional and non-regional sources of financial stress in emerging economies. In addition to concurring with findings from Balakrishnan et al. (2009), the authors find a significance of financial stress from regional and non-regional emerging markets in influencing financial stress in emerging markets.

Balakrishnan et al. (2009) and Park and Mercado Jr (2014) find clear evidence of financial spillovers from advanced to emerging economies, while controlling for some domestic structural vulnerabilities. Nonetheless, these studies do not consider the role of economic and financial imbalances that the early warning literature finds to be important precursors of financial crisis. Misina and Tkacz (2009) investigates if fast growth in asset prices and credit precede incidences of financial stress in Canada through linear and non-linear threshold models. An innovation of their study compared to Borio and Lowe (2002) is their use of an FSI, instead of a binary dependent variable<sup>8</sup>. Misina and Tkacz (2009) estimate linear and threshold models using different permutations of credit and asset price measures. Their findings are consistent with Borio and Lowe (2002). Business credit appears as a reliable predictor of future financial stress in both linear and non-linear models<sup>9</sup>. Meanwhile, Duca and Peltonen (2011) use FSIs to evaluate the importance of external and domestic conditions in twenty-eight advanced and emerging economies. The authors identify periods when the FSI exceed the 90th percentile as “systemic events” and construct a binary variable to identify when such “systemic events” occurred. Using this as their dependent variable, the authors estimate discrete choice (logit) models with the domestic variables, foreign variables and both. A key result of their paper is that the specification with the highest out-of-sample predictive power of stress events includes both country specific and common external variables.

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<sup>8</sup> In their assessment, Borio and Lowe (2002) measure credit conditions with total credit as a ratio of GDP. Misina and Tkacz (2009) consider a wider range of credit measures – growth of household credit, business credit and the ratio of total credit to GDP. There are more similarities in the definition of asset prices, except the latter study also include gold prices in Canadian dollars.

<sup>9</sup> See Cardarelli, Elekdag, and Lall (2011) and Claessens, Kose, and Terrones (2010) for stylized features of the behavior of credit, asset prices and financial crisis historically across a wide range of countries.

## 2.5 A Panel Model of ASEAN-5 Financial Stress

A panel model of financial stress is developed in this section with the objective of assessing the determinants of financial stress for the ASEAN-5 economies. Following Balakrishnan et al. (2009), Misina and Tkacz (2009), Duca and Peltonen (2011) and Park and Mercado Jr (2014), the panel model captures three main sources of financial stress – common external factors, regional financial contagion effects and country-specific sources.

### 2.5.1 Data

The dataset consists of 5 ASEAN countries: Indonesia, Malaysia, Philippines, Singapore and Thailand. The series are in quarterly frequency and span from 1997-2013. Table 1 lists the variables, their sources and transformations where applicable. The dependent variable is the Financial Stress Index (FSI) for the ASEAN-5 economies from Tng, Kwek and Sheng (2012). The FSIs are composite indices that reflect stress in major segments of the financial market: (1) the banking sector, (2) equity market, (3) foreign exchange market, and (4) the bond market. The FSIs are originally in monthly frequency (Figure 2). For the panel estimations, I convert them to quarterly frequency by averaging the monthly values within each quarter.

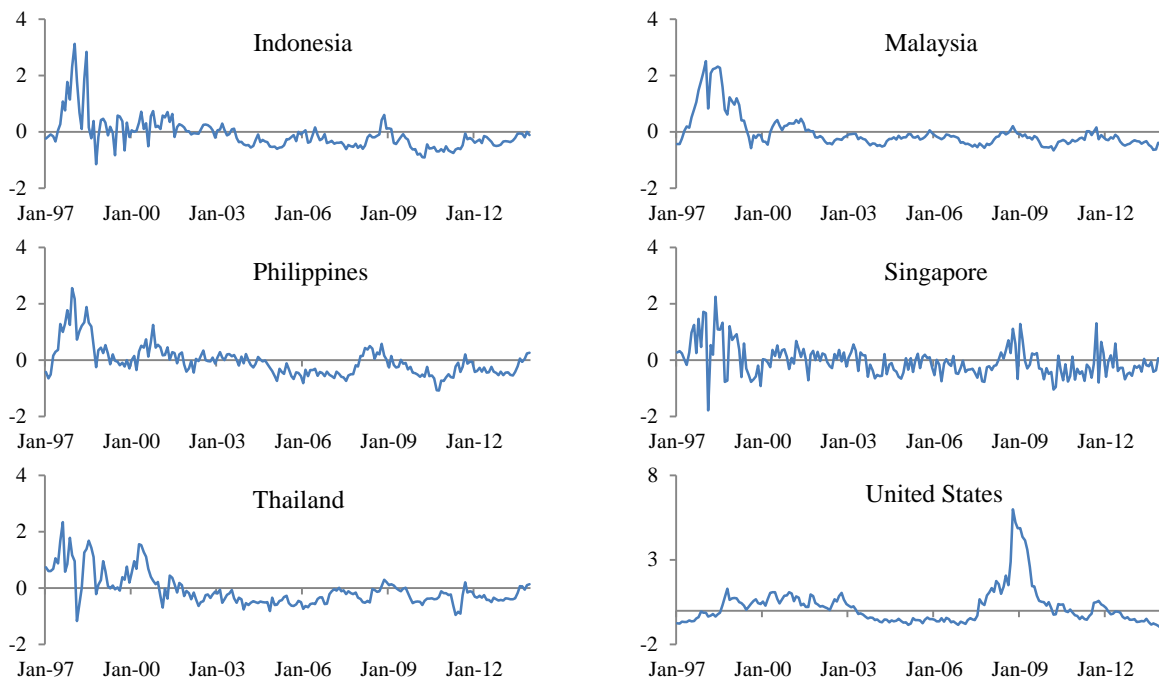
**Table 1. List of Variables for Panel Estimation**

