THE ROLE OF AGGREGATE DEMAND SHOCKS IN EXPLAINING INDONESIAN MACRO-ECONOMIC FLUCTUATIONS

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April 2000

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ISSN 1174-5045
ISBN 1-877176-63-X
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Abstract

A variant of the Mundell-Fleming model of the Indonesian macroeconomy is constructed and analysed using the SVAR methodology. The short-run relations among the variables in the model are identified through the use of contemporaneous restrictions. The long-run relations are developed by imposing restrictions related to (i) a long-run money demand equation and (ii) a modified McCallum (1994) policy reaction function on the cointegration matrix. The smallness of the economy is acknowledged by restricting appropriate elements of the loading matrix. Most of the estimated parameters of short-run as well as long-run relations, and the shape of impulse response functions, are consistent with small open economic theory. The model produces richer dynamics of the variables compared to a similar SVAR study of the macroeconomy of Indonesia. Our strategy of explicitly incorporating transmission mechanisms for aggregate external shocks, imposing the two long run restrictions and acknowledging the smallness of the economy allows greater (smaller) role for shocks to aggregate demand (supply) to affect macroeconomic fluctuations.
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1. Introduction

Most of the recent studies assessing sources of macroeconomic fluctuations using variants of the IS-LM model within the Structural VAR (SVAR) framework have been carried out within a closed economy setting as for a relatively large economy like the US. For example, in Keating (1992), Gali (1992), and Rapach (1998), sources of economic fluctuations are identified through four shocks (aggregate supply, real spending, money demand and money supply), with the main difference amongst them being the way in which (over-)identifying restrictions are imposed on the parameters. Utilising contemporaneous identifying restrictions, Keating found that output fluctuations of the US economy are determined not only by shocks to aggregate supply, but also by shocks to real spending and to money demand. Employing long-run identifying restrictions for the same set of variables, he furthermore found that, beside aggregate supply shocks, output variability is also explained by real spending shocks and, to a lesser effect, by money supply shocks. Gali, through the use of a combination of contemporaneous and long-run identifying restrictions, obtains similar findings. Using similar long-run identifying restrictions, Rapach also confirms this finding but among the aggregate demand shocks, it is only the spending balance shock that affects US output fluctuations. Hence, the three studies reach very similar conclusions in that output fluctuations (i.e., business cycle movements) are driven not only by aggregate supply shocks but also by aggregate demand shocks, particularly in the short-run.

Siregar and Ward (1999) develop a similar model in searching for sources of fluctuations in the Indonesian macro-economy. They found that fluctuations in output and in other macroeconomic variables are predominantly explained by shocks to aggregate supply with aggregate demand shocks playing a lesser role. Although their model is able to forecast that aggregate demand shocks, such as the Asian Financial Crisis (AFC), would affect Indonesian output fluctuations for only about three years, which is by now in accordance with reality, the absence of explicit transmission mechanisms for foreign shocks to affect the economy is a drawback. Hence in this study we develop answers to the following two research questions: (a) Will the role of aggregate demand shocks in explaining macro-economic variability empirically change if the small and open nature of the economy, and transmission mechanisms for foreign shocks are explicitly incorporated into the model? (b) Among the various shocks to aggregate demand, which is the most important one in accounting for output fluctuations?
The present study employs 62 quarterly observations spanning the period from 1984:2 to 1999:1. The limited number of observations, however, only enables us to construct a five-variable SVAR model containing a foreign variable (interest rate of the US), the real exchange rate, and three domestic variables (output, money demand, and interest rate). The model is developed based on the Mundell-Fleming open economy framework. Long-run restrictions including a modification of the Uncovered Interest Parity (UIP) condition, and the existence of a long-run money demand function are imposed on the cointegration matrix (β). The small, open nature of the economy is considered explicitly through the imposition of zero restrictions on the structural loading matrix (α). Identification of shocks to the economy is made through the use of contemporaneous restrictions, including (a) shocks to the rest of the world’s interest rate, (b) aggregate supply shocks, (c) spending balance shocks, (d) shocks to short-run money demand, and (e) money supply shocks.

2. Model Specification

On the demand side, momentarily assuming no currency substitution, the economy can be represented by LM and IS equations, respectively, as follows:

\[
\frac{M}{P} = m(Y_i, I) \quad (1)
\]

\[
Y = f(I-\pi^e, Y_i, S.P*/P) \quad (2)
\]

where \(M\) is money stock, \(P\) is the price level, \(Y_i\) is real income, \(I\) is the nominal interest rate, \(I-\pi^e\) is the real interest rate (\(\pi\) is the inflation rate and the superscript (\(^e\)) indicates expectation), \(Y\) is real output, \(S\) is the nominal exchange rate defined as the domestic price of foreign currency (Rp/US$). The asterisk indicates a foreign (the rest of the world) variable, and \(S.P*/P \equiv Q\) is the real exchange rate. Equation (1) is the money demand, in which it is generally accepted that \(m_{Y_i} > 0\) and \(m_I < 0\). Under equilibrium, output equals income, hence

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only Y is used in what follows. The relation between domestic and the rest of the world interest rates is, as usual, specified through a proposed UIP relation:

\[ I - I^* = \frac{S^e}{S}. \]  (3)

Following Blanchard and Fischer (1989), in equation (3) \( S^e \equiv (dS/dt)^e \), which is the current expectation of next period’s value of S.

The smallness of the Indonesian economy implies that I* is given. It is assumed that I* is solely governed by exogenous shocks consistent with the rest of the world’s monetary policy as follows

\[ I^* = g(msw) \]  (4)

where msw represents unexpected contractionary monetary policy in the rest of the world. It is expected that \( g_{msw} > 0 \).

Assuming (3) holds, any combination of two of I, I*, and S' \( \equiv S^e/S \) may lead to determination of the third. So, to account for currency substitution, since I is already in (1), we may only introduce into (1) either I* or S'. The coefficient on I* could be interpreted as the effect of a change in the opportunity cost of holding foreign currency, which in general is \( m_{I^*} > 0 \). A depreciation (appreciation) in domestic currency would lead to a decrease (increase) in rupiah holding, i.e., \( m_S < 0 \).\(^2\) Fluctuations in M/P may also occur due to a change in ‘preference’ (T) associated with the risk of holding the currency.\(^3\) The steady growth of the economy during the 1970s to 1996, for example, had induced economic agents not to place more preference on foreign currencies over the Rupiah. Beside these variables, it is also assumed that fluctuations in M/P are driven by exogenous shocks of its own (md) and that \( m_{md} > 0 \). Based on some experimentation (details available on request), statistically adequate specifications were found by including Y, I and S in the contemporaneous demand function and the other variables in the long run function. The contemporaneous demand function is as follows:

\[ M/P = m'(Y, I, S, md) \]  (1’)

---

\(^2\) Since \( S^e \) is unobservable, to simplify the model, instead of S' we include S into the equation of M/P.

\(^3\) It is commonly assumed that preference or taste is constant in the short run. So, this variable is only included in a ‘long-run’ money demand equation.
Following Blanchard and Fischer (1989, pp. 537-540), it is momentarily assumed that prices are fixed (hence $\pi_e=0$) and that the economy is in its static equilibrium state (hence $S^e=0$). Fixing prices in the short-run implies that $\partial(M/P)/\partial S = \partial(M/P)/\partial Q$. So, the short-run money demand (1’) can be re-written as:

$$M/P = m''(Y, I, Q, md)$$

(1’)

Under these assumptions, the right hand side of (3) becomes zero, hence the domestic interest rate must equal the world rate. Normalizing the IS equation in terms of the real exchange rate, equation (2) can therefore be re-expressed as:

$$Q = q'(Y, I^*)$$

(2’)

Output and the real exchange rate could be related in a positive or negative manner (Garratt et al., 1999). The direction of this relationship depends on sources of changes in output. An increase in $Y$ could originate either from an increase in investment or from an increase in net exports. Through the former the increased investment leads to a rise in interest rates, which, from (3), would be followed by an exchange rate appreciation, implying that $q'_Y < 0$. Through the latter the increase in net exports would have required that the real exchange rate be depreciated, implying that $q'_Y > 0$. Ahmad and Harnhirun (1996), however, found only evidence of exports Granger-causing economic growth in developing economies (i.e., the ASEAN countries including Indonesia). This may call into question the importance of the net-exports-to-output route, suggesting that it is more likely to have $q'_Y < 0$. Furthermore, an increase in the world interest rate reduces investment, leading to an increase in the supply of Rupiahs, hence causing the real exchange rate to depreciate, i.e., $q'_i > 0$. Finally, following De Arcangelis (1996), $Q$ is also assumed to be driven by general shocks to spending balance (bp). These shocks may include unanticipated fiscal policies, which, if contractionary would lead to a real exchange rate depreciation, i.e. $q'_{bp} > 0$. Hence, the IS equation can then be specified as follows:

---

4 This assumption might hold particularly in earlier parts of the period under study; the country started to float its currency in 1997. Over the entire sample period, however, $(dS/dt)^e=0$ is not reasonable, so this strong assumption is relaxed in the long run through a modification of the UIP relation.

5 Under fixed exchange rate, this mechanism is of course most unlikely to occur, for fixing the exchange rate would theoretically make its correlation with output be equal, or at least close, to zero.

6 As Indonesia is an OPEC member, through this channel, it may be more intuitive to state that the increased output is due to an unexpected increase in OPEC oil price, which has in general been followed by increases in investment.
\[ Q = q''(Y, I^*, \text{bp}) \]  

The presence of nominal rigidities may lead to a situation whereby changes in nominal variables have effects on real variables such as output. Returning to equation (3), in response to a currency crisis, for example, the monetary authority may implement a contractionary policy which decreases the nominal money supply, leading to a one percentage point increase in \( I \). On one hand, for given values of \( I^* \) and \( S^e \), this would be followed by a decrease in \( S \) (a nominal appreciation). On the other hand, the money contraction would bring about price decreases. If the nominal money reduction induces all firms to reduce their prices by the same factor as of the money reduction, the monetary contraction would translate to an equivalent decrease in general price level (\( P \)), thus, given \( P^* \), leaving the real exchange rate unchanged. The presence of menu costs and/or coordination problems, however, may cause some firms to decrease their prices by less than that factor, leading to aggregate price rigidity. This implies that the decrease in \( P \) is not equivalent to the decrease in \( S \), therefore, given \( P^* \), the monetary policy may affect real exchange rate fluctuations. So, if (2”) were to be specified in terms of \( Y \), nominal influences such as the crisis would affect the output through \( Q \).

