Working Paper
in Economics and
Development Studies

Department of Economics
Padjadjaran University

No. 200101

Optimum Monetary Instrument Option in the Case of a Small Open Economy

Arief Ramayandi

Department of Economics,
Padjadjaran University

September, 2001

Center for Economics and Development Studies,
Department of Economics, Padjadjaran University
Jalan Cimandiri no. 6, Bandung, Indonesia.
Phone/Fax: +62-22-4204510
http://www.lp3e-unpad.org

Optimum Monetary Instrument Option in the Case of a Small Open Economy

By:
Arief Ramayandi

Abstract

This essay examines the choice of monetary policy instrument for a small open economy under flexible exchange rate regime with some reference to Indonesia. To approach the issue a simple ad-hoc aggregate supply-IS-LM model is used for the analysis. Although basically the issue concerning monetary instrument problem tend to be more empirical rather than theoretical, this essay argues that some rules of thumb could still be drawn from the analysis of the theoretical model to solve the problem. The recognition of the true behavioural relationship among aggregate variables in the economy is important as guidance for the optimal policy rule. The analysis also recognises that a credible commitment from the monetary authority towards the instrument chosen is important.

Contents

1. Introduction

Uncertainty is part of our everyday life, and in fact it presents itself everywhere in our everyday activity. Besides that fact, certainty is always preferred to maturity. In terms of the aggregate economy, one form of uncertainty is translated in fluctuations in the key aggregate economic variables. As certainty is always preferred to uncertainty, macroeconomic managers seek ways to eliminate -- or, more realistically, moderate -- these fluctuations. One way to deal with these economic fluctuations is through monetary policy, so that it can serve as a tool to ensure that the economy achieves a relative state of stability.

The task of conducting monetary policy is delegated to the monetary authority in the economy. One of the most common devices available to the monetary authority for conducting monetary policy is open market operations (OMO). In conducting open market operation, monetary authority should specify the instrument that it is going to use in implementing monetary policy. Essentially the instrument has to be the one that is directly under the control of monetary authority. There are two instruments available in a mutually exclusive manner to be chosen by the monetary authority: the money base (a quantity rule) and the interest rate (a price rule).

The choice for the right instrument has long been debated as an instrument problem faced by the monetary authority. The monetary authority cannot fix both instruments at the same time. If the quantity is fixed (money base targeting), then the monetary authority has to let the market determine the price (interest rate) to ensure equilibrium in the money market, and vice versa. In other words, once one of the two variables is chosen as an instrument by the monetary authority, the other one becomes a random variable.

The optimal solution for this instrument problem would be to choose the one which produces the minimum variation in the key aggregate macroeconomic variables. This essay attempts to deal with the instrument problem faced by the monetary authority in a small open economy. Therefore the question to be addressed is to figure out the best solution to this instrument problem in the context of a small open economy.

In the open economy case, generally the monetary policy issue concerns more to the choice of the exchange rate regime instead of this instrument problem. Under the case of a fixed exchange rate regime, the instrument problem becomes relatively irrelevant since the domestic interest rate would basically determined by the international interest rate, while the monetary base would be the random variable given the fixed exchange rate of the domestic currency. Under the free-floating regime, the domestic exchange rate acts as the random variable. However, in the circumstances where the luxury to choose between the exchange rate regime is not available, then the domestic monetary policy will still faced the instrument problem in attempting to moderate the aggregate economic fluctuations.

The recent Asian crisis has not only brought a dramatic fluctuation in the crisis hit economies, but also forced those economies to float their exchange rate freely. The reason is that to defend the fixed target of domestic exchange rate, the economy needs to have an adequately sufficient amount of international reserves. During the crisis, the amount of international reserves available for those countries was just not enough to keep their exchange rate target. The essay takes this as the starting point, and looks at the choice of monetary policy instrument under a flexible exchange rate regime.

In order to approach the question of this essay, a simple ad-hoc aggregate supply (AS)-IS-LM model is used to represent the economic system. The model explicitly takes into account the real exchange rate as additional information for the monetary authority to determine its optimal policy rule. There has been substantial debate about the choice of operating instrument in Indonesia, and the model can be used to assess some of this debate.

The outline of this paper is as follows: Section 2 outlines the model and describes the structure of the particular small open economy used to do the analysis. Section 3 presents the analysis of the model to approach the instrument problem in conducting monetary policy. This section also presents the analysis for the target variables under both the quantity and price rules. Section 4 provides a further qualification for the analysis of the model with reference to Indonesia. And, Section 5 sets out some concluding remarks.

2. The Structure of a Small Open Economy

To approach the question put forward in this essay, the economic structure based on a simple ad-hoc aggregate supply (AS)-IS-LM model is used. The model is not derived directly by optimising economic agents' behaviour, and so in this sense it is an ad-hoc model. However, the model used has already been widely utilised to approach such problem, and to some extent is considered consistent with the money in the utility (MIU) function model (as described in McCallum, 1999 and Walsh, 1998). This section will describe the behavioural relationship in each component considered in the model.

The first three equations in the model are as follows:

Aggregate supply (AS) is represented as:

AS: $$y_t^s = a_0 + a_1(p_t - E_{-1}p_t) + a_2 y_{t-1} + e_t \quad (1)$$

Aggregate demand in the economy (AD) is represented as:

IS: $$y_t^d = b_0 + b_1 r_t - b_2 r_t + b_3 z_t + d_t \quad (2)$$

and,

LM: $$m_t - p_t = c_0 - c_1 i_t + c_2 y_t + m_t \quad (3)$$

All variables above are expressed in the natural log form, except for r (the real interest rate) and i (the nominal interest rate). The economy is assumed to be in equilibrium, hence, the log of the aggregate output supplied (y_t^s) and the log of the aggregate output demanded (y_t^d) is assumed to be the same. p is the log of the economy's aggregate price level. E_i is an expectation operator, with subscript i indicates the

period of the expectation formation. r is the real exchange rate variable (a rise indicates a depreciation). z is the sum of exogenous variables affecting aggregate demand of the economy, e.g. government outlay etc. m is the log of money circulated in the economy. a, b and c are positive parameters.

Equation (1) represents the relationship in the aggregate supply of the economy. This equation is rationalised by Lucas (1973), which follows from an overlapping generation model optimisation he constructed by incorporating one period nominal wage rigidity (as indicated by Walsh, 1998, p.204). By this equation, the deviation in the current actual aggregate price level to its expected value given the observable previous information (the price surprises due to the presence of nominal wage and price rigidities) will induce higher output. Therefore, a_1 is the elasticity of y_t^s over the change in $(p_t - E_{-1}p_t)$, which has a positive impact on aggregate output supplied. a_2 is the adjustment coefficient for y. By assuming that the aggregate supply function is stable, then $0<a_2<1$. e_t is the white noise residual for the AS function. It could also be interpreted as the representation of any unexpected innovation to aggregate productivity. In summary, aggregate supply of the economy increases if the actual price level is higher than expected, the higher the previous period output level, and if there is a positive innovation to the aggregate productivity.

Equation (2) represents the IS function of the economy. It is basically a reduced form of the aggregate demand in the economy[1]. Aggregate demand of the economy is perceived to be negatively related to the real interest rate (r). r in each period is

[1] This type of equation is commonly used for analyzing the choice of an optimal instrument problem using an ad-hoc closed aggregate economic model (e.g. Poole, 1970, Sargent and Wallace, 1975, etc.). This line of literature was initiated by Poole (1970).

characterised by the Fisher equation, relating the real and nominal interest rate as follows:

$$r_t = i_t - (Ep_{t+1} - p_t) \qquad (4)$$

where $(Ep_{t+1} - p_t)$ is expected inflation within each period of time. To capture the open economy characteristic, the log of the real exchange rate variable (r) is included in the function. This variable determines the magnitude of the economy's net export, where, when r depreciates (increasing in value), net export increases, and vice versa. r for each period itself is defined as the following equation:

$$r_t = s_t + p_t^* - p_t \qquad (5)$$

where s and p^* represent the log of nominal exchange rate of the domestic economy and the international price level respectively. The nominal exchange rate is quoted in terms of domestic currency over foreign currency, so that the increased (decreased) value of the nominal exchange rate signifies a depreciation (appreciation) of domestic currency. b_3 is the multiplier effect of z with respect to y_t^d. Therefore, b_3 is assumed to be greater than one ($b_3 > 1$). d is a white noise residual that can be interpreted as an aggregate demand shock in the economy. For further simplicity, it is going to be convenient to assume that all the white noise components in the system are not correlated with each other.

