The Transmission of Financial Stress and Monetary Policy Responses in the ASEAN-5 Economies

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Abstract
Since the 2008 Global Financial Crisis, there has been a resurgence of interest in the linkages between the economy and financial markets. This paper analyses the determinants of financial stress, the impact of financial stress on the real economy and the relationship between monetary policy and financial stress in the ASEAN-5 economies. I estimate a panel model of the determinants of financial stress, and find that US financial stress, financial contagion within the region and domestic credit emerge as important sources of stress. Through a subsequent VAR analysis, I find that financial stress has adverse effects on the real economy, with the largest effects occurring in the first six months after the financial shock. In response to higher financial stress, the central banks in Malaysia, the Philippines and Thailand tend to reduce their policy rates beyond other macro-financial considerations. Although lower policy interest rates have limited effects in alleviating financial stress (except in Malaysia), they are effective in stimulating economic activity through other channels.

JEL Classification: E44, E52, G10
Key Words: Financial stress; Financial spillovers; Monetary policy

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1. Introduction

There has been a resurgence of interest in the linkages between the real economy and the financial sector, especially in the aftermath of the 2008 Global Financial Crisis (GFC) and European sovereign debt crisis, as these episodes have been global in their reach. The recovery in many advanced economies have since been weak and protracted, which is consistent with historical experiences of recoveries from financial crises. Other open economies have also been affected, through weak exports and financial spillovers. These episodes indeed underscore the fact that financial markets in small-open economies are susceptible to both domestic imbalances and spillovers from major financial markets. For example, Tng, Kwek, and Sheng (2012) show that financial stress in the ASEAN-5 economies increased not only during the Asian Financial Crisis, which was a domestic episode, but also during financial episodes that originated in the United States such as the tech bubble burst in 2000-2001 and the recent GFC.

Against this backdrop, understanding the transmission channels of financial stress, its effects on the real economy and the effectiveness of monetary policy under such conditions is important for policy efforts to promote macroeconomic and financial stability. This paper is an attempt to address some of these topics. I use the ASEAN-5 economies of Indonesia, Malaysia, Philippines, Singapore and Thailand as my sample to study two main issues:

- First, I examine the determinants of financial stress in the ASEAN-5 economies. I estimate a panel model using quarterly data from 1997-2011. Following Balakrishnan, Danninger, Elekdag, and Tytell (2009) and Duca and Peltonen (2011), I model financial stress as a function of common global and regional variables, as well as country-specific business cycle and vulnerability indicators. I also analyse the significance of trade and three distinct financial linkages – banking, portfolio and direct investment – in the transmission of financial stress across borders. For robustness, I also estimate the panel model using an instrumental variables approach, by using lags of the variables as instruments to address potential endogeneity concerns between the explanatory variables and financial stress.

- Second, I analyse the impact of financial stress on economic activity and explore the relationship between monetary policy and financial stress. I study how ASEAN-5 central
banks tend to respond to financial stress in the past, and what is its role in the transmission of monetary policy to the real economy. I rely on the impulse response functions from the SVAR model developed in Tng (2013) to address these issues.

The methodologies applied in this paper are premised on the use of Financial Stress Indices (FSIs) as a synthetic measure of financial stability. Using the FSIs offer two advantages: First, the FSIs facilitate an analysis of financial linkages during tranquil and stressful periods in financial markets, as they are continuous measures of financial stress. As such, the FSIs are useful for analysing the determinants of financial stress in countries with few historical incidences of severe financial episodes. Second, the FSIs summarize financial conditions across all major asset markets, hence sidestepping the potential pitfalls from analysing spillovers within specific asset markets.

The panel estimations reveal that ASEAN-5 financial stress is driven by both external and domestic determinants. US financial stress is the only significant external determinant of financial stress. There is limited evidence that the financial spillover occurs through trade and portfolio investment linkages. The level of contagion among the ASEAN region’s financial markets emerges as a robust determinant of financial stress. For the domestic determinants, a positive credit-to-GDP gap is the only variable that is consistently associated with higher financial stress. Turning to the country-level SVAR analysis, I find that financial stress leads to lower economic activity in all five countries. The impact is often the largest during the first six months after the shock. In Malaysia, the Philippines and Thailand, policy interest rates are lowered in response to higher financial stress beyond the magnitudes implied by other macro-financial concerns, although there is substantial cross-country variation in the responses and time dynamics. Lower policy interest rates are found to have no significant effects in lowering financial stress (except in Malaysia), but are nonetheless effective in stimulating economic activity through other channels.

The remaining sections proceed as follows. Section 2 contains the panel data analysis of the determinants of financial stress. The section begins with a brief overview of the transmission channels, followed by the estimation methodology and results. Section 3 presents the SVAR analysis of the impact of financial stress on the real economy and its relationship with monetary policy. The final section concludes with the main findings.
2. The Determinants of Financial Stress

Spillovers of External Financial Stress

In open-economies, financial stress may arise from domestic and external sources. When financial shocks originate from external sources, the spillover effects on other financial markets depend on interactions between three main factors. The first is the trade and financial linkages to the origin of the shock, as they determine the fundamental reasons for cross-border crisis spillovers. In general, economies with more integrated trade and financial markets expose themselves to larger spillovers from external shocks. The second are country-specific conditions. While strong fundamental ties to other economies determines financial spillovers, the varying financial market responses across-countries are also differentiated on the basis of country-specific levels of vulnerabilities and capacities to cope with the external shocks. The final factor is the level of financial contagion, which may magnify the effects of financial shocks.

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 may occur before the real economy effects. This is because the financial spillovers reflect the effects of shifting expectations of the real economy effects, while the direct effect of lower trade on growth occurs with some lag. The trade channel may operate in two ways. First, an adverse external shock reduces the external economy’s income. This 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 instance, an exchange rate depreciation by an economy increases its export competitiveness in comparison with its other competing exporters to a common export destination. Eichengreen and Rose (1999), Glick and Rose (1999), Forbes (2002) and Forbes (2004) find a significance for these direct and indirect trade linkages.
Financial Linkages

Financial spillovers may also occur through financial linkages between 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 period, many financial institutions are forced to sell assets often at the same time. This triggers capital outflows in both portfolio securities and direct investments, and depresses asset prices in other financial markets. In addition, banks facing crisis may also reduce their exposures to higher risk loans, including in other countries. Cumulatively, these raise the risk of a credit and liquidity crunch in the affected economies. For example, 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 Rijckegehem and Weder (2001) find that commercial banks were common creditors to the affected countries during the AFC, as well as the Mexican and Russian crises for the latter study.