Still on the demand side of the economy, the monetary authority is assumed to formulate its short-run policy based on the reaction function as follows:

\[ I = i(I^*, Y, Q, M/P) \]  

Traditionally, this kind of reaction function is expressed in terms of a money stock variable. However, Cushman and Zha (1995), based on Bernanke and Blinder (1992), argue that the monetary policy should be identified through the short-run interest rate, implying that the reaction function be expressed as the interest rate equation. It is expected that, consistent with (3), \( i_I > 0 \) and \( i_Q > 0 \), whereas \( i_Y \) could be positive or negative depending on whether or not the monetary authority would attempt to accommodate an increase in real money balance, and \( i_{M/P} < 0 \). Furthermore, it is assumed that fluctuations in domestic interest rates are also driven by unexpected monetary policy shocks (\( m_s \)). As commonly expected, a monetary contraction would lead to an increase in domestic interest rates, i.e., \( i_{m_s} > 0 \). Since, given \( P \), it is difficult to distinguish effects of \( m_s \) (e.g., a contractionary monetary policy) on \( I \) from

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7 Besides, based on various unit root tests, it is found that log of money stock is of \( I(2) \). So, expressing the reaction function in terms of money may lead the system to be ‘imbalance’. Using interest rate equation to identify monetary policy shocks however requires an increase in the disturbance term of the equation to be interpreted as a contractionary policy. This is because the residuals are positively correlated with the endogenous variable.
effects of a decrease in M/P on I, M/P is excluded from (5), so the contemporaneous (i.e., short run) reaction function is expressed as

\[ I = i'(I^*, Y, Q, ms) \]  \hspace{1cm} (5')

The supply side of economy is represented by an aggregate supply function. Output in this function is assumed to be solely governed by supply or technology shocks (as) as follows:

\[ Y = y(as) \]  \hspace{1cm} (6)

Technology shocks would increase the level of output by improving productivity. Aggregate supply shocks, such as an unexpected increase in OPEC oil prices, would lead to increases in income of this oil producer country. So, it is expected that \( y_{as} > 0 \). Equations (4), \( (1'') \), \( (2'') \), \( (5') \) and (6) constitute the contemporaneous relations of the model. Long-run relationships are obtained as follows.

McCallum (1994), and the literature cited therein, provide sufficient evidence that the UIP expressed as (3) does not hold. That is, a unit increase in (I-I*) in fact leads to a three to four fold decrease in \( \log(S^*/S) \), which clearly violates the one-for-one relation in (3) and implies a positive correlation between I and S. Although in general the correlation is asserted to be negative -- i.e. a policy-induced increase in domestic interest rates would, with foreign conditions and expectations of future conditions unchanged, lead to an appreciation (a decrease in S) -- a positive correlation between I and S could also occur, particularly if (I-I*) is thought to be endogenous. That is, using (I-I*) as policy instrument, monetary authorities tend to resist quick changes in exchange rates (and to smooth fluctuations in interest rates too). This way, an exchange rate appreciation would be followed by monetary expansion, resulting in a decrease in interest rates. This suggests the use of a policy reaction function as in McCallum (1994), namely:

\[ x_t = a_1 (s_t - s_{t-1}) + a_2 x_{t-1} + u_t \]

where \( x = (I-I^*) \), \( s \) is the log of \( S \), and \( u \) represents random policy influences.

McCallum (1994) found that application of both UIP and the reaction function simultaneously would ensure that the UIP holds, and explain the positive correlation between I and S. This
inspires us to use UIP, but only implicitly by taking it into consideration in the construction of the IS and LM equations above, and to employ a policy reaction function developed below. To make it useful as a long-run relation, McCallum’s reaction function is generalised as follows.

To be relevant to the long run, the variables in the reaction function need to form a cointegrating vector with an I(0) error term, say \( v_t \), which can replace \( u_t \) in representing random policy influences. Generalising the above equation in explicit form, we have:

\[
\sigma_1 I_t + \sigma_2 I_t^* + \lambda_1 s_t + \lambda_2 s_{t-1} + \sigma_3 I_{t-1} + \sigma_4 I_{t-1}^* = v_t,
\]

which, when normalised in terms of \( I_t - I_t^* \) gives:

\[
\sigma_1 (I_t + \sigma_2 / \sigma_1 I_t^*) + \lambda_1 (s_t + \lambda_2 / \lambda_1 s_{t-1}) + \sigma_3 (I_{t-1} + \sigma_4 / \sigma_3 I_{t-1}^*) = v_t.
\]

Dividing through by \( \sigma_1 \), and letting \( \sigma_1 = -\sigma_2 \), and \( \sigma_3 = -\sigma_4 \) we have:

\[
(I_t - I_t^*) + \frac{\lambda_1}{\sigma_1} (s_t + \lambda_2 / \lambda_1 s_{t-1}) + \sigma_3 / \sigma_1 (I_{t-1} - I_{t-1}^*) = v_t / \sigma_1.
\]

Now, since \( x = (I-I^*) \), defining \( c_1 = -\lambda_1 / \sigma_1 \), \( c_2 = -\lambda_2 / \lambda_1 \), and \( c_3 = -\sigma_3 / \sigma_1 \), the above equation can be simplified to:

\[
x_t = c_1 (s_t - c_2 s_{t-1}) + c_3 x_{t-1} + v_t / \sigma_1. 
\]  (7)

So the McCallum reaction function is the special case of (7) where \( c_2=1 \), i.e., \(-\lambda_2=\lambda_1\), and \( v_t / \sigma_1 \equiv u_t \). Now (7) can be expressed using the lag operator as follows:

\[
(1 - c_3 L) x_t = c_1 (1 - c_2 L) s_t + v_t / \sigma_1,
\]

and since in the long-run the time subscripts can be ignored, we have:

\[
I-I^* = \theta s + z_l \quad \text{where} \quad \theta = \frac{c_1 (1 - c_2 L)}{1 - c_3 L} \quad \text{and} \quad z_l = \frac{v}{\sigma_1 (1 - c_3 L)}. 
\]  (7')
Equation (7') depicts the long run version of McCallum’s policy reaction function. Under sensible values of the parameters, i.e., $c_1 > 0$ and $0 < (c_2, c_3) < 1$, it will be the case that $\theta > 0$. Moreover, it should be clear that since $z_1$ is I(0) and represents white-noise random shocks influencing long-run monetary policy, these random shocks would only temporarily affect variables of the model, especially the real ones.

The second long-run relation is a long-run money demand function. As was described in the explanation for (1’) and in footnote 4, this function is specified as follows:

$$M/P = v(Y, I, I^*, T, z_2)$$

(8)

where $z_2$ represents white-noise exogenous shocks that cause $M/P$ to deviate from its long-run level. Following Garratt et al (1999), who also employ a similar long-run money demand equation, $v_Y$ is set to unity, and the expected signs of the other derivatives are as before. Applying this restriction allows us to interpret (8) as the equation of money velocity.

Before constructing the empirical model, it is necessary to examine the time series properties of each variable used in the model. Based on a series of unit root tests (details available on request), each of the variables ($I^*, Y, Q, M/P, \text{ and } I$) is found to be I(1), hence cointegration becomes a critical issue. As some variables, especially output and real money, clearly exhibit trends, in addition to including seasonal dummy variables ($d_t$) in the underlying standard (reduced form) VAR system, an unrestricted constant ($\mu_0$) and a restricted trend ($t$) are included. In compact matrix notation, this can be expressed as follows:

$$x_t = \sum_{i=1}^{k} \Pi_i x_{t-i} + \mu_0 + \mu_1 t + \psi d_t + \varepsilon_t$$

(9)

where $x = (I^*, Y, Q, M/P, I)'$. The corresponding VEC representation of (9), which is also called in the literature as the cointegrated VAR model, is as follows:

$$\Delta x_t = \sum_{i=1}^{k-1} \Gamma_i \Delta x_{t-i} + \mu_0 + \mu_1 t + \psi d_t + \alpha \beta' x_{t-1} + \varepsilon_t$$

(9')

---

8 Except interest rates, all variables are in logarithmic form. The interest rate is written in the form of $\log(1+i/100)$ which approximately equal to $i$ (interest rates) itself. So, in what follows the variables are written, respectively, as: IRW, LY, LQ, LMP, and IR.
Elements of $\alpha$ and $\beta$ in (9') form, respectively, the loading and the cointegration matrices. Since (9’) is a representation of (9), estimates of (9), which will be used in the SVAR analysis, can obviously be obtained from estimated (9’). In a more compact form, the reduced form (RF) VAR in (9) can be re-expressed as follows:

$$\Pi(L) x_t = \varepsilon_t$$

where $\Pi(L) = I_n - \sum_{i=1}^{k} \Pi_1 L^i$ and $\varepsilon_t \sim VWN(0,\Sigma)$.

Following Mosconi (1998), the structural version of the VAR model can be expressed as:

$$A(L) x_t = v_t = B e_t$$

where $A(L) = A + \sum_{i=1}^{k} A_1 L^i$, $v_t \sim VWN(0,\Omega)$, $e_t \sim VWN(0,I_n)$, and $\Omega = BB'$. The RFVAR and SVAR parameters are related through: $A \Pi_i = -A_i$ for $i=1,2,\ldots,k$ and $A \Sigma A' = \Omega$. This leads to:

$$\Sigma = A^{-1} B B' A^{-1}$$  \hspace{1cm} (10)

3. **Data and Time Series Property of Each Variable**

The series used in the model originate from the following variables: nominal exchange rate (NER), money stock (MS), domestic short term interest rate (IR6), real output (GDP90), consumer price index (CPI90), short term interest rate of the US (USIR3), and consumer price index of the US (USCPI). All these series are seasonally unadjusted and observed from 1984:2 to 1999:1.9 NER, measured in Rp/US$, is employed to represent the rate of exchange of Rupiah. Up to 1996:2, the NER is collected from the IFS0996 CDROM (key: 536AE.ZF). For 1996:3 this variable is gathered from the IFS (Aug 1997) Book and for 1996:4-1999:1 from the Indonesian Central Bank (Bank Indonesia, BI).