Another simplifying assumption that is going to be utilised in the analysis of this economic system is that the Marshall-Lerner condition holds, where the sum of the absolute value of the export and import elasticity is greater than one for each period. By holding this condition, we assure that the direct impact of the domestic currency

depreciation on net exports will be positive. Therefore, as suggested by the Marshall-Lerner consistent assumption, b_1 in equation (2) is expected to be greater than one. However, relaxation of this simplifying assumption could also be explored, to see the implication towards the volatility of aggregate output and prices given the specific instrument as a tool of monetary policy.

Equation (3) represents the demand for real balances in the economy. The log of real balances ($m - p$) is perceived as negatively determined by the nominal interest rate and positively determined by the current aggregate income (which, is assumed to be equal to the aggregate output of the economy). m represents the white noise shock in the demand for real balances, and as mentioned above, is assumed to be not contemporaneously correlated with other variables.

On the other hand, the money supply process is modelled by incorporating the banking sector behaviour in it. It is assumed that the interest rate would have an effect on the formation of the banking sector reserves in the central bank (as explained in Hadjimichalakis, 1982, Mishkin, 1995, etc.). The higher the market interest rate, the lower the excess reserves over deposits in the banking sector. Hence, the higher is the money multiplier. Therefore, the equation that represents the money supply formation is as follows[2]:

$$m_t = g_1 h_t + g_2 i_1 + q_t \qquad (6)$$

Equation (6) says that the money supply process is being determined positively by the monetary base (h, i.e., the relevant reserve aggregate) and interest rate (i). q represents the shock on the money supply process within each period, and as the other

[2] The equation follows from the one ustilised by McCallum and Hoehn (1983).

shocks, is assumed to be white noise and contemporaneously uncorrelated with other variables. By this set up, it could also represent the view that the money supply process is, to some extent, demand determined.

Interest parity condition is taken as the rule that governs the flow of capital into and out of the country. The condition that is utilised in this essay is the uncovered interest parity condition by adding a white noise variable (y) to capture the imperfection in the international capital movement.

$$(i_t - i_t^*) = (Es_{t+1} - s_t) + y_t \qquad (7)$$

Equation (7) says that the difference between domestic and international interest rate is equal to the expected change in the log of exchange rate plus some white noise component that could be interpreted as a risk factor of the domestic economy. y_t is conjectured to move randomly with the average value of zero and is assumed to be uncorrelated with the other variables in the economic system considered in this essay. However, the inclusion of this variable in the interest parity condition allows the difference between domestic and international interest rate to be different with the expected change in the exchange rate.

To characterise the small economy assumption, i_t^* and p_t^* are assumed to be absolutely exogenously determined. The domestic economy does not have the ability to alter those variables. In addition, since the purpose of this essay is to analyse the impact of monetary intervention on the aggregate economy, government outlay (which is captured in the z variable in the IS equation) is also assumed to be exogenously determined. The intuition behind this is that the government is assumed to announce the value of its outlay in the beginning of each period, so that the

information on z within each period is observable in that same period. For the sake of simplicity in analysis, those variables are assumed to be constant. This simplifying assumption could be relaxed in the interpretation of the analysis later. However, the relaxation will still be a simplification of the true economic model, which still assumes that those variables are all absolutely exogenously determined and that the agents in the economy do not form any expectation in the value of those variables. Therefore, it is basically a very stringent assumption in the sense that it assumes that the international market situation is absolutely stable, and hence completely predictable.

The other thing that needs to be clarified in this set up is the way economic agents form their expectation of the log of the future nominal exchange rate (Es_{t+1}). In forming their expectation of the future nominal exchange rate, agents are assumed to follow the purchasing power parity argument. Therefore, it is expressed as follows:

$$Es_{t+1} = Ep_{t+1} - p^* \qquad (8)$$

Due to the assumption made in the above paragraph, then the expected value of the log of the future international price level is just the value of itself, which is assumed to be constant.

As a consequence of the above assumptions and given the interest parity assumption outlined in equation (7), we could get an equation expressing the determination of the log of the current nominal exchange rate as follows:

$$s_t = Ep_{t+1} - p^* - (i_t - i^*) + y_t \qquad (9)$$

Equation (9) says that the log of the current nominal exchange rate for the domestic economy is simply the log of the current period expected value of the difference of the domestic and international price level in the next period, minus the difference between domestic and international interest rate in the current period, plus some international shock on the domestic economy in the current period. Therefore, besides the expected future purchasing power parity, the capital movement in the current period also plays a role in determining the current nominal exchange rate of the domestic economy's currency.

3. Analysis

From the economic model set up in the previous section, we can conduct an analysis of how a particular choice of monetary policy instrument can influence the target variables given the specified model. The main target variables considered in this essay are the aggregate output and the aggregate price level. However, the analysis could also be conducted to access the variability in the nominal exchange rate of the domestic economy and the money stock as an intermediate target given quantity rule (setting up the monetary base) of monetary policy choice. Those additional variables would give a wider range of target variables to be considered by the central bank when deciding an ad-hoc aggregate loss function for the economy as a whole. This aggregate loss function is assumed to be formed by some weighted average of those target variables[3].

There are two schemes that will be analysed in this essay. The first would be analysing the impact of choosing the quantity rule, i.e. fixing h as the choice of the monetary instrument; and, the second would be the impact of choosing the price rule, i.e. fixing the interest rate as the monetary policy tool. Since the model incorporate expectation for some endogenous variable in the system, the solution would be difficult to be traced. In order to work out the solution for the analysis, the method of undetermined coefficient is used to help in finding out the solution for the variables under consideration.

[3] This type of aggregate loss function has already commonly being used in the analysis utilizing an ad-hoc aggregate economic models (e.g. Checchetti, 1995, Svensson, 1999, etc.)

3.1 The Method of Undetermined Coefficients

This method consists of guessing the solution of the parameterisation of the solution equation. The idea is to utilise the theory or an educated guess work to find the general functional form of the solution. After the conjecture of the general functional form of the solution is decided, the next task is to determine the values of the parameters in the conjectured general solution that satisfy the system of equations used in the model.

In this particular case, the equation of interest is the equilibrium aggregate price level, which is derived from the system of equations representing the economic system. The educated guess for the equilibrium aggregate price level is a linear function of all the exogenous variables included in the system. Using the conjectured solution for the price level (as shown later in this section), we work out the solution for the expectational function of the aggregate price level. As the functional forms of those variables are figured out, we can substitute it in to get all the solution of other endogenous variables of interest.

For the model considered in this essay, the exogenous variables that will determine the aggregate price level would be the constant (including the assumed constant value of z, i_t^* and p_t^*), all the shock variables relevant to the case under consideration, the lagged endogenous variable y_{t-1} (which is already known during the current period), and all the exogenous shocks. Therefore, the solution for p, in this case, is a function of a constant, y_{t-1} and all the shock variables related to the scenario used to analyse the determination of p in the system.

3.2 Target Variables

Analysis concerning target variables will be conducted under two different scenarios. First, under the quantity rule, i.e. by fixing or controlling the monetary base as an instrument in conducting monetary policy. Second, under the price rule, i.e. by controlling the interest rate as an instrument of monetary policy.

3.2.1 Quantity Rule

This rule means that the monetary authority is taking the monetary base (h) as the instrument to influence the aggregate economy. As a consequence, the domestic nominal interest rate is now being determined in the money market as specified by the mechanism explained in equation (3) and (6):

$$i_t = \frac{1}{c_1 + g_2}(c_0 - g_1 h + p_t + c_2 y_t + m_t - q_t) \tag{10}$$

Equation (10) says that under this policy rule, the nominal interest rate is negatively determined by the chosen level of money base. The other variables that determine the nominal interest rate are the current price level and income (where both affect the nominal interest rate positively). Another feature that characterises the nominal interest rate here is the white noise shocks from the money demand and supply process.