Country-Specific Vulnerabilities

Trade and financial linkages pre-dispose economies to external shocks, but these linkages by themselves are insufficient to propagate stress in domestic financial markets. The latter depends also on their vulnerability to adverse shocks. Chui et al. (2004) describes three main areas of vulnerability: First, the financial position of creditors and investors. Sound balance sheet positions help to preserve confidence and mitigate the risks to financial markets from a sudden stop of foreign capital, such as direct investment, credit and other portfolio flows (e.g. bond and equity) in response to an adverse shock. Second, the policy space that policymakers have to respond to adverse shocks. Strong fiscal positions give creditors and investors confidence that
policymakers can afford fiscal stimulus measures and financial assistance to bailout distressed financial institutions should the need arise. Similarly, having adequate foreign reserves helps to assure investors that the central bank can credibly support the exchange rate during periods of depreciating pressure from a sudden reversal in capital flows. Third, healthy liquidity, capital and low leverage positions help to insulate financial markets from adverse external shocks.

A strand of literature develops early warning systems of financial crisis. These studies analyse the predictive content of economic and financial indicators to the economies’ susceptibility to financial crisis. Early influential studies in this strand include Eichengreen, Rose, Wyplosz, Dumas, and Weber (1995) and Kaminsky, Lizondo, and Reinhart (1998) for currency crises, and Kaminsky and Reinhart (1999) for currency and banking crises. A key finding from this literature is that financial crises have a higher probability of occurring 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. For instance, Kaminsky and Reinhart (1999) find that, on average, the credit-to-GDP ratio during crises periods is about 15% higher compared to tranquil periods. The authors also find the presence of excess money balances\(^3\) during crisis periods.

**Recent Investigations of Financial Spillovers using Financial Stress Indices**

A majority of the empirical studies cited thus far rely on identifying crisis episodes, then testing the ability of these 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”. One pitfall of this event driven method of identifying financial episodes is that it misses periods marked by higher stress in financial markets but were without systemic failures of financial institutions, currency or sovereign debt defaults. While not fitting the traditional definitions of crises, such episodes are nonetheless significant if they had

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\(^3\) Defined as M1 balances net of estimated money demand.
large adverse macroeconomic effects (Borio & Lowe, 2002). For instance, the US tech bubble burst in 2000-2001 had adverse macroeconomic effects domestically and to its trade partners, but is not formally a crisis in most crisis databases\(^4\). Therefore, this methodology of dating crises potentially limits country-level analysis of financial spillovers in countries where crises have been rare (Misina & Tkacz, 2009).

To address this shortcoming, Balakrishnan et al. (2009) and Misina and Tkacz (2009) use financial stress indices (FSIs), composite indices of stress, instead of the binary crisis indicator to analyze 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 through three econometric exercises. In the first exercise, the authors estimate a common time varying component among twenty-six emerging economies, and run a regression of this component on an index of advanced economy financial stress and variables capturing global conditions\(^5\). In the second exercise, the authors run individual country-specific regressions to estimate the degree of stress transmission from advanced economies. The difference in the variables used compared to the first exercise is the inclusion of a variable that captures financial stress in other emerging economies, to control for horizontal contagion among emerging markets. They then run a cross-section regression of the estimated pass-through coefficients for each individual country on variables capturing trade and financial linkages to the advanced economies\(^6\). The authors estimate the first two econometric models with monthly frequency data to capture as much as possible the high frequency dynamics in financial markets. In their final econometric exercise, the authors estimate an annual frequency panel model to uncover structural level and vulnerability related determinants using data usually available only at annual frequency. They run a fixed-effects panel regression of the emerging market FSIs on the 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 vulnerability to financial crisis – the current account balance, fiscal balance and the level of foreign reserves. Overall, the authors find strong evidence that financial stress in emerging

\(^4\) See Laeven and Valencia (2012) and Reinhart and Rogoff (2009) for recent examples of databases of banking, debt and currency crisis.

\(^5\) Index of commodity prices, the London Interbank Offered Rate (LIBOR) and world industrial production

\(^6\) The financial linkages investigated are bank, portfolio and direct investment
markets is driven largely by common global financial and economic conditions. The authors find that trade and financial linkages are both important. However, the financial linkages variables tested significant more often compared to the trade linkages variables in their estimations.

While Balakrishnan et al. (2009) focus on the transmission of financial stress from advanced to emerging economies, other studies emphasize financial vulnerabilities arising from domestic conditions, especially credit and asset prices. Using data for 34 countries spanning from 1960-1999, Borio and Lowe (2002) show that economies with sustained loose credit conditions and fast growth in asset prices have a higher probability of experiencing financial stress episodes. Building on Borio and Lowe (2002), Misina and Tkacz (2009) investigate if fast growth in asset prices and credit precede incidences of financial stress in Canada. One innovation of their study compared to Borio and Lowe (2002) is their use of an FSI, instead of a binary dependent variable. The authors 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. In their threshold model, business credit, together with house prices, are robust indicators of financial stress. Duca and Peltonen (2011) use FSIs to evaluate the importance of external and domestic conditions in twenty-eight emerging and advanced economies. The authors identify periods when the FSI exceed the 90th percentile as “systemic events” and construct a binary variable indicating when such “systemic events” occurred. Using this as their dependent variable, the authors separately 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 domestic and external variables.

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7 Credit conditions are represented by credit/GDP. The assets considered here are equity, residential and non-residential property.
8 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.
9 See Cardarelli, Elekdag, and Lall (2011) and Claessens, Ayhan Kose, and Terrones (2010) for stylized features of the behavior of credit, asset prices and financial crisis historically across a wide range of countries.
The Panel Model

Following from the literature, the baseline specification of the panel model is expressed in (1), with the main objective to assess the determinants of financial stress in the ASEAN-5 economies.

\[ FSI_{it} = \alpha_i + \sum_{g=1}^{3} \beta^g EF^g_t + \gamma Cont_t + \sum_{l=1}^{4} \mu^l Dom^l_{it} + D^{AFC} + \varepsilon_{it} \]  

(1)

