THE RELATIVE IMPORTANCE OF MONETARY POLICY TRANSMISSION CHANNELS IN MALAYSIA

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Abstract

This paper investigates the relative strength of four monetary policy transmission channels (exchange rate, asset price, interest rate and credit) in Malaysia using a 12-variable open economy VAR model. By comparing the baseline impulse response with the constrained impulse response where a particular channel is being switched off, the interest rate channel is found to be most important in influencing output and inflation in the horizon of about two years, and the credit channel beyond that. The asset price channel is also relevant in the shorter-horizon, more so than the exchange rate channel, particularly in influencing output. For inflation, the exchange rate channel is more relevant than the asset price channel.

Keywords: Monetary policy transmission mechanism, vector autoregression, small open economy, Malaysia.

1 Introduction

Most economists would agree that monetary disturbances have important short-term effects on economic activities such as consumption and investment (Taylor (1997)). Nonetheless, when it comes to the precise nature in which monetary policy actions are transmitted throughout the economy, there appears to be a genuine lack of consensus. Indeed, the monetary policy transmission mechanism has been called the “black box” (Bernanke and

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Gertler (1995). The aim of this paper is, therefore, to shed some light on the “black box” of monetary policy transmission mechanism in Malaysia, specifically to uncover the relative strength of the different channels of monetary transmission. Four transmission channels are studied: interest rate, credit, exchange rate, and asset price/wealth channels, based on their particular merits in Malaysia. As Bank Negara Malaysia (BNM), the central bank of Malaysia has increasingly shifted towards the use of indirect monetary instruments, the interest rate channel should gain greater prominence. Since the banking sector has been the traditional source of funding for firms and individuals, the credit channel is also expected to play an important role.\(^1\) The exchange rate channel should also be significant especially given Malaysia is a small and highly open economy with total trade double that of GNP. The increased popularity of the stock market as an alternative saving/investment avenue, understandably since the stock market is the most developed segment of the capital market, makes the asset price channel another interesting conduit to be studied.

For central banks, knowledge about the relative importance of the transmission channels provides useful policy information and suggestions. First, a more accurate assessment of the nature of monetary conditions can be gleaned. If the interest rate channel is the main conduit, then the short-term real interest rate can be a good indicator of the monetary policy stance (page 473, Walsh (2003)). On the other hand, if the exchange rate channel is important, even if domestic interest rates are low, a strong Malaysian ringgit can be associated with tight monetary conditions. Viewed in the context of a highly open economy, a strong ringgit could be an effective strategy to ward-off inflationary pressures from abroad and cool an overheating economy.

Similarly, if the credit channel is important, loan activity is also an important signal to watch. A case in point was Malaysia’s experience in the early part of the 1990s amidst a period of relatively high interest rates which coincided with high loan growth, particularly for the purchase of properties and shares. To judge from interest rates alone, monetary policy would have been inaccurately interpreted as sufficiently contractionary. In reality, the period was connected with the stock market bull-run, which oozed “irrational exuberance” and precipitated in a borrowing binge with the view that any potential upside gains would more than offset the exorbitant cost of borrowing.

Second, the presence of other transmission channels provides practical insights into monetary policy strategies when the main channel becomes benign. Consider a scenario where nominal interest rates are near zero percent, and the economy is also hit with deflationary fears (a situation reminisces the US monetary policy experience a few years back). In such

\(^{1}\)Strictly speaking, the credit channel can be categorised into the bank lending channel and the balance sheet channel. For simplicity, the term, credit channel, is used. There has been a growing literature attempting to distinguish the presence of the bank lending channel versus the balance sheet channel through the use of bank or firm-level (micro) data. For example, see Oliner and Rudebusch (1995, 1996) and Kashyap and Stein (2000). The focus of this paper will be on the use of macro data as the lack of micro-level data for Malaysia precludes detailed analysis separating the bank lending and the balance sheet channels.
circumstance, the interest rate channel becomes impotent should additional easing of the nominal interest rates be required to avoid further worsening of the economy. The presence of other transmission channels provides other viable strategies. Chief amongst these is quantitative monetary easing by pumping liquidity into the system to raise expectations in general price levels and to halt the deflationary slide. Policymakers can also reflate other asset prices such as stocks and properties, thereby boosting individual wealth to stimulate aggregate demand (Mishkin (1996)). Knowing which channel is more relevant provides valuable information to policymakers for enhanced monetary policy effectiveness.

The existence of other transmission channels also means monetary policy is more potent – a small change in interest rates will have a larger impact on the economy than would otherwise be the case if the central bank were to be solely dependent on the interest rate channel. Bernanke and Gertler (1995) state the credit channel “can amplify and propagate conventional interest rate effects” (page 28). If other channels, such as the exchange rate and asset price channels are also relevant, the potency of monetary policy will be further enhanced. For instance, the presence of the exchange rate channel in a small open economy like Malaysia, provides policymakers with a flexible and powerful policy option to boost the country’s competitiveness should this be deemed necessary. As such, knowing which channel is relatively important can provide a better indication of the likely impact of monetary policy shocks on the real economy.

A long list of studies has looked at the monetary policy transmission mechanism using the vector autoregression (VAR) methodology. Some examples include Sims (1980, 1992); Bernanke and Blinder (1992); Ramaswamy and Sloek (1997); Christiano et al. (1999) and Morsink and Bayoumi (2001). Nonetheless, none of these studies focus on the issue of the relative strength of the transmission channels. The approach adopted in this thesis builds on this literature and also the shutdown methodology found in Ramey (1993) and Ludvigson et al. (2002), among others. The approach involves shutting down or muting one channel at a time and comparing that with the baseline impulse response when all channels are operating. In addition, particular attention is also devoted to modelling Malaysia as a small and open economy. This involves invoking the open economy framework in VAR modelling, whereby the US is taken as representative of the world economy e.g., Cushman and Zhal (1997) and Dungey and Pagan (2000). Nonetheless, unlike the latter two papers which use a zero-type or structural identifying restriction, this study uses a recursive identifying restriction. This appears to be reasonable first step considering the lack of theoretical guidance in estimating a structural VAR where the interest encompasses several transmission channels in the same model.

The rest of this paper is structured as follows. Section 2 briefly discusses the theoretical overview of the transmission channels and the literature on Malaysia. Section 3 discusses

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2 An earlier application of this methodology can be found in Helliwell and Higgins (1976).
methodological issues relating to the rationale for the selection and ordering of variables, their transformations, model estimation and the shutdown methodology. All results are presented in Section 4 and divided into two parts. Section 4.1 investigates whether there exists a monetary policy transmission process in Malaysia and whether the four transmission channels identified in this paper are relevant. The core question on the relative importance of the different transmission channels is answered in Section 4.2. Finally, Section 5 ends with some concluding remarks, policy considerations and future areas of research.

