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Central Bank Credibility and Monetary Policy: Evidence from Small Scale Macroeconomic Model of Indonesia

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ABSTRACT

In this paper, we develop a forward-looking small scale macroeconomic model (SSMM) of the Indonesian economy which is potentially useful for carrying out monetary policy analysis. The Batini-Haldane (1999) model is used as the theoretical underpinning for the development of the model along with the well-known Taylor policy rule (1993). The tracking performance of the model is found to be satisfactory. We conduct deterministic and stochastic simulations to examine the role of the central bank's credibility in achieving the inflation target and to suggest appropriate monetary policy responses. Policy simulations indicate that it is crucial for the Indonesian authority to address its credibility for Indonesia to achieve a lower inflation rate. Simulations to trace out the inflation-output tradeoff frontier also show that a monetary policy rule that targeted both the inflation and output gap will result in less macroeconomic volatility. We also found that the inclusion of the exchange rate into the monetary policy rule as an additional feedback variable warrants serious consideration in the future course of monetary policy management.

1. Introduction

Indonesia, a country with a vast archipelago, has always been the subject of fascination by people in the world for her richness in cultural diversity, abundance of her natural resources, and the

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remarkable economic success achieved over the last few decades—setting aside the incidence of the Asian financial crisis in 1997. A country that has always amazed observers is now facing uncertainties regarding her future economic direction which makes her an intriguing case study for economic discussion, policy studies, and debates at international forums. After the inception of the so-called “new order” regime, Indonesia began to experience a period of sustained economic growth and expansion in broad-based sectors of the economy for about three decades. Not long after, however, this impressive economic growth was followed by sudden economic turmoil that was sparked off by the Asian financial crisis. This episode has created major structural changes for the Indonesian economy, leading the country to undergo several major policy changes in the areas of the exchange rate system, debt restructuring, tighter bank regulation, and inflation targeting policies, *inter alia*.

Most notably, the conduct of monetary policy has changed. The exchange rate regime has altered from the long-standing of fixed and managed floating system into an essentially market-determined exchange rate system. Monetary policy is aimed specifically at stabilizing medium-term inflation to promote sustained economic growth to provide added momentum towards economic recovery (BI 2003, 2004). At the same time, monetary policy tries to maintain the stability of the Rupiah *vis-à-vis* other foreign currencies to boost trade activities and to minimize fluctuations by prudent intervention that is necessary to absorb excess liquidity resulting from fiscal expansion. Further cuts in interest rates are also on its way at a gradual pace that are consistent with the achievement of inflation targets (BI 2003, 2004). To sum that all, one major change in the conduct of monetary policy in the aftermath of the financial crisis was the enactment of the new central banking law in May 1999. This law gives full autonomy to the central bank in designing, formulating, and implementing monetary policy—including the choice of monetary policy instrument and macroeconomic targets—in relation to achieving the goal of lowering the country’s inflation rate.

In line with this change in monetary policy conduct, this paper attempts to shed light on the role of central bank credibility in achieving the inflation target based on a small scale macroeconomic model (SSMM) of the Indonesian economy. The issue of central bank credibility is critical in the formation of inflationary expectations. In other words, how people perceive and whether they believe the central bank will be able to meet its inflation target or otherwise has a significant impact on economic outcomes. Indonesia has a long history combating high inflation rates and this paper contributes to further understanding about the importance of central bank credibility and its role in achieving a lower inflation rate. The small scale model that we built can also be useful for policy analysis in general. Thus, we also study appropriate monetary policy responses for Indonesia in the face of shocks based on a modified Taylor policy rule. The objective is to enable the central bank to take suitable policy actions to minimize inflation and output variability so as to ensure the stability of the economy in achieving sustained economic growth. As Taylor (2000a) has asserted, a very high priority is to build and estimate models in emerging countries, and to evaluate policy rules in these models.

The rest of the paper is organized as follows. Section 2 discusses the structure of the Indonesian SSMM and describes each equation in the model in detail. Section 3 presents the data and estimation results. Section 4 presents two sets of simulation experiments. The first set details the results of deterministic simulations to evaluate central bank credibility. The second set uses stochastic simulation to investigate the performance of monetary policy rules. Finally, Section 5 concludes.

2. A Small Scale Macroeconomic Model for Indonesia

To understand the ways for achieving a lower inflation rate and sustained economic growth in Indonesia, we need a model of how the economy works. Based on this model and our understanding of the economy, we will try to pin down important factors that should be

considered by monetary policymakers in formulating their economic policies. In constructing a macroeconomic model, researchers usually have the option of building large-, medium-, or small-scale models. Due to the relatively less attention given to the small scale macroeconomic model and its merits, we are motivated to build an SSMM for the Indonesian economy by adapting the Batini and Haldane (1999) model, so as to complement other existing larger-scale macroeconomic models for Indonesia and, hopefully, to offer an improvement to the small quarterly model developed by the Central Bank of Indonesia.¹ The next two subsections will explain the merits of an SSMM and describe our Indonesian SSMM.

2.1 Why A Small Scale Macroeconomic Model?

Macroeconomic models are usually developed in a large framework that comprises hundreds of equations. Some pitfalls, however, are inevitable, such as theoretical shortcomings and a partial failure of forecasts (Wallis 1989). In the early 1990s, the SSMM emerged as an alternative tool for comparing the results obtained from larger macroeconomic models. The SSMM has been adopted by countries such as New Zealand, Canada, the United Kingdom, Sweden, Finland, Australia, Spain, Brazil, Chile, and Venezuela (see Haldane 1995, Leiderman and Svensson 1995, de Freitas and Muinhos 1999, Arreaza et al. 2003). Among the countries we have mentioned, it may not be coincidental that most of them are inflation-targeting countries. At this point in time, the SSMM has not been applied extensively and formally to Asian countries in general and Indonesia in particular. Hence, we hope to pioneer the study of SSMMs in the Asian context, with Indonesia being our choice of country in this regard.

The SSMM has some important merits: first, there is a complete treatment of both the supply and demand sides of the economy in a succinct manner. An SSMM is deliberately kept small with a substantial level of aggregation, thus forcing the model to focus on key issues rather

¹ See Alamsyah (2000).

than to look at excessive details in the economy. Furthermore, an SSMM is characterized by a compact system of equations that describe the behaviour of key macroeconomic aggregates such as output, inflation, money demand, exchange rates (for an open economy), interest rates, etc. Although the SSMM is not meant primarily for forecasting, it helps to clarify and understand the developments of key macroeconomic variables, for example those relevant in the process of determining the inflation rate in the economy. Another advantage of an SSMM is that, being highly aggregated, it can help to mitigate the problem of poor fit in large macroeconomic models.