The dependent variable, FSI, is a financial stress index. EF is a vector of three external variables – world GDP (GDPw), commodity prices (GCP) and US financial stress (FSI_US). Dom contains four domestic country specific variables – GDP, credit (Credit), current account balance (CA) and international reserves (Res). \( D^{AFC} \) is a dummy variable for the AFC from 1997-1998. \( \alpha_i \) is time constant and varies across countries. \( Cont \), is a measure of financial contagion within the ASEAN region. Financial contagion is defined various ways in the literature\(^{10}\). 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 that are not attributable to fundamental linkages or common sources, suggesting that contagion is reflected empirically as excess cross-country correlations or co-movement in financial market variables after controlling for such linkages and common global shocks. Accordingly, I estimate \( Cont \) in two steps. In the first step, I estimate country-specific regressions similar to (1), but without the AFC dummy and Cont. In the regressions, I include a one period lag of the variables in Dom to account as much as possible for the current and lagged variation due to fundamental reasons\(^{11}\). I then obtain the residuals from these regressions and interpret them as unaccounted movements in financial stress in each


\(^{11}\) To side-step unit root issues for now, I estimate these equations with the variables in gaps using the Hodrick-Prescott filter. These equations include the trade and financial linkages by themselves and interacting with US financial stress.
country. In the second step, I assume that contagion among the sample countries is the underlying factor driving the co-movement in the country-specific residuals from the first step. I identify this factor as the first principal component of the residuals. As such, I conduct principal components analysis on the residuals and derive the eigenvectors (loadings) from the first principal component. I then use these loadings as weights for the residuals from step 1 to construct an index, which I interpret as reflecting financial contagion in the ASEAN region. Subsequently, I also estimate other permutations to analyse if the pass-through of financial stress from external to ASEAN-5 financial markets is dependent on trade (TL) and three financial channels – bank, portfolio and direct investment.

I estimate the panel models with country fixed-effects to control for unobserved time-constant cross-country heterogeneities. These may include differences in financial development, institutions and perceptions of government. Finally, I include an AR(1) term to control for first order serial correlation. This specification can be seen as an extension of the annual panel model in Balakrishnan et al. (2009). The approach here differs in several notable aspects. First, there are more country-specific explanatory variables. A notable addition is the domestic credit gap, which consistently emerges as a significant indicator of financial crisis/stress in the 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 conditions were a statistically significantly predictor of future financial stress. This finding is robust across model specifications and countries. Second, I measure contagion differently. Balakrishnan et al. (2009) aggregate all the emerging economy financial stress indices except the dependent variable and strip away variations attributed only to external factors. I strip away variations at the country level from all the other domestic variables as well. I also aggregate the resulting residuals using a methodology that is consistent with the financial contagion literature, since I utilize information on their co-movements by using principal component analysis, instead of GDP-based weights in their study. Finally, I estimate the model in quarter instead of annual frequency. This increases the number of observations, which improves the statistical power and gives me more scope to increase the

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12 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).

13 Comprising of global industrial production, 3-month LIBOR, commodity prices and an index of financial stress for the advanced economies.
number of explanatory variables. It also allows me to include variables that affect financial stress with varying frequency ranges. For instance, the relationship between US and ASEAN-5 financial stress is probably more appropriately captured in higher frequency, while the roles of credit, the current account and international reserves may determine domestic financial stress at relatively lower frequencies.

**Data**

The sample consists of 5 ASEAN countries: Indonesia, Malaysia, Philippines, Singapore and Thailand. The data is in quarterly frequency and spans from 1997-2011. Table 1 lists the variables and data sources, with data plots in Appendix 1.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Abbreviation</th>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>World GDP</td>
<td>GDP&lt;sub&gt;w&lt;/sub&gt;</td>
<td>World GDP (log)</td>
<td>World Bank</td>
</tr>
<tr>
<td>Commodity Prices</td>
<td>GCP</td>
<td>Commodity price (log)</td>
<td>International Monetary Fund</td>
</tr>
<tr>
<td>Regional Contagion</td>
<td>Cont</td>
<td>See section 2.4</td>
<td>Author’s calculations</td>
</tr>
<tr>
<td>Trade Exposure</td>
<td>EX</td>
<td>Exports/GDP (in real terms)</td>
<td>Haver Analytics</td>
</tr>
<tr>
<td>External Bank Linkages</td>
<td>FL&lt;sub&gt;Bank&lt;/sub&gt;</td>
<td>Ratio of Consolidated foreign claims of BIS reporting banks/ GDP</td>
<td>Bank for International Settlements</td>
</tr>
<tr>
<td>External Portfolio Liabilities</td>
<td>FL&lt;sub&gt;PL&lt;/sub&gt;</td>
<td>External portfolio liabilities/</td>
<td>International Financial Statistics, Haver Analytics</td>
</tr>
<tr>
<td>External Direct Investment Liabilities</td>
<td>FL&lt;sub&gt;DI&lt;/sub&gt;</td>
<td>External portfolio liabilities/GDP</td>
<td>International Financial Statistics, Haver Analytics</td>
</tr>
<tr>
<td>Leverage</td>
<td>Lev</td>
<td>Domestic credit/GDP</td>
<td>International Financial Statistics, Haver Analytics</td>
</tr>
<tr>
<td>Current Account</td>
<td>CA</td>
<td>Current account/GDP</td>
<td>Haver Analytics</td>
</tr>
<tr>
<td>Foreign Reserves</td>
<td>Res</td>
<td>Foreign reserves (exc. gold)/Import</td>
<td>International Financial Statistics, Haver Analytics</td>
</tr>
</tbody>
</table>

The dependent variable is the Financial Stress Index (FSI) developed in 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. I convert them to quarterly frequency by
averaging the monthly values within each quarter. For the independent variables, the first group are the common variables: World gross domestic product (GDPw) measures global economic conditions; a weighted index of commodity prices (GCP) controls for global price conditions; a FSI of the United States (FSIus) proxies for external financial conditions. The index used is from Hakkio and Keeton (2009)\textsuperscript{14}; following Balakrishnan et al. (2009), the last variable, Cont, captures horizontal financial contagion within the region.

