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Estimating Monetary Policy Rules: An Optimal Monetary Conditions Index for Malaysia

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Keywords: Output Gap; Unobservable Components; Band-pass Filter; Hodrick-Prescott Filter; Monetary Policy Rules; Optimal Monetary Conditions Index
JEL Classification Codes: C5, B3, E52, E58, F31

1. Introduction

In terms of the management of monetary policy, interest rates changes are part of central bank decisions of everyday life. The interest rates is often determined by the expected inflation rate and the appropriate interest rates is targeted as an approach of achieving certain inflation rate. Besides the interest rates, equivalently speaking, the exchange rate is another cornerstone of the management of the monetary policy. Regrettably, the influences in exchange rate are much less touched in the contemporary works. The changes in exchange rate are subject to frequent and sudden changes, especially in those countries adopting the restrictive strategy to function in the internalization of domestic currency (e.g. floating exchange rate) (Gan and Kwek, 2007). Moreover, exchange rate as well as interest rates may have influences on monetary conditions and thus on inflation targets.

Some of the previous studies examined that interest rates and exchange rate exert roles in gauging monetary conditions (Tseng and Corker, 1991; Bayangos, 2000; Knedlik, 2006). The absence of model of certainty have led many scholars to call for a more thorough assessment before put into operation, empirical studies underlined that counting exchange rate in the policy rule would lead to better economic outcomes, or at least cooperative in guiding future research, than neglecting the exchange rate (Batini et al., 2003; Clarida et al., 2001; Guender, 2001; Leitemo and Soderstrom, 2005).

Using monetary conditions index framework, Svensson (1999) explained the rational encompassed uncovered interest parity (UIP) condition behind conducting monetary policy. The study recognized that domestic interest rates and exchange rate cannot be set independently in a small open economy under flexible exchange rate (Ball, 1999; Svensson, 2000 and 2001). Moreover, Reserve Bank of New Zealand in 1999 gave up the concept of MCI because of strong volatility of interest rates without targeting the intervention triggered by the exchange rate in foreign exchange market (Reserve Bank of New Zealand, 2000).

Relevant studies continues, however, according to Bofinger and Wollmershauser (2001 and 2002) elucidated that monetary arrangement is set aside under the management of floating exchange rate, which characterizes that Mundell-Fleming model enables central bank directly target the real interest rates on the domestic money market and the real exchange rate on the foreign exchange market. Later, Burger and Knedlik (2004) in their work, "*The MCI As A Monetary Policy Guide In A Small, Open Emerging Market Economy*" reinforced the work of Bofinger and Wollmershauser above.

The aim of this paper is to estimate a model of optimal monetary policy for open emerging market economies based on the concept of the monetary conditions index (MCI) and to underscore the important role of the interest rate parity putting Malaysia in the case. Taking a more functionalist view, the model combined the estimation of the MCI with theoretic modeling of monetary policy rules. The idea is originated from analyzing the insufficient monetary policy that triggered the currency crises in 1997/98 and inspired by the call for more reliable rules from the experience of the worldwide spread of Asian crisis. It is set to shed a light of the importance of the internal and external equilibrium and provide a new attempt for developing innovative statuses and approaches.

The MCI is a potentially useful tool for blueprinting the monetary policy rule. The rest of the paper is organized as follows. The MCI will be introduced in section 2. Section 3 reiterates monetary policy rules derived from economic theory. Section 4 and section 5 cover the empirical works. Section 4 is the estimation of the monetary conditions index in Malaysia, while section 5 combines theoretical rules from section 3 and estimations in section 4 to specify monetary policy rules. Section 6 reports the main conclusion.