In our case, the forward-looking nature of the BH model—the one that we are going to adapt—is rather appealing since it takes into account agents' expectations for the future. The BH model also takes explicit account of the impact of the exchange rate on the dynamics of inflation and output which is a crucial channel of the monetary transmission mechanism. Finally, the main benefit of using this model is that it is thought to be disaggregated enough to capture the main characteristics of the monetary transmission mechanism, but is still simple enough to be analytically tractable. Thus, an SSMM can be very useful in providing a vehicle for analyzing the effects of monetary policy which is credible enough to be of interest to policy-makers and academics alike.

2.2 Indonesian SSMM

As mentioned above, the Indonesian SSMM in this paper is adapted from the Batini and Haldane (1999) model. In the presentation of our SSMM for Indonesia below, lower case variables are in logarithms (except for interest rates) while upper case variables refer to levels. The present model is a small, compact, and highly aggregated macroeconometric model. There are 4 behavioural equations, 2 identities, and a policy rule. A description of the model is given below.

IS Equation:

$$(y^{no} - y^{no*})_t = \alpha_1(y^{no} - y^{no*})_{t-1} + \alpha_2 E_t(y^{no} - y^{no*})_{t+1} + \alpha_3(i_t - E_t\pi_{t+1}) + \alpha_4\Delta g_t + \alpha_5\Delta q_t + \alpha_6\Delta y_t^f + \varepsilon_{1t} \quad (1)$$

Oil Equation:

$$(y^o - y^{o*})_t = \beta_1\Delta y_t^f + \beta_2\Delta oil_t + \varepsilon_{2t} \quad (2)$$

National Income Identity:

$$Y_t = Y_t^{no} + Y_t^o \quad (3)$$

LM Equation:

$$m_t - p_t = \beta_3 y_t + \beta_4 i_t + \varepsilon_{3t} \quad (4)$$

UIP Identity:

$$e_t = E_t e_{t+1} - i_t + i_t^f + \varepsilon_{4t} \quad (5)$$

Inflation Equation:

$$\pi_t = \theta E_t \pi_{t+1} + (1-\theta)\pi_{t-1} + \phi(y - y^*)_{t-1} + \gamma\Delta e_t + \psi\Delta p_t^f + \phi\Delta m_t + \varepsilon_{5t} \quad (6)$$

Monetary Policy Rule:

$$i_t = r^* + E_t \pi_{t+1} + \alpha_9(y - y^*)_{t-1} + \alpha_{10}(\pi - \pi^*)_{t-1} + \alpha_{11}\Delta e_{t-1} + \varepsilon_{6t} \quad (7)$$

In Equation (1), y^{no} denotes non-oil GDP while y^{no*} denotes non-oil potential output. The variable $q = e - p + p^f$ represents the real exchange rate with e , the nominal exchange rate, being the domestic currency price of foreign currency (Rupiah/foreign currency). p and p^f are the domestic and foreign price levels respectively, y^f is real foreign output, representing external demand, and g represents government spending. Δ denotes change with respect to previous period. Equation (1) explains the non-oil component of aggregate demand for the Indonesian economy. It is a typical IS curve with the usual sign expectations such as the negative relation between the *ex-ante* real interest rate ($i_t - E_t\pi_{t+1}$) and the non-oil output gap ($y^{no} - y^{no*}$) as well as the positive relation between the real exchange rate (q) and the non-oil output gap.

A distinguishing feature of Equation (1) is the existence of a term allowing the output gap to depend on its own lag to capture the effect of adjustment costs and the presence of forward-looking (or the lead) term. The lead term for the non-oil output gap is motivated by the work of McCallum and Nelson (1999) on the optimizing IS-LM specification for monetary policy and business cycle analysis. This is an important modification that needs to be considered for Indonesia's case since we have to acknowledge the forward-looking behaviour of economic agents in decision-making processes, thus enabling monetary policy to work more effectively by recognizing these responses. Moreover, the recent tendency for the BI to move to an inflation targeting regime requires a certain degree of forward-lookingness about future economic conditions.

In Equation (2), y^o , y^{o*} , and oil denote oil output, potential oil output, and the oil price respectively. Since oil revenues are critical to the Indonesian economy, we feel that a separate treatment of the non-oil and oil sectors is necessary and that by specifying the oil output as in Equation (2), we can better explain how the oil price affects the oil output gap and hence the dynamics in overall output movements. This equation highlights the vulnerability of Indonesia's real GDP to fluctuations in the world oil price and the income from the oil sector. Equation (3) is an identity that states that the sum of the real non-oil output and the real oil output is equal to real GDP.

Equation (4) is an LM curve with the conventional explanatory variables that depict real money balances as being dependent on a nominal interest rate (i), reflecting the opportunity cost of holding money, and real output. The innovation ε_{3t} is called "velocity" shocks on the demand for money. Equation (5) is the uncovered interest parity (UIP) condition for an open economy, with the exchange risk premium being captured by the error term. i^f is the foreign short-term

interest rate. Given the financial openness of the Indonesian economy, it is plausible to assume that UIP holds at least approximately. However, the UIP relationship, being a stochastic identity, is not estimated but is included in full model simulations.

Equation (6) is the inflation equation in the Indonesian SSMM based on an open economy Phillips curve where π denotes the current rate of inflation and ε_{5t} is the innovation in the inflation process. Like the IS equation, the inflation equation acknowledges the lag and lead terms in determining the current level of inflation rate, as given by $\theta E_t \pi_{t+1} + (1-\theta)\pi_{t-1}$. In other words, the inflation rate is partially determined by a weighted average of past inflation and expected future inflation. The presence of the lagged term produces a short-run trade-off between output and inflation as well as inflation persistence. Inflation expectations are given by $E_t \pi_{t+1} = \lambda \pi_{t+1} + (1-\lambda)\pi_t^*$, where π^* represents the inflation target and $0 \leq \lambda \leq 1$ represents a measure of credibility of the central bank. As λ approaches 1, monetary policy becomes less credible and hence, λ can be interpreted as the *credibility* parameter for the central bank. Thus, the inflation expectations term explicitly allows for a targeted rate of inflation provided that λ is not equal to 1. Our specification of Equation (6) differs from those typically considered in the literature due to the addition of an exchange rate effect on domestic inflation. The presence of the nominal exchange rate reflects the pass-through effect of foreign prices (p^f) on the Indonesian economy while the money supply lagged output gap found in this equation reflects the possible domestic sources of inflation.

Equation (7) is a modified Taylor rule to determine the interest rate path for the authority which includes the exchange rate variable. In addition to the inflation and output gaps, this rule reacts to the change in the nominal exchange rate e . It forces the central bank to respond automatically to currency shocks in order to stabilize both the nominal and real exchange rates.