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9 Prior to 1984:2 the government controlled the interest rate. The six monthly time deposit interest rate from 1981:1-1984:1, for example, had been kept constant at 6% p.a. Avoiding this fixed variable, we choose to start the observation from 1984:2, which is also the beginning of Pelita IV (The Fourth National Development Planning), from which the economy has been started emphasising on industrial sectors.
To represent MS, we use M1 measured in Rp billions. For 1984:2-1993:1 this series is collected from the IFS0996 CDROM (key: 53634.ZF), for 1993:4-1996:3 from the IFS Book, and for 1996:4-1999:1 from BI. As the series is not available in these sources for 1993:2-1993:3, these two missing observations are filled by interpolation using an exponential growth equation.

Since for the rest of the world we use the three-month T-bill rate, it will be more appropriate to use a similar series for Indonesia. Due to non-availability of consistent series for the sample period, we decide to use the six month time deposit interest rate, measured in \% p.a., as a proxy for the Indonesian short term interest rate (IR6). The use of this series (annually) in Siregar and Ward (1999) results in theoretically consistent estimates of interest rate related equations. For 1984:2-1985:4 and 1986:3-1992:4, IR6 is available from the IFS0996 CDROM (key: 53660L.ZF) and for 1996:4-1999:1 from the BI. The missing observations for 1986:1-1986:2 and 1993:1-1993:4 are filled using the formula: \[ y(t+j) = y(t) + \frac{d}{(m+1)}j, \] where \( y(t+j) \) is the \( j \)-th missing observation in a particular time interval, \( y(t) \) is the last available observation, \( d \) is the difference between the last and the next available observations, and \( m \) is the number of missing observations in the time interval. The missing quarterly observations for 1994:1-1996:3 are filled by employing a linear regression of IR6 on IR3 estimated using annual data.

To represent output, Indonesian GDP at 1990 prices (GDP90, in Rp billions) is used. In the IFS0996 CDROM, this series is available annually up to 1995 (key: 53699B.PZF). Quarterly GDP data is published by the BPS (Central Bureau of Statistics of the Republic of Indonesia) only from 1997:1, so this variable is also available annually for 1996. To obtain a quarterly proxy for 1984:2-1996:4, we interpolate the annual data, started from 1981 (so as to have a sufficient number of observations for the interpolation) up to 1996, using the EZX11 program.

Due to the non-availability of a quarterly GDP deflator for Indonesia over the sample period, to represent prices we use the consumer price index with 1990=100 (CPI90). Throughout 1984:2-1996:1 this variable is obtained from the IFS0996 CDROM (key: 53664.ZF). For 1996:2-1999:1 this series is collected from the BPS.

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10 IMF started to publish 3-monthly time deposit interest rate (IR3), rather than the 6-month one, from 1994:1.
11 The estimation uses the sample period of 1990-1997. It is started from 1990, for this is the first available observation for annual IR3, published in the 1999 IFS Yearbook from 1990. As mentioned in footnote above, IR6 is no more published by the IMF from 1994. Since, however, it is available in Siregar and Ward (1999) up to 1997, we then use 1997 as the last observation to estimate the regression line.
Since domestic prices are represented by CPI90, we also use consumer price index of the U.S. with 1990=100 (USCPI90) to represent prices of the rest of the world. This series is collected from the IFS0996 for 1984:2-1996:2 and from IFS books for 1996:3-1999:1. The short term interest rates of the rest of the world are represented by the 3-monthly T-bill interest rate of the USA measured in % p.a. (USIR3). This series is collected from the US Federal Reserve System webpage.

All the series are expressed in natural logarithms.\textsuperscript{12} Time series graphs of the series are presented in Appendix Figures 1 and 2. It can be seen from these graphs that all series exhibit a trend. The (logs of) nominal and real exchange rates clearly indicate that from the first observation to 1997:2, the government still had some control on the rate of exchanges. However, from mid 1997, due to the Asian Financial Crisis (AFC), the government could not afford to keep the control and started to float the Rupiah. This has led, not only the exchange rate but, almost all domestic variables, to depart from their historical trend. It is worth noting at this point that during the last two years of observations, LNER and LQ jumped up, forming a hump shape in their plots. This might indicate an exchange rate undershooting (Appendix Figure 1). Furthermore, the gap between IR and IRW had in general been constant up to the mid-1990 (Appendix Figure 2). After that point of time, however, it has varied and tended to become wider in the most recent observations. For the whole sample period, it is clear that LP has a steeper slope than LPW and even steeper after mid-1990. Relating this fact to the non-constancy of the gap between the two interest rates may suggest that the usual UIP relation does not hold for the economy during the 1990s, and that this has something to do with the (ratio of) two prices. Since the ratio of two prices defines the real exchange rate, this may be seen as empirical justification of replacing the nominal exchange rate in (7) with the real one.

Before constructing the econometric model, it is necessary to test for unit roots in each series with various testing procedures, the results being presented in Tables 1-3.

\textsuperscript{12} Interest rate i is expressed as log(1+i/100), which is approximately the same as i itself. The mnemonics for the logged variables are: LNER and LQ for nominal and real exchange rates, LMS and LMP for nominal and real money stocks, LY for real output, LP and LPW for domestic and the rest of the world prices, and IR and IRW for domestic and the rest of the world short term interest rates.
Table 1

<table>
<thead>
<tr>
<th>Variable / Optimal Lag Lengtha</th>
<th>Constant and Trend</th>
<th>Constant, No Trend</th>
<th>No Constant, No Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LM Test: p=3</td>
<td>-2.502</td>
<td>0.326</td>
<td>-2.201</td>
</tr>
<tr>
<td>BIC: p=2</td>
<td>-2.360</td>
<td>0.396</td>
<td>-1.934</td>
</tr>
<tr>
<td>LPW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIC: p=5</td>
<td>-0.498</td>
<td>0.981</td>
<td>-1.563</td>
</tr>
<tr>
<td>LM: p=1</td>
<td>0.143</td>
<td>0.997</td>
<td>-1.752</td>
</tr>
<tr>
<td>LY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIC, GS Test: p=6</td>
<td>0.004</td>
<td>0.995</td>
<td>-2.829</td>
</tr>
<tr>
<td>LB Test: p=1</td>
<td>-0.531</td>
<td>0.979</td>
<td>-1.383</td>
</tr>
<tr>
<td>LNER</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIC, LM Test: p=5</td>
<td>-1.133</td>
<td>0.914</td>
<td>0.823</td>
</tr>
<tr>
<td>LB Test: p=1</td>
<td>-1.773</td>
<td>0.705</td>
<td>-0.282</td>
</tr>
<tr>
<td>LQ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIC: p=5</td>
<td>-1.509</td>
<td>0.814</td>
<td>-0.513</td>
</tr>
<tr>
<td>LB Test: p=1</td>
<td>-2.852</td>
<td>0.185</td>
<td>-1.981</td>
</tr>
<tr>
<td>LB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIC, GS Test: p=8</td>
<td>0.307</td>
<td>0.998</td>
<td>2.418</td>
</tr>
<tr>
<td>BIC, LB, LM: p=2</td>
<td>-1.323</td>
<td>0.872</td>
<td>1.458</td>
</tr>
<tr>
<td>LMS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min. AIC: p=7</td>
<td>-1.844</td>
<td>0.669</td>
<td>1.379</td>
</tr>
<tr>
<td>BIC, LB Test: p=1</td>
<td>-1.813</td>
<td>0.686</td>
<td>0.600</td>
</tr>
<tr>
<td>LMP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIC: p=6</td>
<td>-3.652</td>
<td>0.035</td>
<td></td>
</tr>
<tr>
<td>All Others: p=5</td>
<td>-3.740</td>
<td>0.028</td>
<td></td>
</tr>
<tr>
<td>IR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All: p=2</td>
<td>-2.612</td>
<td>0.277</td>
<td>-2.742</td>
</tr>
<tr>
<td>DIRW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GS Test: p=7</td>
<td>-3.428</td>
<td>0.059</td>
<td>-3.462</td>
</tr>
<tr>
<td>BIC: p=1</td>
<td>-3.712</td>
<td>0.029</td>
<td>-3.822</td>
</tr>
<tr>
<td>DLQ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIC: p=3</td>
<td>-2.829</td>
<td>0.194</td>
<td>-2.372</td>
</tr>
<tr>
<td>All Others: p=1</td>
<td>-3.609</td>
<td>0.038</td>
<td></td>
</tr>
<tr>
<td>DLY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIC, BIC, GS: p=8</td>
<td>2.747</td>
<td>1.000</td>
<td>0.899</td>
</tr>
<tr>
<td>LM: p=2</td>
<td>-3.564</td>
<td>0.042</td>
<td></td>
</tr>
<tr>
<td>DLNER</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIC, BIC, GS: p=4</td>
<td>-2.303</td>
<td>0.425</td>
<td>-2.051</td>
</tr>
<tr>
<td>LM: p=1</td>
<td>-4.379</td>
<td>0.005</td>
<td></td>
</tr>
<tr>
<td>DLMP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIC, GS Test: p=7</td>
<td>-3.513</td>
<td>0.049</td>
<td>-2.493</td>
</tr>
<tr>
<td>LB, LM: p=3</td>
<td>-2.222</td>
<td>0.468</td>
<td>-2.245</td>
</tr>
<tr>
<td>DIR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIC: p=3</td>
<td>-3.752</td>
<td>0.027</td>
<td></td>
</tr>
<tr>
<td>LB, LM, GS: p=1</td>
<td>-4.458</td>
<td>0.004</td>
<td></td>
</tr>
</tbody>
</table>

a. Optimal lag length for each variable in its testing equation is determined by using selection criteria (AIC and BIC) and the Ljung-Box (LB), the Lagrange Multiplier (LM), and the General to Specific (GS) tests. To do all unit root tests in this study, we use the RATS software.

b. The constant is significant under unit root. Blank cells suggest that the previous statistic (in the left) has been statistically significant under α=5%.
For all variables in levels, except for LMP, the ADF tests clearly suggest that the null hypothesis of a unit root cannot be rejected (Table 1). Using the KPSS tests, however, the null hypothesis of stationarity is rejected for LMP in levels (Table 2). Furthermore, there is some evidence from the ADF tests on variables in the first differences that the null also cannot be rejected for domestic and the rest of the world prices, output, nominal exchange rate, and money stock, indicating that these variables in levels could be I(2). Using the KPSS tests, however, the null of stationarity cannot be rejected for the first difference of output, provided
that the output growth is non-trending and that the test equation contains positive lags. This may provide a justification to assume that output is I(1). Other variables that are clearly I(1), from Tables 1 and 2, are the domestic and the rest of the world interest rates, the real exchange rate, and the real money stock.