2. The Monetary Conditions Index

MCI is the term used to describe the combined effects of the level of interest rates and exchange rate. The weights of the two measures reflect the respective importance of the interest rates and exchange rate for real measures such as output gap, finally, inflation. In specific, the ratio of these weights would encode whether a rise in interest rates is compensated along with depreciation in the exchange rate. The weights also reflect the relative impacts and changes of the interest rates as well as in the exchange rate affected on monetary conditions. Therefore, the MCI is viewed as a summative and informative tool for the public; meanwhile it serves as an early indicator for the central banks. The given such understanding of MCI, It is now broadly used by several central banks across countries like Canada, Netherlands, Norway and Sweden.

$$MCI_t = b_1 \Delta r_t + b_2 \Delta e_t \tag{1}$$

The MCI is defined as equation (1). It is a combination of changes in interest rates[1] and changes in effective exchange rate[2]. Thereby, increases in interest rates as well as increases in effective exchange rate[3] indicate a higher MCI figure and, therefore, the tighter monetary conditions lies in here. The estimation of the weights of the two variables in the MCI is at the heart of calculating of the MCI.

1 Interest rates in the current period minus interest rates in the base period.

2 The level of the effective exchange rate minus the effective exchange rate in the base period divided by the level of the base period.

3 A positive value for $+b_2 \Delta e_t$ indicates appreciation of the domestic currency.

Table 1: Selected relative weights for MCIs

Country	Source							
	Central Banks	**IMF**	**OECD**	**Deutsche Bank**	**Goldman Sachs**	**JP Morgan**	**Merrill Lynch**	**Dorn-busch et al.**
Australia			2.3			4.3	4	
Austria				3.3				
Belgium						0.4		
Canada	2, 3	4, 3	2.3		4.3	2.7	3	
Denmark						1.9		
EMU								2.17
Finland						2.5		
France		3	4	3.4	2.1	3.5		2.1
Germany		2.5, 4	4	2.6	4.2	2.3	4	1.39
Italy		3	4	6.6	6	4.1		2.89
Japan		10	4		8.8	7.9	10	
Netherlands				3.7		0.8		
New Zealand	2							
Norway	3					1.4		
Spain			1.5	2.5		4.2		1.46
Sweden	3 - 4		1.5	0.5		2.1		8.13
Switzerland				6.4		1.7		
United Kingdom		3	4	14.4	5	2.9	3	
United States		10	9		39	10.1	10	

Source: Ericsson et al. (2000).

Ericsson et al. (2000) compiled a list of MCI ratio (Table 1). The MCI ratio shows the weight of the interest rates parameter relative to the exchange rate parameter. As it can be aptly illustrated from the table, the figures compiled by the different sources vary moderately in the same country, but change drastically among different ones from the same sources. Overall, the figures range from 1.5 to 10 with three exceptions of 0.4, 0.5, and 39.

Other studies estimated MCI weights for Hong Kong of 4.3:1, Thailand of 3.3:1, Czech Republic of 2.7:1 and Poland of 0.3:1[4]. In general, the MCI ratios tend to be smaller for small open economies (i.e. it attributes more weight to exchange rate) than for a larger or closed economies. In an attempt to provide the explanations, the following sections would identify the relevant data and try to estimate the optimal MCI for Malaysia.

3. Optimal Monetary Conditions Index

In order to tailor rules of the operating targets for central bank, the study follows the model of optimal monetary policy based on the concept of MCI developed by Bofinger and Wollmershauser (2001) and Burger and Knedlik (2004). The model is briefly summarized as equation (4) and equation (5), which is specified by using the actual MCI in equation (3). The weights of MCI are estimated from output gap equation as equation (2). The output gap equation is formulated under the equilibrium condition, in which the demand side output gap is set to equal the supply side the output gap. Specifically, demand side is a simple reduced form of the IS curve, whereas supply side is a simple augmented Phillips curve. For further details on model and optimal monetary policy rules derivation, please refer Burger and Knedlik (2004).

$$y_{g_t} = b_1 r_{g_t} + b_2 e_{g_t} + u_t \tag{2}$$

Equation (2) illustrates that y_{g_t} = output gap (where positive output gap indicates that the actual output is below potential output – inflation will decelerate, and vice versa for a negative output gap); r_{g_t} = the deviation of the real interest rates from its value at potential output; e_{g_t} = the deviation