This may be very relevant for Indonesia as an emerging market economy with substantial deal of international trade but less than fully developed financial markets.

The exchange rate plays an important role in aggregate demand through its effect on net exports and also on inflation through the pass-through effect. Clearly, exchange rate and interest rates are linked through the UIP condition. In the above policy rule, a depreciation of the exchange rate is expected to cause the monetary authority to raise interest rates in the next period. The recent increase in interest rates by BI in the face of a depreciating currency can be viewed as an example of such a reaction (Taylor 2000)².

3. Data and Estimation Results

In this section, we describe data issues and discuss our empirical results. The datasets used in this paper cover quarterly series from 1983 to 2003.³ All the data that is used in this paper are seasonally adjusted, wherever seasonality is found to be present. We apply the most commonly used Augmented Dickey-Fuller (ADF) unit-root tests on the logarithmic forms of the relevant variables.⁴ The results reveal that only the domestic short-term interest rate (i) and oil output (y^o) are found to be stationary with the rest of the variables found to be an $I(1)$ series.⁵

The domestic output variable is represented by the quarterly real GDP of Indonesia from 1983:Q1 to 2003:Q4 that is decomposed into non-oil output and oil output. We employ 1993 as

² Taylor (2000) explicitly pointed out the need for the Indonesian Central Bank, BI, to consider the role of the exchange rate in its policy rule during a conference held by BI in July 2000. For more elaborate, but complex, microfoundations regarding the role of the exchange rate in policy rules, see Ball (1999). He found that such a rule has only a minor improvement over the conventional interest rate rule. Readers are also referred to Svensson (2000) on small open economy models that examined the role of the exchange rate in policy rules explicitly.

³ We document the sources of the data in the appendix.

⁴ Only i and i^f are not tested in log form.

⁵ The unit-root test results are available upon request.

the base year for our study. Non-oil output is represented by the real GDP of Indonesia, excluding the oil output component, whereas oil output is represented by the real oil output data. The domestic price is represented by Indonesian Consumer Price Index (CPI), short-term interest rate by the 1-month SBI (Sertifikat Bank Indonesia) rate, the foreign interest rate by the US 3-month T-Bill rate, and inflation rate is calculated as the change in the CPI. The variable g is represented by the interpolated annual Indonesian government spending using the cubic spline method since the quarterly Indonesian government spending data is not available. The oil price variable is represented by the average oil price data from the *International Financial Statistics*. For oil output, we have to resort to interpolated data from 1983 to 1992. We employ the Chow-Lin (1971) method for best linear unbiased distribution and interpolation of time series by related series, and use the oil price (in Rupiah) as the related series to convert annual oil output into quarterly oil output.⁶

The money supply data used in this paper is the M1 measure. In constructing the foreign income index, we use a geometric average of the GDPs of Indonesia's major trading partners, weighted by nominal exports. These include 10 countries and 1 region: Malaysia, the Philippines, Thailand, Hong Kong, Singapore, South Korea, Taiwan, China, Japan, the U.S. and the rest of the OECD (ROECD). ROECD includes all members of the OECD except Japan, South Korea and the United States. Statistics for the ROECD are calculated as the weighted-average effect of all countries in the group, so that the ROECD can be interpreted as one large "country".⁷ The construction of the nominal effective exchange rate follows the same principle as that of the foreign income index. Finally, we use the World CPI Index from the *International Financial Statistics* as the proxy for the foreign price level, with the base year rebased to 1993.

⁶ The annual data for oil output from Indonesia's statistical yearbook has two base years, namely 1983 and 1993. We rebased the real oil output from the 1983 base year to the 1993 base year using growth rates. Subsequently, we obtained the quarterly oil price series as described in the text.

⁷ We thank the Econometric Studies Unit (ESU) of the Department of Economics at the National University of Singapore for making the data available.

Potential non-oil and oil output are measured by the Hodrick-Prescott filter, which is a commonly used method to estimate potential output. We specify the inflation target to be time-varying over three different sub-periods: 1983:Q1–1996:Q4, 1997:Q1–1998:Q4, 1999:Q1–2003:Q4, in which the inflation target is the average inflation rate in each of these sub-periods. The quarterly inflation targets are 2% for 1983:Q1–1996:Q4, 8.33% for 1997:Q1–1998:Q4, and 1.85% for 1999:Q1–2003:Q4. Finally, Table 1 presents our estimation results.

A constant term was included in all the estimated equations. In the estimation, we deal with uncertainty through the *perfect foresight* assumption i.e. rational agents make unbiased forecasts. Consequently, actual historical outcomes are used as a proxy for expectations, thereby combining expectational errors with structural residuals. The perfect foresight assumption was imposed in equations that contain the expected future values of macroeconomic variables viz. the IS and inflation equations, and the monetary policy rule.

Concerning the estimation method, Valadkhani (2004) has pointed out that data availability in developing countries is a restrictive factor in doing sound macroeconomic modelling. This is very true in the case of Indonesia where the quality of data might be somewhere in between the undependable and the reliable due to time lags in gathering island-wide economic data and frequent revisions. Given this, the model-builder should use a robust and simple method, such as OLS, which is not too sensitive to the quality of data. Klein (1989) also argued that applying a method of joint estimation such as maximum likelihood should be avoided

Table 1: Estimation Results of Indonesian SSMM

(1) IS Equation

$$(y^{no} - y^{no*})_t = -0.01 + 0.32(y^{no} - y^{no*})_{t-1} + 0.60E_t(y^{no} - y^{no*})_{t+1} + 0.09\Delta q_t + 0.84\Delta y_t^f$$

(0.004)*** (0.07)*** (0.07)*** (0.02)*** (0.37)***

R-squared=0.80; DW=2.70; F-stat=75.7; Prob(F-stat)=0.00; ARCH(Prob)=0.70; Prob(JB)=0.80
Prob(Q(4)) = 0.48

(2) Oil Equation

$$(y^o - y^{o*})_t = -0.005 + 1.32\Delta y_t^f + 0.03\Delta oil_t - 0.17DUM_YEAR_86\Delta y_t^f$$

(0.007) (0.61)** (0.02)* (0.02)**

$$+ 0.13DUM_GULF_WAR - 0.09DUM_POST_GULF_WAR$$

(0.02)** (0.02)***

R-Squared=0.73; DW=1.24; F-stat=42.16; Prob(F-stat)=0.00; ARCH(Prob)=0.92; Prob(JB)=0.23
Prob(Q(4)) = 0.29