By substituting equation (10) to the system specified previously, we can solve for the current aggregate price level. As described in the appendix, we can then characterise the conjecture for the general solution for the aggregate price level as follows:

$$p_t = f_0 + f_1(m_t - q_t) + f_2 y_t + f_3 d_t + f_4 e_t + f_5 y_{t-1} \tag{11}$$

Using the method of undetermined coefficient, we then get the parameters in the conjecture as follows:

Table 1 **Coefficients for the general solution of prices under the quantity rule**

Coefficient for:	
- Constant term	$f_0 = \frac{(g_0 - a_0 + g_4 f_5 a_0) + g_1 h + g_2 i^* + g_3 z}{g_5}$
- The money demand and the money supply process shocks (m -q)	$f_1 = \frac{-g_5}{g_5 + a_1 - g_4(f_5 a_2 - 1)} < 0$
- The international economy's assessment disturbance (y)	$f_2 = \frac{g_2}{g_5 + a_1 - g_4(f_5 a_2 - 1)} > 0$
- The aggregate demand shock (d)	$f_3 = \frac{g_6}{g_5 + a_1 - g_4(f_5 a_2 - 1)} > 0$
- The aggregate supply shock (ε)	$f_4 = \frac{g_4 f_5 - 1}{g_5 + g_4 + a_1 - g_4(f_5 a_2 - 1)} < 0$
- The lagged output (y_{t-1})	$f_5 = \frac{-a_2}{g_5 - g_4(a_2 - 1)} < 0$

Note: The derivation is shown and symbols are explained in the appendix

From the above table, the intuition behind the conjectured general solution for prices is theoretically acceptable. The current aggregate price level (p) is negatively influenced by the money demand shock and positively influenced by the shock in the money supply process. In this sense, the unanticipated increase in the money supply (*cet. par.*) will reduce the value of money, which means an increase in the aggregate price level. On the other hand, the increase in money demand means there is a shortage of money in the economy, which reduces the aggregate price level. The increase in the international economy's disturbance (y), e.g. the increase in the country risk factor of the domestic economy, will depreciate the current nominal exchange rate (as seen in the equation (9)), increasing the aggregate price level through the transmission mechanism process in the aggregate economy. A positive aggregate demand shock would affect p positively, while a positive aggregate supply

shock (positive innovation shock in the aggregate production process) would affect *p* negatively. As the adjustment process affects the aggregate supply process positively, the lagged aggregate output influences *p* negatively.

Using the above result for the determination of the current aggregate price level and by working on its expectational form, the determination of aggregate output is defined as follows:

$$y_t = a_0 + a_1(f_1(m_t - q_t) + f_2 y_t + f_3 d_t + f_4 e_t) + a_2 y_{t-1} + e_t \qquad (12)$$

From the above equation, the term in the bracket represents the unanticipated movement in the price level. Therefore, the impact of each shock is just their impact on the aggregate price level times a_1. Any of those shocks represents the deviation of the current price level from the expected value of it created in the previous period. Hence, the positive deviation will induce more production by the production sector in the economy due to the lower real wages they are facing, and vice versa[4]. One thing that is interesting to note here is the impact of the innovation in the production process for the aggregate current output itself. From equation (12), the positive (*cet. par.*) unexpected innovation in production process (e) no longer has a one-to-one relationship with aggregate output. The intuition behind that is the fact that this current innovation induces the decline in the aggregate price level (as shown in table 1). Hence, it will increase the level of real wage paid in the production processes. As a result, producers will tend to lower their consumption of labour in order to meet their budget constraint. Therefore, the impact of a positive innovation on current aggregate output of the economy is not clear (as it is an empirical matter rather than a theoretical one). If a_1 times f_4 is less than -1, then the positive innovation will decrease the

[4] Note that this aggregate supply model implicitly assumes nominal wage rigidity.

aggregate current output instead of increasing it. However, if a_1 times f_4 is greater than -1 (but lower than 0 since f_4 is negative as shown in table 1), the positive innovation in production processes will still be increasing the current aggregate output by less than proportional.

Having set up the target variables in terms of the exogenous variables in the system, we can move to the area which is of interest to policy makers. Given any policy taken, it is under the policy makers' interest to get information about the variability of the outcome of target variables. In this essay, the variability of the target variables is accessed by measuring the associated variance of the target variables under consideration. To simplify the expression, it is also assumed that all the unanticipated shock variables are independent of each other, so that the co-variances among those shocks are equal to zero. The violation of this assumption will not change the intuition behind the eventual variances of those target variables too much, except that it is only going to increase the variances of interest.

From equation (11) the variance of the aggregate price level ($Var(p_t)$) is as follows:

$$E(p_t - Ep_t)^2\Big|_h = f_1^{\,2}(Var(m_t) + Var(q_t)) + f_2^{\,2}Var(y_t) + f_3^{\,2}Var(d_t) + f_4^{\,2}Var(e_t)$$

It could be seen that the variance of the aggregate price level consists of the variances of all the shocks in the economic system. There are several things that need to be noted here. First, from Table 1, it is quite clear that the value of f_1 is between zero and minus one ($-1<f_1<0$) since the denominator is positive and greater than g_5. Therefore, the absolute value of $f_1^{\,2}$ must be smaller than the absolute value of f_1 itself, and hence both the variances of money demand and supply enter the variance of

the aggregate price level with a smaller value. The value of f_3 is between zero and one (since $0<g_6<1$ as indicated in the appendix). f_2 also lies in between zero and one (as shown in the appendix and explained later in this section). Therefore, the variance of the aggregate demand shock and the variance of international disturbance term also enters *Var(p)* in the same way as the variance of the shock of money demand and money supply. On the contrary, the absolute value of f_4 could be either less or more than 1. Hence, and the variance of the productivity shock enters *Var(p)* with an unclear magnitude.

The variance of aggregate output (*Var(y)*) is derived from equation (12) as follows:

$$E(y_t - Ey_t)^2\Big|_h = \begin{bmatrix} (a_1 f_1)^2 (Var(m_t) + Var(q_t)) + (a_1 f_2)^2 Var(y_t) + (a_1 f_3)^2 Var(d_t) \\ + (a_1 f_4 + 1)^2 Var(e_t) \end{bmatrix}$$

In the case of the variance of aggregate output, the manner of how the shocks variances enters *Var(y)* depend on the magnitude of a_1.

3.2.2 Price Rule

Under this rule, the monetary authority chooses to fix the nominal interest rate as an instrument in conducting the monetary policy. However, as pointed out by Wicksell, fixing the nominal interest rate as a monetary policy instrument could possibly generate an inflation or deflation if done at an incorrect level[5]. Permanently fixing the nominal interest rate would require the free fluctuation in the money supply in order to keep the interest level intact at its decided rate. The free fluctuation in the money market would have an effect on the aggregate price level, where the aggregate price level will also fluctuate without having anything to anchor it down. Therefore, as

[5] Blanchard and Fisher, 1990 (p.577)

economic agents believe that the monetary authority will always accommodate whatever money is demanded, they may have different expectations of the aggregate price level, each of which is as good as the other. As a consequence, there is no definite anchor in the determination of the current aggregate price level. In other words, permanently fixing the nominal interest rate results in price indeterminacy. This case is true, either under an adaptive or rational expectation assumption in the economic agents expectation formation. For the case of rational expectation assumption (as shown by Sargent and Wallace, 1975), the current price level will have a one to one relationship with the expected future price level, which is indeterminate because agents in the economy might have different expectations, which, each of those are based on the correct assumption that the authority will always accommodate whatever quantity of money demanded at the given nominal interest rate.

This price indeterminacy problem can be easily overcome by introducing a nominal anchor to tie down the price level[6]. In this essay, the monetary policy is assumed to aim for stabilising the inflation. Therefore, it is assumed that the monetary authority fixes the nominal interest rate according to the following rule:

$$i_t = (Ep_{t+1} - p_t) + kp_t \qquad (13)$$

where k is a constant parameter relating nominal interest rate to the aggregate price level that is chosen by the monetary authority. This rule simply says that the nominal interest rate is set to incorporate the actual movement of the aggregate price level in order to stabilize inflation.

[6] This solution was put forward initially by McCallum (1981)

By fixing the interest rate, then the role of the money market is merely just to determine the amount of money base needed to keep the nominal interest rate given. Therefore, under this scheme, the movement in the money market does not have anything to do with the determination of the target aggregates. In other words, by fixing the nominal interest rate, the money market only serves as an appendage in the overall economic system. The only task of the money market under this scheme is determining the level of money base (h) needed to assure that the given nominal interest rate is achieved. The intuition behind this process is that since the government has fixed the nominal rate of interest in the manner described in equation (13), then basically the real cost of capital (the real interest rate, r) is being kept out of the impact from the expected inflation and being tied down to the current price level by a certain proportion k. The process of determination of the aggregate price level and output is now left to the goods market.