4 See Hong Kong Monetary Authority (2000), Hataiseree (1998) for Thailand, Korhonen (2002) for Czech Republic and Poland.

of the real effective exchange rate from its potential output value; $b_1 > 0$ and $b_2 > 0$ (capturing a positive effect on the output gap is expected in case of an appreciation in interest rates as well as the exchange rate) and a negative u_t means negative demand shocks or positive supply shocks, which would lead to a lower MCI figure.

$$MCI_t = b_1(r_t - r_b) - b_2(\frac{e_t}{e_b} - 1) = b_1\Delta r_t - b_2\Delta e_t \quad (3)$$

Basically the idea behind targeting MCI is to keep MCI constant (usually at zero, following convention), so that $r_t = r_b$ and $e_t = e_b$ when the economy closed to long-run equilibrium. The MCI in its simplest form can be formulated as equation (3), where b_1 and b_2 are the weights estimated from equation (2); $\Delta r_t =$ real interest rates in the current period (r_t) minus real interest rates in the base period (r_b) and $\Delta e_t =$ current real exchange rate (e_t) minus the real exchange rate in the base period (e_b) divided by the level of the base period. A negative value for $-b_2\Delta e_t$ indicates depreciation of the currency. Thereby, increased real interest rates and real effective exchange rate (domestic currency appreciates) indicate a higher MCI figure and, therefore, the tighter monetary conditions.

$$\Delta r_{t+1}^{target} = \frac{-MCI_t - u_t - b_3 y_{g_{t-1}} + b_2(r_t - r_{t+1}^f)}{b_1 - b_2} \quad (4)$$

$$\Delta e_{t+1}^{target} = \frac{MCI_t + u_t + b_3 y_{g_{t-1}} + b_1(r_{t+1}^f - r_t)}{b_1 - b_2} \quad (5)$$

Following the model of optimal monetary policy developed by Burger and Knedlik (2004), interest rates and exchange rate are used as two autonomous operating targets. These targets are aimed to provide optimal monetary conditions and target interest rate parity to avoid volatility of capital flows; ultimately these targets ensure internal and external equilibrium. In addition, the model allows central bank not to react on shocks. The derived rules from optimal monetary policy model for the operating targets are presented as equation (4) and equation (5).

In order to derive the target deviation of the real interest rates $(\Delta r_{t+1}^{target})$ and the real effective exchange rate $(\Delta e_{t+1}^{target})$ at equilibrium level as equation (4) and equation (5). The central bank should take into account the current development in the MCI, current shocks to economy (u_t), the output gap of the previous period $(y_{g_{t-1}})$ and the inter-temporal interest rates differential between the domestic and foreign economies $(r_t - r_{t+1}^f)$. The optimal use of instrument, Δr_{t+1}^{target} and Δe_{t+1}^{target}, are weighted with the weights of interest rates (b_1) and exchange rate (b_2) in equation (2) and persistence of shocks (b_3)[5]. Hence equation (6) indicates the optimum monetary conditions index at time $t+1$ has corrected the monetary conditions index deviations from zero at time t.

$$MCI_{t+1}^{optimal} = b_1\Delta r_{t+1}^{target} + b_2\Delta e_{t+1}^{target} \quad (6)$$

In terms of policy guiding, optimum monetary conditions index is useful to sustain the growth. In addition, it is also valuable to target inflation rate with a managed floating exchange rate. Thereby inflation rate plays the role as a nominal anchor while interest rates as well as exchange rate are used as monetary policy operating targets. Since, the exchange rate in this framework is targeted by adjusting interest rates, which is different from a system using exchange rate as intermediate target. Thus, interest rates and exchange rate can be adjusted by refinancing operations on money markets and by opening market operations on the foreign exchange market.

The paper is not aimed to discuss the theoretical issues of modeling optimal monetary policy rather to specify the monetary policy rules. This is done in the empirical works below.

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[5] See equation (7) in this paper for more details.