(3) LM Equation

$$m_t - p_t = -8.66 + 1.38y_t - 0.28i_{t-1} + 0.06DUM_YEAR_89 + 0.21DUM_CRISIS$$

(0.52)*** (0.05)*** (0.10)*** (0.03)*** (0.04)***

R-squared=0.98; DW=0.47; F-stat=996.36; Prob(F-stat)=0.00; ARCH(Prob)=0.19; Prob(JB)=0.60
Prob(Q(4)) = 0.00

(4) Inflation Equation

$$\pi_t = -0.01 + 0.23E_t\pi_{t+1} + 0.77\pi_{t-1} + 0.11\Delta e_t + 0.12\Delta m_t$$

(0.002)*** (0.07)*** (NA) (0.02)*** (0.06)**

R-squared=0.73; DW=2.67; F-stat=49.52; Prob(F-stat)=0.00; ARCH(Prob)=0.003; Prob(JB)=0.003
Prob(Q(4)) = 0.026

(5) Monetary Policy Rule Equation

$$i_t = 0.14 + 0.25(y - y^*)_t - 3 + 1.28(\pi - \pi^*)_{t-1} + 0.29\Delta e_{t-2}$$

(0.01)*** (0.19) (0.27)*** (0.06)***

R-squared=0.52; DW=1.01; F-stat=27.42; Prob(F-stat)=0.00; ARCH(Prob)=0.85; Prob(JB)=0.00
Prob(Q(4)) = 0.005

Notes: Standard errors are in parentheses. DW: Durbin-Watson; Q: the Ljung-Box Q autocorrelation test; JB: Jarque-Bera Normality test statistic. *, **, and *** denote 10%, 5%, and 1% levels of significance.

when the quality of the data is mediocre and it is subject to frequent revisions. Hence, in estimating our Indonesian SSMM, we employ the OLS method.⁸

The IS equation we estimated in Table 1 shows that the economy tends to be forward-looking, as evidenced by a larger coefficient on the future output gap as compared to the previous period's output gap. The future output gap parameter is found to be around 0.6 while the lagged output gap parameter is estimated to be only 0.32. We found that the change in the real exchange rate has a contemporaneous effect on the economy and it is estimated that for a 10% depreciation of the rupiah, the non-oil output gap will increase by about 1%. The effect of the contemporaneous foreign income change on the domestic non-oil output gap is found to be positive with an estimated coefficient of 0.84. Interestingly, the impact of the Asian financial crisis on Indonesia in 1997/98 was adequately captured by the explanatory variables, thus there was no need to introduce additional dummy variables to account for the structural break in non-oil output.⁹

Moving to the oil equation, the foreign income elasticity is found to be 1.32. The change in foreign income is found to have a one-quarter lagged effect on the oil output gap. We employ three dummy variables in the oil equation: DUM_YEAR_86 is a temporary break in 1986, signifying a noticeable sharp drop in the oil price and thus oil revenue; DUM_GULF_WAR is

⁸ We also estimated the system using the Full Information Maximum Likelihood (FIML) method and found the results to be quite similar with the OLS method, except that some variables are found to be insignificant. Given the reasons mentioned, we prefer to stick to the OLS method in obtaining the parameter estimates.

⁹ The estimated coefficient on the real interest rate shows a negative sign as postulated by theory i.e. as the real cost of borrowing increase, investment is expected to fall and at the same time people will tend to save more and delay their spending, causing real output to fall and the output gap to narrow. However, the effect of the real interest rate is of a trivial magnitude and found to be statistically insignificant. Thus, we conclude that the domestic interest rate does not significantly affect output movements but instead affects the economy indirectly through the exchange rate. We therefore decided to drop the real interest rate variable in our final IS equation. The government gap is found to have a positive elasticity in the OLS results but it is again statistically insignificant. This could be due to a data problem, since we had to interpolate the government spending data using the cubic spline method. Thus, we also dropped the government spending variable in our final estimated model.

another temporary break in 1991, when the oil price started to spike up again due to the Gulf war in the late 1990s; and finally DUM_POST_GULF_WAR is to capture the effect of oil price stabilization and adjustment after the war.

The LM equation is estimated in log levels because the variables in it are found to be cointegrated. In the LM equation, the income elasticity of the real demand for money is estimated to be about 1.4 and it is statistically significant at the 1% level. This estimate of above unity seems plausible for a developing economy such as Indonesia in view of the high volume of day-to-day transactions that use hard cash. The nominal interest rate is found to have a one-period lagged effect on the demand for money, with an estimated semi-elasticity which indicates that when the interest rate is raised by 100 basis points, the real demand for money is reduced by 0.2–0.3 of a percentage point. Such a relatively large interest semi-elasticity is expected of the Indonesian economy, given that the monetary authority has used punitive interest rates to control the real demand for money and consequently curb inflation. The most notable instance of this occurred during the period of financial crisis in 1998. To account for the structural break in money supply in 1998 and another one in 1989, two impulse dummy variables are included in the LM equation.

In the inflation equation, we impose a long-run vertical Phillips curve restriction whereby the sum of future and past inflation terms adds up to one. Imposing this restriction gives us an OLS coefficient of 0.23 for the future inflation term, which is very close to the calibrated value in the Batini-Haldane model. Thus, the implied elasticity for lagged inflation is 0.77. It seems that economic agents in Indonesia tend to be more backward rather than forward-looking in forming their expectations of inflation. The high persistence of inflation means that the current rate of inflation is strongly influenced by the previous period's inflation rate and not so much by expected future inflation. This might be partly due to the fact that during the financial crisis, for

example, BI did not get much credibility for its attempt to target the inflation rate. Thus, the general public has tended to form their views about the current, and perhaps also the future, inflation rate based on past realized inflation. This conjecture will be re-examined later in our simulation exercises. The effect of a change in the nominal exchange rate is another robustly estimated parameter in the inflation equation. A 10% depreciation of the nominal exchange rate will cause the inflation rate to immediately rise by 1.1%.

The main domestic source of inflation seems to be increases in the money stock. This is not surprising in the light of the results reported in Siregar and Rajaguru (2005). For a 10% increase in the money supply, the current inflation rate will increase by 1.2%. As for the total output gap variable, we decided to drop it after several attempts to include it at various lags failed to produce correctly signed and statistically significant estimates. Similarly, the impact of the foreign price change on domestic inflation is estimated to be small and insignificant so it was also omitted from the final specification of the Indonesian SSMM.