Since the variables are observed quarterly, it is instructive to consider seasonality in testing for the unit root. This can be done using the testing procedure (called HEGY) developed by Hylleberg et al. (1990). The HEGY testing procedure implies that there will be no seasonal unit roots if $'t':\pi_2$ jointly with $'F':\pi_3\cap\pi_4$ are (in absolute terms) greater than their critical values. Furthermore, a series has no unit root at all if the test indicates that all the $\pi$s are be statistically different from zero. As can be seen from Table 3, apart from LPW, the null hypothesis of a seasonal unit root cannot be rejected for all variables in levels. The HEGY tests for variables in the first differences clearly suggest no unit root at all for DIRW and DIR, indicating that the two interest rates are I(1). For the other first differenced variables, however, the null of no unit root at all cannot be rejected, except for the rest of the world prices--where the null of seasonal unit root is rejected. Given the small size of observations in the present study, the test's lack of power against stationary but near unit root processes, and the wider use of the previous two tests, we prefer to conclude this section by using results from the ADF and the KPSS tests. On balance these tests suggest that each of IRW, IR, LY, LQ, and LMP is integrated of order one. This, obviously, needs further analyses to be carried out using first differenced variables, if no cointegration exists among the five variables in levels. The presence of cointegration(s) will, otherwise, require further analyses to be based on variables in levels using the Johansen methodology.

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13 From the KPSS test statistics, similar assertions can also be made for nominal exchange rates and money stock. This, nevertheless, is not needed because the construction of the SVAR model, which will be done in the next section, would require these variables in the real terms.

14 A rejection of the null of no unit root at all, according to Hylleberg et al. (1990, p.223), would still be 'safe' if among $\pi_3$ and $\pi_4$ only one is different from zero.
4. Results and Discussion

4.1 Routine Tests

As mentioned previously, the presence of cointegration will determine whether or not to use the variables in the first differences. To test for the cointegration rank, it is required to construct a reduced form (RF) VAR model. The (finite) number of lag lengths included in the model is firstly to be selected. 'Optimal' lag length \( k_{\text{opt}} \) for the RF VAR or unrestricted VEC model is generally determined by means of some selection criteria and tests. Through the former, it is practical to begin the selection by fitting a VAR(p) model with the order \( p=0, \ldots, k_{\text{max}} \) and select an estimator of the order \( k_{\text{opt}} \) that minimises the selection criteria. According to Lütkepohl (1999), if the actual data generating process has a finite VAR order and the maximum order \( k_{\text{max}} \) is at least as large as the true order, then Akaike Information Criterion (AIC) asymptotically overestimates the order, whereas the Hannan-Quinn (HQ) and Schwarz (SC) criteria choose the order consistently under quite general conditions. In regard to tests, Franses (1999) argues that the most reliable test is the likelihood ratio (LR).\(^{15}\) As in the case of selection criteria, the LR tests are calculated under predetermined \( k_{\text{max}} \). The test proceeds by calculating the LR statistic for \( p \) vs. \( p-1 \). As long as the resulting statistic is significant, the test is continued for larger values of the integer \( p \). The optimal lag would be found at \( p=k-1 \), where \( k \) is the lag at which the statistic is firstly insignificant.

\(^{15}\) To account for small sample size, the corrected LR statistics are used. See Mosconi (1998) for details.
Table 3
The HEGY Tests for All Series for the SVAR Models and Their First Differences

<table>
<thead>
<tr>
<th>Variable</th>
<th>( t^1: \pi_1 )</th>
<th>( t^1: \pi_2 )</th>
<th>( t^1: \pi_3 )</th>
<th>( t^1: \pi_4 )</th>
<th>F: ( \pi_3 \cap \pi_4 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRW</td>
<td>-1.774</td>
<td>-2.275</td>
<td>-0.708</td>
<td>-6.359***</td>
<td>21.264***</td>
</tr>
<tr>
<td>LPW</td>
<td>-1.036</td>
<td>-3.999***</td>
<td>-3.187</td>
<td>-3.266***</td>
<td>13.055***</td>
</tr>
<tr>
<td>LXR</td>
<td>-0.069</td>
<td>-4.589***</td>
<td>1.599</td>
<td>-0.780</td>
<td>3.108</td>
</tr>
<tr>
<td>LNER</td>
<td>-1.293</td>
<td>-0.825</td>
<td>0.270</td>
<td>-2.209*</td>
<td>2.441</td>
</tr>
<tr>
<td>LQ</td>
<td>-1.876</td>
<td>-1.071</td>
<td>-0.291</td>
<td>-2.430**</td>
<td>3.122</td>
</tr>
<tr>
<td>LP</td>
<td>-0.093</td>
<td>1.132</td>
<td>0.819</td>
<td>-3.342***</td>
<td>6.588</td>
</tr>
<tr>
<td>LMS</td>
<td>-2.631</td>
<td>-1.751</td>
<td>-0.050</td>
<td>-4.387***</td>
<td>10.829***</td>
</tr>
<tr>
<td>LMP</td>
<td>-2.481</td>
<td>-1.394</td>
<td>0.278</td>
<td>-3.708***</td>
<td>6.956*</td>
</tr>
<tr>
<td>IR</td>
<td>-1.872</td>
<td>-2.659</td>
<td>0.254</td>
<td>-2.683**</td>
<td>3.598</td>
</tr>
<tr>
<td>DIRW</td>
<td>-3.458***</td>
<td>-2.334**</td>
<td>-5.263***</td>
<td>-2.790***</td>
<td>25.754***</td>
</tr>
<tr>
<td>DLPW</td>
<td>-1.407</td>
<td>-3.739***</td>
<td>-5.246***</td>
<td>0.449</td>
<td>13.833***</td>
</tr>
<tr>
<td>DLY</td>
<td>0.254</td>
<td>-5.650***</td>
<td>-0.277</td>
<td>0.163</td>
<td>0.042</td>
</tr>
<tr>
<td>DLNER</td>
<td>-0.857</td>
<td>-0.619</td>
<td>-1.039</td>
<td>-1.878</td>
<td>2.273</td>
</tr>
<tr>
<td>DLQ</td>
<td>-1.276</td>
<td>-1.001</td>
<td>-1.670</td>
<td>-1.655</td>
<td>2.631</td>
</tr>
<tr>
<td>DLP</td>
<td>-1.745</td>
<td>1.099</td>
<td>-1.202</td>
<td>-2.661**</td>
<td>4.481</td>
</tr>
<tr>
<td>DLMS</td>
<td>-2.548</td>
<td>-1.564</td>
<td>-2.907</td>
<td>-3.804***</td>
<td>15.440***</td>
</tr>
<tr>
<td>DLMP</td>
<td>-4.031***</td>
<td>-1.509</td>
<td>-2.768</td>
<td>-3.310***</td>
<td>10.835***</td>
</tr>
<tr>
<td>DIR</td>
<td>-2.847***</td>
<td>-2.465**</td>
<td>-1.672</td>
<td>-2.260**</td>
<td>4.399**</td>
</tr>
</tbody>
</table>

a. Critical values are different for testing equations with different deterministic components.
Considering time series plots of variables a priori, the testing equation for each of the non-interest rate variables in levels is set to include an intercept, seasonal dummies, and a deterministic trend (I,S,T). For interest rates in levels and for the first differences of non-interest rate variables, the testing equations are imposed to contain an intercept and seasonal dummies as deterministic components (I,S). Testing equations for interest rates in the first differences contain no deterministic components (N).

b. With no deterministic component (N), critical values for \( t^1: \pi_1 \), \( t^1: \pi_2 \), \( t^1: \pi_3 \), \( t^1: \pi_4 \), and the 'F' under \( \alpha= (5\%, 2.5\%, 1\%) \), respectively, are (-1.95, -2.29, -2.72), (-1.95, -2.27, -2.67), (-1.93, -2.23, -2.66), (-1.76, -2.11, -2.51), and (3.26, 4.04, 5.02). With deterministic components (I,S), critical values for \( t^1: \pi_1 \), \( t^1: \pi_2 \), \( t^1: \pi_3 \), \( t^1: \pi_4 \), and the 'F' under \( \alpha= (5\%, 2.5\%, 1\%) \), respectively, are (-3.08, -3.39, -3.77), (-3.04, -3.37, -3.75), (-3.61, -3.92, -4.31), (-1.98, -2.37, -2.86), and (6.60, 7.68, 9.22). With deterministic components (I,S,T), critical values for \( t^1: \pi_1 \), \( t^1: \pi_2 \), \( t^1: \pi_3 \), \( t^1: \pi_4 \), and the 'F' under \( \alpha= (5\%, 2.5\%, 1\%) \), respectively, are (-3.71, -4.04, -4.46), (-3.08, -3.41, -3.80), (-3.66, -4.02, -4.46), (-1.91, -2.26, -2.75), and (6.55, 7.70, 9.27).