4. The Monetary Conditions Index in Malaysia

The study in this paper will follow the approach of Dennis (1997) and Korhonen (2002), which is simple but generally enough adequate to estimate monetary conditions index (MCI) -- real output gap is function of real interest rates and real exchange rate measures. The estimating equation of the least square approach is assumed to be linear and it is estimated base on different lags.

The quarterly data ranges from first quarter 1995 to the fourth quarter of 2006 in the present analysis, according to the online database International Financial Statistics (IFS) for Malaysia. These variables are money market rate as interest rates, real effective exchange rate as exchange rate, and gross domestic output (GDP) as national output or income.

As noted earlier, the output gap is the difference between potential output and current output, real interest rates is the difference between current real interest rates and real interest rates at potential output, and real exchange rate is the difference between current real exchange rate and real exchange rate at potential output. The potential output, interest rates at potential output, and exchange rate at potential output are constructed by using Hodrick-Prescott (HP) filter. The smoothing parameter, λ, set is equal to 1600.

The time series "Output Gap" is calculated by the difference of the logged time series of potential output and current output, and then multiplied by 100. Difference between the current real interest rates and the potential real interest rates is calculated to gain a percentage point change to derive time series "Real Interest Rates". Similarly, the differences between current logged REER and potential logged REER can be calculated to gain a percentage point change to derive "Real Exchange Rate". These time series are stationary. The results using HP filter for the gaps are available in Figures 1 – 3.

There are several ways to compute potential output, potential real interest rates and potential real exchange rate. This has raised some issues about whether different methods providing mutual-conflicted estimate results; whether a method that works well in one economy may not perform well on the other (Gerlach and Smets, 1999; Gerlach and Yiu, 2004). To explore these concerns, this paper furthered the HP filter by employing Baxter and King (BP) filter and Unobservable-components (UC) model to provide a comparative study on the estimation of the potential variables.

Figure 1: The output gap in Malaysia

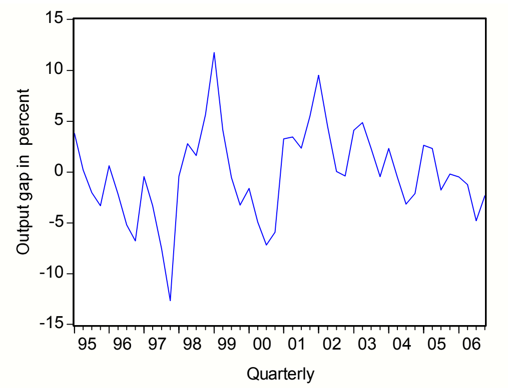


Figure 2: Percentage point deviation of real interest rates from base interest rates

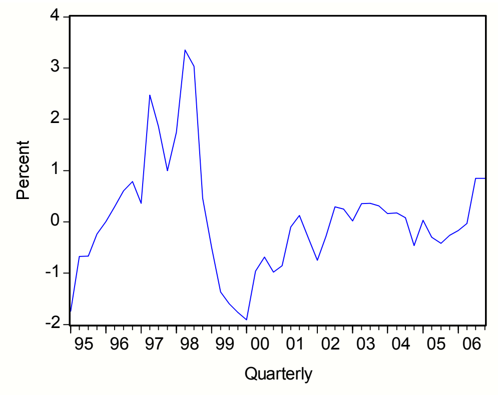


Figure 3: Percentage point deviation of the real effective exchange rate from its base values

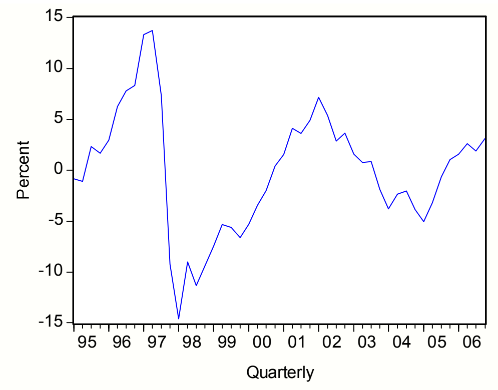


Figure 4: Output gap (with HPs' 95% confidence band)