Variable	Abbreviation	Definition	Source
Financial Stress for ASEAN-5 economies	FSI	Financial Stress Index	Tng, Kwek Sheng (2012)
World GDP	GDP <sub>w</sub>	World Real GDP (log, sa)	World Bank
Commodity Prices	GCP	Commodity price (log, sa)	International Monetary Fund
US Financial Stress	FSI <sub>US</sub>	US Financial Stress Index	Hakkio and Keaton (2009)
Regional Contagion	Cont	See section 2.4	Author's calculations
GDP	GDP	Real GDP (log, sa)	World Bank
Bank Credit	Credit	Domestic bank credit (log, sa)	International Financial Statistics, Haver Analytics
Current Account	CA	Current account/GDP (sa)	Haver Analytics
Foreign Reserves	Res	Foreign reserves (exc. gold) (log, sa)	International Financial Statistics, Haver
Fiscal Balance	FB	Fiscal balance (% of GDP)	Haver

The independent variables consist of common external and country specific domestic variables. There are four external variables: World Gross Domestic Product (GDP<sub>w</sub>) to capture global economic conditions; a weighted index of commodity prices (GCP) to capture

global prices; a FSI of the United States (FSIus) from Hakkio and Keeton (2009), which proxies for global financial conditions<sup>10</sup>. The last common variable, Cont, captures regional financial contagion. The next section details the methodology applied to construct this variable. Five domestic variables are included in the panel model: Real GDP reflects real economic conditions; Credit captures the buildup of domestic bank credit. The current account balance, international reserves and the fiscal balance are also considered as potential triggers of financial stress.

**Figure 2. Financial Stress Indices for the ASEAN-5 Economies (1997-2013)**



Source: Tng, Kwek and Sheng (2012) and author's calculations

The variables are initially tested for stationarity using the Im, Pesaran, and Shin (2003) (IPS) panel unit root test<sup>11</sup>. These tests are conducted on the variables in levels and de-trended using the Hodrick-Prescott (HP) filter. This method of de-trending follows from Borio and Lowe (2002), Cardarelli et al. (2011) and Duca and Peltonen (2011). An economic reason for applying a time-varying filter (instead of taking the first difference) to de-trend the variables is that it removes country-specific changes in financial development and in how

<sup>10</sup> This index is quantitatively similar to other FSIs of the US economy in the literature, for instance, by Cardarelli et al. (2011) from the IMF, Kliesen and Smith (2010) from the Federal Reserve Bank of St. Louis.

<sup>11</sup> The Levin, Lin & Chu test is more restrictive as it assumes the panels have the same autoregressive (AR) structure. The Im, Pesaran & Shin test allows the AR process to vary across series.

economic agents utilize financial markets to facilitate real economic activity. Cardarelli et al. (2011) thus refer to this method of de-trending as a “time-varying fixed-effect”, which facilitates cross-country analysis. All variables are stationary after HP de-trending. Variables not stationary in levels with significance below 5% are de-trended for the panel estimations.

**Table 2. Unit Root Test Results**

		Gap		De-trend in panel model
		Levels	(HP filtered)	
Dependent variable	FSI	0.00	0.00	no
External variables	World GDP	0.96	0.00	yes
	Commodity prices	0.98	0.00	yes
	US Financial Stress	0.00	0.00	no
	Contagion	0.00	0.00	no
Domestic variables	GDP	1.00	0.00	yes
	Bank Credit	1.00	0.00	yes
	International reserves	1.00	0.00	yes
	Current account	0.00	0.00	no
	Fiscal balance	0.00	0.00	no

Notes: The null hypothesis is the variables have a unit root. The alternative hypothesis is some of the series are stationary. The values in the table are  $\rho$ -values. The specifications include a constant. Lags are optimally selected using the Schwarz Information Criterion (SIC).

## 2.5.2 Panel Estimation Methodology

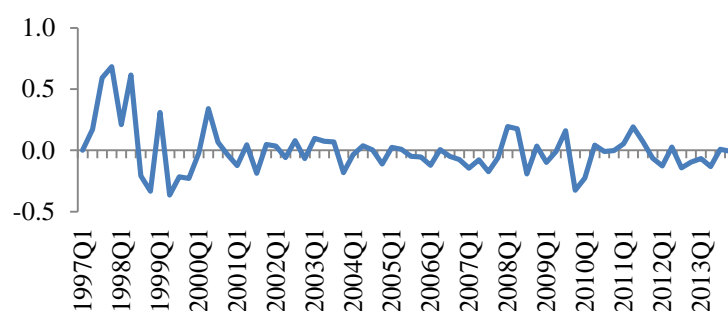
The panel model is presented as (1):

$$FSI_{it} = \alpha_i + \sum_{g=1}^3 \beta^g EF_t^g + \gamma Cont_t + \sum_{l=1}^4 \mu^l Dom_{it}^l + \varepsilon_{it} \quad (1)$$

The dependent variable, *FSI*, is the financial stress index for each ASEAN-5 economy. *EF* is a vector of three global variables – world GDP (*GDP<sub>w</sub>*), commodity prices (*GCP*) and US financial stress (*FSI<sub>US</sub>*). *FSI<sub>US</sub>* is taken as a proxy of global financial conditions. *Dom* is a vector of five domestic country-specific variables – GDP (*GDP*), bank credit (*Credit*), the current account balance (*CA*), international reserves (*Res*) and the fiscal balance (*FB*).  $\alpha_i$  is a time constant variable.

Finally, *Cont* is a measure of regional financial contagion. Financial contagion is defined various ways in the literature<sup>12</sup>. I use the World Bank’s “restrictive” definition of contagion as a guide. This definition refers to contagion as the transmission of shocks to other countries for reasons not attributable to fundamentals or common sources<sup>13</sup>, which suggests that contagion is empirically reflected as cross-country co-movement in financial market variables after controlling for fundamentals and global shocks. Accordingly, I estimate *Cont* in two steps. First, I estimate regressions equivalent to (1) but without *Cont* for each country. I obtain the residuals from these five regressions and interpret them as unaccounted movements in financial stress in each country<sup>14</sup>. Secondly, I interpret the co-movement among these residuals as a reflection of financial contagion and identify this common factor from the first principal component of the residuals. I then conduct principal components analysis on the residuals and derive the eigenvectors (loadings) from the first principal component. The loadings are used as weights for the residuals from step 1 to construct an index of financial contagion among the ASEAN-5 economies. The resulting index is presented below (Figure 3), showing that this measure of regional contagion spiked to its highest level during the AFC period and, to a smaller extent, during three other periods corresponding with the US tech bubble burst in 2000-2001, the global financial crisis in 2008-2009 and the euro debt crisis in 2011-2012.