Finally, the estimated Taylor rule suggests that the long-run real interest rate for the Indonesian economy is around 14%. We also found that the total output gap affects the behaviour of the Central Bank with a lag of three, and not one, quarters. The estimated coefficient on the gap is 0.42. The inflation gap lagged one period is found to have a coefficient of 1.08, which means that for every 1 percentage point increase in the inflation gap, BI will increase the policy rate by 1.08 percentage point. Finally, the pressure from exchange rate changes also contributes significantly to interest rate movements with a positive coefficient of 0.27 and it takes half a year for the BI to react to this change. Our results are broadly similar to those in Taylor (1993), who obtained coefficients for the output gap and inflation gap of 0.5 and 1.5 respectively.¹⁰ This

¹⁰Note, however, the original Taylor rule is specified to with respect to the contemporaneous output and inflation gap.

suggests that our modified Taylor rule might be a satisfactory approximation to the conduct of Indonesian monetary policy. We will, therefore, use these estimated and other calibrated coefficients in our analysis of the performance of alternative monetary policy rules.

The R^2 test-statistics suggests a good fit for every structural equation in our model, which is above 0.73 for all equations except for the policy rule. F -statistics confirm that the explanatory variables are jointly significant. Engle's ARCH results suggest no heteroskedasticity is found in the residuals of the equations, except for the inflation equation. Similarly, the Jarque-Bera test-statistics reject the normality of residuals only in the inflation and policy rule equations.

4. Simulation Experiments

Two sets of policy simulation experiments are carried out here: the first set is designed to evaluate the credibility of monetary policy while the second set is mainly aimed at evaluating alternative monetary policy rules.

4.1 Model Evaluation

Before performing the policy simulations, we present the within-sample predictive performance of the Indonesian SSMM in the dynamic and deterministic setting by comparing the baseline simulation results of the model with actual historical outcomes. In this simulation, our aim is to examine how the model performs in tracking the historical reality in Indonesia. Specifically, the charts shown in Figure 1 illustrate how our model would have performed if we had used it back in 1983 to make a forecast for the Indonesian economy over the next twenty years, assuming that we had used the correct paths for the exogenous variables.¹¹

¹¹ In reality, of course, we would not have known these values at the time the forecasts were generated.

All the structural equations performed well during the period prior to the Asian financial crisis. However, the simulated non-oil output, money supply, and exchange rate show deviations from actual outcomes after 1997/1998—a period when Indonesia was experiencing economic turmoil—although they do seem to follow the general trends in the data. In the case of the exchange rate, the discrepancy between the simulated and actual values most likely reflects an increased risk premium on the Indonesian Rupiah which our model did not allow for. The oil output and the inflation equations show a good fit for the entire period under study. As for the monetary policy rule, the baseline result broadly captures the cycles in the domestic interest rate but it is not able to reproduce well the latter’s volatility. This may not matter much since we are going to experiment with different coefficients in the rule when performing stochastic policy simulations later.

4.2 The Role of Credibility in Inflation Targeting

The scenario in our first deterministic simulation concerns different degrees of credibility that people have in the central bank. This is reflected in the formation of inflationary expectations. Earlier in Section 3, we specified expected inflation as $E_t \pi_{t+1} = \lambda \pi_{t+1} + (1 - \lambda) \pi^*$, whereby π^* represents the inflation target and $0 \leq \lambda \leq 1$ represents a measure of credibility of the inflation targeting monetary authority. As λ approaches 1, the policy becomes less credible since very little weight is given by economic agents to the inflation target in the formation of inflationary expectations. The opposite is true as λ approaches 0. Therefore, the parameter λ can be interpreted as the credibility parameter for the central bank.

In our inflation targeting scenario, we will look at several cases where the credibility given to the central bank is zero (the credibility parameter is 1); between zero and full credibility (the credibility parameter is between 0 and 1); and finally full credibility (the credibility

parameter is 0). We will then compare the disinflation effects of different degrees of credibility in the face of a reduction in the inflation target by specifying an out-of-sample simulation whereby the inflation target is reduced by 1 percentage point. The results are shown in Figure 2.

In Figure 2, we see that when the central bank has zero credibility—as shown by the solid line—it takes an extremely long time for the inflation target to be achieved. This is because if the public does not have any confidence in the Central Bank, they rely more on the past inflation rate to form their expectations of future inflation, thus introducing substantial inertia into the actual inflation rate. If we look at the coefficient of the lagged inflation term in our estimated SSMM, the elasticity of 0.77 supports our claim. Although somewhat extreme, our scenario of zero credibility might not be so unrealistic. In Indonesia, the inflation target is not publicly announced, so people have to form their expectations on the inflation rate in the next period based on the past inflation rate and other information. Moreover, the (implicit) inflation target in Indonesia tends to change frequently, causing people to lose trust in the Central Bank's determination and ability to achieve the target.

If the Central Bank can successfully build up at least 50% credibility, i.e. when people put equal weights on the model-consistent expected inflation rate and the inflation target announced by the Central Bank, the inflation target can be reached by around 15 quarters, as shown by the line with rectangles in Figure 2. This result is of even more interest to the BI—the central bank must show some commitment to the public that it is determined and able to achieve the announced inflation target in order to attain non-inflationary economic growth for the Indonesian economy.