From Table 4, it can be seen that the optimal lag length suggested by the selection criteria alters under different values of \( k_{max} \), whereas the LR test consistently suggests that \( k_{opt}=3 \). (Notice, however, that under \( k_{max}=6 \), the \( k_{opt}=3 \) result occurs only if the 1% significance level is employed.) These results convince us to employ the underlying VAR model of order three.

16 Although, in discussing the time series plots, we have mentioned that IR and IRW also exhibit trend, it is commonly assumed that interest rate testing equations contain no trend.
Table 4
Selection of Lag Length for the Reduced Form VAR Model

<table>
<thead>
<tr>
<th>Selection Criteria / Test</th>
<th>Lag (k)</th>
<th>Optimal Lag Length (k opt)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Under k_max = 8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIC</td>
<td>-38.60</td>
<td>-39.07</td>
</tr>
<tr>
<td>HQC</td>
<td>-37.96</td>
<td>-38.08</td>
</tr>
<tr>
<td>SC</td>
<td>-36.95</td>
<td>-36.48</td>
</tr>
<tr>
<td>LR</td>
<td>-0.001</td>
<td>0.000</td>
</tr>
<tr>
<td>Under k_max = 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIC</td>
<td>-38.64</td>
<td>-39.16</td>
</tr>
<tr>
<td>HQC</td>
<td>-38.01</td>
<td>-38.17</td>
</tr>
<tr>
<td>SC</td>
<td>-37.00</td>
<td>-36.59</td>
</tr>
<tr>
<td>LR</td>
<td>-0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Under k_max = 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIC</td>
<td>-38.64</td>
<td>-39.02</td>
</tr>
<tr>
<td>HQC</td>
<td>-38.01</td>
<td>-38.04</td>
</tr>
<tr>
<td>SC</td>
<td>-37.02</td>
<td>-36.48</td>
</tr>
<tr>
<td>LR</td>
<td>-0.001</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Although determination of the cointegration order (r) can be carried out jointly with determination of relevant deterministic components by using the Pantula principle, we choose to determine r (using Johansen's trace likelihood ratio statistic) conditional on the deterministic components as in (9'). The reason for this is that, as mentioned before, all the series used seem to exhibit trend. Results of the test are summarised in Table 5. It can be seen from the table, that the LR statistic is first 'accepted' at r=2 under unrestricted intercept and restricted trend. Even under the 10% significance level, this conclusion, which suggests the use of two long-run relations, cannot be rejected. The term 'restricted' implies that the trend is linear. The conclusion on the presence of cointegrating relations justifies the use of level variables in the VAR system.

Table 5
Determination of the Rank of the Cointegration Matrix

<table>
<thead>
<tr>
<th>Cointegration Rank (r)</th>
<th>Intercept (μ_0)</th>
<th>Trend (μ_1)</th>
<th>LR-Statistic</th>
<th>Critical Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>α=10%</td>
</tr>
<tr>
<td>0</td>
<td>Unrestricted</td>
<td>Restricted</td>
<td>104.37</td>
<td>83.20</td>
</tr>
<tr>
<td>0</td>
<td>Unrestricted</td>
<td>Unrestricted</td>
<td>100.37</td>
<td>73.40</td>
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<tr>
<td>1</td>
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<td>Restricted</td>
<td>63.14</td>
<td>59.14</td>
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<tr>
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<td>Unrestricted</td>
<td>59.38</td>
<td>50.74</td>
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<td>31.78</td>
<td>39.06</td>
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<td>Unrestricted</td>
<td>28.13</td>
<td>31.42</td>
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<tr>
<td>3</td>
<td>Unrestricted</td>
<td>Restricted</td>
<td>17.55</td>
<td>22.76</td>
</tr>
<tr>
<td>3</td>
<td>Unrestricted</td>
<td>Unrestricted</td>
<td>13.96</td>
<td>16.06</td>
</tr>
<tr>
<td>4</td>
<td>Unrestricted</td>
<td>Restricted</td>
<td>6.12</td>
<td>10.49</td>
</tr>
<tr>
<td>4</td>
<td>Unrestricted</td>
<td>Unrestricted</td>
<td>3.13</td>
<td>2.57</td>
</tr>
</tbody>
</table>

17 Practical discussion on how to deal with intercept and trend in the cointegration analysis can be found, for example, in Franses (1999).
Before imposing any restrictions on the cointegration (and the factor loading) matrices, since the construction of SVAR model requires that the error terms of the underlying VAR(3) model be vector white noise (VWN), a series of diagnostic tests needs to be carried out on the VAR residuals. In the present study, this consists of normality and autocorrelation tests. The former is carried out using the Jarque-Bera test, whereas the latter using the Ljung-Box test and plots of residuals, autocorrelation and partial autocorrelation functions. For the first test, it can be seen from the second column of Table 6 that the p-values for skewness and kurtosis statistics separately suggest that the residuals of the model are multivariate normal (MVN). Jointly, under \( \alpha=5\% \), however, the null of MVN is rejected. From the tests on individual equations, it is clear that this rejection is primarily due to the real exchange rate equation, and to a lesser extent to IRW equation. Considering, however, that the p-value for the joint test on the system (0.031) is still larger than the implied conventional significance level for a 2-tailed test, it would not be an over simplification to assert that the residuals do not posses serious MV non-normality problems.

<table>
<thead>
<tr>
<th>Test / Statistics</th>
<th>The System</th>
<th>Individual Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>IRW</td>
</tr>
<tr>
<td>1. Jarque-Bera for Normality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Skewness</td>
<td>0.115</td>
<td>0.596</td>
</tr>
<tr>
<td>b. Kurtosis</td>
<td>0.053</td>
<td>0.005</td>
</tr>
<tr>
<td>c. Skewness and Kurtosis</td>
<td>0.031</td>
<td>0.016</td>
</tr>
<tr>
<td>2. Ljung-Box for Autocorrelation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Q(4)</td>
<td>n.a.</td>
<td>0.066</td>
</tr>
<tr>
<td>b. Q(8)</td>
<td>n.a.</td>
<td>0.056</td>
</tr>
</tbody>
</table>

Estimates of AutoCorrelation Functions (ACF) and Partial AutoCorrelation Functions (PACF) are presented in a set of graphs in Appendix Figure 3. In general, the estimates are within the boundaries, indicating the serially independence of residuals. It is apparent from the appendix that there are 2 significant spikes in the PACF of IRW equation and 1 in each of the ACF and the PACF of LMP equation. Nevertheless, from the last two rows of Table 6, p-values for the Ljung-Box Q-statistics, evaluating the lags of the residuals for 1 year and 2 years, clearly indicate that, under conventional significance levels, there is no significant autocorrelation problem. The overall results from the above set of tests prompt us to continue with the cointegration analysis. Accordingly, the next task is to estimate an appropriate VEC model and then test relevant long run restrictions.
4.2 Further Tests and Estimated Parameters of the VEC Model

The restrictions indicated in the Introduction are to be imposed on parameters of the $\beta$ matrix of the vector error correction representation of the model (9'). Before imposing these restrictions, however, we firstly need to carry out a test of the hypothesis that Indonesia possesses the essential characteristics of a small, open economy in that domestic variables are affected by changes in world variables but the converse is not true. That is, we need to test the null hypothesis that the world interest rate (IRW) is (strongly) exogenous for the domestic variables in the model in that IRW unidirectionally Granger causes the domestic variables (Mosconi, 1998). This test involves excluding any effects on the world interest rate (IRW) of all domestic and real exchange rate variables in levels ($\pi_{1j}=0$) and in the first and the second differences (the first rows of $\Gamma_{1j}$ and $\Gamma_{2j}$) for $j=2,\ldots,5$. This test produces the likelihood-ratio (LR) statistic of 32.155, which, with degrees of freedom of 14, has the significance level of 0.004. Hence, since strong exogeneity is not consistent with the data, we impose only the weak form of exogeneity of IRW by means of exclusion restrictions on the loading matrix. Moreover, since Masih and Masih (1996)\(^{18}\) and Siregar and Ward (1999) found that that output is the most exogenous variable among a set of domestic variables, we impose the weak exogeneity of output jointly with the weak exogeneity of IRW through zero restrictions on parameters of the loading matrix. The restricted form of the matrix is as follows:

$$
\alpha' = \begin{pmatrix}
0 & 0 & \alpha_{31} & \alpha_{41} & \alpha_{51} \\
0 & 0 & \alpha_{32} & \alpha_{42} & \alpha_{52}
\end{pmatrix}
$$

(11)

The resulting LR statistic is 6.550, which, with the degrees of freedom 4, has the p-value of 0.162, suggesting that the restrictions being consistent with the data. Imposition of the long run restrictions in (7) and (8) forms the augmented cointegration matrix to be as follows:

$$
\begin{pmatrix}
-1 & 0 & \beta_{13} & 0 & 1 & \vdots & 0 \\
\beta_{21} & -1 & 0 & 1 & \beta_{25} & \vdots & \beta_{26}
\end{pmatrix}
$$

(12)

where the sixth (augmenting) column is associated with the trend. Since we do not have priors so as whether to impose the long run relations on the cointegrating matrix given the restricted loading matrix or the other way around, both sets of restrictions are jointly tested. Imposing

\(^{18}\) These authors construct a VEC model for the Indonesian economy, consisting of real output, money, interest rate, inflation and the exchange rate. This is consistent with Siregar and Ward (1999), in which almost 100% of the variability of output is found to be explained by its own shock.
these long run restrictions jointly with (11) produces the LR statistic of 32.214, which, with
the degrees of freedom of 9, has a p-value of 0.0002,\(^{19}\) indicating that the restrictions are
rejected. However, according to Garratt et al. (1999), an adjustment to account for small
sample bias in this type of test is required and so these authors carried out a bootstrapping
exercise to obtain more appropriate critical values for testing restrictions on the \(\beta\) matrix.
Consequently, their test statistic that originally had a p-value of 0.0001 turned out to be
accepted at the 5% significance level. Even though the replication of this exercise is beyond
the scope of the present study, in light of this result we maintain the imposition of the
restrictions in (11) and (12).