**Figure 3. Measure of ASEAN-5 Regional Financial Contagion**



Source: Author’s calculations

<sup>12</sup> The World Bank definitions of contagion is available here:

<http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/EXTPROGRAMS/EXTMACR/OECO/0,,contentMDK:20889756~pagePK:64168182~piPK:64168060~theSitePK:477872,00.html>

<sup>13</sup> This approach of stripping away variations in financial variables is also used, among others, in Hatzius, Hooper, Mishkin, Schoenholtz, and Watson (2010) and Balakrishnan et al. (2009).

<sup>14</sup> In this case, the decision on whether to use the variables in levels or gap terms is premised on the Phillips-Perron unit root test.

The panel model is estimated without cross-section fixed effects as likelihood ratio and joint F-squared tests of the null hypothesis that the restrictions are redundant could not be rejected. The standard errors are robust to serial correlation and heteroskedasticity.

This specification is most analogous to the annual panel model in Balakrishnan et al. (2009), but differs in several notable aspects. First, there are more country-specific explanatory variables, notably domestic GDP and bank credit. The latter, in particular, consistently emerges as a significant indicator of financial crisis/stress in related literature. Misina and Tkacz (2009) and Duca and Peltonen (2011) are two recent examples who use FSIs as their dependent variable. In both cases, credit is a statistically significant predictor of future financial stress. These findings are robust across most model specifications and countries. Second, financial contagion is measured differently from most existing panel studies in the FSI literature. Balakrishnan et al. (2009) aggregate all the emerging economy financial stress indices except the dependent variable and strip away variations attributed to external factors (global industrial production, 3-month LIBOR, commodity prices and an index of financial stress for the advanced economies). Park and Mercado Jr (2014) measure regional effects by excluding the country under study. In contrast, I strip away variations at the country level attributable to all global and domestic determinants. Furthermore, I aggregate the resulting residuals using a methodology that is consistent with the financial contagion literature, as I utilize information on their co-movements by using principal component analysis. Finally, I estimate the model in quarterly instead of annual frequency. In addition to increasing the number of observations, this allows me to include variables that may affect financial stress transmission with varying frequency ranges. For example, the role of financial channels such as portfolio rebalancing and herding behaviour in the transmission of financial stress from the US to the ASEAN-5 economies is likely better captured in higher frequency, while the more fundamental determinants such as bank credit, the current balance or international reserves may determine domestic financial stress at relatively lower frequencies.

### 2.5.3 Panel Estimation Results

Table 3 presents results from five permutations of equation (1). Specification 1 shows results from a model with only the global and regional variables; Specification 2 presents results from only the domestic variables; Specifications 3 and 4 includes all external variables and different combinations of the domestic variables; Specification 4 includes all the variables.

**Table 3. Baseline Panel Regression Results**

<b>Dependent Variable</b>					
Financial Stress	1	2	3	4	5
World GDP	5.054**		5.389***	4.476***	5.099***
	0.013		0.001	0.008	0.008
Commodity prices	-0.596***		-0.218	-0.322	-0.009
	0.000		0.200	0.133	0.959
US financial stress	0.082***		0.064***	0.084***	0.066***
	0.000		0.001	0.000	0.001
Regional financial contagion	1.508***		1.507***	1.507***	1.509***
	0.000		0.000	0.000	0.000
GDP		-0.267	-3.023		-3.265
		0.883	0.127		0.106
Bank Credit		2.878***	1.636***		1.446***
		0.000	0.000		0.001
International reserves		-0.000		-0.000***	-0.000**
		0.340		0.010	0.030
Current account balance		-0.004		0.001	-0.000
		0.588		0.798	0.960
Fiscal balance		0.018		0.006	0.008
		0.125		0.549	0.349
Constant	-0.072***	-0.010	-0.068***	-0.078	-0.060
	0.000	0.893	0.000	0.135	0.268
Adjusted R <sup>2</sup>	0.334	0.084	0.379	0.345	0.386

Notes: Figures in italics are *p*-values. \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% significance levels. The detailed coefficient estimates for international reserves in specifications 2, 4 and 5 are -0.00000398, -0.0000107 and -0.00000883, respectively.

Of the three global variables considered, World GDP and US financial stress are consistently positive and significant. This supports the view that because the ASEAN-5 are relatively small and open, stability in their financial markets are significantly influenced by global economic and financial conditions. It also reflects the significant roles of cross-border trade and financial linkages in the transmission of financial stress. Regional financial contagion, *Cont*, is also significant in all included specifications, which is broadly consistent



with Park and Mercado Jr (2014), who find that regional financial stress levels have a positive and significant impact on the domestic FSIs.

Of the five country-specific variables considered, only bank credit emerge as consistently significant. The positive sign of the coefficient indicates that loose credit conditions predispose financial markets to higher stress. This is similar to recent findings from Misina and Tkacz (2009), Duca and Peltonen (2011) and Park and Mercado Jr<sup>15</sup> (2014). The significant relationship between boom/bust credit cycles and financial crises is also consistent with early warning indicator studies embodied, for example, by Kaminsky and Reinhart (1999), Borio and Lowe (2002). International reserves is significant with the expected negative sign in two of the three models it was considered. This reflects the use of reserves to maintain exchange rate stability during periods of volatile capital flows. However, the small size of the estimated coefficients make this result relatively insignificant economically.

The remaining two macroeconomic vulnerability indicators, the current account and fiscal balances, are consistently insignificant. This does not necessarily negate their significance in reality. A likely reason for their insignificance in these estimations is that the vulnerabilities associated with these variables are important only as triggers of high financial stress episodes. Since the panel model is estimated over low and high levels of financial stress, these vulnerabilities are averaged out over two phases – as the vulnerabilities accumulate but are insignificant determinants of financial stress and at high stress levels as market participants reach a tipping point and suddenly deem these variables to be significant sources of vulnerabilities. Another plausible reason is that these variables, including international reserves, have largely remained above “safe threshold levels” during most of the sample period under study.