Figure 1 Baseline Simulation Results

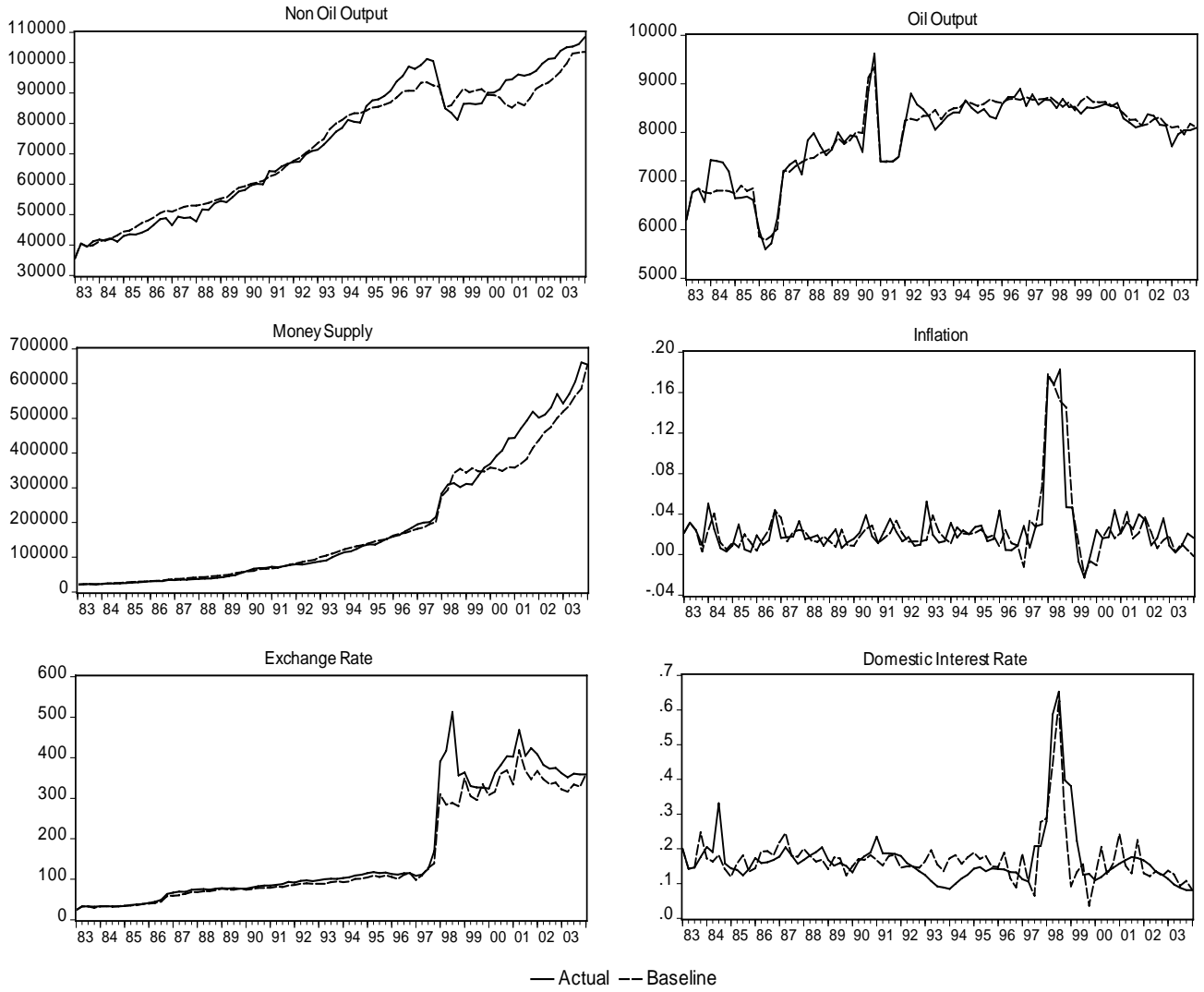
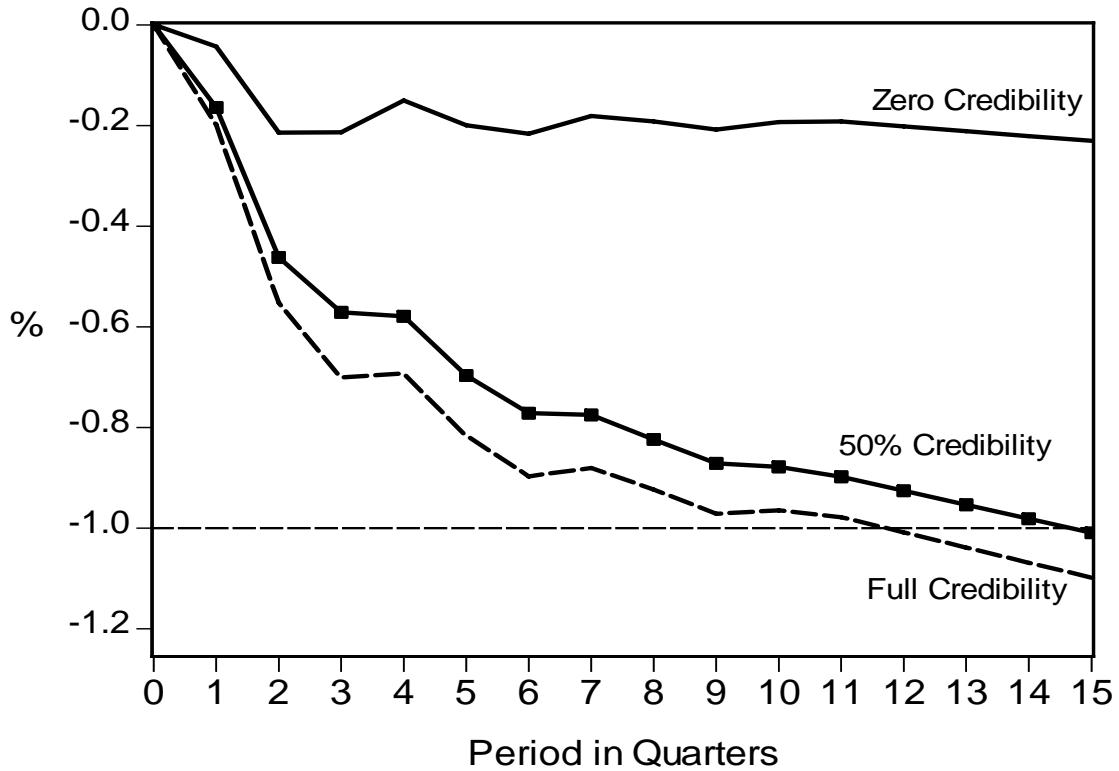


Figure 2 Effects of Central Bank Credibility in Achieving Inflation Target



When the Central Bank gains full credibility from the public, then the inflation target will be met in 3 years' time as shown by the dashed line in Figure 2. The implication of our results is that BI does not require an extremely high level of confidence on the part of economic agents in order to achieve the inflation target, but as long as it can “signal” its commitment to meet the inflation target clearly to the public, inflation can be brought down much faster.

4.3 The Policy Frontier

In this exercise, we experiment with different weights for the inflation, output, and exchange rate variables in the modified Taylor rule equation to trace out the so-called *policy frontier*. The policy frontier is defined as a set of combinations of inflation and output gap volatility that can be attained given a particular form of the policy rule. It is traced out by varying the coefficients on

the inflation and output gap in Equation (7) and then plotting the standard deviations for these two target variables that are obtained from stochastic simulation of the Indonesian SSMM.