2 Theoretical Overview of the Transmission Channels and Literature on Malaysia

This section provides a simple theoretical overview of the transmission channels studied in this paper and a brief literature review on Malaysia. Using Mishkin’s (1996) instructive schematic, the interest rate channel can be depicted as follows: $M \uparrow \Rightarrow r \downarrow \Rightarrow I, C \uparrow \Rightarrow Y \uparrow$. An expansionary monetary policy ($M$) causes a fall in nominal interest rates and, given price rigidity, a fall in real interest rates ($r$). Falling real interest rates boost investment ($I$) as the required rate of return of a project and the cost of borrowing decline. Similarly, consumption ($C$) increases and hence aggregate demand and output ($Y$) rise.

The credit channel studied here captures elements of both the bank lending and the broad credit (balance-sheet) channel for the reason that the variable used, that is, the total outstanding loans of the banking system, incorporates the features of both the channels. The bank lending channel works through the supply of bank loans. For instance, an expansionary monetary policy increases the reserves of private banks and hence the pool of loans ($L$). Bank dependent borrowers will then borrow to finance their investment and consumption, which boost aggregate demand and output: $M \uparrow \Rightarrow L \uparrow \Rightarrow I, C \uparrow \Rightarrow Y \uparrow$. On the other hand, the broad credit channel transmit monetary policy shocks on the basis of how banks assess borrowers or specifically borrowers’ balance sheets (Bernanke and Gertler (1995)) – hence, it is also known as the balance sheet channel. In this channel, an expansionary monetary policy leads to lower nominal interest rates ($i$) and alleviates the debt service burden of companies and consumers. As cash-flows of borrowers ($C_F$) improve, banks become more willing to lend and aggregate demand and output rise. At the same time, asset prices ($P_a$) rise, pushing up borrowers’ collateral value ($C_V$) and increases their net worth, and boosts bank lending and aggregate demand and output: $M \uparrow \Rightarrow (i \downarrow \Rightarrow C_F \uparrow \text{ and } P_a \uparrow \Rightarrow C_V \uparrow) \Rightarrow L \uparrow \Rightarrow Y \uparrow$.

According to the exchange rate channel, monetary policy shocks are transmitted via net exports. An expansionary monetary policy causes domestic real interest rates to decline assuming price stickiness (nominal rigidities). This leads to capital outflows and a depreciation in the domestic currency ($E \uparrow$: RM/USD) resulting in cheaper domestic products relative to
foreign goods. Hence, all else equal, exports increase due to improvement in competitiveness, and imports decrease due to expenditure switching among residents. Therefore, net exports \((X_n)\) increase and aggregate demand and output rise: \(M \uparrow \Rightarrow r \downarrow \Rightarrow E \uparrow \Rightarrow X_n \uparrow \Rightarrow Y \uparrow\).

One exposition of the asset price channel is linked to Tobin’s \(q\) theory (1969). When monetary policy expands, the general interest rate levels fall, including the required rate of return. As the required rate of return or discount rate falls, current share valuation \((P_s)\) increases, this implies a rise in \(q\) and a rise in investment and output: \(M \uparrow \Rightarrow P_s \uparrow \Rightarrow q \uparrow \Rightarrow I \uparrow \Rightarrow Y \uparrow\). A related exposition follows from the impact of monetary policy shocks on individual wealth. An expansionary monetary policy by boosting share prices also boost individual wealth \((W)\), which spurs consumption and in turn aggregate demand and output: \(M \uparrow \Rightarrow P_s \uparrow \Rightarrow W \uparrow \Rightarrow C \uparrow \Rightarrow Y \uparrow\). Hence, the asset price channel is also known as the wealth channel.

Only a few studies on the monetary policy transmission mechanism in Malaysia have been published, however none focuses on the issue of relative importance of the transmission channels. Azali and Matthews (1999) examine the money and credit channels pre and post-liberalisation in the late 1990s, using Bernanke’s 1986 closed-economy contemporaneous SVAR model where the money channel is found to be more important in influencing output fluctuations post-liberalisation. Bernanke and Blinder (1992), who in their own study use a recursive VAR like here, criticise the results from the 1986 Bernanke model as “sensitive to choice of specification and to the identifying assumptions” (page 902). Another study by Domac (1999) looks at the distributional consequences of monetary policy on small and large manufacturing firms. His main finding provides support that small firms are more severely affected by monetary policy. This finding is based on a detailed descriptive analysis of banking and bond yields statistics, as well as a simple closed form recursive VAR model. However, there are several weaknesses worth highlighting. Any analysis that relies on information from the bond market should be interpreted with caution because of the distortions caused by the lack of breadth and depth of the market. In addition, the analysis based on the banking statistics appears to be broad-brush and reflects a lack of understanding about local banking conditions, particularly during the period of the Asian crisis; and the choice of overnight interbank interest rate as the policy instrument may not be appropriate. More recently, Ibrahim (2005) uses a recursive VAR to study the impact of monetary policy shocks on various economic sectors. Likewise, the choice of the 3-month Treasury bill rate as the monetary instrument is less appropriate given the problems in the debt market, and the source of the quarterly aggregate real output and sectoral data, which starts from 1978:1, is questionable.
3 Methodological Issues

3.1 Choice and Rationale of Variables

The VAR model estimated comprises 12 variables divided into two blocks: foreign (four) and domestic (eight). The foreign block comprises a commodity price index (CP), the US consumer inflation rate (PFUS), real GDP (RUS) and the Federal Funds Rate (RUS). The commodity price index is included to account for inflationary expectations (Sims (1992)), while the rest of the variables which represents the open economy component of the model are included based on work done in Grilli and Roubini (1995), Fry (2001) and Suzuki (2003). Grilli and Roubini, for example, find these variables to be helpful in addressing the price and exchange rate puzzles commonly found in empirical work associated with estimating a closed economy VAR on a small open economy. The US economy is taken as proxy for the rest of the world to Malaysia, which is not unreasonable given that the US is Malaysia’s single largest trading partner accounting for 18.8% and 14.5% of total exports and imports, respectively in 2004.\footnote{In earlier years, its share was even larger, e.g., in 1995, it was 20.7% of total exports.}

The domestic block comprises of two target variables of monetary policy: consumer price inflation (PFMY) and real GDP (YMY); a monetary policy instrument, the monetary aggregate M1 and the 3-month interbank interest rate (R3M); and four intermediate variables representing each monetary transmission channel: the ringgit (RM)/US dollar exchange rate (ER) for the exchange rate channel, the Kuala Lumpur Composite Index (KLCI) for the asset price channel, the base lending rate (BLR) for the interest rate channel, and the total outstanding loans of the banking system (L) for the credit channel.