#### **2.5.4 Robustness**

A concern is many of the macroeconomic relations in the panel model are endogenous. For example, causality between GDP and financial stress can run in both directions. Slower growth weaken banks’ balance sheets through higher non-performing loans, which may lead to higher financial stress. Weak GDP can also affect financial stress through the expectations channel, as dismal growth prospects are “priced-in” by investors, which is reflected through

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<sup>15</sup> The authors estimate many different permutations of their panel model. The results on the estimated coefficient of global GDP growth vary in statistical significance and the sign. Nonetheless, the estimated coefficient using emerging Asia as their sample, which is most similar to the ASEAN-5 sample in this study, is positive and statistically significant.

lower asset prices and higher yields and, hence, as increased financial stress. Meanwhile, causality from financial stress to economic activity occurs through several channels, for example, through lower bank capital, a financial accelerator mechanism and higher uncertainty<sup>16</sup>. Similarly, the causality between credit and financial cycles can also occur in both directions.

To address these endogeneity concerns, Balakrishnan et al. (2009) and Park and Mercado Jr (2014) lag their country-specific variables by one year in their annual panel model. I adopt an instrumental variables (IV) approach by using the previous four quarters (one year) as instruments for the country-specific variables and re-estimating the specifications in Table 3 as a robustness check. I only instrument for the country-specific variables because I assume that the ASEAN-5, being small-open economies, cannot influence external conditions. For the variables being instrumented, validity is satisfied because the variables are correlated with their lags and are exogenous to financial stress. Using lags as instruments also reflects information delays as investors use past information to form expectations of current conditions. Table 4 presents results from the IV estimations. The results are in general similar to the baseline estimations (Table 3), with the only noted difference being the increased (negative) sizes and significance of GDP coefficients. The IV estimations thus reinforce the observation that financial crisis tend to occur after the peak of the growth cycle, and that as income levels moderate with the slowing real economy, servicing existing loan/financial obligations become tougher and this places more stress on the balance sheets of the banking/financial system.

In summary, three robust findings stand out from the panel estimations. First, financial spillovers of two distinct dimensions play a significant role in the transmission of financial stress – from global financial markets and financial contagion within the region. Second, of the country-specific variables considered, the credit gap is the only consistently significant indicator across all the specifications and robustness tests. This concurs with established findings from the literature on early warning indicators of crises, financial imbalances and more recent studies that draw on financial stress indices to analyse financial spillovers. Finally, the panel estimations reveal the significance of the global business cycle, as measured by the world GDP gap, in fuelling domestic financial stress in the ASEAN-5 economies. Indeed, the significance of world GDP is a more robust result compared to

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<sup>16</sup> See Tng (2013) for a more detailed discussion and references of the transmission channels.

domestic GDP, a potential reflection of the large trade linkages between the ASEAN-5 economies and global demand conditions.

**Table 4. Instrumental Variable Estimation of the Panel Model**

<b>Dependent Variable</b>	1	2	3	4	5
<b>Financial Stress</b>					
World GDP	5.054**		5.389***	4.476***	11.064***
	0.013		0.001	0.008	0.009
Commodity prices	-0.596***		-0.218	-0.322	-0.359**
	0.000		0.200	0.133	0.032
US financial stress	0.082***		0.064***	0.084***	0.069***
	0.000		0.001	0.000	0.000
Regional financial contagion	1.508***		1.507***	1.507***	1.009***
	0.000		0.000	0.000	0.000
GDP		-5.239**	-3.023		-7.051***
		0.016	0.127		0.057
Bank Credit		2.827***	1.636***		1.754***
		0.002	0.000		0.008
International reserves		0.000		-0.000***	-0.000
		0.377		0.010	0.792
Current account balance		0.001		0.001	0.001
		0.886		0.798	0.836
Fiscal balance		0.007		0.006	0.005
		0.448		0.549	0.586
Constant	-0.072***	-0.123	-0.068***	-0.078	-0.128*
	0.000	0.122	0.000	0.135	0.079
Adjusted R <sup>2</sup>	0.334	0.182	0.379	0.345	0.360

Notes: Figures in italics are p-values. \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% significance levels.

### 3. Financial Stress, Economic Activity and Monetary Policy

Having established the sources of financial stress, this section changes focus to the effects of financial stress on the real economy and how financial stress interacts with monetary policy transmission. From an analytical point of view, the focus on monetary policy is also of interest because few studies have explored the interactions between monetary policy and financial stability, especially in the context of the ASEAN economies. I use a Structural Vector Autoregression (SVAR) approach to give insight to these issues, by asking three specific questions: First, what is the impact of financial shocks on the real economy? Second, what are the typical monetary policy reactions when financial stress increase? Third, what is the role of financial stress in the transmission of monetary policy to the real economy?

The SVAR models for the ASEAN-5 are drawn from Tng (2013). The data is in monthly frequency ranging from 1997 to 2013. The variables are broadly similar to the panel model, comprising of common global and country-specific variables. Three variables – world production, a commodity price index and US financial stress – characterise the external environment. The domestic variables comprise of production, consumer prices, a short-term interest rate, real credit, the nominal effective exchange rate and domestic financial stress. The SVARs are estimated with four lags. Restrictions are imposed on the coefficients of the contemporaneous and lags of the foreign variables, so that they affect the sample countries but cannot be influenced by the country-specific variables. This assumption explicitly models the sample countries as small-open economies. The domestic variables are identified recursively with the same ordering as above. The only departure is that the exchange rate and financial stress react contemporaneously to the foreign variables, while the other domestic variables only do so in lags<sup>17</sup>. The impulse responses are traced over 60 months and plotted with the 95<sup>th</sup> percentile bootstrapped confidence intervals.