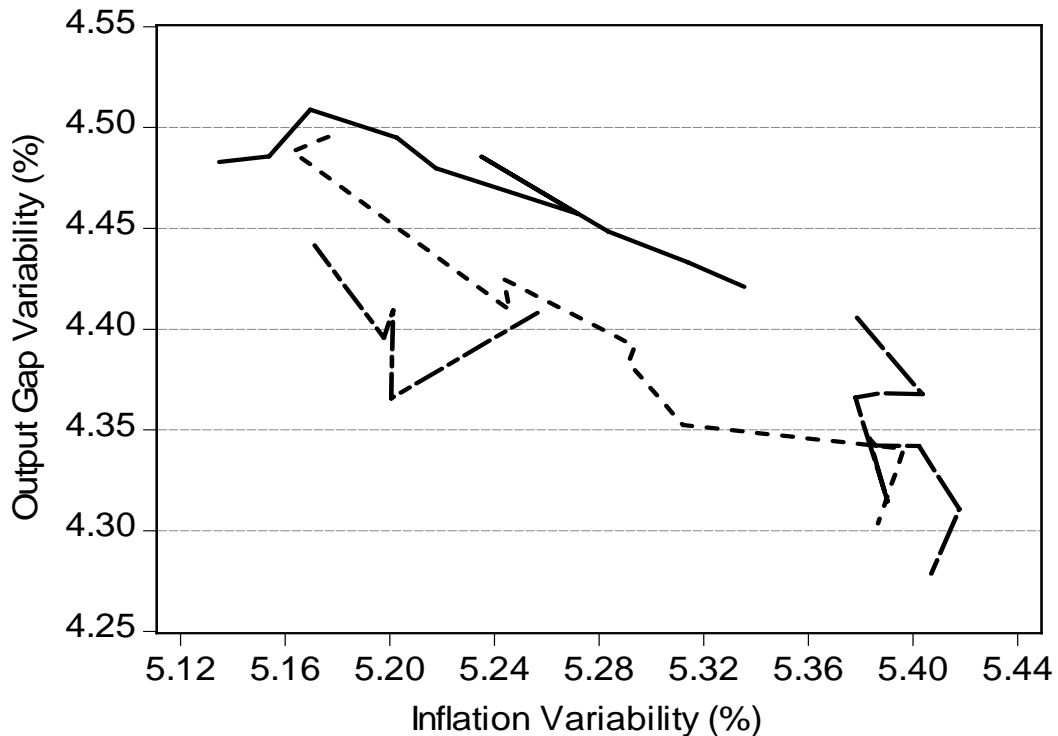
In this exercise, we will deal with two cases. In the first case, we assume no exchange rate effect to be present in the Taylor rule and in the second case, the nominal exchange rate is explicitly included in the policy rule. Furthermore, we will restrict the sum of the parameters on the output and inflation gaps to be equal to one. We feel that by looking at recent trends, more meaningful policy implications can be drawn rather than by focusing on the whole sample because during and after the crisis period, the monetary authority seems to be looking for a “mechanical” rule to guide their policy-making management after the collapse of the managed-floating exchange rate system. Consequently, we will focus on generating the policy frontier for the time period of 1996–2003.

The results from the alternative Taylor rules are traced out in Figure 3. The policy frontier (and its constituent points) that moves in the southwest direction corresponds to a better outcome for the economy since it will generate less volatility in both the output gap and inflation. Along each frontier, the points depict the trade-off between output and inflation volatility as measured by the standard deviations in percentage terms. Our results show that without assuming any exchange rate feedback in the policy rule, a Taylor-type rule with both inflation and output targeting generates a superior result for the economy in terms of lower variability in output and inflation as shown by the short-dashed line. This means that by heeding concerns on both inflation and output stability, the authority can direct the economy into an improved state of welfare. In the figure, the solid line corresponds to a zero weight for the output gap in the policy rule and varying the weight attached to the inflation gap—a strict ‘inflation targeting’ regime. As the weight on the latter is gradually increased, we move in the northwest direction. The long-

dashed line is obtained by changing the weight attached to the output gap while assigning a zero weight to the inflation gap—an ‘output targeting’ regime.

As the weight on the inflation is gradually increased, we move in the northwest direction (the solid line). The results are in line with research in this area which found that, when the authority targets only the inflation rate, the variability of inflation will be lowered at the cost of increased volatility of the output gap (Saxegaard 2000; de Freitas and Muinhos 1999). The same logic applies when the authority only cares about output stability. However, the short-dashed line in Figure 3 lies below the solid and the long-dashed line in the southwest direction, suggesting an improvement when the authority cares about both output and inflation stability. In particular, we find that equal weights given to the output and inflation gaps in this policy rule will generate the lowest possible combination of output gap and inflation volatility of 4.39% and 5.3% respectively.

Figure 3 Policy Frontiers for the Monetary Policy Rule



When we introduce the modified Taylor rule with the exchange rate present, the simulation results show that there is a further improvement in terms of reducing both output gap and inflation volatility. The short-long-dashed line, representing the results from this modified rule, lies below the short-dashed line, suggesting that a further improvement in terms of macroeconomic stabilization policy is possible.¹² Specifically, the results show that for a weight of 0.2 given to the exchange rate term in the policy equation, the best combination of output gap and inflation volatility of 4.36% and 5.2% can be achieved.

To understand our results better, we will explain the economics behind them. The solid line frontier in Figure 3 that corresponds to strict inflation targeting tells us that BI will only respond to the change in the inflation gap and as the weight attached to it is increased, the magnitude of the policy response will also increase. In other words, as the weight attached to the inflation gap is increased, the policy rate—the interest rate—will be raised by a bigger amount. A higher interest rate will then cause money demand to fall, as is evident from the LM equation whereby the interest rate has a negative elasticity with respect to money demand. As money demand and supply falls, the inflation rate also declines. Furthermore, there is an indirect effect working through the UIP equation that reinforces the drop in the inflation rate because an increase in the policy rate will appreciate the Rupiah, thus reducing foreign inflationary pressures.¹³ The result is that inflation volatility will be brought down at the cost of an increase in output gap volatility, which increases due to the appreciation of the real exchange rate.

¹² We vary the weight attached to the exchange rate term starting from 0.1 up to 0.5 only since increasing the weight to more than 0.5 generates unstable results. The weights attached to the inflation and output gap is whatever 1 minus the weight attached to the exchange rate term and then divided equally among them.

¹³ Note also that when we trace out the policy frontier in the context of strict inflation targeting, we set the coefficient on exchange rate to be equal to zero. Thus, we eliminate any direct pressure from the exchange rate unto the interest rate as specified by the modified Taylor rule, i.e. it becomes a standard Taylor-type rule.

The long-dashed line in Figure 3 traces out the policy frontier whereby the authority is only concerned about minimizing output volatility regardless of inflation volatility. In this case, BI will only respond to any deviation that occurs in the output gap term in the monetary policy rule equation. When output falls below trend, the domestic interest rate is lowered in response, leading to an immediate depreciation of the exchange rate which in turn improves the competitiveness of the economy, resulting in a rise in exports and thus output. The depreciation now leads to an increase in the domestic price level. At the same time, money demand increases with the output level, which aggravates inflation. Consequently, output variability is reduced under an output targeting regime, but at the expense of higher inflation variability.