By installing equation (13) (the interest rule) to the specified economic system and repeating the method used to figure out the aggregate price level as described in the quantity rule section, we can characterise the conjecture for the general solution for the aggregate price level as follows:

$$p_t = V_0 + V_1 y_t + V_2 d_t + V_3 e_t + V_4 y_{t-1} \qquad (14)$$

By applying the method of undetermined coefficient, we then get the parameters in the above conjecture as follows:

Table 2 **Coefficients for the general solution of prices under the price rule**

Coefficient for:	
- Constant term	$V_0 = f_0 + f_2 i^* + f_4 z$
- The international economy's assessment disturbance (y)	$V_1 = \frac{f_2}{1+f_1} > 0$
- The aggregate demand shock (d)	$V_2 = \frac{f_5}{1+f_1} > 0$
- The aggregate supply shock (ε)	$V_3 = \frac{-f_5}{1+f_1} = -V_2 < 0$
- The lagged output (y_{t-1})	$V_4 = -f_3 < 0$

Note: The derivation is shown and the symbols are explained in the appendix

As in the case of the quantity rule, the intuition behind the result of our conjecture solution for the aggregate price level determination in this scheme is also theoretically acceptable. Under the price rule scheme, the international economy's disturbance (y) has a positive impact on the domestic aggregate price level. The aggregate demand shock (d) also has a positive impact on the determination of p. Although the aggregate supply shock (the unanticipated innovation in production processes) has a negative impact on the determination of the aggregate price level under this scheme, there is a slight difference in the magnitude compared to the one under the quantity rule scheme. While under the quantity rule the absolute value of the parameter for these two shocks is different (with the absolute value for the parameter of aggregate supply shock being either greater than or less than one) the absolute value of the parameter for these two shocks under the price rule is the same but with different signs. Lagged output also has a negative impact on the determination of p.

Another thing that is important to note here is the fact that in the process of determining the aggregate price level under the price rule scheme, unanticipated shocks in the money market do not enter the equation. This means that the variability

in the money market (in this particular specification) does not affect the process of aggregate price level determination.

Using the general solution for aggregate price level determination, the determination process of the aggregate output is represented as follows:

$$y_t^s = a_0 + a_1(V_1 y_t + V_2 d_t + V_3 e_t) + a_2 y_{t-1} + e_t \qquad (15)$$

Again, as in the case of the quantity rule scheme, the impact of each shock is just their impact on the aggregate price level times a_1. However, as seen in the equation (15), the positive (*cet. par.*) unexpected innovation in the production process (e) no longer has a one-to-one relationship with aggregate output. The impact of a positive innovation on the current aggregate output of the economy is ambiguous. If a_1 times V_3 is less than -1, then the positive innovation will decrease the aggregate current output instead of increasing it. However, if a_1 times V_3 is greater than -1 (but lower than 0 since V_3 is negative as shown in table 1), the positive innovation in production processes will still be increasing current aggregate output but less than proportionally so.

The variances for those target variables can be derived as follows:

$Var(p_t)$:

$$E(p_t - Ep_t)^2\Big|_k = V_1^2 Var(y_t) + V_2^2 (Var(d_t) + Var(e_t)$$

and, $Var(y)$:

$$E(y_t - Ey_t)^2\Big|_k = (a_1 V_1)^2 Var(y_t) + (a_1 V_2)^2 Var(d_t) + (a_1 V_3 + 1)^2 Var(e_t)$$

Unlike the one we get for the quantity rule scheme, the parameter that determines how the variance of demand shock enters the variance of the aggregate price level is not

really clear in this case. *Var*(*d*) enters *var*(*p*) by the magnitude of $V_2 = \frac{1}{(b_1 + b_2)k + a_1}$ (as shown in the appendix). Therefore, the magnitude of *var*(*d*) in *var*(*p*) depends on the value of k (the constant parameter relating the nominal interest rate to the aggregate price level) chosen by the monetary authority. That is, if k is not small enough to guarantee that $(b_1+b_2)\ k+a_1$ to have a value in between zero and one, then $V_2^{\ 2}$ would also be quite small. On the other hand, if k is small enough to guarantee that $(b_1+b_2)\ k+a_1$ to have a value in between zero and one, then $V_2^{\ 2}$ would be greater than one, i.e. the variances of the aggregate demand and aggregate supply shock in this case enters the variance of the aggregate price level with the magnitude greater than one. As in the case of how the variance of the aggregate demand shock enters the variance of the aggregate price level, the way that the variances of the other two shocks enter the variance of p is highly dependent on the value of k chosen by the monetary authority. In the case of the variance of the aggregate output, again, the manner of how the shocks variances enter *Var*(*y*) depends on the magnitude of a_1.

3.2.3 Intermediate Target Variables

Aside from the final target variables, there are also some other intermediate target variables which could be accessed directly from time to time by the monetary authority. Those intermediate target variables are the nominal exchange rate and the nominal money circulated in the economy. As already shown above, under the economic system set up in this essay, the nominal exchange rate is shown by equation (9) and the nominal money circulated in the economy could be derived from the equation (3) by solving for the *m*. Under the two schemes considered above, it is possible to assess the variances of those two intermediate variables.

Under the quantity rule:

$$Var(s_t) = \left\{ \begin{array}{l} \left(\frac{1}{c_1 + g_2}\right)^2 (Var(p) + Var(m)) + \left(\frac{c_2}{c_1 + g_2}\right)^2 Var(y) + Var(y) \\ + 2\left(\frac{1}{c_1 + g_2}\right)\left(\frac{c_2}{c_1 + g_2}\right) Cov(p, y) + 2\left(\frac{1}{c_1 + g_2}\right)^2 Cov(p, m) + 2\left(\frac{1}{c_1 + g_2}\right) Cov(p, y) \\ + 2\left(\frac{1}{c_1 + g_2}\right)\left(\frac{c_2}{c_1 + g_2}\right) Cov(y, m) + 2\left(\frac{c_2}{c_1 + g_2}\right) Cov(y, y) \end{array} \right\}$$

and,

$$Var(m_t) = \left\{ \begin{array}{l} \left(1 - \frac{c_1}{c_1 + g_2}\right)^2 Var(p) + \left(c_2 - \frac{c_1 c_2}{c_1 + g_2}\right)^2 Var(y) + \left(1 - \frac{c_1}{c_1 + g_2}\right)^2 Var(m) + \left(\frac{c_1}{c_1 + g_2}\right)^2 Var(q) \\ + 2\left(1 - \frac{c_1}{c_1 + g_2}\right)\left(c_2 - \frac{c_1 c_2}{c_1 + g_2}\right) Cov(p, y) + 2\left(1 - \frac{c_1}{c_1 + g_2}\right)^2 Cov(p, m) \\ + 2\left(1 - \frac{c_1}{c_1 + g_2}\right)\left(\frac{c_1}{c_1 + g_2}\right) Cov(p, q) + 2\left(c_2 - \frac{c_1 c_2}{c_1 + g_2}\right)\left(1 - \frac{c_1}{c_1 + g_2}\right) Cov(y, m) \\ + 2\left(c_2 - \frac{c_1 c_2}{c_1 + g_2}\right)\left(\frac{c_1}{c_1 + g_2}\right) Cov(y, q) \end{array} \right\}$$

Under the Price rule:

$$Var(s_t) = (1 - k)^2 Var(p) + Var(y) + 2(1 - k)\text{cov}(p, y)$$

and,

$$Var(m_t) = \left\{ \begin{array}{l} (1 + c_1 - c_1 k)^2 Var(p) + c_2^2 Var(y) + Var(m) + 2(1 + c_1 - c_1 k) c_2 Cov(p, y) \\ + 2(1 + c_1 - c_1 k) Cov(p, m) + 2c_2 Cov(y, m) \end{array} \right\}$$

The variances of these two variables (nominal exchange rate and the money supply), could also be used as a guide by the monetary authority in conducting their policies. Especially for the nominal exchange rate variability under each certain policy scheme considered in this essay, it could also serve as a component in the aggregate loss function to be minimised as an objective of the policy taken by the monetary

authority. The behaviour of the above variances will be discussed later in the next subsection.