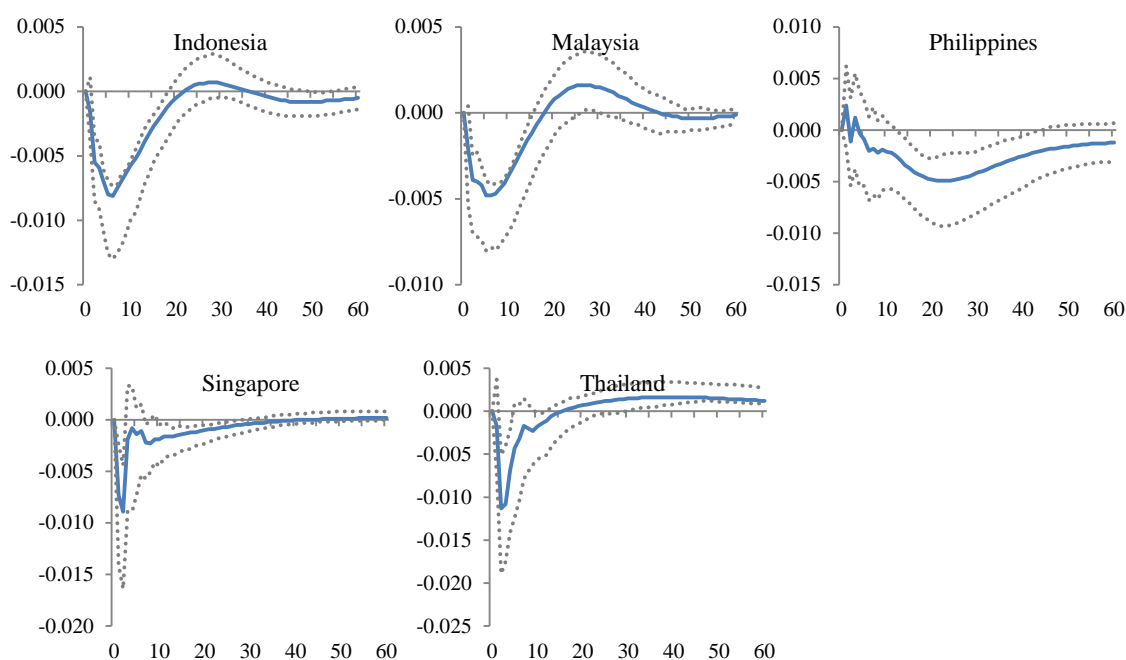
### 3.1 SVAR Estimation Results

Figure 4 illustrates the impulse responses of industrial production to a one standard deviation increase in financial stress. The impulse responses show that higher financial stress leads to a decline in output. A similarity in the output responses across countries is that the initial declines are rapid and followed by a more gradual dissipation back to trend. Most of the contractionary effects occur within the first year after the shock with the effects dissipating by the second year. The response in the Philippines is the most persistent, with the largest effects felt approximately 2 years after the shock. These estimated dynamics – a sharp drop and gradual dissipation - are consistent with results from other similar studies, for instance Davig and Hakkio (2012) for the US economy and Holo, Kremer and Duca (2012) for the euro area economies. The results also sets the premise for a quick policy response to reduce the adverse output effects of higher financial stress, especially considering that the policy effects on the economy occur with a lag.

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<sup>17</sup> See Tng (2013) for a review of the transmission of financial stress to the real economy and a description of the SVAR model. Appendix 2 presents an abbreviated presentation of the SVAR models for the ASEAN-5 economies.

**Figure 4. Response of Industrial Production to a Financial Stress Shock**



Source: Author's estimates

Figure 5 analyses monetary policy behaviour when financial stress increases<sup>18</sup>, by illustrating the impulse response of short-term interest rates to a one standard deviation increase in the financial stress index<sup>19</sup>. The impulse responses show that short-term interest rates in Malaysia and the Philippines become more accommodative when financial stress increase<sup>20</sup>. Their interest rates decline the most during the first year after the financial shock. Meanwhile, interest rates in Thailand display an initial spike, followed by an easing trajectory similar to Malaysia and the Philippines. To see if the initial interest rate spike in Thailand's case is attributable to the brief period of high interest rates during the Asian Financial Crisis (AFC) period, I also show the impulse response function from the SVAR model estimated from 2000 onwards in Figure 3. The results show that removing the AFC period from the sample eliminates the initial spike in the interest rate, which suggests that the spike is indeed a reflection of monetary policy tightening during the AFC period. In Indonesia, the interest

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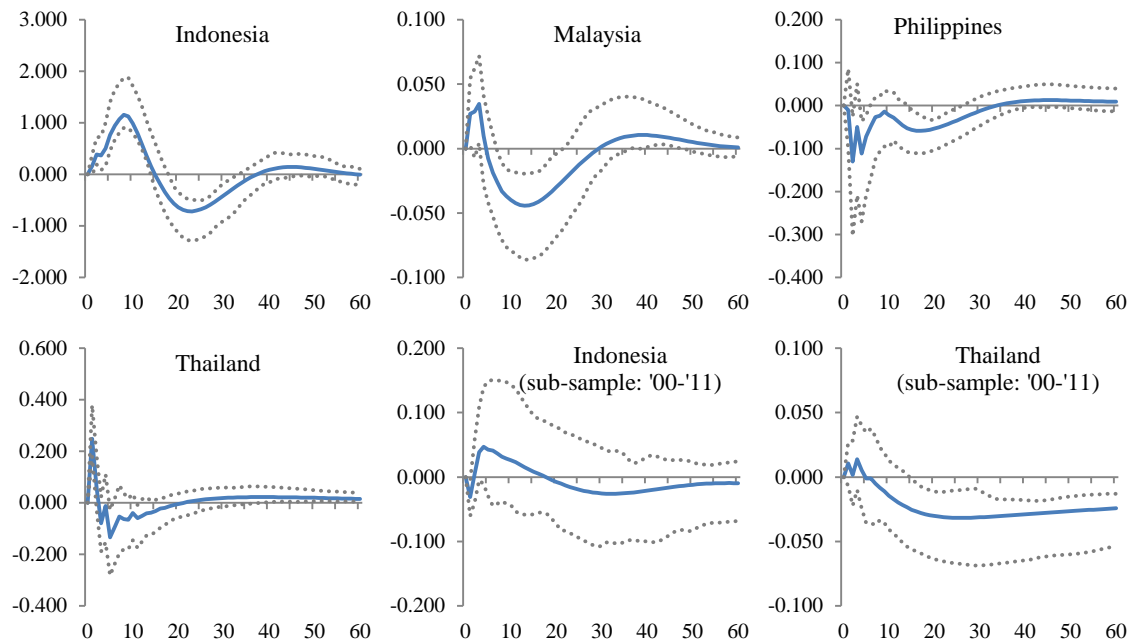
<sup>18</sup> Singapore is excluded from this analysis because its central bank uses the exchange rate instead of a short-term interest rate as its policy instrument to conduct monetary policy. The results for Singapore is therefore not comparable with the other economies, due to differences in the policy instrument and identification of monetary policy shocks in the VAR.