There are three types of financial linkages. The bank lending channel is captured using total consolidated foreign claims by BIS reporting banks as a ratio of GDP. The portfolio channel is measured by the stock of external portfolio debt and equity liabilities as a ratio of GDP. Portfolio liabilities is constructed from three separate sources. The first is the International Investment Position from 2001-2011. This is spliced with corresponding estimates from Lane and Milesi-Ferretti (2007) to obtain a series dating back to 1997. Being in annual frequency, the next task is to convert the series into quarterly frequency for estimations. I do this by exploiting the quarterly variation from balance of payments data by computing the annual change in the stock and estimating the quarterly variation that is consistent with the balance of payment statistics. The total variation over the four quarters of a particular year is limited to the first difference of the year’s stock estimates. The formula is as follows:

$$PL^s_{t,q} = \frac{PL^f_{t,q}}{\sum_{q=1}^{4} PL^f_{t,q}} \times \Delta PL^s_t$$

$PL$ refers to portfolio liabilities, superscripts $s$ and $f$ refer, respectively, to stock and flow estimates, subscripts $t$ and $q$ refer, respectively, to the year and quarter, and $\Delta$ is the difference operator. The last financial channel, direct investment, is measured as external direct investment liabilities as a ratio of GDP. The methodology to construct this series is similar as portfolio investments. For credit, I use the ratio of domestic credit-to-GDP to capture the cumulative buildup of leverage in the economy. This characterization of credit reflects the notion that credit-

\textsuperscript{14} 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.
related vulnerabilities may arise gradually over time or quickly through a few years of rapid credit growth (Borio & Lowe, 2002). I define credit as the deviation of the credit-to-GDP ratio from its trend. Real economic conditions are measured by the deviation of GDP from its underlying trend.

There are two estimation issues to address. The first is the large change in levels in many of the series during the AFC period. To the extent that this is not captured by the dependent variables, I include a dummy for the AFC in all estimations to partially control for this. The second issue is how to control for the structural changes that have potentially taken place in the ASEAN-5 financial markets since the AFC. The data plots in appendix 1 reveal several trends, such as the improved reserve adequacy, current account positions and lower borrowing by domestic actors from external sources, which possibly reflect structural change in the form of changing risk attitudes by policy makers and the private sector. The increase in external portfolio liabilities is, to some extent, likely attributable to the opening of domestic capital markets, which constitute gradual structural change as well. To the extent that the persistence in many of the variables reflects gradual structural change, an econometric issue is that the persistence suggests that they are non-stationary over the sample. I conduct two panel unit root tests based on Levin, Lin, and Chu (2002) (LLC) and Im,Pesaran, and Shin (2003) (IPS) to test for stationarity. Anticipating non-stationarity in several of the series, I also conduct unit root tests of the series in gaps, de-trended using a Hodrick-Prescott filter. This transformation is applied in Borio and Lowe (2002), Cardarelli et al. (2011) and Duca and Peltonen (2011). An economic interpretation for applying a time-varying filter to de-trend the series is that it removes evolving financial development and changes in how economic agents utilize financial markets to facilitate real economic activity. Cardarelli et al. (2011) refers to this method of de-trending as a “time-varying fixed-effect” that facilitates cross-country analyses such as the current effort. Table 2 presents results of the unit root tests.

15 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. Unit root testing based on Maddala and Wu (1999), Breitung (2000) and Choi (2001) show broadly similar consistent results.
Table 2. Panel Unit Root Test Results

<table>
<thead>
<tr>
<th></th>
<th>Levels</th>
<th>Gap (Hodrick Prescott)</th>
<th>De-trend</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LLC</td>
<td>IPS</td>
<td>LLC</td>
</tr>
<tr>
<td>FSI</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>World growth</td>
<td>0.00</td>
<td>0.53</td>
<td>0.00</td>
</tr>
<tr>
<td>Commodity prices</td>
<td>0.97</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>US FSI</td>
<td>0.01</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Regional contagion</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Export</td>
<td>0.04</td>
<td>0.05</td>
<td>0.00</td>
</tr>
<tr>
<td>Portfolio</td>
<td>0.60</td>
<td>0.68</td>
<td>0.00</td>
</tr>
<tr>
<td>Direct investment</td>
<td>0.47</td>
<td>0.44</td>
<td>0.00</td>
</tr>
<tr>
<td>Bank</td>
<td>0.06</td>
<td>0.24</td>
<td>0.01</td>
</tr>
<tr>
<td>Domestic growth</td>
<td>0.98</td>
<td>1.00</td>
<td>0.03</td>
</tr>
<tr>
<td>Credit</td>
<td>0.49</td>
<td>0.46</td>
<td>0.00</td>
</tr>
<tr>
<td>International reserves</td>
<td>1.00</td>
<td>0.90</td>
<td>0.06</td>
</tr>
<tr>
<td>Current account</td>
<td>0.01</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Notes: In both tests, the null hypothesis is the variables have a unit root. The alternative hypothesis for LLC and IPS, respectively, is all series are stationary and some of the series are stationary. The values in the table are $\rho$-values. The specifications include a constant. Lags are selected using the Schwarz Information Criterion (SIC).

GDP (world and domestic), commodity prices and international reserves are non-stationary in levels regardless of the test type. I de-trend these variables. The portfolio and direct investment variables exhibit evidence of non-stationarity in level terms. The exception is bank linkages for the LLC test, which is significant at the 10% level, but not in the IPS test. I de-trend the portfolio and direct investment variables, but not bank linkages$^{16}$. The export dependence variable is stationary and enters (1) in level terms. Domestic credit is not stationary in level terms in both unit root tests, and is therefore de-trended. All variables test non-stationary after being de-trended by the Hodrick Prescott filter.

Panel Estimation Results

Table 3 presents results from six permutations of (1). Overall, the model seems to capture the data relatively well with the adjusted-$R^2$s close to 0.7 A joint significance test of the null that the cross-section fixed effects are redundant is rejected. World GDP and commodity prices are

$^{16}$Given mixed results over the stationarity of bank linkages, I also estimate the models with this variable in gap terms to see if the results change. The main results presented in the text remain similar. I do not report the results, but they are available upon request.
consistently insignificant. US financial stress is positive and significant in all specifications, with
the value of the coefficients stable at approximately 0.1. This supports the view that domestic
financial markets are subject to spillovers from external financial markets, but less so from
external demand and price conditions. The coefficient on US financial stress is, nonetheless,
substantially smaller compared to regional contagion (Cont), which is consistent with the
findings in Balakrishnan et al. (2009)17. Specification 2 includes an interaction of US financial
stress with regional contagion to test if the financial spillovers are larger when external financial
shocks affect regional financial conditions on a systemic scale. The coefficient on the interaction
term is insignificant. The insignificance may, however, be due to the scarcity of external
financial episodes over the period studied. I conduct a Wald test to see if US financial stress and
its interaction with contagion are jointly significant. The joint restriction test is statistically
significant ($\chi^2$: 9.296, p-value: 0.01), suggesting that the spillovers from external financial shocks
to domestic financial markets is contingent upon the stability of regional financial markets.
External shocks have a larger effect on domestic financial stress when financial contagion within
the region is high. One interpretation is that this result reflects a positive feedback effect, where
external shocks to the ASEAN-5 economies are magnified via further contagion within regional
financial markets. It also suggests that if regional financial markets display a collective resilience
towards external shocks, the impact of those shocks on individual markets will be lower as a
result. Domestic credit and real GDP are statistically significant with positive signs. Loose credit
conditions and an overheating real economy thus predispose financial markets to higher stress.
This is similar to findings from Misina and Tkacz (2009) and Duca and Peltonen (2011). The
coefficients on international reserves and the current account balance have the expected negative
signs but are insignificant. One potential reason for the insignificance is that the vulnerabilities
from these variables accumulate gradually and become important only as triggers of high
financial stress episodes, and when financial stress is already high and there is increased
attention by financial markets on these variables. Since the panel model is estimated over low
and high levels of financial stress, these vulnerabilities are averaged out over two phases – first,
as the vulnerabilities accumulate but are still insignificant determinants of financial stress and