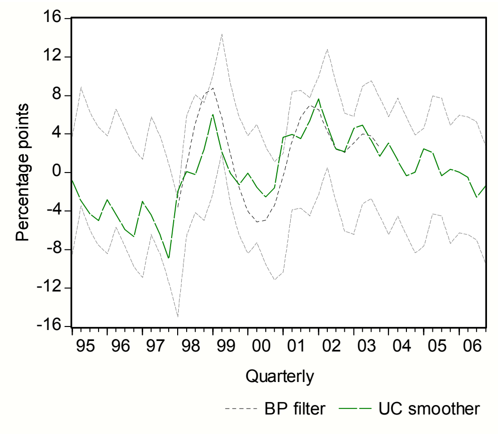


Figure 5: Interest rates gap (with HPs' 95% confidence band)

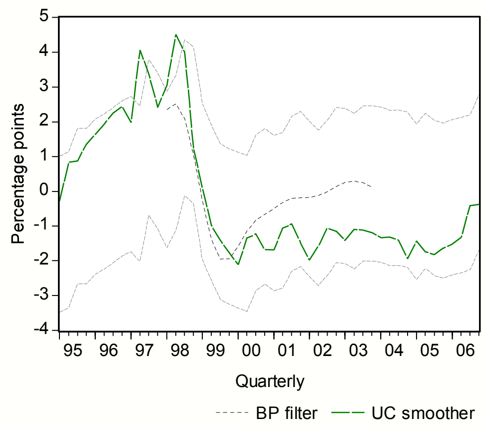
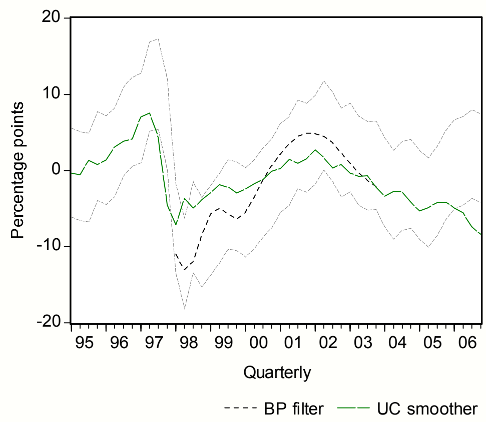


Figure 6: Exchange rate gap (with HPs' 95% confidence band)



The BP filter was proposed by Baxter and King (1999). This filter recommends dropping the first and last 12 observations in quarterly data sets. Today, many statistical packages employ BP filter to estimate potential variables. The UC time series model was proposed by Watson (1986) and Clark (1989). The model can be written in state-space form and it can estimate the potential variables by using Kalman filtering. From Figures 4 – 6, the gaps obtained by using estimated potential variables, by BP filter and UC approach appear quite similar. In addition, the output gaps for real output, real interest rates and real exchange rate are quite frequently within the $\pm 2\sigma$ broad bands arising from the HP model. This means that the HP approach used in this study is valuably informative for inflation and other variables interested by policy makers.

$$y_{g_t} = b_0 + \sum_{i=0}^{n} b_{1i}\Delta r_{t-i} + \sum_{i=0}^{n} b_{2i}\Delta e_{t-i} + b_3 y_{g_{t-1}} + u_t \tag{7}$$

The weights of real interest rates and real exchange rate in the MCI can be determined from equation (7). The estimation for equation (7) is the extension from equation (2), which follows economic and econometric considerations. A constant term (b_0), lagged output gap $(y_{g_{t-1}})$ and parameter of deviations of output from its long term trend (b_3) are introduced in equation (7). In particular, b_0 is to cover possible level effects; $y_{g_{t-1}}$ is to reflect longer lasting shocks to the economy; b_3 measures the influence of past output gaps on the current output gap. The lag structure of monetary policy is discussed in the context of controllability of economic aggregates by monetary authorities. The appropriate lag length includes eight lags for interest rates and the exchange rate measuring approach. Lags are determined by those variables proved to be significant to the model.