<sup>19</sup> There is a conceptual debate on whether monetary policy should respond to financial factors. These views are briefly reviewed in Appendix 3. This study does not contribute further to this debate, but rather focuses on how the ASEAN-5 central banks have tended to respond in the past.

<sup>20</sup> The initial spike in Malaysia's case is statistically insignificant and thus discounted for inference.

rate initially increases as well. Unlike Thailand, the initial increase in Indonesia’s interest rate lasts for a longer duration and does not disappear when the AFC episode is removed from the sample. However, the increase becomes substantially smaller in magnitude and is largely statistically insignificant from zero.

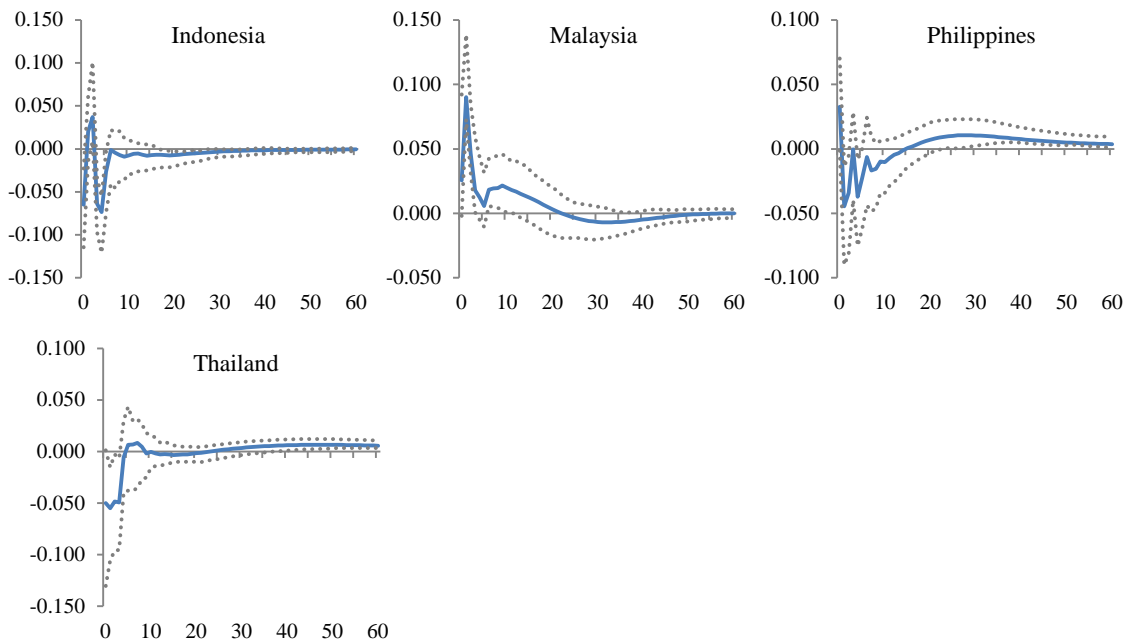
**Figure 5. Response of Interest Rate to a Financial Stress Shock**



Source: Author’s estimates

A natural follow-up question is whether monetary policy movements influence financial stress levels. Figure 6 provides an indication by illustrating the impulse responses of financial stress to interest rate shocks. The results show that the responses of financial stress are heterogeneous across countries, but are often small and statistically insignificant. This reflects a limit in the use of monetary policy to alleviate financial stress and that more direct financial sector intervention is likely more effective to restore financial stability during crisis periods. This result, however, is not a case against monetary policy easing during periods of higher financial stress. As shown earlier, higher financial stress adversely affects economic activity and central banks may still use monetary policy to maintain macroeconomic (output) stability during episodes of financial instability. A key premise is that lower interest rates stimulate output not by restoring financial stability but through other channels.

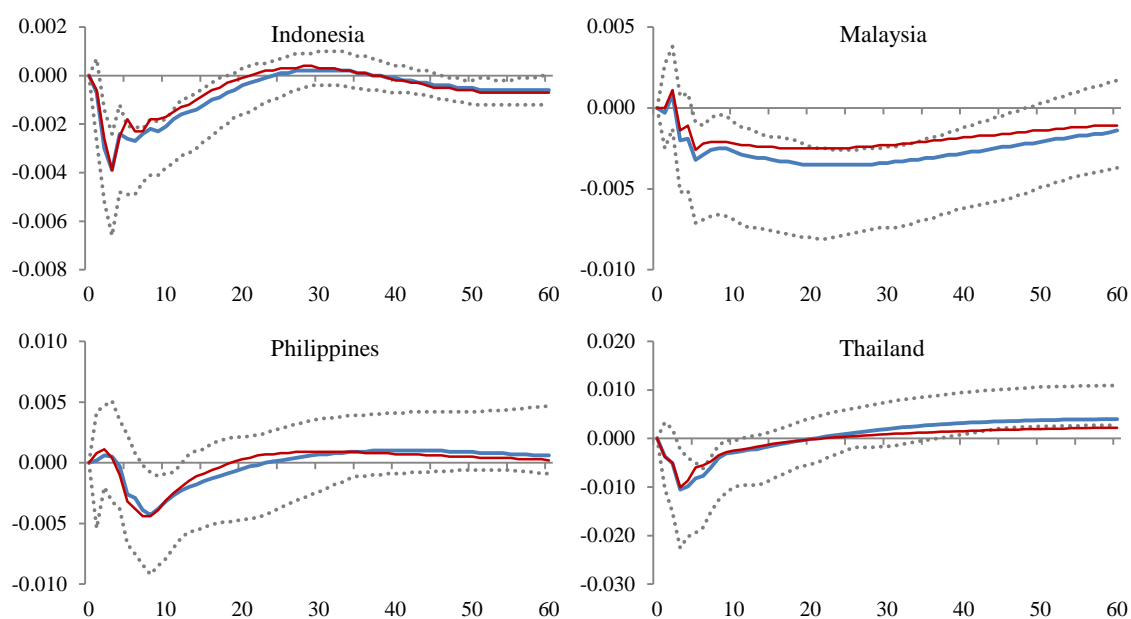
**Figure 6. Response of Financial Stress to an Interest Rate Shock**



Source: Author's estimates

To give insight to this hypothesis, I attempt to distinguish the effects of interest rates on output that is attributable to domestic financial stress as a transmission channel. I achieve this by comparing the impulse response functions from the baseline model to those from a restricted model. The restricted model is similar to the baseline model, except that domestic financial stress is now exogenous. Doing so blocks off the responses of output to a change in the policy interest rate that passes through financial stress. The differences in the impulse responses between the baseline and restricted SVARs hence reflect the degree of pass-through via domestic financial stress. This method of analysing the transmission channels of monetary policy follows from Morsink and Bayoumi (2001), Chow (2004) and Raghavan, Silvapulle, and Athanasopoulos (2012). To avoid estimation issues due to instabilities in the monetary policy reaction function during the AFC period, the impulse responses for this analysis are estimated using data only from 2000 onwards.