The monetary policy objective of BNM is to ensure sustainable economic growth with price stability – hence, the inclusion of both the consumer price inflation and real GDP in the model. The choice for the monetary policy instrument is less obvious because of the absence of formal announcement. BNM claims that as late as the early 1990s, it was still operating under a monetary targeting framework, whereby prior to 1987, M1 was the main policy target, while in the midst of greater financial liberalisation and innovation, M3 assumed greater importance (page 139, Bank Negara Malaysia, 1999). Since then, the Bank has moved towards an interest rate targeting framework where the \textit{de-facto} policy rate, up until April 2004, was the 3-month interbank rate. Nonetheless since April 2004, the Bank has finally formally announced the Overnight Policy Rate (OPR) as the official monetary policy rate. Arising from this, Tang (2006) investigates a whole series of potential

\footnote{The IMF’s \textit{World Export Price Index - All Exports excluding Fuels} is used in this paper as per Sims (1992). Other researchers have used the oil price index (Kim and Roubini 2000 and Brischetto and Voss (1999)) or the industrial/producer price index (Lown and Morgan 2002 and Christiano et al. (1999)). The oil price index is found to be less suitable especially when the monetary policy instrument is the money supply, in which case the price puzzle is evident. The producer price index is not used because unpublished work has found it to be a poor leading indicator of inflation.}
monetary instruments (the statutory reserve requirement ratio, various measures of monetary 
aggregates and various maturity of interbank interest rates) and find that M1 and the 3-
month interbank rate to be the most reasonable candidate – monetary shocks attributed to 
these variables are more consistent with economic priori.\(^5\)

In terms of the intermediate variables, the use of RM/USD exchange rate is motivated by 
the position of the US in Malaysia’s trade profile as mentioned before and that a large part of 
Malaysia’s total trade (exports and imports) are denominated in US dollar (approximately 
75% in 2003).\(^6\) An alternative variable to proxy for the asset price channel would be the 
property price index, but alas such series only starts in the late 1990s. Hence, the main 
stock price index of the Kuala Lumpur stock exchange is used. For the interest rate channel, 
the commercial banks’ average base lending rate is employed. This is the quoted rate to 
the best customers as opposed to the actual lending rate; the latter may vary according 
to customers’ risk profiles. Again the unavailability of other possible proxies, such as the 
average lending rate and other interest rates like the longer-dated government securities of 
5 to 10-year maturities, at sufficient length, precludes such considerations. For the credit 
channel, the total outstanding loans of the banking system is used.\(^7\) Interestingly, bank loans 
contributed, on average, about half of the economy’s total annual financing over the past 20 
years.\(^8\)

3.2 Data Collection and Transformations

All monthly data are converted to quarterly numbers by taking the quarterly average, except 
real GDP which is already in quarterly. This accounts for activities that take place during 
a quarter, instead of, say, in the last month of a quarter if an end-month series is collected. 
The sample period spans from 1981:1 to 2004:1 giving a total of 93 observations.\(^9\) Detailed 
data description and sources as well as their descriptive statistics can be found in Appendix [A].

All variables are transformed into natural logarithm except for interest rates and inflation 
which are in percentage terms. The inflation rate is calculated as quarter-on-quarter per-

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\(^5\) Using both monetary policy variables help to provide comparison as well as for robustness checks. The 
inclusion of the 3-month interbank rate is also useful as there is reason to argue that the monetary targeting 
framework was never truly adopted in Malaysia. For more detailed discussion, see Chapter 2 of *ibid*. In 
fact, similar evidence is found in other countries such as Germany and the UK (*Goodhart* (1995)), Australia 
(*Grenville* (2005)) and the US (*Bernanke* (2003)).

\(^6\) Author’s calculation based on BNM (2005a), assuming trade with Japan is denominated in yen and the 
European Union in euro.

\(^7\) This series includes loans which may be subsequently securitised to Cagamas (the national mortgage 
corporation), but excludes loans sold to Danaharta (the asset management company set-up to acquire and 
manage non-performing loans). This is the only publicly available series on total banking loans.

\(^8\) Represents all forms of debt (private and public) in ringgit and foreign currencies but does not constitute 
firms’ working capital.

\(^9\) The starting date was constrained by the availability of the 3-month interbank rate. Otherwise, a longer 
period, albeit only slightly, could be obtained from 1979:1.
centage change as opposed to the preceding change. This also has the advantage of handling seasonality.\textsuperscript{10} Inflation rate is used instead of CPI at levels because central banks target the rate of change in prices rather than the level of prices. Most of the data used are already seasonally adjusted at source, except for Malaysian real GDP. To adjust for seasonality, the Census-X11 method is used. But the adjusted series hardly differs from another series using simple moving average.

3.3 Choice of Ordering

One of the key issues that relates to the use of Cholesky decomposition in VAR estimations is the choice of ordering of variables. In this study, the variables are ordered as follows: CP, PFUS, YUS, RUS (foreign block); PFMY, YMY, M1, R3M, ER, KLCI, BLR and L (domestic block). The foreign block is ordered ahead of the domestic block in the spirit of Cushman and Zha\textsuperscript{(1997)} and, later, by others such as Dungey and Pagan\textsuperscript{(2000)}, Fry\textsuperscript{(2001)} and Suzuki\textsuperscript{(2003)}, for an open economy VAR. One difference, however, is that in this study because of the strict recursive ordering, the foreign block is not completely exogenous to the domestic block. In other words, the domestic block does affect the foreign block in lags but not contemporaneously. The complete block exogeneity model was also estimated, but the model was unstable as not all its roots lie outside the unit circle – it was not adopted in this paper. Having said that, the model’s results on the relative importance of the different transmission channels were not qualitatively different from the current specification with strict recursive ordering.\textsuperscript{11}

The commodity price index is placed ahead of the rest with the view that it is contemporaneously exogenous to both the US and Malaysian influences. In both blocks, interest rates are ordered after prices and real output, and in the case of Malaysia, after money. This mimics a simplified monetary feedback equation whereby interest rate decisions are made based on the contemporaneous availability of the aforementioned information. Inflation is positioned before output as per Suzuki\textsuperscript{(2003)} which assumes prices are sluggish and hence other variables only affect prices after a lag. Output could also be placed before inflation à la the aggregate supply equation. Encouragingly, doing so does not affect the overall results.

All the intermediate transmission variables are positioned after the monetary policy instrument since monetary policy shocks are effectively being transmitted via these variables. Since financial prices react faster to monetary policy shocks, the exchange rate and stock price variables are placed before the base lending rate and bank loans. Institutional rigidity in the banking system further supports the placement of the base lending rate before bank loans.

\textsuperscript{10} Preceding change in CPI was also used, but the results were qualitatively similar. An aside, if the CPI in levels was used instead, there was a persistent price puzzle in the results.

\textsuperscript{11} For more details, see Chapter 5 of Tang\textsuperscript{(2006)}.
3.4 Model Estimation

In the footsteps of previous studies on the monetary policy transmission mechanism, Bernanke and Blinder (1992), Sims (1992) and Levy and Halikias (1997), to name a few, the VAR model used here is also estimated in levels, despite having most variables which are non-stationary and cointegrated (see Tables 3 and 4 in Appendix B). This debate between estimating in levels or via the vector error correction method (VECM) given the objective of this study and the variables are non-stationary and cointegrated, is best summarised by Ramaswamy and Sloek (1997), page 13:

“If cointegration exists, and the true cointegrating relationship is both known and can be given an economic interpretation, the VAR should be estimated using the [VECM] with the reduced rank estimation suggested by Johansen (1995). However, if the true cointegrating relationships are unknown, and furthermore, when the relationships are the main focus of the analysis, then imposing cointegration may not be the appropriate estimation strategy. Imposing inappropriate cointegration relationships can lead to biased estimates and hence bias the impulse-responses derived from the reduced form VARs. In the cases, where there is no a priori economic theory which can suggest either the number of long-run relationships or how they should be interpreted, it is reasonable not to impose the restriction on the VAR model.”