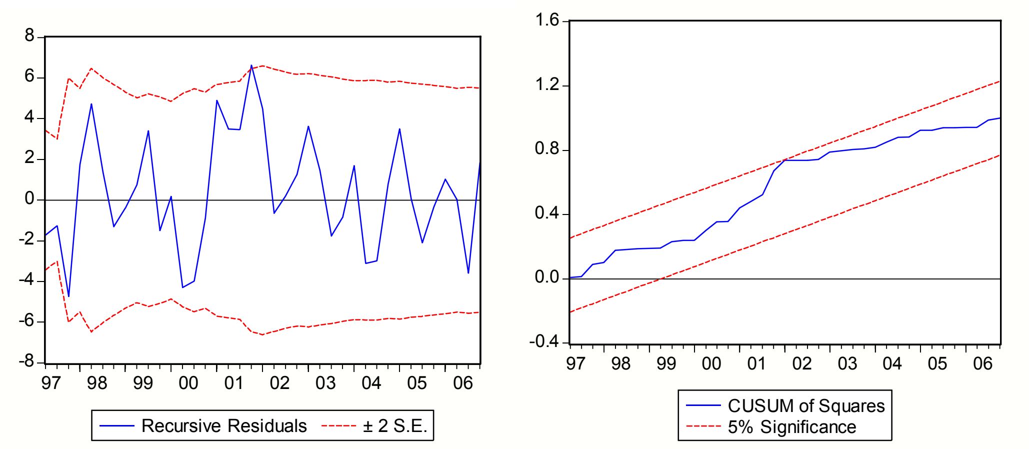
Table 2 reports the estimation of equation (7). The constant term is not significant at a 10 percent significance level. However, the estimated coefficient for the lagged output gap is significant at 1 percent level. The change in real interest rates appears significant at 1 percent level when it is lagged by three periods to four, while the exchange rates measure lagged by two and three are significant at 1 and 10 percent level, respectively. Analyzing the estimation results may safely lead to the conclusion that changes in real interest rates robustly influence the output gap after three and four periods, whereas changes in real effective exchange rate would become the strongest driver after two and three periods.

Significant F-statistic suggested that the slope coefficients are clearly different from zero. It tends to confirm the overall goodness-of-fit of the regression. The R^2 of the estimated model was reasonable as high as 68 percent, and there were no serious problems with a number of diagnostic tests. The model passed a battery of model misspecification tests, which is regarded as RESET test. The Jarque-Bera confirmed normality. ARCH test rejected heteroscedasticity in the disturbance term. The calculated Durbin h-statistic (h=1.579) showed that there is no first-order autocorrelation at 5 percent level. Finally, plots of recursive residuals and CUSUM of squares revealed that the estimated parameters of equation (7) are stable over the sample period (Figure 7).

Table 2: Estimation of output gap and weights for the MCI

Dependent Variable: y_{g_t} **Method: Least Squares** **Sample: 1995Q1 2006Q4** **Included observations: 48**				
Variable	**Coefficient**		**t-Statistic**	**Prob.**
C	-0.278496		-0.690132	0.4942
y_g (-1)	0.669843		6.337217	0.0000
r_g (-3)	3.137158		5.001576	0.0000
r_g (-4)	-3.056764		-4.497845	0.0001
r_g (-5)	0.113092		0.237136	0.8138
e_g (-2)	-0.401848		-2.715363	0.0098
e_g (-3)	0.452188		1.877406	0.0680
e_g (-4)	-0.376419		-1.589928	0.1199
e_g (-5)	0.179233		1.216424	0.2311
R-squared	0.684363		Mean dependent var	-0.146534
Adjusted R-squared	0.619617		S.D. dependent var	4.464092
S.E. of regression	2.753236		Akaike info criterion	5.030791
Sum squared resid	295.6320		Schwarz criterion	5.381642
Log likelihood	-111.7390		F-statistic	10.56998
Durbin-Watson stat	1.689607		Prob(F-statistic)	0.000000
Heteroskedasticity Test:	1.100151	(0.395700)		
Ramsey RESET test (1):	2.618183	(0.113917)		
ARCH Test (1):	0.034169	(0.854178)		
Jarque-Bera	1.500688	(0.472204)		
Q-Statistics (12)	White noise			