What is interesting and important is that when BI targets both inflation and output, then their variability can be reduced. This is because the effect from the depreciation in the real exchange rate (that increases output volatility) is countered by a lower interest rate. This means that by caring not only for output but also inflation, the total variability of the economy can be mitigated. Furthermore, by acknowledging the role of the exchange rate, the ability of the central Bank to reduce the volatility of the output gap and inflation is improved further, as is evident from the fact that the short-long-dashed line rests entirely below the short-dashed line in the southwest direction in Figure 3. The implication is that, apart from responding to output and inflation gaps, BI is stabilizing exchange rate fluctuations in a way that is beneficial to the economy. The improvement resulting from the inclusion of the exchange rate argument is in contrast to the conclusion stated in Ball (1999), Svensson (2000) and Taylor (2000b) which found no, or little, improvement with an exchange rate variable. We will discuss the policy implications of our empirical findings in the concluding section.

5. Policy Implications and Conclusion

The first policy implication that we can draw from this study is that the small scale macroeconomic model that we have built is able to capture the short to medium-term economic dynamics in Indonesia. This finding suggests that the implementation of a small scale model warrants consideration in policy-making and it can also provide a cross-check on results from larger scale models developed and maintained by BI, such as the Annual Model of Bank Indonesia MODBI.¹⁴ An important feature is that our model explicitly considers the role of expectations in the form of model-consistent expectations. This is important because the lack of any forward-looking element significantly decreases the ability of the model to provide a credible description of the economy which is valuable to policymakers.

A second implication concerns the conduct of monetary policy in Indonesia. Based on a deterministic simulation exercise, we show that the credibility of the Central Bank is very important for achieving sustainable non-inflationary economic growth. In the case where the Central Bank has no credibility at all as perceived by the public, it will take an extremely long time for the inflation rate to be brought down to the targeted level. Nevertheless, we see a major improvement when the Central Bank can successfully build some credibility. This finding supports the new Central Bank Act in 1999 that requires BI to announce the inflation target on a regular basis to the public so as to ensure its accountability. By announcing the inflation target, BI can “earn” the credibility it requires and the public’s beliefs can be built up gradually. When BI can successfully achieve this “critical” level of credibility by announcing and committing to the inflation target, we can expect a reduction in inflation volatility that will ensure the sustainability of economic growth in Indonesia.

¹⁴ See Warjiyo (2001) for existing macroeconomic models of Indonesia.

The final and most important implication is that the best Taylor-type policy rule for BI is to focus on a monetary policy rule with equal weights given to the output gap and inflation gap. The literature on monetary policy rules has often been restricted to a closed economy framework. Nevertheless, there is a growing consensus in recent years that an explicit modeling of the exchange rate is a necessary condition for a macroeconomic model to provide a credible description of the monetary transmission mechanism in a small open economy. This is also evident from the rapid increase in the number of structural models with an explicit role for the exchange rate such as Blake and Westaway (1996), Ball (1999), Svensson (2000), Batini and Nelson (2000), Leitemo and Roisland (2000), and Leitemo and Soderstrom (2000).

Our study shows that the exchange rate plays a crucial role in the conduct of monetary policy and in ensuring the stability of the Indonesian economy that is in line with key findings from Siregar and Ward (2002). Specifically, this paper proposes a rule in which the exchange rate is also an important target variable so as to capture the open economy aspects of the Indonesian economy. When we introduce an exchange rate argument in the monetary policy rule, BI can reduce the variability of output gap and the inflation rate further as compared to the best Taylor-type rule that we have specified in this paper, provided that certain threshold is met when assigning the weights on exchange rate variable. We believe that this finding is a crucial indication of how important the exchange rate could be in the future course of monetary policy management in Indonesia and to improve its best monetary policy response.

APPENDIX

The datasets used in the Indonesian SSMM comes from several sources and it covers quarterly series from 1983 to 2003. The Indonesian Consumer Price Index (CPI) data, the world CPI data, the domestic short-term interest rate, the foreign interest rate, the oil price, exchange rates, and annual Indonesian government expenditure are taken from the *International Financial Statistics* (IFS) CD-ROM (latest edition for April 2004 by the International Monetary Fund). The quarterly data on real GDP, money supply as given by M1, and the core inflation data from 1988 to 2003 is by courtesy of Dr. Martin Panggabean, Chief Economist at Bank Mandiri, Indonesia. The quarterly data on real oil output from 1993 to 2003 is obtained from the website of Bank Indonesia (www.bi.go.id).

We have to resort to the Chow-Lin interpolation method to construct the quarterly oil output data from 1983 to 1993. We use the average oil price series (in US Dollars) that is obtained from the *International Financial Statistics* (IFS) CD ROM is employed as related series to perform disaggregation in the oil output data. In doing so, we found some interesting points to note. The full sample data from 1983 to 2003 yielded a cross-correlation between oil output and oil price of 0.40, confirming that the oil price is a good related series for interpolating oil output. However, the positive and strong relationship between the oil price and oil output seems to be distorted by the occurrence of the Asian financial crisis. During the crisis, the Indonesian authority abandoned the historical managed floating exchange rate system, thus subjecting the Rupiah/US dollar to high volatility. Since we use the Rupiah oil price as the related series, the change in the exchange rate regime will affect the relationship between the oil price and output. As a remedy, we excluded the permanent structural break starting from 1998, the year when the

impact of financial crisis was most severe for Indonesia. By doing so, the cross-correlation between oil output and the oil price improved to 0.68¹⁵.

In constructing the foreign income level and the nominal effective exchange rate indices we use are the export shares to Indonesia's major trading partners as weights. The export data that we utilized is the data on merchandise exports between countries to measure bilateral trade flows. This is obtained from the Econometric Studies Unit (ESU) of the Department of Economics, National University of Singapore. The export-share matrix (W) is calculated as a 12-quarter moving average of export shares. This method has some benefits according to Abeyasinghe and Forbes (2001). It allows the export share matrix to vary smoothly over time, for example. Our final dataset consists of 11 real foreign GDP series and 121 export share series, all compiled on a quarterly basis from 1983:Q1 through 2003:Q4. Formally, the construction of the foreign income level in the Indonesian SSMM is as follows:

$$y_t^f = \sum_{i=1}^{11} w_{it} y_{it} \quad \forall \quad i \neq j$$

$$w_{it} = \frac{\text{export}_{it}}{\sum \text{export}_{it}}$$

¹⁵ The regression result also shows an improvement in the R^2 from 0.16 to 0.58 after eliminating the permanent structural break, showing a much better fit of the model.

Table 2: Variable description for datasets used in Indonesian SSMM

Variable	Description (1993 = 100 for real variables)
y	Real GDP
y^o	Real oil output
y^{no}	Real non-oil output
oil	Average oil prices (in Rupiah)
m	Money Supply
p	Domestic Consumer Price Index (CPI)
p^f	World Consumer Price Index (CPI)
i	Nominal short-term interest rates
i^f	US 3-Month T-Bill rates
y^f	Foreign income index using export shares as weights
e	Exchange rate index using export shares as weights
g	Government spending

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