To choose a lag order for the model, the standard information criteria of Akaike (AIC), Schwarz (SC) and Hannan-Quinn (HQC) are utilised. SC and HQC recommend a lag order of one, while AIC, four (see Table 5, Appendix B). Choosing a lag order of one, however, contributes to autocorrelation in the residuals at one, two and three lags at the 5% level of significance (based on the autocorrelation LM test). In addition, a one-period model is unlikely to account for much of the dynamics of the variables. On the other hand, a four-period model shows much greater variability in impulse responses, to the extent that the paths oscillate explosively over time. This suggests that the model is unstable and attested by its eigenvalues. Taking these factors into consideration, a lag order of two is chosen as the model remains stable and only has autocorrelation at one lag.

The following VAR(2) expressed in reduced form is then estimated:

\[ Y_t = C_t + \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \varepsilon_t, \] (1)

where \( Y_t \) is the 12 × 1 matrix of variables; \( C_t \) is the 12 × 4 matrix of the intercept term, the Asian-crisis dummy variable (1997:3 to 1998:4=1, 0 otherwise) and two dummy variables interacting with the exchange rate to account for the pegging of the ringgit to the US dollar at lag one and two (the dummy variable takes on the value zero from 1981:1 to 1998:3 and

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12See also Sims et al. (1990), Chapter 11 of Lütkepohl (1993) and pages 650-651 of Hamilton (1994).
one from 1998:4 to 2004:1); and Φ₁ and Φ₂ are the 12 × 12 matrices of parameter estimates of Yᵢ at lag one and two, respectively.

3.5 Shutdown Methodology

The key idea behind the examination of the relative strength of the monetary policy transmission channels is to compare the impulse responses of the target variables of output and inflation to monetary policy shocks, under two scenarios: the baseline model versus the constrained model (Levy and Halikias (1997); Ludvigson et al. (2002); Ramey (1993)). The constrained model is equivalent to the baseline model but with a certain channel shutdown. Therefore, the deviation of the constrained impulse response function from the baseline impulse response function represents the strength of that channel – the larger the deviation, the stronger or more important the channel.

Recall, Equation 1 comprises: 1. the commodity price index (CP), 2. the US inflation rate (PFUS), 3. real output (YUS), 4. Fed Funds Rate (RUS); 5. Malaysian inflation rate (PFMY), 6. real output (YMY), 7. money supply (M1), 8. 3-month interbank interest rate (R3M), 9. ringgit/US dollar exchange rate (ER), 10. stock price index (KLCI), 11. base lending rate (BLR), and 12. bank loans (L). The constrained model is the one which sets certain coefficients (elements) in ˆΦ₁ and ˆΦ₂ to zero. As alluded to above, there are four transmission channels of interest: exchange rate, asset price/wealth, interest rate and credit; represented by ER, KLCI, BLR and L, respectively.

To illustrate the shutdown technique, for example, to shutdown the interest rate channel on inflation, the estimated coefficients of BLR in the inflation equation, ˆφ₁₅,11 and ˆφ₂₅,11, are set to zero; where the subscript “5” corresponds to the row of the Malaysian inflation (PFMY) equation, and the second subscript, “11”, corresponds to the ordering of the BLR in the model, while the superscripts “1” and “2” refer to lag one and two, respectively. The impulse response of inflation can then be calculated in the usual way and shall be labelled as “Without Interest Rate Channel”. Similarly, to shutdown the interest rate channel on output, the estimated coefficients of BLR in the Malaysian output equation, ˆφ₁₆,11 and ˆφ₂₆,11, are set to zero. In this case, the first subscript “6” refers to ordering of the Malaysian output variable (YMY) in the model. Following the same approach for each variable representing each transmission channel, the rest of the constrained impulse response functions can be obtained. In each case, the constrained impulse response refers to the case where a particular transmission channel is being shutdown or muted, as opposed to the baseline impulse response, where all the transmission channels are operating.
4 Results

Two sets of results are presented. The first looks at the impulse responses of the Malaysian variables to monetary policy shocks namely that of M1 and the 3-month interbank rate, and the impulse responses of the two target variables (output and inflation) to the intermediate variable shocks (exchange rate, stock price, lending rate and bank loans). What is of interest here is to investigate whether the responses are consistent with the theoretical discussion in Section 2. In so doing, to determine whether the model specification is in fact appropriate. The second set of results focuses on the core of this study by comparing the relative strength of the different transmission channels. Only results pertaining to Malaysia are shown given the interest of the study. For completeness, the two standard error bands are also presented along the impulse responses to one standard deviation shock.

4.1 Preliminary

Figure 1 shows the impulse responses of the Malaysian variables to M1 shock. A quick glance reveals that they are consistent with economic predictions – following an expansionary monetary policy (modelled as a rise in M1), both the interbank and bank lending rates fall, fuelling economic expansion and higher inflation. Lower interest rate also translate to lower discounting rate which enhances share prices. At the same time, lower interest rates also reduce the attractiveness of domestic interest-bearing papers vis-à-vis foreign papers, leading to capital outflows and a depreciation in the ringgit (a rise in ER). One oddity is the initial fall in bank loans before rising after one year. Bernanke and Blinder (1992) explains the slow rise in bank loans as due to loans being quasi-contractual agreements whose volume cannot be changed quickly.

Similar evidence is also observed in Figure 2, the case where the shock is a positive rise in the 3-month interbank rate, tightening of monetary policy. Again, bank loans rise initially, before declining. Gertler and Gilchrist (1994) offer another explanation that large firms in particular tend to respond to an unanticipated contractionary monetary policy by increasing their short-term borrowing to finance an inventory build-up. One difference between the results in Figures 1 and 2 is that in the case of the 3-month interbank rate, there is evidence of an exchange rate puzzle – a rise in interest rates counterintuitively lead to a depreciation in the ringgit instead of an appreciation. Presumably, Grilli and Roubini’s (1995) suggestion to include the US variables, particularly the US interest rates, to control for the leader-follower effect does not work when the 3-month interbank rate is the monetary policy instrument.\textsuperscript{13}

\textsuperscript{13}The leader-follower hypothesis contends when a leading country, like the US, increases interest rates, other countries will follow because they are concerned their weaker currencies will lead to higher inflationary pressures from abroad. So when the US interest rates increase, the US dollar appreciates (or the ringgit depreciates), Malaysian interest rates are also raised to minimise the depreciation of the ringgit to contain imported inflationary pressures. Some supporting evidence is provided by the impulse response of the 3-month interbank rate to the Federal Funds rate which shows a rise in the former following a positive shock to the...
Figure 1: Impulse Responses of Malaysian Variable to M1 Shock

- Response of PFMY to M1
- Response of YMY to M1
- Response of M1 to M1
- Response of R3M to M1
- Response of ER to M1
- Response of KLCI to M1
- Response of BLR to M1
- Response of L to M1
Figure 2: Impulse Responses of Malaysian Variable to R3M Shock

- Response of PFMY to R3M
- Response of YMY_X11 to R3M
- Response of M1 to R3M
- Response of R3M to R3M
- Response of ER to R3M
- Response of KLCI to R3M
- Response of BLR to R3M
- Response of L to R3M
As a robustness check, the variables are also ordered differently. In some cases, they affect the overall results. If both the target variables are placed at the end, as in Levy and Halikias (1997), then the price puzzle emerges regardless of the choice of policy instrument. However, swapping the position of the intermediate transmission variables, that is, placing the base lending rate and bank loans ahead of the exchange rate and the stock price index, all else remained unchanged, does not matter. In addition, some scaled down specifications of the open-economy model – with some US variables being dropped – are also examined. Generally, they do not perform as well as the open-economy model; they tend to be unstable and have some puzzling results.