After the imposition of the restrictions on the loading and cointegration matrices, some
important estimates of the VEC model are summarised as in Table 7. Maximum likelihood
estimates of the parameters of the long-run relations are obtained as follows:

\[
\text{IR} - \text{IRW} = 0.092 \text{ LQ} \\
\text{LMP} - \text{LY} = -0.007 \text{ IR} + 3.141 \text{ IRW} + 0.007 \text{ T}.
\]

All coefficients have the signs as expected. A real appreciation of the Rupiah (a one-percent
decrease in LQ) would be followed by 0.09 percentage point decrease in IR for a given IRW.
Effects of changes in the domestic interest rate on the long-run money demand are as
expected but quite small. Changes in the interest rate of the rest of the world, however, have
important effects on the holding of rupiahs, which might indicate the possibility of currency
substitution in Indonesia. Finally, the velocity of money tends to exhibit a slightly positive
trend in the long run.\(^{20}\)

\(^{19}\) Without imposing the income elasticity of the long-run money demand to be unity, the log-likelihood (LL)
under Ho is 1205.28; and with imposing it LL the changes only slightly to 1204.95 and signs and magnitudes
of estimates of \(\beta\)s are relatively unchanged. However, in both situations the domestic interest rate has wrong
sign. Imposing ‘homogeneity’ in IR and T, i.e. restricting \(\beta_{25} = \beta_{26}\) leads to correct negative coefficient on IR.

\(^{20}\) This might reflect a very limited adoption of technological innovations in financial intermediation.
Alternatively, this positive trend may be interpreted as an increase in the relative preference of holding
rupiahs, which however may not be the case for the last nine observations used in this study.
## Table 7

**Estimated Parameters of the VEC Representation of the Model**

<table>
<thead>
<tr>
<th>Equation</th>
<th>Coefficient on: ( a )</th>
<th>IRW</th>
<th>LY</th>
<th>LQ</th>
<th>LMP</th>
<th>IR</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Cointegration Matrix(^b):</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. L.R. Reaction Function</td>
<td>-1</td>
<td>0</td>
<td>-0.092</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2. L.R. Money Demand</td>
<td>-3.141</td>
<td>-1</td>
<td>0</td>
<td>1</td>
<td>0.007</td>
<td>-0.007</td>
<td></td>
</tr>
<tr>
<td><strong>B. Levels Variables: ( X(t-1) ):</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. ΔIRW</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>2. ΔLY</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>3. ΔLQ</td>
<td>0.119</td>
<td>-0.182</td>
<td>0.064</td>
<td>0.182</td>
<td>-0.688</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>4. ΔLMP</td>
<td>1.206</td>
<td>0.315</td>
<td>0.020</td>
<td>-0.315</td>
<td>-0.218</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>5. ΔIR</td>
<td>0.283</td>
<td>-0.003</td>
<td>0.027</td>
<td>0.003</td>
<td>-0.293</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td><strong>C. 1st Diffs. Variables: ( ΔX(t-1) ):</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. ΔIRW</td>
<td>0.648</td>
<td>-0.037</td>
<td>-0.007</td>
<td>0.005</td>
<td>0.002</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>2. ΔLY</td>
<td>-0.141</td>
<td>-0.014</td>
<td>-0.158</td>
<td>0.022</td>
<td>-0.251</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>3. ΔLQ</td>
<td>-2.955</td>
<td>1.035</td>
<td>0.166</td>
<td>-0.083</td>
<td>-1.117</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>4. ΔLMP</td>
<td>-2.183</td>
<td>0.036</td>
<td>-0.007</td>
<td>-0.029</td>
<td>-0.098</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>5. ΔIR</td>
<td>-0.414</td>
<td>-0.009</td>
<td>0.002</td>
<td>-0.040</td>
<td>0.227</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td><strong>D. 1st Diffs. Variables: ( ΔX(t-2) ):</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. ΔIRW</td>
<td>-0.048</td>
<td>0.033</td>
<td>0.004</td>
<td>-0.019</td>
<td>-0.084</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>2. ΔLY</td>
<td>0.129</td>
<td>0.065</td>
<td>0.011</td>
<td>0.094</td>
<td>-0.278</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>3. ΔLQ</td>
<td>1.328</td>
<td>3.777</td>
<td>0.425</td>
<td>-0.564</td>
<td>1.052</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>4. ΔLMP</td>
<td>-1.352</td>
<td>0.952</td>
<td>-0.093</td>
<td>0.253</td>
<td>0.013</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>5. ΔIR</td>
<td>0.144</td>
<td>-0.169</td>
<td>0.022</td>
<td>-0.045</td>
<td>0.096</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td><strong>E. Deterministic Components:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trend</td>
<td>Intercept</td>
<td>Seasonal Dummies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>D1</td>
<td>D2</td>
<td>D3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. ΔIRW</td>
<td>0</td>
<td>3.1e-4</td>
<td>-0.002</td>
<td>3.1e-5</td>
<td>-0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. ΔLY</td>
<td>0</td>
<td>0.011</td>
<td>-0.010</td>
<td>-0.008</td>
<td>0.003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. ΔLQ</td>
<td>-0.001</td>
<td>0.618</td>
<td>0.008</td>
<td>0.009</td>
<td>0.027</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. ΔLMP</td>
<td>0.002</td>
<td>-1.967</td>
<td>-0.043</td>
<td>-0.046</td>
<td>-0.047</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. ΔIR</td>
<td>-2.2e-5</td>
<td>-0.148</td>
<td>8.2e-4</td>
<td>0.001</td>
<td>-0.003</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Figures in the brackets are the t-statistics.*

*Using Malcolm (Mosconi, 1999), the imposition of restrictions on parameters of the cointegration matrix jointly with those of the loading matrix produces only the estimated parameters without their standard errors.*

\(^a\) Figures in the brackets are the t-statistics.

\(^b\) Using Malcolm (Mosconi, 1999), the imposition of restrictions on parameters of the cointegration matrix jointly with those of the loading matrix produces only the estimated parameters without their standard errors.
Movements of $\Delta IRW_t$ are driven by its own lag (indicating significant persistence of this variable), by $\Delta LMP_{t-2}$ and by $\Delta IR_{t-2}$. Given the smallness of the economy, the significance of the last two effects should not be viewed as an evidence of domestic variables affecting the rest of the world interest rates. Rather, this may suggest the presence of global aggregate demand shocks that affect simultaneously changes in the real money holdings, in the domestic interest rates, and in the rest of the world interest rates. These shocks might be in a form of some combination of the prolonged Japanese recession in the 1990s and the sharp appreciation of the US dollar that began in 1995.\(^{21}\)

Fluctuations in output growth are significantly negatively affected by $\Delta LQ_{t-1}$. This indicates that an increase in the rate of depreciation in the previous quarter may bring about a decrease in the output growth in the present quarter.\(^{22}\) It is worth noting at this point that the intercept is significant in this output growth equation, indicating that, on average, the economy grows at the rate of 1.1% per quarter. An increase in the rate of real exchange rate depreciation (an increase in $\Delta LQ_t$) is affected significantly positively by $\Delta LQ_{t-2}$ and by $\Delta LY_{t-2}$. The former indicates persistence of the rate of real appreciation, whereas the latter suggests that a short run increase in the output growth could eventually (after six months) raise the rate of real depreciation. This suggests that, in order to smooth changes in the exchange rate, The Bank of Indonesia (BI) needs to closely observe short run movements of output growth.

Fluctuations in $\Delta LMP_t$ are significantly affected by $LMP_{t-1}$, $\Delta LMP_{t-2}$, $IRW_{t-1}$, $LY_{t-1}$ and $\Delta LY_{t-2}$. Effects of the first two variables indicate persistence of changes in the demand for money. The significance of the effect of $IRW_{t-1}$ may be seen as evidence of currency substitution in Indonesia. Significantly positive effects of the last two variables place importance of income in determining the holding of Rupiahs. Apart from IR and LQ in levels or in differenced forms, the rest of variables, including the deterministic components, have significant effects on changes in real money.

Finally, changes in $IR_t$ are significantly affected by $IR_{t-1}$, $\Delta IR_t$, $IRW_{t-1}$, $LQ_{t-1}$ and $\Delta LY_t$. The significance of the first two effects, like in the rest of the world interest rates, suggests persistence of domestic interest rates. The significance of the last three effects indicates that, if BI needs to smooth changes in interest rates, it may do so by taking into consideration...

\(^{21}\) Whitt (1999) provides detailed discussion about the importance of these two factors that led to the AFC.

\(^{22}\) When the rate of depreciation is sufficiently large, it may be the case that output growth becomes negative. This reflects the situation during the AFC, where a substantially large reduction in the value of the Rupiah was followed by negative growth of output.
fluctuations in the rest of the world interest rate, in the exchange rates and in the output growth.

The next step in the analysis utilises the results obtained from a Structural VAR (SVAR) model. To be able to construct the SVAR model, the above estimated VEC model needs to be represented by a restricted VAR model (not shown here). As suggested by equation (10), estimated parameters and variance covariance matrix of the VAR model are then used to build the SVAR as in equation (13). This is presented in the next section.

4.3 Structural VAR Analysis

The contemporaneous model as depicted by equations (4), (6), (2”), (1”), and (5’), respectively, can be expressed in the AB-class of SVAR models (Amisano and Giannini, 1997) as follows:

\[
\begin{pmatrix}
1 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 \\
a_{31} & a_{32} & 1 & 0 & 0 \\
a_{41} & a_{42} & a_{43} & 1 & a_{45} \\
a_{51} & a_{52} & a_{53} & 0 & 1 \\
\end{pmatrix}
\begin{pmatrix}
\varepsilon_{IR} \\
\varepsilon_{LY} \\
\varepsilon_{LQ} \\
\varepsilon_{LMP} \\
\varepsilon_{IRW} \\
\end{pmatrix}
=
\begin{pmatrix}
b_{ij} \\
\end{pmatrix}
\begin{pmatrix}
\epsilon_{msw} \\
\epsilon_{as} \\
\epsilon_{bp} \\
\epsilon_{md} \\
\epsilon_{ms} \\
\end{pmatrix}
\tag{13}
\]

where \( a_{ij} \) are elements of \( A \), \( \varepsilon^j \) is an innovation in variable \( j \), \( b_{ij} \) are elements of \( B \), which in this case \( i=j \) for \( i,j=1,\ldots,5 \), and \( \varepsilon^j \) is a structural shock to variable \( j \). It is obvious that, given these contemporaneous restrictions, model (13) is over identified. With 2 degrees of freedom the test for the over-identifying restrictions produces a LR statistic of 0.004, which has a p-value of 0.998. This indicates that the contemporaneous model, as implied by the overidentifying restrictions, is not rejected by the data.