17 The authors estimate the transmission of financial stress from advanced to emerging economies, while this study
estimates the transmission on a country-basis.
second, when high stress is triggered as market participants reach a tipping point and suddenly deem these variables to be significant sources of vulnerabilities.

Table 3. Panel Regression Results with Country Fixed-Effects

<table>
<thead>
<tr>
<th>Financial Stress</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>World GDP</td>
<td>2.749</td>
<td>1.961</td>
<td>2.794</td>
<td>2.844</td>
<td>2.756</td>
<td>2.731</td>
</tr>
<tr>
<td></td>
<td>4.120</td>
<td>4.119</td>
<td>4.143</td>
<td>4.171</td>
<td>4.096</td>
<td>4.141</td>
</tr>
<tr>
<td>Commodity prices</td>
<td>0.052</td>
<td>0.070</td>
<td>0.062</td>
<td>0.061</td>
<td>0.051</td>
<td>0.020</td>
</tr>
<tr>
<td></td>
<td>0.418</td>
<td>0.414</td>
<td>0.415</td>
<td>0.416</td>
<td>0.417</td>
<td>0.431</td>
</tr>
<tr>
<td>US financial stress</td>
<td>0.078</td>
<td>0.076</td>
<td>0.094</td>
<td>0.092</td>
<td>0.088</td>
<td>0.086</td>
</tr>
<tr>
<td></td>
<td>0.031**</td>
<td>0.033**</td>
<td>0.044**</td>
<td>0.038**</td>
<td>0.036**</td>
<td>0.034***</td>
</tr>
<tr>
<td>Regional contagion</td>
<td>0.498</td>
<td>0.493</td>
<td>0.497</td>
<td>0.495</td>
<td>0.498</td>
<td>0.491</td>
</tr>
<tr>
<td></td>
<td>0.220**</td>
<td>0.218**</td>
<td>0.221**</td>
<td>0.221**</td>
<td>0.221**</td>
<td>0.220**</td>
</tr>
<tr>
<td>US financial stress x Regional contagion</td>
<td>-0.016</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Export Dependence</td>
<td>0.035</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US financial stress x bank linkages</td>
<td></td>
<td>-0.008</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US financial stress x portfolio linkages</td>
<td></td>
<td></td>
<td>0.044</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US financial stress x direct investment linkages</td>
<td></td>
<td></td>
<td></td>
<td>-0.055</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.827*</td>
<td>1.889*</td>
<td>1.828*</td>
<td>1.831*</td>
<td>1.838*</td>
<td>1.828*</td>
</tr>
<tr>
<td>Credit</td>
<td>0.566</td>
<td>0.563</td>
<td>0.578</td>
<td>0.583</td>
<td>0.569</td>
<td>0.585</td>
</tr>
<tr>
<td></td>
<td>0.212***</td>
<td>0.214***</td>
<td>0.214***</td>
<td>0.211***</td>
<td>0.213***</td>
<td>0.213***</td>
</tr>
<tr>
<td>International reserve</td>
<td>-0.000</td>
<td>-0.000</td>
<td>-0.000</td>
<td>-0.000</td>
<td>-0.000</td>
<td>-0.000</td>
</tr>
<tr>
<td>Current account</td>
<td>-0.703</td>
<td>-0.659</td>
<td>-0.726</td>
<td>-0.729</td>
<td>-0.707</td>
<td>-0.734</td>
</tr>
<tr>
<td>AFC dummy ('97-'98)</td>
<td>0.399</td>
<td>0.417</td>
<td>0.398</td>
<td>0.396</td>
<td>0.402</td>
<td>0.395</td>
</tr>
<tr>
<td></td>
<td>0.196**</td>
<td>0.204*</td>
<td>0.195**</td>
<td>0.194**</td>
<td>0.196**</td>
<td>0.194**</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.050</td>
<td>-0.054</td>
<td>-0.049</td>
<td>-0.048</td>
<td>-0.050</td>
<td>-0.048</td>
</tr>
<tr>
<td></td>
<td>0.075</td>
<td>0.072</td>
<td>0.075</td>
<td>0.076</td>
<td>0.074</td>
<td>0.075</td>
</tr>
<tr>
<td>AR(1)</td>
<td>0.646</td>
<td>0.644</td>
<td>0.647</td>
<td>0.648</td>
<td>0.644</td>
<td>0.647</td>
</tr>
<tr>
<td></td>
<td>0.050***</td>
<td>0.050***</td>
<td>0.050***</td>
<td>0.051***</td>
<td>0.050***</td>
<td>0.050***</td>
</tr>
<tr>
<td>Adj. R-Squared</td>
<td>0.641</td>
<td>0.641</td>
<td>0.640</td>
<td>0.641</td>
<td>0.640</td>
<td>0.641</td>
</tr>
</tbody>
</table>

Notes: Figures in parentheses are robust cross-section standard errors. *, ** and *** denote statistical significance at the 10%, 5% and 1% significance levels.
Specifications 3-6 in Table 3 explore the role of trade and financial linkages in influencing financial spillovers from the US to the ASEAN-5. None of the linkages are significant factors in propagating the transmission of external financial stress. However, this may be because other variables in the model have already captured these linkages. For instance, domestic and world GDP likely capture some aspect of trade and financial linkages. To test for this possibility, I pare down the panel model to include only regional contagion, US financial stress and the trade and financial linkages variables. Table 4 presents the results from models that include the linkages individually as well as together. When individually included, the export and bank lending channels are significant. However, when all the linkages are included together (specification 6), the export and portfolio investment channels became significant, while the bank channel becomes insignificant. This provides some evidence of the importance of both trade and financial channels in the transmission of financial stress across borders. The sensitivity of the results to the model specifications nonetheless highlights the difficulties to empirically differentiate the respective channels, a concern also echoed in Kaminsky and Reinhart (2000).