Figure 7: Plot of recursive residuals and CUSUM of squares test



In this study, the summation of the estimated coefficients for interest rates and exchange rate are in expected sign. This means that an increase in interest rates as well as an appreciation of the domestic currency may have positive effect on the output gap. The overall influence of interest rates and exchange rate on output gap can be estimated when all significant estimation results are summed up. The sum of coefficients for the interest rates measure stays at 0.080394, whereas the sum of coefficients for the exchange rate measure is 0.05034. Each of this total value of coefficients can be used to estimate the relative influence of changes in interest rates and changes in exchange rate on the output gap. In other words, the influence of the interest rates outweighs the one of the exchange rates in MCI. Specifically speaking, MCI ratio plays its function here. The estimated MCI ratio is 1.6:1. Interestingly enough, this estimated MCI is closed to a study investigated by Joiner (2006) by using the IS-based aggregate demand function (the estimated MCI ratio for Malaysia is 2:1).

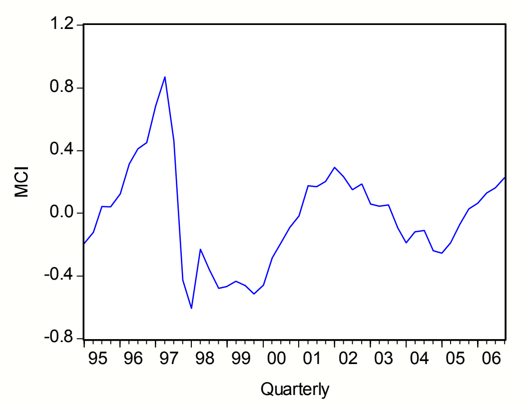
The important estimation result appears in line with the set of expectations, in which MCI ratios tend to be smaller for small open economies (i.e. attribute more weight to the exchange rate) than for large, closed economies (Reserve Bank of New Zealand, 1996). In addition, the results of the analysis indicated that changes in the interest rates as well as changes in the exchange rate influence the output gap significantly. Both of these transmission effects have been functioned in the current year.

Based on equation (3) and using the estimation of the coefficients of the MCI, the index over the sample period is constructed as follows –

$$\begin{aligned} MCI_t = {} & 0.080394 \text{ (interest rates at current period - interest rates at base period) +} \\ & 0.05034 \text{ ((REER at current period / REER at base period) - 1)} \end{aligned} \tag{8}$$

In this computation, the MCI is a linear combination of deviation of interest rates and exchange rate from the defined base period. It is essential to select the most appropriate base period as an equilibrium period. Only by doing so can seek a possible approach to compare any situation with equilibrium and conclude the degree of tightness and looseness in monetary conditions. The Hodrick-Prescott (HP) filter is often used to calculate deviations from a base period. It is suggested that the deviation of interest rates and exchange rate are calculated by current period minus previous period, wherein previous period is the equilibrium period estimated from HP filter. By estimating the weights, the deviations can be weighted to reveal the monetary conditions in Malaysia (Figure 8).

Figure 8: Monetary conditions index for Malaysia



Monetary conditions index (MCI) in Malaysia has been through different phases of development during the year 1995 to 2006. MCI rose sharply in 1997 mainly due to relatively high real interest rates and high exchange rate before the Asian crisis. During the Asian crisis of in 1997 and 1998, Malaysia ringgit depreciated nearly from 2.5 to one dollar to 4 to the dollar; the real interest rates had been dropped from about 9.97 percent to lower about 5.92 percent and it aroused a drastic fall of MCI. The tightening conditions in 1998 reflect the dramatic devaluation of the ringgit, the major measurement capturing MCI taken by central bank of Malaysia to fix the ringgit exchange rate against US dollar was took effect on 2nd September 1998.