**Figure 7. Response of IPI to an Interest Rate Shock**



Source: Author's estimates.

Notes: Similar to the other impulse response figures, the blue line and the dotted lines are the responses and error bands generated from the baseline model. The red line is the response from the restricted model.

Figure 7 shows the impulse responses of industrial production to interest rate shocks from the baseline and restricted models. In all cases, the impulse responses from both models are largely similar and fall within the error bands generated from the baseline model. This analysis of monetary policy thus show that lowering interest rates have generally limited effects in restoring financial stability. Perhaps more importantly, this analysis also shows that such policy moves are effective in stimulating economic activity through other channels. Easing monetary policy in the midst of financial episodes can therefore be used to offset the contractionary effects of higher financial stress on output.

#### **4. Concluding Remarks**

The goal of this paper has been to contribute to the understanding of the transmission of financial stress, its impact on the real economy and its relationship with monetary policy in five ASEAN economies (Indonesia, Malaysia, Philippines, Thailand and Singapore). I start with a panel data investigation of the determinants of financial stress, with vulnerabilities from domestic and external sources taken into account. Four variables are found to be significant determinants of financial stress in the ASEAN-5 – US financial stress, world GDP, domestic bank credit and regional financial contagion. These findings are consistent with broad narrative from the financial crisis and financial contagion literatures: Loose credit



conditions are precursors of financial crises, financial markets in emerging and small-open economies are highly susceptible to spillovers from external conditions and financial episodes marked by large contagion effects are, in general, severe. The subsequent SVAR analysis finds that higher financial stress is associated with lower economic activity and that central banks tend to reduce policy interest rates when financial stress increase. The estimations also find that although lower interest rates have limited effectiveness to reduce financial stress, they are still effective in stimulating economic activity through other channels.

More generally, these findings suggest the necessity for monetary policy easing to help offset the contractionary effects of adverse financial shocks on the real economy. However, monetary policy easing likely also needs to be accompanied by direct financial sector interventions to restore financial stability. This may include, for example, short-term loans to alleviate liquidity shortages, direct equity injections to financial institutions to reduce solvency concerns and ensuring the sufficiency of trade credit to facilitate continued trade activities. In addition to achieving a higher effectiveness in restoring financial stability, another benefit of a targeted policy approach to restore financial stability is that it alleviates time lag issues between the policies' effects on output and the effect that higher financial stress has on output. While there is potentially such a timing mismatch for monetary policy, policy instruments that directly restore financial stress to normal levels reduces this pitfall.

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## Appendix 1. The SVAR Model<sup>21</sup>

### Variables

Table A4.1. Variables in the SVAR model (1997-2013)

Variable	Abbreviation	Definition	Source
<b>External</b>			
Commodity prices	GCP	Commodity price index (sa, log)	International Monetary Fund
World output	IPI <sub>W</sub>	World industrial production index (sa, log)	CPB Netherlands Bureau for Economic Policy Analysis
US Financial stress	FSI <sub>US</sub>	US Financial stress index	Hakkio and Keeton (2009)
<b>Domestic</b>			
Output	IPI	Industrial production index (sa, log)	International Financial Statistics
Prices	CPI	Consumer price index (sa, log)	International Financial Statistics
Interest rate	IR	Short-term interest rate	International Financial Statistics
Real credit	C	Bank credit, deflated by CPI (sa, log)	International Financial Statistics
Exchange rate	EX	Nominal effective exchange rate (log)	Bank for International Settlements
Financial stress	FSI	Financial stress index	Tng et al. (2012)

### Methodology

The SVAR model for each ASEAN-5 economy can be expressed as:

$$AX_t = B(L)X_{t-1} + \varepsilon_t$$

$X$  is a vector of variables with a similar ordering as Table 1.  $A$  is a matrix of the contemporaneous coefficients in structural form.  $B(L)$  is a matrix polynomial in the lag operator,  $L$ .  $\varepsilon_t$  is a vector of structural disturbances, such that:

$$\varepsilon_t = Ae_t$$

$e_t$  is a vector of residuals from the corresponding reduced-form VAR. The equations are organised into external and domestic sub-blocks. Structural shocks are identified by placing the following restrictions on  $A$ <sup>22</sup>:

<sup>21</sup> This appendix is an abbreviated version of Section 3.2 in Tng (2013). One departure from the SVAR models in this study compared to Tng (2013) is that Indonesia's model is now similar to the other sample countries.

<sup>22</sup> This identification approach is suggested by Sims (1986), Bernanke (1986) and applied by many others thereafter.

$$A = \begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & a_{44} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & a_{54} & a_{55} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & a_{64} & a_{74} & a_{21} & 0 & 0 & 0 \\ 0 & 0 & 0 & a_{74} & a_{75} & a_{76} & a_{21} & 0 & 0 \\ a_{81} & a_{82} & a_{83} & a_{84} & a_{85} & a_{86} & a_{87} & a_{21} & 0 \\ a_{91} & a_{92} & a_{93} & a_{94} & a_{95} & a_{96} & a_{97} & a_{98} & a_{21} \end{bmatrix}$$