Table 4. Trade and Financial Linkages in a Pared Down Panel Model

<table>
<thead>
<tr>
<th>Financial Stress</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>US financial stress</td>
<td>0.048</td>
<td>0.008</td>
<td>0.028</td>
<td>0.086</td>
<td>0.042</td>
<td>0.028</td>
</tr>
<tr>
<td>US financial stress x export dependence</td>
<td>0.026**</td>
<td>0.040</td>
<td>0.031</td>
<td>0.042**</td>
<td>0.030</td>
<td>0.071</td>
</tr>
<tr>
<td>US financial stress x Cross-border bank linkages</td>
<td>0.041</td>
<td>0.098</td>
<td>0.031</td>
<td>0.042**</td>
<td>0.030</td>
<td>0.071</td>
</tr>
<tr>
<td>US financial stress x Cross-border portfolio linkages</td>
<td>0.011</td>
<td>-0.457</td>
<td>0.289</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US financial stress x Cross-border direct investment linkages</td>
<td>0.007*</td>
<td>0.197</td>
<td>0.399</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US financial stress x all trade and financial linkages</td>
<td>0.136</td>
<td>0.135***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional contagion</td>
<td>1.009</td>
<td>1.009</td>
<td>1.009</td>
<td>1.027</td>
<td>1.014</td>
<td>1.033</td>
</tr>
<tr>
<td>Constant</td>
<td>0.607*</td>
<td>0.607*</td>
<td>0.611*</td>
<td>0.609*</td>
<td>0.610*</td>
<td>0.590*</td>
</tr>
<tr>
<td>-0.043</td>
<td>0.052</td>
<td>0.052</td>
<td>0.052</td>
<td>0.051</td>
<td>0.052</td>
<td>0.047</td>
</tr>
<tr>
<td>Adj. R-Squared</td>
<td>0.087</td>
<td>0.088</td>
<td>0.086</td>
<td>0.091</td>
<td>0.085</td>
<td>0.113</td>
</tr>
<tr>
<td>Observations</td>
<td>300</td>
<td>300</td>
<td>300</td>
<td>300</td>
<td>300</td>
<td>300</td>
</tr>
</tbody>
</table>

Notes: Figures in parentheses are robust cross-section standard errors.*, ** and *** denote statistical significance at the 10%, 5% and 1% significance levels.
Robustness: Endogeneity and Instrumental Variables Estimation

A concern that arises is that many of the macroeconomic relations in the panel model are potentially endogenous. For example, the causality between GDP and financial stress can run in both directions. Slower growth may weaken banks’ balance sheets through higher non-performing loans, which in turn leads 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 lower asset prices and, hence, as increased financial stress. Causality from financial shocks to economic activity occurs through several channels as well, for example, through bank capital, a financial accelerator mechanism and uncertainty. The relationship between credit and financial cycles may also be endogenous. Both variables are influenced in part by economic activity. There are also self-reinforcing mechanisms – inflated asset prices and wealth are used as collateral to obtain credit, which further fuel asset prices, and so on.

To reduce these endogeneity concerns, Balakrishnan et al. (2009) lag international reserves and the current account balance by one year in their annual panel model. I adopt an instrumental variables (IV) approach using the previous four observations (one year) as instruments. I only instrument for the country-specific variables because I assume that small open economies such as the ASEAN-5 cannot influence external conditions. Instrument validity is satisfied because the variables are correlated with their lags and are exogenous to financial stress. Using the lags as instruments also reflects the information delays and imperfect foresight of investors from their use of past information to form expectations of current and future conditions. The IV estimation results are generally similar to the baseline estimations (Table 5). Variables that were statistically significant in Table 3 remain significant. The exception is GDP, which becomes insignificant in all of the IV regression specifications.

18 See Tng (2013) for a more detailed discussion and references of the transmission channels.
19 See Gerdesmeier, Reimers, and Roffia (2010) and Bayoumi and Darius (2013) for recent investigations of the inter-linkages between credit and asset prices.
To summarize, evidence from the panel regressions indicate the significance of both domestic and external variables in determining financial stress in the ASEAN-5 economies. The variables related to financial markets are significant more often compared to prices (e.g. global commodity prices) and the real economy (domestic and global GDP). Two findings stand out. Firstly, there are adverse spillover effects to ASEAN-5 financial markets when external financial conditions deteriorate. There is evidence that the transmission of financial stress occurs through