Another means of finding out whether the existing VAR model is reasonable is to examine the impulse response of the target variables to the intermediate variable shocks (see Figure 3). On the whole, the results are again supportive of the a priori. In the first two rows of Figure 3, with regard to the impulse responses of inflation, a positive exchange rate shock (a depreciation in the ringgit) leads to higher inflation as higher foreign prices are passed on to domestic goods and services. Similarly, a positive stock price shock leads to higher inflation due to the wealth effects. A positive bank lending rate shock, on the other hand, increases the cost of borrowings which reduces aggregate demand and exerts downward pressure on prices. A positive bank loans shock has the opposite effect on aggregate demand and hence on prices.

In the last two rows of Figure 3, with regard to the impulse responses of output, the results also conform to expectations. A positive stock price shock improves Tobin’s q and boosts new investment, individuals become richer, both of which boost aggregate demand. Similarly, a positive bank loan shock spurs new loans leading to new economic activity. On other hand, increased borrowing cost (a positive base lending rate shock) dampens economic activity. One results which may appear puzzling is that output falls initially before increasing following a depreciation in the ringgit. Normally, output is expected to rise after a depreciation in the ringgit as exports become cheaper boosting their demand and, in turn, output. Perhaps what is observed resembles the so-called J-curve effect, where the initial fall in output is due to the larger rise in the value of imports vis-à-vis exports. Nonetheless, since three-fourth of Malaysian total trade are priced in US dollars, the J-curve effect appears to be less plausible.

An alternative explanation to this observed phenomenon can be gathered from the capital flows perspective, instead of the more conventionally espoused trade linkages/expenditure switching argument. In this case, a positive exchange rate shock can be interpreted as a latter. In addition, in the reverse case, the Federal Funds rate fall after a positive 3-month interbank rate shock; at least it does not increase. Nonetheless, the magnitude of its decline is twice larger than the increase in the 3-month interbank rate as per the first case. Taken together, the evidence does not conclusively support the leader-follower hypothesis.

14 This happens when the value of imports being priced in a foreign (US) currency increases immediately, while the value of exports being priced in ringgit remains unchanged for, say, several quarters, until old contracts are settled and new ones are drawn-up. When this happens, more cheaper Malaysian exports are demanded by foreigners, while dearer imports decline as domestic buyers turn to cheaper domestic substitutes.
Figure 3: Impulse Responses of Target Variables to the Intermediate Variable Shocks

Response of PFMY to ER

Response of PFMY to KLCI

Response of PFMY to BLR

Response of PFMY to L

Response of YMY to ER

Response of YMY to KLCI

Response of YMY to BLR

Response of YMY to L
rise in the ringgit risk premium – investors demand higher returns for holding ringgit assets. A typical outcome of this is that investors sell their ringgit assets, causing bond prices to fall (interest rates to rise), equity prices to fall, and when the funds leave, the ringgit to depreciate. If a central bank chooses to defend its currency, interest rates also rise. The twin impact of falling asset prices and higher interest rates reduce consumers’ wealth and hence their spending, as well as firms’ investments. Hence, output falls accordingly. McKibbin and Vines (2000) illustrate this phenomenon using the G-Cubed model in the context of the Asian crisis. Malaysia’s experience appears to conform to this, as the impulse response of the 3-month interbank rate to the exchange rate shock shows an increase in the interest rate following a ringgit depreciation. In reality, the central bank did raise interest rates initially during the Asian crisis to defend the ringgit.\footnote{As a comparison, the pre-Asian crisis sample was also examined. In contrast, there was no such anomaly observed – ringgit depreciations did lead to greater output – suggesting that the conventional trade/demand side explanation was dominant during the pre-crisis sample.}

To sum up, the results from Figures 1 and 2 highlight the notable role monetary policy plays in affecting the target variables of inflation and output, among other factors. In addition, the results from Figure 3 further support the relevance of the four conduits that transmit monetary policy shocks to the economy. However, these results do not distinguish between the relative importance of each transmission channel. The following section focuses on this issue.

4.2 The Relative Importance of Channels

This section presents the results involving the shutdown methodology to ascertain the relative importance of each transmission channel. A channel is adjudged more important if its constrained impulse response labelled as “Without (W/O) … Channel” in Figures 4 and 5 deviates most markedly from the baseline impulse response. As before, results for both the 3-month interbank rate and M1 as monetary policy shocks are shown. Examining the first plot of Figure 4 shows that in the first eight quarters after a contractionary monetary policy, the interest rate channel appears to be the most prominent channel in transmitting monetary policy shocks to output, followed by the asset price/wealth channel and the exchange rate channel. Beyond the eighth quarter, the credit channel seems to dominate. Similar results are obtained in the next plot in response to M1 shock. Again, in the shorter horizon of first eight quarters, the interest rate channel followed by the asset price channel dominate. Beyond that period, the credit channel becomes more prominent. Notice that the credit channel seems to have a counterintuitive effect on output in the first quarters, whereby switching off the credit channel following a positive interest rate shock counterintuitively worsens the contraction in output as compared with the baseline scenario when the credit channel is operational. Or put differently, as per the second plot, muting the credit channel following an easing of monetary policy increases output more when the credit channel is
Figure 4: Impulse Response of Output to R3M and M1 Shocks

**IRF of YMY to R3M Shock**

- Baseline
- W/O Credit Channel
- W/O Wealth Channel
- W/O Exchange Rate Channel
- W/O Interest Rate Channel

**IRF of YMY to M1 Shock**

- Baseline
- W/O Exchange Rate Channel
- W/O Interest Rate Channel
- W/O Wealth Channel
- W/O Credit Channel
Figure 5: Impulse Response of Inflation to R3M and M1 Shocks

IRF of PFMY to R3M Shock

IRF of PFMY to M1 Shock
switched on. A plausible reason for this can be seen from the last plot in Figures 1 and 2 where bank credit increases after a tightening of monetary policy before declining.

In Figure 3 where the impulse response is that of inflation, a similar sort of pattern is observed. In both the plots, the interest rate channel is again dominant in the first six to eight quarters, and beyond that the credit channel. The main difference to the preceding set of results is the rather muted role of the asset price channel vis-à-vis the exchange rate channel in the short-horizon. In other words, in the case of the impulse response of inflation as opposed to that of output, the exchange rate channel is more important than the asset price channel.