3.3 Assessment and Qualification

In order to be able to assess the efficiency of the two instrument under consideration, we need to compare the variances of the target variables produced by each option of the monetary policy instrument. By roughly observing the variances of the aggregate output and aggregate price level produced by each scheme, one might argue that the policy under a price rule, i.e. fixing up the nominal interest rate, would be a better option to do for the monetary authority. The reason is that the components that build up the target variables variances taking nominal interest rate as the monetary instrument is relatively less than if taking the money base as the monetary instrument. In the latter case, variances of the money demand and money supply processes would contribute to the formation of the aggregate output and price level variances, while in the earlier case, those money market variances are being left out in the formation the target variables variances. By taking this argument per se, then it seems logical to conclude that the variability of the target variables is going to be relatively higher given the money base as a policy instrument compares to given the nominal interest rate as a policy instrument. However, by conducting a little more careful observation of the formation of those target variables variances, one might see that the above conclusion does not necessarily have to be true.

To do a better comparison between those two variances, one need to be carefully comparing the magnitude of the parameters that play a role to dampen or to intensify the shocks variances that contribute to the formation of the target variables variances.

We will first analyse the variance of the aggregate price level given those two different monetary policy instrument, then move on to the variance of the aggregate output level. From table 1, the parameter for the international economic disturbances (y) given money base is

$$f_2 = \frac{g_2}{g_5 + a_1 - g_4(f_5 a_2 - 1)} > 0$$

As given in table 1, $f_5 < 0$, hence, $(f_5 a_2 - 1) < -1$. And as seen in the appendix, g_4 is greater than g_2. Therefore, the value of f_2 lies between zero and one. As a result, the squared value of this parameter would be quite small. In other words, as the fixed money base forces the nominal interest rate to rise or fall so as to damp the impact of the disturbances to spending. The dampen effect produced to the variability of this international economic disturbance is given by the squared value of f_2, where $0 < f_2^2 < f_2 < 1$. From table 2, the parameter for the corresponding disturbance is

$$V_1 = \frac{f_2}{1 + f_1} = \frac{b_1}{(b_1 + b_2)k + a_1} > 0$$

As given in section 2, b_1 is assumed to be greater than one. Therefore, the value of V_1 is highly dependent on the choice of k. The greater the value of k, the more likely for V_1 to have a value in between zero and one. Therefore, given the parameters of the structural equations in the system, the monetary authority needs to ensure that the nominal interest rate is being sufficiently tight up to the price level, in order to dampen the impact of the variance of the international economic disturbance on the variance of the aggregate price level.

As explained in the previous sub section, variability in aggregate demand shock enters the variance of p with a dampen effect in the case of quantity rule ($0<f_3^2<1$). On the other hand, the parameter for this shock under the price rule would again be dependent on the value of k chosen by the monetary authority. It needs to ensure that k is not small enough to guarantee that $(b_1+b_2)\ k+a_1$ to have a value in between zero and one. As explained previously, this condition also applies for the way of the aggregate supply shock enters the variance of the aggregate price level under this scheme. However, the way of the aggregate supply shock enters the variance of the aggregate price level under the quantity rule scheme is also unclear.

Other thing that needs to be noted is that unlike the case for the price rule, under the quantity rule the variances of the money market contributes to the magnitude of the variance of the aggregate price level. Even though its impact is dampen quite heavily by the fact that f_1^2 is closer to zero, the magnitude of the variances in the money market will also be an important factor in determining how large will those variances contribute to the variance of p. If the money market is relatively stable, i.e. the variances of the money demand and money supply is very small, then this part might only contribute for a negligible magnitude to the variance of the aggregate price level.

Since the aggregate output is basically being determined by the aggregate price level, the way of the variability in the aggregate economic shocks affect the variance of the aggregate output would also be similar to the one for the variance of the aggregate price level. However, the magnitude would be altered proportionally by a_1.

In the case of the intermediate target variables, by roughly observing the variance of the nominal exchange rate under the two different rules. we could generally say that

as long as the value of k guarantees that (1-k) lies in between zero and one, it is most likely that the variance for the nominal exchange rate under the price rule is going to be less than its magnitude under the quantity rule. However, for the variance of the nominal money in circulation under the price rule (given the same value of k above), the magnitude of the contribution of variances of the aggregate price level, aggregate output, money demand process and the corresponding co-variances to the variance of m would be intensified. On the contrary, the magnitude of the contribution of variances and co-variances to the variance of the nominal money in circulation under the quantity rule is likely to be dampen. Therefore, given that the co-variances between p and y with q is relatively small (i.e. the money supply process is relatively stable, hence its co-variance with p and y is relatively small), there is a great possibility for the less variability on money in circulation process compares to the one under the price rule. The co-variance among p and y with the shocks variables will be determined by the parameter that indicates the magnitude of impact of the variance of those shocks on the variance of p and y. Again, the issue appears to be empirical rather than theoretical.

In conclusion, the instrument problem faced by the economy is basically an empirical issue rather than theoretical. The optimum choice of the instrument would highly depend on the parameters of the structural economic system. As the parameters of the economic system is specified, then the monetary authority could access on which rule is best for them to adopt.

However, some rules of thumb could still be drawn from this theoretical exercise. Because of the guaranteed small magnitude on the contribution of the variability in the international economic disturbance, aggregate demand and the money market

behaviour, the quantity rule by fixing the money base could create a smaller variability in the target variables, given a stability behaviour in the demand for money and supply of money (the bank portfolio behaviour) in the domestic economy. On the other hand, if the money market behaviour in the domestic economy is relatively unstable (i.e. the variances in the demand and supply component are high), then the monetary authority is facing a risk of higher variability in the target variables under the quantity rule. Therefore, in this case, it is more favourable for the monetary authority to turn to the price rule in conducting its monetary policy.

However, under this price rule scheme, the monetary authority should be able to carefully determine the magnitude of aggregate price level and nominal interest rate relationship (k), as to ensure that it will not blow up the impact of the domestic goods market and international economic disturbance variation on the variability of the target variables.

Another thing that the monetary authority should be fully aware of under the specific price rule considered in this exercise is that the expectational formation of the future aggregate price level that they are using is similar to the one that compatible to those of the economic agents. In this case, the monetary authority should also ensure that the economic agents possess all the information needed for them to form their expectation as rational as possible.

4. Further Qualification

The analysis of the model presented in the previous section can generally be used to assess the relative effectiveness of the choice of monetary policy instrument under the normal economic situation. However, we could as well try to access the situation where the economy is facing some special circumstances. Consider for example, the situation faced by the crisis hit countries during the recent Asian crisis.

In the case of an unordinary situation like the Asian crisis, the economy would certainly be confronting an unusual fluctuation due to a sudden huge deviation in some of its macroeconomic variables. This deviation could bring either a permanent change in the variance of the related macroeconomic variables (hence, the variance of the target variables), or just act as a transitionary shock that perturbs the variation of the related variables for a relatively short period and eventually dies away, leading the related variables back to their initial variational behaviour. In either case, the conduct of monetary policy would, again, essentially be facing the same situation as the one it faced before the perturbation occurs, but with a probability of some changes in the behaviour of the affected variables. In this sense, monetary policy basically still serves as a tool to stabilize the economic fluctuation. Therefore, the objective of the monetary authority should still be solving the policy instrument problem by minimizing the variation in the final target variables of the economy. This section will attempt to discuss further the instrument problem faced by the monetary authority, with also considering some aspects that might not be captured by the particular model used in this essay. In the discussion, this section will consider the particular example of the Indonesian economy, since it is basically a small open economy in nature.

The relevant potential variations of the target variables under the economic specification described previously had already been worked out. The objective of the monetary authority is usually to minimise the aggregate loss function, which usually is the weighted average of the variation of the combined target variables. The most commonly used form of an ad-hoc aggregate loss function in this line of literature usually comprises the weighted average of the variation in the aggregate price level and the aggregate output[7]. However, if the domestic economy has a great dependency on the international economic environment, i.e. it has a great dependence on the foreign trade, the monetary authority might also include nominal exchange rate variation under the preferred policy instrument scheme[8]. In the case of Indonesian economy, foreign trade plays a quite significant role. The Indonesian import to GDP ratio ranged around 24 to 28 per cent in the years before the crisis, and the export to GDP ratio ranged around 26 to 28 per cent. In 1998, it jumped to about 44 per cent for the import to GDP ratio and about 54 per cent for the export to GDP ratio (World Development Indicator, 2000). Therefore, it seems to be plausible for the monetary authority to include the variation of the nominal exchange rate in their preferred objective function.