<table>
<thead>
<tr>
<th>Financial Stress</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>World GDP</td>
<td>3.928</td>
<td>2.833</td>
<td>4.963</td>
<td>5.865</td>
<td>3.985</td>
<td>4.565</td>
</tr>
<tr>
<td>Commodity prices</td>
<td>0.211</td>
<td>0.207</td>
<td>0.263</td>
<td>0.251</td>
<td>0.206</td>
<td>0.152</td>
</tr>
<tr>
<td>US financial stress</td>
<td>0.076</td>
<td>0.075</td>
<td>0.130</td>
<td>0.113</td>
<td>0.089</td>
<td>0.087</td>
</tr>
<tr>
<td>Regional contagion</td>
<td>0.037**</td>
<td>0.038**</td>
<td>0.058**</td>
<td>0.049**</td>
<td>0.045**</td>
<td>0.040**</td>
</tr>
<tr>
<td>US financial stress x Regional contagion</td>
<td>0.465</td>
<td>0.448</td>
<td>0.456</td>
<td>0.453</td>
<td>0.463</td>
<td>0.451</td>
</tr>
<tr>
<td>US financial stress x Export Dependence</td>
<td>0.076</td>
<td>0.075</td>
<td>0.130</td>
<td>0.113</td>
<td>0.089</td>
<td>0.087</td>
</tr>
<tr>
<td>US financial stress x Bank linkages</td>
<td>0.231**</td>
<td>0.233*</td>
<td>0.231**</td>
<td>0.229**</td>
<td>0.233**</td>
<td>0.227**</td>
</tr>
<tr>
<td>US financial stress x Portfolio linkages</td>
<td>0.076</td>
<td>0.075</td>
<td>0.130</td>
<td>0.113</td>
<td>0.089</td>
<td>0.087</td>
</tr>
<tr>
<td>US financial stress x direct investment linkages</td>
<td>0.076</td>
<td>0.075</td>
<td>0.130</td>
<td>0.113</td>
<td>0.089</td>
<td>0.087</td>
</tr>
<tr>
<td>Domestic GDP</td>
<td>3.019</td>
<td>3.593</td>
<td>2.089</td>
<td>1.146</td>
<td>2.970</td>
<td>2.282</td>
</tr>
<tr>
<td>Credit</td>
<td>4.992</td>
<td>4.576</td>
<td>4.604</td>
<td>4.372</td>
<td>5.085</td>
<td>5.170</td>
</tr>
<tr>
<td>International reserve</td>
<td>0.892</td>
<td>0.934</td>
<td>0.932</td>
<td>0.914</td>
<td>0.889</td>
<td>0.924</td>
</tr>
<tr>
<td>Current account</td>
<td>0.491*</td>
<td>0.476*</td>
<td>0.508*</td>
<td>0.505*</td>
<td>0.484*</td>
<td>0.506*</td>
</tr>
<tr>
<td>AFC dummy ('97-'98)</td>
<td>-0.000</td>
<td>-0.000</td>
<td>-0.000</td>
<td>-0.000</td>
<td>-0.000</td>
<td>-0.000</td>
</tr>
<tr>
<td>Constant</td>
<td>1.795</td>
<td>2.070</td>
<td>1.672</td>
<td>1.597*</td>
<td>1.925</td>
<td>1.787</td>
</tr>
<tr>
<td>AR(1)</td>
<td>0.354</td>
<td>0.366</td>
<td>0.350</td>
<td>0.353</td>
<td>0.358</td>
<td>0.349</td>
</tr>
<tr>
<td>Adj. R-Squared</td>
<td>0.141**</td>
<td>0.153*</td>
<td>0.139**</td>
<td>0.137***</td>
<td>0.144*</td>
<td>0.137**</td>
</tr>
<tr>
<td>Observations</td>
<td>0.002</td>
<td>0.027</td>
<td>0.060</td>
<td>0.010</td>
<td>0.014</td>
<td>0.044</td>
</tr>
<tr>
<td></td>
<td>0.142</td>
<td>0.161</td>
<td>0.130</td>
<td>0.126</td>
<td>0.157</td>
<td>0.145</td>
</tr>
<tr>
<td></td>
<td>0.649</td>
<td>0.650</td>
<td>0.645</td>
<td>0.643</td>
<td>0.645</td>
<td>0.647</td>
</tr>
<tr>
<td></td>
<td>0.061***</td>
<td>0.062***</td>
<td>0.063***</td>
<td>0.065***</td>
<td>0.060***</td>
<td>0.062***</td>
</tr>
</tbody>
</table>

Notes: Figures in parentheses are robust cross-section standard errors.
both trade and financial channels. Although empirically distinguishing among the various financial channels is difficult as their significance is relatively sensitive to model specification, there is some evidence that bank and portfolio investment linkages do play a role in the stress transmission. The second robust finding is that financial stability concerns arise when credit conditions relative to the level of real economic activity are consistently above historical trends.

3. Financial Stress, Economic Activity and Monetary Policy

Having established the possible sources of financial stress and its transmission channels, this section now switches attention to issues that arise when financial stress increases. Namely, what are the effects on the real economy and what is the role and effectiveness of policy when financial episodes are triggered. I focus on the role monetary policy in this study since it is one of the major counter-cyclical policy tools, and hence warrants closer attention. I now conduct a VAR analysis to give insight to these issues, specifically, by asking three questions: First, what is the impact of financial shocks on the real economy? Second, what are the typical monetary policy reactions to financial shocks? Third, what is the role of financial stress in the transmission of monetary policy to the real economy?

The VAR models for the five sample countries are from Tng (2013). The data is in monthly frequency ranging from 1997 to 2011. Three variables – world production, a commodity price index and US financial stress – characterise the external environment. The domestic variables comprise of production, consumer prices, short-term interest rates, real credit, the nominal effective exchange rate and domestic financial stress. The VARs are estimated with four lags. Restrictions are imposed on the contemporaneous and lag coefficients 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\textsuperscript{20}. The impulse responses are traced over 60 months and plotted with the 95\textsuperscript{th} percentile bootstrapped confidence intervals\textsuperscript{21}.

**VAR Results**

What is the impact of financial stress on the real economy? Figure 1 illustrates the impulse responses of industrial production to a one standard deviation unexpected increase in financial stress. The impulse responses show that higher financial stress leads to a decline in output, but with some cross-country heterogeneity. The largest output contractions range widely, from -0.9\% in Singapore to -0.4\% in Malaysia. The time dynamics also differ across countries. In Indonesia and Malaysia, there is a subsequent overshoot in production. The response of production in the Philippines is the most persistent, as it remains below the baseline five years after the shock. In contrast, Singapore’s production recovers the quickest, as it returns to the baseline level within 6 months of the shock. Despite these cross-country differences, a striking similarity in the output responses is that the largest contractions tend to occur relatively quickly, within the first six months after the shock. This result thus sets the premise for a quick policy response to reduce the adverse output effects in response to higher financial stress, especially considering that the policy effects on the economy likely occur with a lag.

Figure 2 analyses the response of monetary policy to higher financial stress, by illustrating the impulse response of short-term interest rates to a one standard deviation increase in the financial stress index\textsuperscript{22}. This reflects changes in the monetary policy stance beyond the other macro-financial considerations considered in the model. 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.

\textsuperscript{20} See Tng (2013) for a review of the transmission from financial stress to the real economy and the VAR model.

\textsuperscript{21} The bootstrap methodology applied is from Hall (1999).

\textsuperscript{22} There is a conceptual debate on whether monetary policy should respond to financial factors. I review these views briefly in Appendix 2. Rather than add to this debate, this paper focuses on how the ASEAN-5 central banks have tended to respond in the past.
Figure 1. Response of Industrial Production to a Financial Shock

Source: Author’s estimates

Figure 2. Response of Interest Rate to a Financial Stress Shock

Source: Author’s estimates
The impulse responses show that short-term interest rates in Malaysia and the Philippines become more accommodative when financial stress increases. Interest rates decline the most during the first ten months after the financial shock. 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), I also show the impulse response function from the VAR model estimated from 2000 onwards in Figure 2. The results shows 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’s case, the interest rate initially increases, peaking six months after the shock and moderates thereafter. 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, although the magnitude of the increase is substantially smaller. Note that this result does not imply tighter monetary policy during periods of higher financial stress. Instead, the positive interest rate response to higher financial stress is very likely over-shadowed by the behavioral response to reduce interest rates to stimulate economic activity. This occurred during the GFC period, when Indonesia’s interest rate was lowered as financial stress increased and growth moderated.