It would be interesting to also examine the scenario prior to the Asian crisis. Figures 6 and 7 are the same plots as Figures 4 and 5 respectively, but estimated over the pre-Asian crisis sample period. Figure 6 also shows the dominance of the interest rate channel followed by the asset price channel particularly in short-horizon, and the credit channel beyond that. What is clear is the unimportance of the exchange rate channel, suggesting that the Asian crisis related events has enhanced the role of the exchange rate channel in the full-sample period. Similarly, in Figure 7 there is a vivid pattern of the dominance of the interest rate channel within the first eight quarters, and the credit channel after that. There is a notable absence of the exchange rate channel especially in the case of M1 shock, while the asset price channel is also somewhat important.

5 Concluding Remarks

This paper utilizes a 12-variable open economy VAR model of Malaysia estimated from 1981:1 to 2004:1 to investigate the relative importance of four monetary policy transmission channels of interest: exchange rate, asset price/wealth, interest rate and credit channels. The absence of past empirical work on Malaysia, the lack of theoretical guidance in estimating a structural VAR of this nature (where four different transmission channels are included in the same model at the same time), and the need to let the data speak for themselves motivate the use of the recursive identifying restriction. The selection and ordering of variables are in the spirits of the “best practices” in this line of research, and thought to address anomalies such as the price and exchange rate puzzles. The absence of formal announcement complicates the choice of variable to proxy for monetary policy decisions. As such, this study uses both M1 and the 3-month interbank rate as the monetary policy indicators. Following the central bank’s broad monetary policy objective statement, both real output and consumer price inflation are taken as the target variables of monetary policy.

Preliminary investigations show the relevance of monetary policy in influencing output and inflation as well as the intermediate transmission variables (exchange rate, stock price, bank lending rate and bank loans), with the only exception in the case of the 3-month
Figure 6: Impulse Response of Output to R3M and M1 Shocks: Pre-Crisis Sample
Figure 7: Impulse Response of Inflation to R3M and M1 Shocks: Pre-Crisis Sample
interbank rate shock, where the exchange rate puzzle is present. Each transmission channel also appears to have important influence on the target variables as shown by the impulse responses of the target variables to the intermediate variable shocks.

Using the shutdown methodology, the constrained impulse response is obtained, which represents the case where a particular channel is being switched off. Comparing this, with the baseline impulse responses of the target variables, where all channels are operational, the relative importance of each transmission channel can be ascertained. On the whole, the results show the interest rate channel is the most important transmission channel within a horizon of about two years, and the credit channel beyond that. These results are consistent in both the output and inflation impulse responses, the pre-Asian crisis and full sample periods, and the choice of monetary policy instrument (M1 and the 3-month interbank rate). The asset price channel followed by the exchange rate channel also appear to be important, particularly in influencing output, in the short-horizon. On the other hand, for inflation, the exchange rate channel is also relevant, while the asset price channel is least relevant. In contrast, in the pre-crisis period, the exchange rate channel plays a minimal role in transmitting monetary policy shocks to output and inflation.

5.1 Policy Considerations

The above results provide greater assurance as well as encouragement to BNM. It reassures that the interest rate channel remains a very potent conduit in influencing output and prices. This bodes well with the bank’s recent move towards a new interest rate framework which plans to rely more on the use of indirect instruments in the conduct of monetary policy. The findings should also boost the bank’s confidence to press forward with further developments in the money market, such as, the issuance of more money market securities, and the liberalisation of securities borrowing and lending. Both will facilitate greater interests and price discovery in the market place. In order for the monetary policy actions to be transmitted to the wider economy, developments in the government and private debt securities should be further intensified. This allows monetary policy to have far-reaching influence beyond the sphere of the banking sector. In addition, a deep and broad debt market can act as additional shock absorber and diversifier of risks away from the over-reliance on the banking sector. It also provides useful information, among others, on the state of monetary conditions and the outlook for the economy and inflation, which will further enhance the quality of input into monetary policy decision makings.

The finding that the interest rate channel is most relevant is strong evidence against the view that monetary policy is only effective if the central bank has direct control over the quantity of credit. The absence of the credit channel at the short-horizon is evidence

\footnote{This, however, does not appear to have any notable impact on the key result of this paper on the relative importance of the different transmission channels.}
challenging this view. In fact, the finding that the credit channel is only important at the longer-horizon is suggestive of the opposite. That is, the credit channel may not be important altogether, as the fall in bank loans may be due to the fall in the demand for loans (as higher interest rates constrain economic activity) rather than the fall in the supply of loans. No doubt this implication is not conclusive due to the nature of the macro variable used. Nevertheless, as the fact remains that the interest rate channel is more relevant than the credit channel, reforms to allow greater flexibility in the lending and deposit taking practices should therefore be expedited.

What seems quite unexpected though are the results relating to the transmission channels of secondary importance. The relative strength of the asset price channel in influencing output at the shorter-horizon, or the lack of evidence to support the importance of the exchange rate channel, stands out glaringly. This should provide justification for greater vigilance on the developments in the stock market because they convey useful information about monetary conditions. The 1993/94 stock market bull-run bore this out, where even as interest rates were at high levels, the economy was close to overheating spurred on by the booming stock market. On the other hand, contrary to popular belief, the exchange rate has not been a tool commonly used to raise output. Put differently, if the central bank had used the exchange rate to artificially boost the country’s competitiveness, then it would have failed to achieve that goal. On a positive note, the exchange rate channel appears to have more success in influencing inflation. In short, lowering interest rates has a good chance of exposing the economy to greater imported inflationary pressures with little benefit of higher output from a depreciated exchange rate.

5.2 Future Research

One promising area of research is to look into what actually represents the credit channel – the bank lending channel or the balance sheet channel. The absence of the bank lending channel can resolve the debate between the use of quantity versus price control on credit. Also, it can provide the ultimate boost to move forward towards a market-based framework in the conduct of monetary policy. On the other hand, if the balance sheet channel is more important, this suggests the monitoring of the financial health of both banks and their customers alike should be further enhanced. Equally crucial is information on the general financial health of the public. Financial survey on individuals would be invaluable. Without all this information, it is difficult to appreciate how monetary policy actions actually affect individuals and their well-being and how individuals will respond in turn. In future, as more micro-level data become available, this research agenda will become more promising.