Under normal conditions in the economic environment, we expect that the variances of the shock variables mentioned in the previous sections to be constant over time. Therefore, the game that the monetary authority plays is to find the right policy instrument that stabilises the economic fluctuation in the domestic economy by minimising the variation in the target variables (aggregate price level, aggregate output and the nominal exchange rate) given those potential variation captured the constant variances of those shock variables.

[7] e.g. see Cecchetti 1998 and Svensson 1999.
[8] e.g. see Sanchez-Fung 2000

Given the economic system as specified in this essay, one thing that needs to be put at first under the monetary authority consideration is whether or not the money market, i.e. the behaviour of the demand for money and supply of money, in the domestic economy is relatively contemporaneously stable. The contemporaneous stability that we are referring to here is captured in the variance of the money demand and money supply shocks, i.e. var(m) and var(q) in the economic model considered in this essay. If the domestic money market is found to be relatively stable, then the next task would be to make a credible assessment on the true value of the magnitude of the variances of domestic goods market shock and international disturbances under the quantity rule. Once those magnitudes are credibly estimated, what follows would be figuring out whether or not there is a feasible value of k (a parameter that relates nominal interest rate with the current domestic aggregate price level in order to keep the real interest rate intact with p) that could give a relatively lesser magnitude to the variances of the target variables under the price rule. This last task is basically more difficult compared to the previous ones, because if the monetary authority picks the wrong value of k then the price instrument might increase the variance of the target variables.

Before the onset of the Asian crisis, Indonesia faced a problem of chronic inflation. McLeod (1997) argues that the culprit behind this continuing moderately high inflation was excessive growth of base money. During that period, the Indonesian central bank (Bank Indonesia) adopted explicit growth targets for the broad money (M2) and narrow money (M1). In his paper, McLeod argues that targeting those aggregates had failed to stabilise inflation around its 5 per cent target level in the early 1990s. Further, McLeod shows that the monetary aggregate that explains the chronic inflation in Indonesia is the monetary base. Therefore, he suggests that the appropriate

monetary policy strategy to target inflation in Indonesia is for Bank Indonesia to be committed in targeting base money (h). Another thing that is of importance to be noted here is that Indonesia launched its second round of banking deregulation (Pakto 1988) in October 1988 which removed most of the obstacles to competition among banks. As a result, during the early 1990s the number of banks operating in Indonesia soared tremendously. This environment contributed to wide variability in Indonesia's monetary aggregates during this period.

Taking the above situation in the light of the approach used in here, it is clear that Bank Indonesia has been conducting a monetary policy through a quantity rule. However, rather than targeting the monetary base (h), Bank Indonesia has targeted the money supply instead. The decision to target the money supply has some problem under this setting. The banking sector deregulation that took place had potentially changed the portfolio behaviour of the banking sector. Therefore, the money supply process would be more appropriately represented by equation (6) of our model. Therefore, if the quantity rule is to be taken, then targeting money base would seem to be a more appropriate instrument. Another potential problem is the existence of a wider variability in the money in circulation. In the light of our model, this could be interpreted as a perceptibly wide variance in the domestic money market. Hence, this would contribute to the formation of the variance of domestic aggregate price level under the quantity rule. For that reason, it might be better for Bank Indonesia to consider applying the price rule by setting an appropriate value of k, to ensure that the resulting variance of the aggregate price level is lower relative to its variance under the alternative scheme. Nevertheless, conducting a thorough empirical analysis is

needed to get a better picture of which policy instrument should be applied to minimise the resulting variation in the aggregate price level in this case[9].

At the onset of the crisis, Indonesia faced a huge depreciation of its currency. After trying to defend the Rupiah value for some time, Bank Indonesia finally let go the Rupiah value to be decided by the market, letting the Rupiah to float freely in mid August 1997. This stage of the exchange rate crisis was soon followed by a collapse in confidence in the domestic banking sector, creating a banking panic in the country that necessitated Bank Indonesia to providing some fund to assist the domestic banking sector. In order to restore the economy, Indonesia undertook an IMF-endorsed monetary strategy. One of the main elements of this strategy was to target lower growth of base money. The goal was to prevent continuing collapsing confidence in the Rupiah. Fane (2000) and McLeod (2000) argue that this instrument was appropriate, as long as Bank Indonesia committed to maintaining the target level of the base money. However, another view (Grenville, 2000) argues that base money is not the appropriate instrument to be targeted since basically it was demand determined at the time. Due to the banking panic, the demand for currency, which is the key component of the money base, rose tremendously. Therefore, he advocates a higher interest rate instead. Fane (2000) further argues that basically the choice of the instrument is not the core of the problem as long as the monetary authority is committed to the policy itself.

The goal of monetary policy under this circumstance is not necessarily to provide a direct solution to the problem brought about by the crisis. Instead, it is supposed to be targeted on at least putting a break on the rapid down swing of the economy. During

[9] A thorough empirical investigation concerning this particular case is beyond the scope of this essay.

the crisis, variability in exchange rate went far beyond normal. In the light of our model, the situation above is the one where the transition took place. It is worthwhile for us to see how the situation could be pictured in our model. The sudden pressure of huge depreciation in the Rupiah value (under some simplification) could be captured by the international disturbance (y). The substantial increase in y took place unexpectedly, which forced the nominal exchange rate to depreciate as a consequence. For the period of the crisis, under the condition that Bank Indonesia is letting the Rupiah to float freely according to its market value, it is appropriate to suppose that the variance of y had also risen (at least for the crisis period). The banking panic issue could also be interpreted as a positive significant additional deviation of the domestic money market. Hence, there are at least two huge shocks entering the system.

To simplify the analysis of the impact, lets assume that these two shocks are the only two shocks occuring in the economy. According to the variation produced by the two different scheme assumption, the only shock that will have an impact on the variability of the aggregate price level and output under the price rule is the international shock. The tricky part, in this case, is for the central bank to determine the appropriate magnitude of the parameter that relates nominal interest rate to the aggregate price level (k). Under the quantity rule, the impact of this shock on the aggregate price level variation is definitely less than proportional (as explained in the previous section). In order to ensure that the variance of aggregate price level under the price rule is at least as large as the one under the quantity rule, the choice of k should be made to guarantee that $V_1 = \frac{b_1}{(b_1 + b_2)k + a_1} \leq f_2$. However, the shock in the domestic money market also influenced the variability in these two target variables.

Therefore, the range of value for the central bank to set k is somewhat looser, because then V_1 (the magnitude of $var(y)$ under the price rule) no longer have to be at least as large as f_2 (the magnitude of $var(y)$ under the quantity rule) in this case. Instead, k has then to be set to ensure that the magnitude of $var(y)$ entering $var(p)$ under the price rule is less than the magnitude of $var(y)$ together with the variance from the shock in the domestic money market entering $var(p)$ under the quantity rule. For the case of the variation in the nominal exchange rate given those two shocks, as long as the choice of k is reasonable enough, then it is most likely that the resulting variation would be relatively smaller under the price rule. This case is made possible by the isolation of the domestic money market variational impact on the target variables.

Following the above argument, it seems that the adoption of interest targeting as a monetary policy instrument would perform relatively better in reducing the variation in the aggregate prices, aggregate output and the nominal exchange rate during the crisis period. However, there are still some problems in pursuing this policy scheme. One of the potential problems is if the monetary authority turns out to be not having enough ability to control the market interest rate absolutely. This case is certainly plausible, because as explained in the previous section, under the price rule the magnitude of the shock variances on the variation of the money supply ($var\ (m)$) tend to be intensified. In this case, the market interest rate could still be influenced by the money market behaviour. Under this situation, the instrument will somehow lose its credibility and hence still be transmitting the variation of the money market to the formation of the target variables variations. Consequently, it might be better to go with the base money targeting. However, as Grenville argues, the money base is to some extent demand determined, hence also not totally under the control of the

monetary authority. In this case, then the game would be to determine on which instrument can the monetary authority control best. As Fane asserts in his paper, in this case, the choice of target instrument becomes less important than the making of a credible commitment to some nominal target. Once the credible commitment could be guaranteed, then the price rule seems to be relatively able to perform better than the other one.