Block-exogeneity restrictions are also imposed on the domestic variables in the external equations to strictly impose the small-open economy assumption for the ASEAN-5 countries. Specifically, the external variables are all allowed to affect each other in lags, but are assumed to be unaffected by the domestic variables in lags as well as contemporaneously. This follows from Cushman and Zha (1997), Genberg (1995), Maćkowiak (2007) and Raghavan et al. (2012). The block-exogeneity restrictions translate to the following structure on the matrix of lagged coefficients,  $B(L)$ , with the variables ordered similar to Table 2:

$$B(L) = \begin{bmatrix} b_{11} & b_{12} & b_{13} & 0 & 0 & 0 & 0 & 0 & 0 \\ b_{21} & b_{22} & b_{23} & 0 & 0 & 0 & 0 & 0 & 0 \\ b_{31} & b_{32} & b_{33} & 0 & 0 & 0 & 0 & 0 & 0 \\ b_{41} & b_{42} & b_{43} & b_{44} & b_{45} & b_{46} & b_{47} & b_{48} & b_{49} \\ b_{51} & b_{52} & b_{53} & b_{54} & b_{55} & b_{56} & b_{57} & b_{58} & b_{59} \\ b_{61} & b_{62} & b_{63} & b_{64} & b_{65} & b_{66} & b_{67} & b_{68} & b_{69} \\ b_{71} & b_{72} & b_{73} & b_{74} & b_{75} & b_{76} & b_{77} & b_{78} & b_{79} \\ b_{81} & b_{82} & b_{83} & b_{84} & b_{85} & b_{86} & b_{87} & b_{88} & b_{89} \\ b_{91} & b_{92} & b_{93} & b_{94} & b_{95} & b_{96} & b_{97} & b_{98} & b_{99} \end{bmatrix}$$

The reduced-form systems are estimated by Seemingly Unrelated Regression (SUR) since the VAR's regressors are not identical due to the block exogeneity restrictions. I estimate the SVARs in levels even though there are several non-stationary variables<sup>23</sup>. The estimations are carried out with 4 lags. The Akaike Information Criterion and Schwarz Criterion selected between 1 and 4 lags depending on the country. The ceiling within this subset was chosen to capture as much of the underlying interactions as possible.

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<sup>23</sup> See Sims (1980), Sims, Stock, and Watson (1990) and Ramaswamy and Sloek (1997) for early discussions on the issue of differencing in VAR models, and Disyatat and Vongsinsirikul (2003) and Raghavan *et al.* (2012) for selected recent references in the context of ASEAN economies.

### **Appendix 3. The Relationship between Monetary Policy and Financial Stress**

In the debate on whether monetary policy should respond to financial factors, one literature analyses the desirability of monetary policy responding to asset prices or credit, primarily through simulations of Dynamic Stochastic General Equilibrium (DSGE) models. In a DSGE model with equity market boom and bust cycles, Bernanke and Gertler (1999, 2001) find that a monetary policy rule based on strict inflation targeting is optimal to stabilise inflation and output. This arises because stock market booms lead to stronger demand and higher inflation. It is therefore sufficient to consider the inflation forecast alone to set monetary policy once the informational content of asset prices in predicting inflation is incorporated<sup>24</sup>. Cecchetti, Genberg, Lipsky, and Wadhvani (2000) (CGLW) find, in contrast, that it is optimal for central banks to include equity prices in their policy reaction function. A key departure in the underlying assumptions from Bernanke and Gertler (1999, 2001) is that the central bank has information on whether the equity prices are driven by fundamentals and the timing of the bubble burst. More recently, Christiano, Ilut, Motto, and Rostagno (2010) find that there are welfare benefits from expanding the Taylor rule, in which interest rates are a function of the output gap, inflation and credit. Cúrdia and Woodford (2010) analyse the benefits of adding credit and credit spreads to the Taylor rule. Their simulation results reveal that there are economic benefits to augmenting the Taylor rule with credit spreads and, to a smaller extent, credit as well.

One of the highlighted pitfalls of a monetary policy approach that responds only to inflation is that past experiences reveal that asset price booms are not always inflationary. This is pointed out, among many others, by Borio and Lowe (2002), Bordo and Wheelock (2004) and Christiano et al. (2010). For example, Borio and Lowe (2002) find three stylised features of financial imbalances – rapid asset price increases, credit expansions and capital accumulation. The authors also provide evidence from a large number of financial crises that inflation does not systematically increase during the build-up to financial crises or unwinding of lending booms, but are deflationary there-after. This feature induces an asymmetry among the financial cycle, inflation and monetary policy. Specifically, monetary policy stays unchanged during the build-up of financial imbalances because there is no inflation, but is loosened aggressively after the onset of the crisis due to deflationary pressures. A major pitfall is that because monetary policy was not tightened earlier in the financial cycle, there is

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<sup>24</sup> Despite their strong stance against systematic reactions to asset prices, Bernanke and Gertler (2001) caveat that this does not preclude short-term monetary policy interventions during periods of financial instability.



subsequently less space in how much monetary easing the central bank can do, at least in its conventional instrument. Borio and Lowe (2002, 2004) thus advocate explicit consideration of financial imbalances in setting monetary policy.

Despite the lack of intellectual consensus, there is evidence that many central banks do consider financial factors in monetary policy considerations in practice. A survey of over ninety central banks in advanced and emerging economies revealed a significant positive correlation between monetary policy and financial stability concerns, including financial sector solvency, credit rationing and asset price volatility (Mahadeva & Sterne, 2000). Studies have also estimated the monetary policy reaction functions of central banks to search for indications of explicit attention to financial factors. Borio and Lowe (2004) estimate several permutations of the monetary policy reaction functions for the United States, Germany, Australia and Japan. They start with a standard Taylor rule specification and gradually add measures of financial imbalances – the credit gap, equity price gap and a dummy variable capturing banking sector stress. Their results reflect variations in the reaction functions across countries. The German central bank paid little attention to financial imbalances in its monetary policy decisions. In Australia, the equity and credit gaps were jointly significant predictors of monetary policy movements. In Japan, there is evidence that monetary policy respond asymmetrically to credit and equity gaps, more when the gaps were negative. In the United States, the study also finds that the Federal Reserve respond asymmetrically to financial imbalances. Policy interest rates are more responsive to negative credit and equity gaps than positive gaps. More recently, Baxa, Horváth, and Vašíček (2013) test the significance of financial stress in interest rate decisions using a time-varying specification of monetary policy in five advanced economies (United States, United Kingdom, Australia, Canada and Sweden). The authors find that central banks were unresponsive to financial stress at low and normal levels, but often eased their policy rates in response to higher financial stress, in particular, to equity and bank related financial stress.