Another area for improvement would be to apply a different technique of identifying restriction to the VAR model. The recursive assumption seems particularly problematic for the 3-month interbank rate shock as revealed by the exchange rate puzzle. Being a small
and highly open economy, Malaysia is likely to be concerned about the impact of a rising US dollar on domestic inflation. This implies interest rates may have a contemporaneous relationship with the exchange rate, instead of a recursive one. One approach is via sign restriction, where identification is by means of signs/shapes of a theoretical model. The key question then is which theoretical model should the signs be based upon? As there is no theoretical model which incorporates so many different channels together in an open-economy context, an attempt to use sign restrictions is likely to be based on some loose theoretical underpinnings or economic intuitions.
## A Data: Description, Sources and Statistics

### Table 1: Data Description and Sources

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Code</th>
</tr>
</thead>
</table>
| Commodity Price Index and US data (*DataStream*)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP¹</td>
<td>Commodity Price Index: World Export Price Index - All Exports, excluding Fuels, not adjusted - discontinued.</td>
<td>WDI76AXDF</td>
</tr>
<tr>
<td></td>
<td>World Export Price - Non Fuel Primary Commodities Index, not adjusted.</td>
<td>WDI76NFDF</td>
</tr>
<tr>
<td>PUS</td>
<td>US Consumer Price Index: US CPI seasonally adjusted</td>
<td>USOCOP009E</td>
</tr>
<tr>
<td>YUS</td>
<td>US Real Gross Domestic Product: US GDP, constant prices, seasonally adjusted (US$ billion)</td>
<td>USGDP..D</td>
</tr>
<tr>
<td>RUS</td>
<td>US Federal Funds Rate (%)</td>
<td>USFEDFDUND</td>
</tr>
</tbody>
</table>

### Malaysian data (BNM, *Monthly Statistical Bulletin*)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>PMY</td>
<td>Consumer Price Index (2000=100)</td>
<td>Table VI.12</td>
</tr>
<tr>
<td>YMY²</td>
<td>Real Gross Domestic Product (RM million)</td>
<td>Table VI.2</td>
</tr>
<tr>
<td>M1</td>
<td>Monetary Aggregate, M1 (RM million)</td>
<td>Table II.3</td>
</tr>
<tr>
<td>R3M</td>
<td>Average 3-month interbank interest rate (%)</td>
<td>Table V.3</td>
</tr>
<tr>
<td>BLR</td>
<td>Average Base Lending Rate of Commercial Banks (%)</td>
<td>Table V.1</td>
</tr>
<tr>
<td>L</td>
<td>Total Loans Outstanding of the Banking System, including Cagamas, excluding Danaharta (RM million)</td>
<td>Table II.6</td>
</tr>
<tr>
<td>ER</td>
<td>Average Exchange Rate: RM/USD e.g., RM3.80=1USD</td>
<td>Table V.6</td>
</tr>
<tr>
<td>KLCI</td>
<td>The Kuala Lumpur Stock Exchange Composite Index</td>
<td>Table V.14</td>
</tr>
</tbody>
</table>

¹ The first series was discontinued at end-2002. To have a consistent series, data since then are obtained from the second series, whereby its growth rate (based on the preceding period percentage change) is used to extend the first series.

² Officially, quarterly real GDP series starts from 1987. Data prior to that are based on the work by [Abeysinghe and Rajaguru (2004)](http://courses.nus.edu.sg/course/ecstabey/gdpdata.xls), downloadable from [http://courses.nus.edu.sg/course/ecstabey/gdpdata.xls](http://courses.nus.edu.sg/course/ecstabey/gdpdata.xls). However, since their data use 1978 as a base instead of the current real GDP series which uses 1987, the quarter-on-quarter percentage changes from their data are used to derive the real GDP series prior to 1987 based on the existing official real GDP numbers.
Table 2: Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Median</th>
<th>Max.</th>
<th>Min.</th>
<th>Std. Dev.</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreign Block CP (Index)</td>
<td>82.04</td>
<td>80.85</td>
<td>103.00</td>
<td>65</td>
<td>9.40</td>
<td>0.44</td>
<td>2.44</td>
</tr>
<tr>
<td>PFUS (%)</td>
<td>3.35</td>
<td>3.12</td>
<td>11.26</td>
<td>1.29</td>
<td>1.93</td>
<td>2.05</td>
<td>8.06</td>
</tr>
<tr>
<td>YUS (US$ b)</td>
<td>7,605</td>
<td>7,334</td>
<td>10,600</td>
<td>5,177</td>
<td>1,597</td>
<td>0.21</td>
<td>1.89</td>
</tr>
<tr>
<td>RUS (%)</td>
<td>6.56</td>
<td>5.85</td>
<td>17.81</td>
<td>1.00</td>
<td>3.44</td>
<td>1.07</td>
<td>4.75</td>
</tr>
<tr>
<td>Domestic Block PFMY (%)</td>
<td>3.14</td>
<td>3.29</td>
<td>10.55</td>
<td>-0.29</td>
<td>2.10</td>
<td>1.20</td>
<td>5.33</td>
</tr>
<tr>
<td>YMY (RM m)</td>
<td>4,037</td>
<td>31,573</td>
<td>60,296</td>
<td>4,871</td>
<td>14,181</td>
<td>0.23</td>
<td>1.55</td>
</tr>
<tr>
<td>M1 (RM m)</td>
<td>38,471</td>
<td>28,043</td>
<td>99,356</td>
<td>10,281</td>
<td>25,906</td>
<td>0.59</td>
<td>2.04</td>
</tr>
<tr>
<td>R3M (%)</td>
<td>6.45</td>
<td>7.03</td>
<td>12.04</td>
<td>2.73</td>
<td>2.54</td>
<td>-0.01</td>
<td>1.88</td>
</tr>
<tr>
<td>BLR (%)</td>
<td>8.45</td>
<td>8.22</td>
<td>12.25</td>
<td>6.00</td>
<td>1.70</td>
<td>0.61</td>
<td>2.30</td>
</tr>
<tr>
<td>L (RM m)</td>
<td>198,058</td>
<td>147,024</td>
<td>448,416</td>
<td>27,300</td>
<td>148,519</td>
<td>0.47</td>
<td>1.56</td>
</tr>
<tr>
<td>ER (RM/USD)</td>
<td>2.88</td>
<td>2.61</td>
<td>4.06</td>
<td>2.26</td>
<td>0.59</td>
<td>0.90</td>
<td>2.05</td>
</tr>
<tr>
<td>KLCI (Index)</td>
<td>602.04</td>
<td>573.24</td>
<td>1230.16</td>
<td>193.3</td>
<td>273.11</td>
<td>0.56</td>
<td>2.35</td>
</tr>
</tbody>
</table>

1 The sample period starts from 1981:1 to 2004:1.
2 Positive skewness implies a distribution with long-right tail and negative skewness, long-left tail. Normal distribution has a skewness of nought.
3 Normal distribution has a kurtosis of 3. If kurtosis is greater than 3, the distribution has a higher peak, less than 3, a lower peak.

B Unit Root and Cointegration Tests

To test for unit root, the Augmented Dickey-Fuller test is performed with two different specifications, one with just the intercept term and the other which includes the intercept term and a time trend. In addition, to account for the impact of the Asian crisis and as an extra robustness check, the tests are carried out in two periods: full-sample and pre-crisis sample (1981:1 to 1997:1). On the whole, most series are I(1) across the two sample periods at the conventional 5% level of significance (Table 3). The only exceptions are the US interest rates, both countries’ inflation rates and the 3-month interbank rate, depending on specification and sample period.

To test for cointegration, the Johansen (1995) trace tests are carried out. For robustness, checks are performed involving different assumptions of the deterministic term and different sample periods. A lag of two is chosen in line with the existing model specification. (Tests are also conducted with the optimal lag chosen by the standard information criteria).