Another thing that needs to be emphasised here is the information issue regarding the instrument policy. Once decided, then economic agents should be provided with the relevant information, especially concerning the instrument target. This issue is important to help those economic agents in forming their expectation towards the macroeconomic variables to be consistent with the one formed in designing the policy rules. By doing so, it will help to guarantee the effectiveness of the policy itself. In other words, the set of information spread out in the economy should be maximised, in the sense to be as comprehensive as possible. This is needed to avoid the misperception of the economic agents concerning the policy conduct and how the economic system is running. The common synergic perception towards those things are important to ensure that the formation of expectation towards economic variables do not go randomly, which could further lead to a problem of some nominal indeterminacy in aggregate variables.

5. Concluding Remarks

The goal of this essay is to evaluate the optimum monetary policy instrument choice in the context of a small open economy. The optimality is considered in terms of the success of the monetary instrument choice in providing a greater stability in the target variables, as measured by the variances of those target variables produced under different policy schemes.

The model used to assess the issue is a simplification of how the aggregate small open economy works. By running this simplified specification, we run a risk of overlooking some important interactions in the economy. However, since basically the model used is already widely acceptable in this line of the literature and claimed to be basically consistent with the optimising behaviour of individual economic agents, it is still hoped that it could reveal some important insights about the issue.

From the analysis, it is shown that the recognition of the true behavioral relationship among aggregate variables in the economy is important. This conclusion arises from the fact that the issue concerning the optimal monetary policy instrument problem is more empirical rather than theoretical in nature. As a consequence, in order to conclude on which choice is better, a good estimate of the true behavioural relationship among aggregate variables in the economy needs to be covered. The impact of considering a small open economy specification is basically inviting the potential of a higher instability in to the process of the target variables determination. However, there are still some rules of thumbs that could be drawn from the analysis of the theoretical model. Given that the monetary authority could maintain full control over the instrument variables, under the quantity rule monetary authority lets the market to determine the interest rate equilibrium. By doing so, it lets the money

market behaviour be incorporated in the aggregate pricel level and output determination. Therefore, when the behaviour of the domestic money market is relatively unstable in terms of a high degree of potential fluctuation in it, the quantity rule might not be the best option. On the other hand, under the price rule, the monetary authority simply cuts the relationship between the goods and the money markets in the aggregate economy. By doing so, it curbs the behaviour of the money market to intervene in the determination process of aggregate price level and output. Therefore, the shocks that contribute to the potential variations of the target variables are less compared to the one under the quantity rule. The tricky part in conducting this price rule would be for the monetary authority to determine a stable policy rule (the magnitude of *k)*.

The above rule of thumb, is made under the assumption that the monetary authority could mantain a complete control over the instrument variables. However, this may not be the case in reality. Under the relaxation of this assumption, the issue of an optimum choice becomes less important than the ability of the monetary authority to make a credible commitment. Consequently, it is important for the monetary authority to be fully committed to its choice of policy rule in order to make it credible. Another thing that would be of importance is the dissemination of the correct and relevant information to the economic agents. This factor is needed to enhance the further credibility of the chosen policy rule.

Although the essay did attempt to visit the issue in which there is a substantial perturbation occurs in the economy, the parameters in the structural model are assumed to be exogeneously determined and stable. In the case of Indonesia at least, this assumption might appears to be an obstacle for the model to replicate the true

economic relationship among variables in reality. An exercise using other aggregate modeling approach that has a potential to be best replicating the aggregate economic variables relationship would be of great importance, especially to gain a better alternative view of how this optimal policy choice problem should be solved.

References:

Allsop, C. and Vines, D., (2000). 'The Assessment: macroeconomic policy', *Oxford Review of Economic Policy*, 16(4):1-32.

Blanchard, O.J and Fischer, S., (1989). *Lectures on Macroeconomics*, MIT Press, Cambridge, Massachusetts.

Cecchetti, S.G., (1998). 'Policy Rules and Targets: framing the central banker's problem', *Federal Reserve Bank of New York Economic Policy Review'*, http://www.ny.frb.org/rmaghome/econ_pol/698cec.htm.

_____, (2000). 'Making Monetary Policy: objectives and rules', *Oxford Review of Economic Policy*, 16(4):43-59.

Chauveau, T., (1990). 'Optimal Monetary Policies in a Small Open Economy', in P. Artus and Y. Barroux (eds), *Monetary Policy: a theoretical and econometric approach*, Kluwer Academic Publishers, Dordrecht: Chapter 2.

Edey, M., (1997). 'The Debate on Alternatives for Monetary Policy in Australia', in Lowe (Ed.), *Monetary Policy and Inflation Targeting*, Sydney: Reserve Bank of Australia, pp. 43-67.

_____, (1989). 'Monetary Policy Instruments: A Theoretical Analysis', in I. MacFarlane and G. Stevens (Ed.), *Studies in Money and Credit*, Sydney: Reserve Bank of Australia, pp. 147-161.

Fane, G., (2000). 'Indonesian Monetary Policy During the 1997-98 Crisis: a monetarist perspective', *Bulletin of Indonesian Economic Studies*, 36(3):49-64.

Frenkel, J.A. and Mussa, M.L., (1981). 'Monetary and Fiscal Policies in an Open Economy', *Journal of American Economic Review*, 71(2):253-258.

Friedman, B.M., (1990). 'Targets and Instruments of Monetary Policy', in B.M. Friedman and F.H. Hahn (eds), *Handbook of Monetary Economics*, Elsevier Science Publishers, Amsterdam: Chapter 22.

Grenville, S., (2000). 'Monetary Policy and the Exchange Rate During the Crisis', *Bulletin of Indonesian Economic Studies*, 36(2):43-60.

_____, (2000). 'Indonesian Monetary Policy: a comment', *Bulletin of Indonesian Economic Studies*, 36(3):65-70.

Hadjimichalakis, M.G., (1982). *Monetary Policy and Modern Money Markets*, Lexington Books, Toronto.

Lucas, R.E., (1973). 'Some International Evidence on Output-Inflation Tradeoffs', *The American Economic Review*, 63(3):326-334.

McCallum, B., (1999). 'Recent Development in the Analysis of Monetary Policy Rules', *Federal Reserve Bank of St. Louis.*

_____ and Nelson, E., (1999). 'An Optimizing IS-LM Specification for Monetary Policy and Business Cycle Analysis', *Journal of Money, Credit and Banking,* 31:296-316.

_____, (1981). 'Price Level Determinacy with an Interest Rate Policy Rule and Rational Expectations' *Journal of Monetary Economics*, 8:319-329.

_____ and Hoehn, J.G., (1983). 'Instrument Choice for Money Stock Control with Contemporaneous and Lagged Reserve Requirements', *Journal of Money, Credit, and Banking*, 15(1):96-101.

McLeod, R.H., (1997). 'Explaining Chronic Inflation in Indonesia', *The Journal of Development Studies*, 33(3):392-410.

_____, (2000). 'Survey of Recent Developments', *Bulletin of Indonesian Economic Studies*, 36(2):5-41.

Mishkin, F.S., (1997). *The Economics of Money, Banking, and Financial Markets 5th ed.*, Addison-Wesley, New York.

Poole, W., (1970). 'Optimal Choice of Monetary Policy Instrument in a Simple Stochastic Macro Model', *Quarterly Journal of Economics*, 84:197-216.

Sanchez-Fung, J.R., (2000). 'Estimating a Taylor-type Monetary Policy Reaction Function for the Case of a Small Developing Economy', *Discussion Paper*, Department of Economics, University of Kent at Canterbury, Kent.

Sargent, T.J. and Wallace, N., (1975). '"Rational" Expectations, the Optimal Monetary Instrument, and the Optimal Money Supply Rule', *Journal of Political Economy*, 83(2):241-254.

Svensson, L.E.O., (1999). 'Inflation Targeting as a Monetary Policy Rule', *Journal of Monetary Economics*, 43:607-654.

Taylor, J.B., (2000). 'Alternative Views of the Monetary Transmission Mechanism: what difference do they make for monetary policy?', *Oxford Review of Economic Policy*, 16(4):60-73.