Given that monetary policy tends to respond directly to changes in financial stress, a natural question is to what extent does monetary policy influence financial stress. Figure 3 provides such an indication, by illustrating the impulse response function of financial stress to higher interest rate shocks. In Malaysia, the FSI’s response is large and clearly indicates that financial conditions improve (deteriorate) as its policy interest rate is lowered (increased). However, the effect in the other sample countries is marginal, temporary and often insignificant. This implies that monetary easing by itself may be relatively ineffective in alleviating financial stress (except in Malaysia). Nonetheless, this is not a case against monetary easing during high stress periods, because lower interest rates may also work through other channels to stimulate economic activity.

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23 The initial spike in Malaysia’s case is insignificant and thus discounted for inference.

24 One hypothesis for this result, which requires further research, is that it reflects monetary policy considerations to reduce capital outflows and exchange rate depreciation, which tend to increase with higher financial stress.
To give insight to this hypothesis, I try to distinguish the effects of interest rates on output that is attributable to domestic financial stress. 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 exogenous. Doing so blocks off the responses of output to a change in the interest rate that passes through financial stress. The differences in the impulse responses between the baseline and restricted VARs 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 (2006) and Raghavan, Silvapulle, and Athanasopoulos (2012). To avoid the potential instabilities in the monetary policy reaction function during the AFC period, the impulse responses for this analysis is derived using only data from 2000 onwards. Figure 4 shows the impulse response of industrial production to interest rate shocks from the baseline and restricted models. The impulse responses from both models are similar for the Philippines, Thailand and Indonesia. Financial stress plays the largest role in the transmission of monetary policy shocks to output for Malaysia. Here, the response of output from the restricted model is significantly smaller compared to the impulse responses from the baseline model, and is often outside the error bands from the baseline model.

Source: Author’s estimates
This result is consistent with Figure 3. The extent that lower policy interest rates manage to lower financial stress (Figure 3) is proportionate to the magnitude of the role of financial stress as a transmission mechanism for interest rates to change output (Figure 4).

![Figure 4. Response of IPI to an Interest Rate Shock](image)

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.

I now return to the three questions posed earlier to take stock of the findings in this section. As expected, I find that higher financial stress has negative effects on output. Although there is some heterogeneity in the responses, the largest effects are felt within the first six months of the shock. Second, I find that the central banks from Malaysia, Thailand and the Philippines tend to lower their policy rates in response to higher financial stress. I also find that lower policy interest rates do not significantly improve financial conditions, except in Malaysia. Lower interest rates are, nonetheless, effective in increasing output through other channels. Easing monetary policy in the midst of financial episodes is therefore likely the correct policy prescription if the goal is to offset the contractionary effects from 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 both domestic and external sources taken into account. The three factors that emerge as significant determinants of financial stress are external financial conditions, domestic credit conditions and financial contagion within the region. These findings are broadly consistent with the financial crisis literature: Loose credit conditions are precursors of financial crises; financial markets in emerging and open-economies are susceptible to spillovers from major financial markets, and; financial episodes marked by large contagion effects are, in general, severe. The subsequent VAR analysis finds, as expected, that higher financial stress is associated with lower economic activity. In response, central banks tend to reduce their policy interest rates beyond other macro-financial concerns. Although lower interest rates have mixed results in their ability to reduce financial stress, they are still able to stimulate economic activity through other channels.

From a broader perspective, these findings suggest that traditional countercyclical policies (such as monetary policy), by themselves, may be insufficient as a policy response to financial instability. Instead, to achieve output stability in the face of financial instability, it is likely more effective to implement policies that are targeted towards directly improving financial conditions. This includes, for instance, providing short-term loans to alleviate liquidity shortages and equity injections to financial institutions to reduce solvency concerns. In addition to achieving a higher effectiveness in restoring financial stability, another benefit of policies that are targeted to restoring financial stability is that it reduces the varied time lags 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. The findings also suggest that the cumulative stability of the region’s financial markets is an important precondition for the stability of individual financial markets within the region. This raises the importance of cooperation and policy coordination amongst regional central banks and regulators, and suggests the need to incorporate a multilateral dimension in policy formulation and financial market surveillance for the regional economies.
Bibliography


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Appendix 1. Plots of Variables in the Panel Model

Export Openness (Exports/GDP)

Financial Linkages

Bank (Consolidated foreign banking claims/GDP)

Portfolio (External Portfolio Liabilities/GDP)
Financial Linkages (continued)

Direct Investment (External Direct Investment Liabilities/GDP)

Source: Bank for International Settlements, Haver Analytics

Domestic Credit (Domestic Credit/GDP)

Source: International Financial Statistics, Haver Analytics
Other Aspects of Vulnerability

International Reserves

Current Account Balance (% of GDP)

Source: Haver Analytics, IMF
Appendix 2. The Relationship between Monetary Policy and Financial Stress

In the debate on whether monetary policy should respond to financial factors, one line of 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 from the fact that stock market booms should be reflected in 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. Cecchetti, Genberg, Lipsky, and Wadhwani (2000) (CGLW) conduct simulations of Bernanke and Gertler’s (1999) model and find, in contrast, that it is optimal for central banks to include equity prices in their policy reaction function. Nonetheless, Bernanke and Gertler (2001) point out that this is true only because of how CGLW specify their policy rule, under which reacting to equity prices is optimal if the central bank knows whether the boom/bust is driven by fundamentals and the timing of the bubble burst. The authors contend that these assumptions on central banks’ knowledge of equity prices are unrealistic. 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 and inflation, to include 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 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). Borio and Lowe (2002) find three stylised features of financial imbalances – rapid asset price increases, fast credit expansions and above average 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.

25 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.
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 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 respond to financial factors 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 three 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 responded asymmetrically to credit and equity gaps, more when the gaps were negative. In the United States, the study also finds evidence that the Federal Reserve responded asymmetrically to financial imbalances. The policy interest rates were found to be more responsive to negative credit and equity gaps than positive gaps. More recently, Baxa, Horváth, and Vašiček (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.

26 Chapter titled “The Devil in the Detail of Monetary Policy Frameworks”