The Johansen cointegration/trace tests are performed in JMulti v4.02. In JMulti, the assumption of constant in the deterministic term means intercept in the cointegrating relations but not in VAR; for constant and trend, it means an intercept term and a linear trend term in the cointegrating relations but no linear trend in VAR; and for orthogonal trend, it means an intercept term in the cointegration relations and a linear trend term in VAR. For more details see its help menu or the book accompanying the software by Lütkepohl and Krätzig, M. (eds.) (2004).
### Table 3: Unit Root Tests

<table>
<thead>
<tr>
<th>Variable</th>
<th>Full Sample</th>
<th>Pre-Crisis Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intercept</td>
<td>Intercept &amp; Trend</td>
</tr>
<tr>
<td>CP</td>
<td>-2.63</td>
<td>-2.85</td>
</tr>
<tr>
<td>PFUS</td>
<td>-3.61*</td>
<td>-3.57**</td>
</tr>
<tr>
<td>YUS</td>
<td>-0.50</td>
<td>-3.35</td>
</tr>
<tr>
<td>RUS</td>
<td>-1.32</td>
<td>-4.37*</td>
</tr>
<tr>
<td>PFMY</td>
<td>-3.91*</td>
<td>-3.80**</td>
</tr>
<tr>
<td>YMY³</td>
<td>-0.66</td>
<td>-1.49</td>
</tr>
<tr>
<td>M1</td>
<td>-0.01</td>
<td>-2.72</td>
</tr>
<tr>
<td>R3M</td>
<td>-2.72</td>
<td>-3.42</td>
</tr>
<tr>
<td>BLR</td>
<td>-2.03</td>
<td>-2.67</td>
</tr>
<tr>
<td>L</td>
<td>-1.77</td>
<td>-2.86</td>
</tr>
<tr>
<td>ER</td>
<td>-1.26</td>
<td>-2.58</td>
</tr>
<tr>
<td>KLCI</td>
<td>-1.64</td>
<td>-2.56</td>
</tr>
</tbody>
</table>

1. * and ** refer to the 1% and 5% level of significance respectively. Lag differences included in the tests are chosen automatically based on the AIC.
3. Refers to the seasonally adjusted real GDP series.
4. The test statistic when a structural break in 1987:1 is incorporated is -3.12 and statistically significant at the 5% level.

* shows there are more than one cointegrating relations in the model. These findings are robust across the different assumptions on the deterministic term, different sample periods and the choice of lags. Several general observations can be gleaned. Both the assumptions of intercept, and intercept and linear trend give essentially a similar number of cointegration relations, while the orthogonal trend assumption gives a slightly lower number. However, when the optimal lag is chosen, the number of cointegrating relations increases.
Table 4: Cointegration Tests

<table>
<thead>
<tr>
<th>H0(r)²</th>
<th>Different Deterministic Term Assumptions:</th>
<th>Full Sample</th>
<th>Pre-Crisis Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intercept</td>
<td>Intercept &amp; Trend</td>
<td>Orthogonal Trend</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r = 0</td>
<td>543*</td>
<td>563*</td>
<td>489*</td>
</tr>
<tr>
<td>r = 1</td>
<td>418*</td>
<td>446*</td>
<td>373*</td>
</tr>
<tr>
<td>r = 2</td>
<td>322*</td>
<td>364*</td>
<td>296*</td>
</tr>
<tr>
<td>r = 3</td>
<td>255*</td>
<td>288*</td>
<td>229*</td>
</tr>
<tr>
<td>r = 4</td>
<td>199*</td>
<td>222*</td>
<td>174*</td>
</tr>
<tr>
<td>r = 5</td>
<td>148*</td>
<td>166*</td>
<td>126**</td>
</tr>
<tr>
<td>r = 6</td>
<td>109**</td>
<td>120**</td>
<td>88</td>
</tr>
<tr>
<td>r = 7</td>
<td>77**</td>
<td>81</td>
<td>58</td>
</tr>
<tr>
<td>r = 8</td>
<td>49</td>
<td>52</td>
<td>34</td>
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<td>r = 9</td>
<td>25</td>
<td>29</td>
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<td>5</td>
</tr>
<tr>
<td>r = 11</td>
<td>3.2</td>
<td>3.2</td>
<td>n.a.</td>
</tr>
<tr>
<td>r = 0</td>
<td>582*</td>
<td>627*</td>
<td>548*</td>
</tr>
<tr>
<td>r = 1</td>
<td>438*</td>
<td>477*</td>
<td>406*</td>
</tr>
<tr>
<td>r = 2</td>
<td>360*</td>
<td>388*</td>
<td>334*</td>
</tr>
<tr>
<td>r = 3</td>
<td>291*</td>
<td>319*</td>
<td>268*</td>
</tr>
<tr>
<td>r = 4</td>
<td>225*</td>
<td>253*</td>
<td>209*</td>
</tr>
<tr>
<td>r = 5</td>
<td>172*</td>
<td>199*</td>
<td>154*</td>
</tr>
<tr>
<td>r = 6</td>
<td>124*</td>
<td>150*</td>
<td>107*</td>
</tr>
<tr>
<td>r = 7</td>
<td>77**</td>
<td>104**</td>
<td>62</td>
</tr>
<tr>
<td>r = 8</td>
<td>51</td>
<td>61</td>
<td>37</td>
</tr>
<tr>
<td>r = 9</td>
<td>30</td>
<td>37</td>
<td>20</td>
</tr>
<tr>
<td>r = 10</td>
<td>17</td>
<td>19</td>
<td>6.8</td>
</tr>
<tr>
<td>r = 11</td>
<td>6.5</td>
<td>6.5</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

1 The trace statistics are shown. For simplicity, the VAR model used here comprises the 12 variables, an intercept term and the Asian crisis dummy variable.
2 * and ** refer to the 1% and 5% level of significance respectively. An asterisk at H0 : r = 0 means the rejection of the null hypothesis that there is no cointegrating relations in the system; alternatively, the acceptance of one or more cointegrating relations in the system.
3 This assumes that there is a linear trend in the series but not in the cointegration relations.
4 Optimal lag is chosen based on the AIC, HQC and SC. The results presented are for orthogonal trend. The lag is 6 in the case of the full sample, and 4 in the pre-crisis sample.
5 n.a Not applicable.
Table 5: Lag Order Selection Criteria

<table>
<thead>
<tr>
<th>Lag</th>
<th>Akaike</th>
<th>Schwarz</th>
<th>Hannan-Quinn</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.46</td>
<td>1.13</td>
<td>0.73</td>
</tr>
<tr>
<td>1</td>
<td>-24.94</td>
<td>-20.24*</td>
<td>-23.04*</td>
</tr>
<tr>
<td>2</td>
<td>-25.27</td>
<td>-16.54</td>
<td>-21.75</td>
</tr>
<tr>
<td>3</td>
<td>-25.98</td>
<td>-13.23</td>
<td>-20.84</td>
</tr>
<tr>
<td>4</td>
<td>-29.34*</td>
<td>-12.56</td>
<td>-22.57</td>
</tr>
</tbody>
</table>

* Indicates the lag order selected by the said criterion. The criteria are based on Chapter 4, Lütkepohl (1993). The same VAR model as in the cointegration tests was used.

References