4.3.1 Estimated Parameters of the SVAR Model

Written in explicit form, estimates of \( a_{ij} \) and \( b_{ij} \) are presented in Table 8. The rest of the world's interest rate does not have a significant contemporaneous effect, either on the real exchange rate \( (a_{31}) \) or on the domestic rate \( (a_{51}) \) equation. Together with its relatively strong effect on the long run money demand, the insignificance of IRW in the contemporaneous relations may suggest that the rest of the world interest rate is affecting the Indonesian macroeconomy through the long run money demand equation. The estimate of \( a_{32} \) is negative.
and significant, indicating that an investment induced output growth, which is associated with a real exchange rate appreciation, is greater than an output contraction induced by a reduced net exports due to the appreciation. Income has a negative sign and is significant in the money demand equation.\(^{23}\)

Unexpectedly, \(a_{43}\) is positive and significant, indicating that a real exchange rate depreciation is followed by an increase in the holding of Rupiahs. This contemporaneous relation might however be supported by the situation where in the midst of the Asian Financial Crisis, that is when US$1 had been equal to about Rp10,000 or more, many agents had in fact attempted to increase their holding of Rupiah, speculating that the currency was going to improve soon, hence earning profits.\(^{24}\) The significance of this estimate might therefore be interpreted as the existence of a speculative motive for holding the currency.\(^{25}\) The domestic interest rate has, as expected, a negative effect on money demand, but its coefficient is not statistically significant. Lastly, none of the coefficients in the short-run reaction function are statistically significant. Being independently operative since 1998, this might be seen as statistical evidence that the BI had been considering insufficiently the rest of the world’s monetary policies and fluctuations in other variables in formulating its short-run monetary policies. Finally, estimates for \(b_{ij}\) indicate that each of the variables has significant responses on its own impulses at the impact period.

\(^{23}\) Effects of income on real money could be negative under a very high inflation rate, which is the case in the last four quarters of the sample period. From the Baumol-Tobin model (in Blanchard and Fischer, 1989), for example, it can be seen that both consumption (and hence output) and real money balances are decreasing functions of the rate of inflation. This may imply that a sufficiently high rate of inflation could overcome positive effects of income (output) on the real money.

\(^{24}\) Just before floating the nominal exchange rate, in 1997:2, S was Rp2441/US$ (and, calculated using domestic and the US CPIs, \(Q\) was Rp1729/US$). During the first three quarters of 1998, S had gone up sharply to above Rp9100/US$ --in some weeks even reached Rp15,000/US$—and \(Q\) to above Rp4600/US$. As quick as in 1999:1, S has indeed improved to below Rp8800/US$ and \(Q\) to below Rp3300/US$.

\(^{25}\) This phenomenon also occurred during the New Zealand exchange rate crisis in mid 1984. As devaluation was widely expected, in the spot market, expecting to earn more NZs due to the devaluation, exporters arranged to have their payments from overseas delayed. In contrast, seeking to avoid paying more in terms of NZS, the expectation led importers to arrange their payments soon. This kind of speculation is known as ‘lags and leads’.
### Table 8
**Contemporaneous Relations from the SVAR Model**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimated Coefficient</th>
<th>Standard Error</th>
<th>Significance Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a_{31}$</td>
<td>-0.957</td>
<td>4.2178</td>
<td>0.822</td>
</tr>
<tr>
<td>$a_{32}$</td>
<td>-2.171</td>
<td>0.7095</td>
<td>0.004</td>
</tr>
<tr>
<td>$a_{42}$</td>
<td>-0.697</td>
<td>0.2831</td>
<td>0.018</td>
</tr>
<tr>
<td>$a_{43}$</td>
<td>0.121</td>
<td>0.0482</td>
<td>0.016</td>
</tr>
<tr>
<td>$a_{45}$</td>
<td>-0.128</td>
<td>0.5735</td>
<td>0.824</td>
</tr>
<tr>
<td>$a_{51}$</td>
<td>-0.520</td>
<td>0.3479</td>
<td>0.142</td>
</tr>
<tr>
<td>$a_{52}$</td>
<td>0.087</td>
<td>0.0631</td>
<td>0.176</td>
</tr>
<tr>
<td>$a_{53}$</td>
<td>0.002</td>
<td>0.0109</td>
<td>0.878</td>
</tr>
<tr>
<td>$b_{11}$</td>
<td>0.003</td>
<td>0.0002</td>
<td>0.000</td>
</tr>
<tr>
<td>$b_{22}$</td>
<td>0.016</td>
<td>0.0015</td>
<td>0.000</td>
</tr>
<tr>
<td>$b_{33}$</td>
<td>0.076</td>
<td>0.0078</td>
<td>0.000</td>
</tr>
<tr>
<td>$b_{44}$</td>
<td>0.030</td>
<td>0.0028</td>
<td>0.000</td>
</tr>
<tr>
<td>$b_{55}$</td>
<td>0.007</td>
<td>0.0006</td>
<td>0.000</td>
</tr>
</tbody>
</table>

#### 4.3.2 Impulse Response Function (IRF) Analysis

As shown in Appendix Figure 4, most of the estimated impulse responses are found to be consistent with the underlying economic theory. Technology shocks result in movements in (the log of) output that follow a hump shape. A one-standard error shock to aggregate supply would raise the output by up to 2% in the second quarter after the shock, and it would reach its long-run equilibrium level of about 1% higher than the pre-shock level after approximately three years. Shocks to the rest of the world interest rates have trivial influences on output dynamics. Unexpected contractionary monetary policy might drive the level of output down; however, this effect is quite small (a maximum of 0.2%) and only significant during the second quarter after the policy is announced.

Shocks to general spending balance have a significant negative influence on output. One standard error of such shocks, leading to a real exchange rate depreciation (an increase in LQ), might reduce output by up to 2.5% around one and a half years after the shock; smaller reductions in output would be significant for up to two and a half years. Despite having richer dynamics, this response is quite similar to the output responses (to the same type of shocks) documented in Siregar and Ward (1999).

There is one important difference between the results obtained from the two studies, however. In the earlier study, shocks to aggregate supply were seen to influence short and long-run dynamics of demand side variables, whereas the present study suggests that such shocks
affect these variables only in shorter horizons. Regarding the real exchange rate, for example, output growth induced by aggregate supply shocks would invite investment from the rest of the world, leading to an appreciation. But this effect would vanish (i.e., be insignificantly different from zero) as quickly as two quarters after the occurrence of the shock. The disappearance of this effect may be explained by the significant relationship between the real exchange rate and money demand. As suggested by the responses of LMP to shocks to LY, after 3 quarters, shocks to output cause the money demand to increase, and as suggested by the IRF of LQ to shocks to LMP, the real exchange rate would depreciate due to increased money demand. This would then offset the initial appreciation of the real exchange rate. Another possible cause of the shorter effects of aggregate supply shocks is the absence of the two major OPEC oil price shocks in this study, whereas these shocks are covered through annual observations used in the previous study. As these oil price shocks are well known to be important for explaining output fluctuations, see for example Hamilton (1983), the absence of these events in the current study's observations coupled with the inclusion of observations for 1998 and 1999:1, which contain macroeconomic variabilities due to the Asian Financial Crisis, may place more (less) emphasis on the role of aggregate demand (supply) shocks.

General spending balance shocks, e.g. a fiscal tightening or unfavourable shocks to the balance of payments, would lead the real exchange rate to depreciate. The biggest effect would occur about 3 quarters after the shock, by up to 13% depreciation, after which the rate would appreciate, indicating an under-shooting. The net effect would be a depreciation by around 5% from the pre-shock level. Responses of money demand to shocks to the real exchange rate tend to support our conjecture regarding the existence of a speculative motive for holding Rupiahs. Following the shocks, for the first two quarters the real money holding increases, but after that it goes down, reaching the trough by the eighth quarter. Responses of the domestic interest rate to the real exchange rate shocks are consistent with findings from the contemporaneous relations and the cointegrating vectors. In this case, the IRF graphs show that there is an average lag of about 2 quarters before the monetary authority responds to real exchange rate shocks by implementing appropriate interest rate policies. Identifying monetary policy through the short-term interest rate is empirically consistent, i.e., a monetary contraction causes the rate to increase significantly.

26 In response to the increased output, the monetary authority would increase the supply of money, leading to a decrease in the interest rate. Allowing for nominal price rigidity, this would increase the real money balance. But at the same time, due to the decreased interest rate, given that Se and IRW are unchanged, agents would invest their funds in the rest of the world, causing the domestic currency to depreciate. The rigidity of prices would translate this nominal depreciation to a proportional depreciation of the real exchange rate.
4.3.3 Forecast Error Variance Decomposition (FEVD) Analysis

Key results of the FEVD analysis are presented in Table 9. The most striking result of this analysis is that spending balance shocks are found to be an important determinant in driving fluctuations of output in both the short term and the long term. These shocks are also dominant in driving real exchange rate fluctuations over both horizons and in determining the long-run variability of real money holdings and domestic interest rates. In contrast, apart from output, aggregate supply shocks only play an important role in the short-run fluctuations in real money balances and, to a lesser extent, in the real exchange rate. The occurrence of these results is due, perhaps, to the explicit imposition of the long-run monetary policy reaction and money demand functions. That is, demand side shocks are allowed to affect output through such long-run relationships. Shocks to the rest of the world’s interest rate are not important in explaining short-run variability of any domestic variable, but they are quite important in determining long-run fluctuations of real money holdings. All these findings lend more support to the New-Keynesian view of macro-fluctuations, i.e. allowing for nominal rigidities, aggregate demand shocks could affect not only nominal variables but real variables, such as output, as well.