Walsh, C.E., (1998). *Monetary Theory and Policy*, MIT Press, Cambridge, Massachusetts.

World Bank, (2000). *2000 World Development Indicators CD ROM* , International Bank for Reconstruction and Development/The World Bank.

APPENDIX

(1) $y_t^s = a_0 + a_1(p_t - E_{-1}p_t) + a_2 y_{t-1} + e_t$

(2) $y_t^d = b_0 + b_1 r_t - b_2 r_t + b_3 z_t + d_t$

(3) $m_t - p_t = c_0 - c_1 i_t + c_2 y_t + m_t$

(4) $r_t = i_t - (Ep_{t+1} - p_t)$

(5) $r_t = s_t + p_t^* - p_t$

(6) $m_t = g_1 h_t + g_2 i_1 + q_t$

(7) $(i_t - i_t^*) = (Es_{t+1} - s_t) + y_t$

(8) p_t^*, i_t^*, z_t are assumed to be constant for simplicity.

(9) $Es_{t+1} = Ep_{t+1} - p^*$

Note: all the parameters are positive.

using equation (7), (8) and (9):

(10) $s_t = Ep_{t+1} - p^* - (i_t - i^*) + y_t$

therefore,

$r_t = (Ep_{t+1} - p_t) - (i_t - i^*) + y_t$

Quantity rule (fixing *h*)

From equation (3) and (6):

$$i_t = \frac{1}{c_1 + g_2}(c_0 - g_1 h + p_t + c_2 y_t + m_t - q_t)$$

thus, using (2) and (3) to get AD equation:

$$y_t^d = \frac{1}{\left[1 + (b_1 + b_2)\frac{c_2}{c_1 + g_2}\right]} \left\{ \begin{array}{l} \left[b_0 - (b_1 + b_2)\frac{c_0}{c_1 + g_2}\right] + (b_1 + b_2)\frac{g_1}{c_1 + g_2} h + b_1(i^* + y_t) + b_3 z \\ + (b_1 + b_2)(Ep_{t+1} - p_t) - (b_1 + b_2)\frac{1}{c_1 + g_2}(p_t + (m_t - q_t)) + d_t \end{array} \right\}$$

or,

$$y_t^d = g_0 + g_1 h + g_2(i^* + y_t) + g_3 z + g_4(Ep_{t+1} - p_t) - g_5(p_t + (m_t - q_t)) + g_6 d_t$$

where:

$$g_0 = \frac{b_0 - (b_1 + b_2)\frac{c_0}{c_1 + g_2}}{1 + (b_1 + b_2)\frac{c_2}{c_1 + g_2}} \qquad g_4 = \frac{(b_1 + b_2)}{1 + (b_1 + b_2)\frac{c_2}{c_1 + g_2}} > 0$$

$$g_1 = \frac{(b_1 + b_2)\frac{g_1}{c_1 + g_2}}{1 + (b_1 + b_2)\frac{c_2}{c_1 + g_2}} > 0 \qquad g_5 = \frac{(b_1 + b_2)\frac{1}{c_1 + g_2}}{1 + (b_1 + b_2)\frac{c_2}{c_1 + g_2}} > 0$$

$$g_2 = \frac{b_1}{1 + (b_1 + b_2)\frac{c_2}{c_1 + g_2}} > 0 \qquad 0 < g_6 = \frac{1}{1 + (b_1 + b_2)\frac{c_2}{c_1 + g_2}} < 1$$

$$g_3 = \frac{b_3}{1 + (b_1 + b_2)\frac{c_2}{c_1 + g_2}} > 0$$

Equating AD and AS:

$$p_t = \frac{1}{g_5}\left[\begin{array}{l} (g_0 - a_0) + g_1 h + g_2 i^* + g_3 z + g_4(Ep_{t+1} - p_t) - a_1(p_t - E_{-1} p_t) \\ - a_2 y_{t-1} - g_5(m_t - q_t) + g_2 y_t + g_6 d_t - e_t \end{array} \right]$$

Conjecture for price determination:

$$p_t = f_0 + f_1(m_t - q_t) + f_2 y_t + f_3 d_t + f_4 e_t + f_5 y_{t-1}$$

therefore,

$$E_{-1} p_t = f_0 + f_5 y_{t-1}$$

$$(p_t - E_{-1} p_t) = f_1(m_t - q_t) + f_2 y_t + f_3 d_t + f_4 e_t$$

$$E p_{t+1} = f_0 + f_5 y_t$$

but, by (1):

$$y_t^s = a_0 + a_1(f_1(m_t - q_t) + f_2 y_t + f_3 d_t + f_4 e_t) + a_2 y_{t-1} + e_t$$

hence,

$$E p_{t+1} - p_t = \begin{bmatrix} f_5 a_0 + (f_5 a_1 - 1) f_1 (m_t - q_t) + (f_5 a_1 - 1) f_2 y_t + (f_5 a_1 - 1) f_3 d_t \\ + (f_5 f_4 a_1 - f_4 + f_5) e_t + (a_1 - 1) f_5 y_{t-1} \end{bmatrix}$$

Equating coefficients for the conjecture (with all the g's positive, as indicated in the AD equation after substituting the market nominal interest rate equilibrium):

$$f_0 = \frac{(g_0 - a_0 + g_4 f_5 a_0) + g_1 h + g_2 i^* + g_3 z}{g_5}$$

$$f_1 = \frac{-g_5}{g_5 + a_1 - g_4(f_5 a_2 - 1)} < 0 \qquad \text{(look at the sign for } f_5\text{)}$$

$$f_2 = \frac{g_2}{g_5 + a_1 - g_4(f_5 a_2 - 1)} > 0$$

$$f_3 = \frac{g_6}{g_5 + a_1 - g_4(f_5 a_2 - 1)} > 0$$

$$f_4 = \frac{g_4 f_5 - 1}{g_5 + g_4 + a_1 - g_4(f_5 a_2 - 1)} < 0$$

$$f_5 = \frac{-a_2}{g_5 - g_4(a_2 - 1)} < 0 \qquad \text{(given that } 0<a_2<1\text{)}$$

Price rule (fixing *i*)

To have a nominal anchor to determine the equilibrium price level in each period of time, i is assumed to be determined as follows:

$$i_t = (Ep_{t+1} - p_t) + kp_t$$

By fixing nominal interest rate, equation (3) only serves as an appendage in the system, determining only the level of h to assure the fixed i is achieved.

Equating AD and AS:

$$p_t = \frac{1}{(b_1 + b_2)k}\left[(b_0 - a_0) - a_1(p_t - E_{-1}p_t) + b_1(i^* + y_t) - a_2 y_{t-1} + b_3 z + d_t - e_t\right]$$

or,

$$p_t = f_0 - f_1(p_t - E_{-1}p_t) + f_2(i^* + y_t) - f_3 y_{t-1} + f_4 z + f_5(d_t - e_t)$$

where:

$$f_0 = \frac{(b_0 - a_0)}{(b_1 + b_2)k} \qquad f_3 = \frac{a_2}{(b_1 + b_2)k} > 0$$

$$f_1 = \frac{a_1}{(b_1 + b_2)k} > 0 \qquad f_4 = \frac{b_3}{(b_1 + b_2)k} > 0$$

$$f_2 = \frac{b_1}{(b_1 + b_2)k} > 0 \qquad f_5 = \frac{1}{(b_1 + b_2)k} > 0$$

Conjecture for price determination:

$$p_t = V_0 + V_1 y_t + V_2 d_t + V_3 e_t + V_4 y_{t-1}$$

$$E_{-1}p_t = V_0 + V_4 y_{t-1}$$

hence,

$$(p_t - E_{-1}p_t) = V_1 y_t + V_2 d_t + V_3 e_t$$

Equating coefficients for the conjecture:

$$V_0 = f_0 + f_2 i^* + f_4 z$$

$$V_1 = \frac{f_2}{1 + f_1} = \frac{b_1}{(b_1 + b_2)k + a_1} > 0$$

$$V_2 = \frac{f_5}{1 + f_1} = \frac{1}{(b_1 + b_2)k + a_1} > 0$$

$$V_3 = \frac{-f_5}{1 + f_1} = -V_2 < 0$$

$$V_4 = -f_3 = \frac{-a_2}{(b_1 + b_2)k + a_1} < 0$$