To check for the robustness of these findings, we restrict the parameter $a_{42}$ to zero, ruling out the case of negative effect of income on the real money, and keep the other restrictions unchanged (model 2). Furthermore, we keep the contemporaneous restrictions unchanged as in (13) but allow the long run money demand to influence the output growth, i.e. we leave $\alpha_{22}$ unrestricted (model 3). Lastly, we combine model 2 and model 3, i.e. $a_{42}$ is restricted to be zero but $\alpha_{22}$ is unrestricted (model 4). The estimated parameters of contemporaneous relations of models 2, 3 and 4 are presented in Appendix Table 1. P-values for the overidentifying restrictions indicate that the contemporaneous restrictions embedded in these models are consistent with the data. Compared to the results from the original model (Table 8), the signs of estimated parameters of these models are unchanged and their magnitudes are quite similar. Moreover, the IRFs for models 2, 3 and 4 (Appendix Figures 5-7) have very similar shape as the one in Appendix Figure 4. The FEVDs for the three models (Appendix Table 2) are

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27 This seems to be contradictory to the restriction that sets the long-run money demand so as to not affect long-run output movements. As was mentioned in the discussion on the real exchange rate equation (2’'), notice, however, that the presence of nominal rigidity might lead aggregate demand variables to influence output, at least in the short run. The influence might persist in the long run if the demand variables are allowed to affect long run fluctuations in $LQ$. This mechanism is allowed to work by leaving $\alpha_{32}$ unrestricted. From IRF analysis, it can be seen that, even until five years, $LQ$ keeps fluctuating in response to LMP shocks. Magnitudes of the fluctuations are however non-precise (the estimated responses have relatively high standard errors).
almost the same as the model's FEVD in Table 9. All of these results suggest that the SVAR model and the analyses carried out in this present study are reasonably robust.

### Table 9
FEVD Analysis (%)

<table>
<thead>
<tr>
<th>Endogenous Variable</th>
<th>Step Ahead</th>
<th>IRW</th>
<th>LY</th>
<th>LQ</th>
<th>LMP</th>
<th>IR</th>
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<td><strong>Output</strong></td>
<td>1</td>
<td>0.0 (-)</td>
<td>100 (-)</td>
<td>0.0 (-)</td>
<td>0.0 (-)</td>
<td>0.0 (-)</td>
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<tr>
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<td>4</td>
<td>0.3 (1.2)</td>
<td>56.9 (10.3)</td>
<td>41.0 (9.9)</td>
<td>1.4 (1.7)</td>
<td>0.4 (0.7)</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>0.4 (2.2)</td>
<td>37.5 (15.6)</td>
<td>59.0 (15.2)</td>
<td>1.5 (1.7)</td>
<td>1.6 (3.0)</td>
</tr>
<tr>
<td></td>
<td>16</td>
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<td>36.8 (17.5)</td>
<td>53.8 (16.9)</td>
<td>4.4 (6.4)</td>
<td>2.8 (5.8)</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>2.0 (5.8)</td>
<td>35.7 (18.9)</td>
<td>55.9 (18.8)</td>
<td>3.6 (5.9)</td>
<td>2.8 (6.0)</td>
</tr>
<tr>
<td><strong>Real Exchange Rate</strong></td>
<td>1</td>
<td>0.1 (0.7)</td>
<td>14.1 (8.5)</td>
<td>85.8 (8.6)</td>
<td>0.0 (-)</td>
<td>0.0 (-)</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>0.7 (2.3)</td>
<td>9.3 (4.8)</td>
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<td>0.3 (0.4)</td>
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<td></td>
<td>8</td>
<td>1.8 (4.6)</td>
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<td>69.8 (14.9)</td>
<td>5.5 (6.7)</td>
<td>5.5 (6.5)</td>
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<td>3.2 (6.7)</td>
<td>18.4 (14.6)</td>
<td>69.1 (18.2)</td>
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<td>4.3 (5.7)</td>
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<tr>
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<td>3.7 (7.6)</td>
<td>19.6 (16.5)</td>
<td>68.0 (19.4)</td>
<td>4.5 (6.4)</td>
<td>4.2 (6.2)</td>
</tr>
<tr>
<td><strong>Real Money</strong></td>
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<td>30.1 (15.0)</td>
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<td>11.1 (8.9)</td>
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<td>12.7 (7.3)</td>
<td>1.9 (6.2)</td>
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<tr>
<td><strong>Domestic Interest Rate</strong></td>
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<td>0.0 (-)</td>
<td>0.0 (-)</td>
<td>93.0 (6.5)</td>
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<tr>
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<td>4</td>
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<td>53.8 (9.0)</td>
<td>1.7 (1.4)</td>
<td>31.9 (7.2)</td>
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<td>7.0 (10.5)</td>
<td>74.8 (8.4)</td>
<td>2.4 (2.9)</td>
<td>12.8 (5.3)</td>
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<td></td>
<td>16</td>
<td>6.9 (8.0)</td>
<td>12.9 (7.9)</td>
<td>58.1 (13.6)</td>
<td>9.2 (8.9)</td>
<td>12.9 (7.0)</td>
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<td>13.1 (11.0)</td>
<td>11.2 (8.9)</td>
<td>57.4 (15.0)</td>
<td>8.6 (9.3)</td>
<td>9.7 (6.3)</td>
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</table>

Note: Figures in the brackets are the standard errors.
5. Conclusion and Recommendation

Various unit root tests carried out in this study indicate that each of the world- and domestic-interest rates, (logs of) output, real exchange rate, and real money balance is integrated of order one. Using likelihood ratio (LR) tests and lag selection criteria, it is found that an unrestricted VAR(3) can be constructed based on these five variables. The fact that each of the five variables is of I(1), however, guides us to use a cointegrated VAR(3) model. Based on the LR tests for determining the number of cointegrating vectors, it is found that this number is two. Various diagnostic tests on the residuals do not suggest that the structural VAR model is mis-specified.

The weak-exogeneity of the world interest rate, tested through elements of the loading matrix, indicates the smallness of the economy. The LR test for the restrictions on the cointegrating vectors indicates that the long-run money demand equation and a modified version of McCallum's (1994) policy reaction function are quite consistent (in terms of explaining long run relations among variables) with the data. Under these circumstances, short-run relations among the variables --which are constructed based on a variant of the Mundell-Fleming framework-- are then imposed by using a set of contemporaneous restrictions. The LR test for contemporaneous restrictions suggests that the short-run relations are consistent with the data.

Estimates of long run and contemporaneous relations as well as the dynamics of the IRF suggest that these empirical results are consistent with the small open economy model framed on the SVAR methodology. Explicitly incorporating transmission mechanisms for aggregate external shocks to influence the economy and imposing the smallness of the economy and the two long run restrictions leads to richer dynamics of the relationships amongst the model's variables. Most importantly, this allows greater (smaller) role for shocks to aggregate demand (supply) in affecting fluctuations in output and in the other variables.

General spending balance shocks leading to depreciation of real exchange rates appear to be important in driving output fluctuations. However, such shocks would not be able, on their own, to increase the economy's output. As far as positive output growth is concerned, shocks to aggregate supply play the most important role for Indonesia. If it is correct that the reduced role of aggregate supply in explaining cyclical fluctuations is a result of the absence of OPEC oil price shocks, these shocks would be useful for helping to overcome Indonesian's depression after the AFC. If agreed by OPEC members, appropriate formulation of the oil
production quota that results in unexpected increases in the OPEC oil price could increase the
government revenues, enabling it to implement fiscal expansions. Indeed, as reflected by the
impulse responses of output, it is the unexpected component of fiscal expansions and shocks
to aggregate supply that are important in increasing the economy's output.

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Appendix Figure 1: Time Series Plots of LNER, LQ, LMS, LMP, and LY

Appendix Figure 2: Time Series Plots of IR, IRW, LP, and LPW
Appendix Figure 3: Residuals, ACF and PACF from RF VAR(3),
Appendix Figure 4: Impulse Response Function Analysis
Appendix Figure 5: IRFs for Model 2
Appendix Figure 6: IRFs for Model 3
Appendix Figure 7: IRFs for Model 4

RESP. OF IRW TO IRW
SIZE = 5%

RESP. OF IRW TO LY
SIZE = 5%

RESP. OF IRW TO LQ
SIZE = 5%

RESP. OF IRW TO LMP
SIZE = 5%

RESP. OF IRW TO IR
SIZE = 5%

RESP. OF IRW TO LY
SIZE = 5%

RESP. OF IRW TO LQ
SIZE = 5%

RESP. OF IRW TO LMP
SIZE = 5%

RESP. OF IRW TO IR
SIZE = 5%

RESP. OF IRW TO IRW
SIZE = 5%

RESP. OF IRW TO LY
SIZE = 5%

RESP. OF IRW TO LQ
SIZE = 5%

RESP. OF IRW TO LMP
SIZE = 5%

RESP. OF IRW TO IR
SIZE = 5%

RESP. OF IRW TO IR
SIZE = 5%
Appendix Table 1: Estimated Parameters of Contemporaneous Models 2, 3 and 4

<table>
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<tr>
<th>Elements of A and B Matrices</th>
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<th></th>
<th>Model 3</th>
<th></th>
<th>Model 4</th>
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<tbody>
<tr>
<td></td>
<td>Estimates</td>
<td>Std. Error</td>
<td>P-Value</td>
<td>Estimates</td>
<td>Std. Error</td>
<td>P-Value</td>
</tr>
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<td>a31</td>
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<td>0.822</td>
<td>-0.685</td>
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<td>Overidentifying LR statistic (p-value)</td>
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<td>Endog Variable</td>
<td>Steps Ahead</td>
<td>Model 2: Shocks to:</td>
<td>Model 3: Shocks to:</td>
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<tr>
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