The estimated weights of the MCI and computed MCI in the preceding paragraphs are economically meaningful. Conclusions can be drawn from this analysis. First, MCI was subject to the change during the period of observation. Given that the MCI is closed to zero. i.e. the optimum, the monetary conditions in Malaysia closed to the optimum in defined periods and it kept distance from reaching optimum in the crisis and recovery periods of observation. The second conclusion is that the coefficients and the MCI finding meet the periodic expectation. Therefore, monetary authorities as well as public observers may safely use the concept of MCI as an analyzing tool to deliver and interpret economically and meaningfully.

The preliminary analysis above suggests that ignoring exchange rate developments in the management of monetary policy causes monetary conditions volatile. The following section would describe the implications of the MCI concepts has for monetary policy. The MCI is used to derive the optimal operating targets (i.e. interest rates target and exchange rate target) to target the inflation rate.

5. Optimal Monetary Conditions Index in Malaysia

The optimal monetary policy rules developed by Burger and knedlik (2004) have implications for monetary policy. The optimal use of interest rates policy and exchange rate policy can be derived from the MCI concept to targeting the inflation rate. This process incorporates the empirical estimations of parameters and the rules of operating targetings consisting by the targeting value of interest rates and the targeting value of exchange rate. Two targetings designated here can be viewed as the internal and the external stability.

According to the estimation in section 3, the actual parameter values, MCI and domestic interest rates are accessible. These information are gauged together with the equation (4) and equation (5) to derive specific rules for the monetary policy instrument implementation as follows –

$$\Delta r_{t+1}^{target} = \frac{-MCI_t - u_t - 0.669843 y_{g_{t-1}} + 0.05034(r_t - r_{t+1}^f)}{0.080394 - 0.05034} \qquad (4.1)$$

$$\Delta e_{t+1}^{target} = \frac{MCI_t + u_t + 0.669843 y_{g_{t-1}} + 0.080394(r_{t+1}^f - r_t)}{0.080394 - 0.05034} \quad (5.1)$$

Equation (4.1) and equation (5.1) signified targeting value of interest rates and targeting value of exchange rate, respectively. Since the values for foreign interest rates (r_{t+1}^f) and shocks (u_t) are unknown. It is assumed the foreign interest rates is equal to two percent. This assumption is based on the long-term interest rates estimated by Taylor (1993) for America. This assumption excludes the computation of capital or trade transfer weighted index of foreign interest rates, which are satisfied to use specific rules with equation (4.1) and equation (5.1). However, shocks are assumed to be zero in the targeting rules equations because of the subject difficulty of identifying demand and supply shocks in the economy. Moreover, central bank may not react to these shocks aiming at minimizing the output gap. Even though the past output gaps values are remained known, it won't be taking into account in current operating target. The reason is that the strong influence of past output gap on current operating target can cause tremendous change in the operating targets.

In order to compute the ex-post target changes of interest rates and exchange rate during the period selected in this study. The target values for the fourth quarter of 2005 are selected to demonstrate its performance. To extend this, following information are provided –

- Foreign real interest rates = 2 %
- Domestic real interest rates in the third quarter 2005 = 1.757695 %
- Actual MCI in the third quarter 2005 = - 0.07025

Incorporating information above into equation (4.2) and equation (5.2), following results can be calculated.

$$\Delta r_{2005:4}^{target} = \frac{-(-0.07025) + 0.05034(1.757695 - 2)}{0.080394 - 0.05034} = 1.931602 \quad (4.2)$$

$$\Delta e_{2005:4}^{target} = \frac{(-0.07025) + 0.080394(2 - 1.757695)}{0.080394 - 0.05034} = -1.68929 \quad (5.2)$$

The actual MCI $(MCI_{2005:3} = -0.07025)$ in the example period appears too loose, in a sense that central bank should tighten its monetary policy instruments. This optimal MCI is calculated as above to offset the deviation of the actual MCI from its constant value that the economy is closed to its long-run equilibrium. In particular, the computed target value of interest rates indicates that real interest rates should be increased by 1.9 percent, whereas the computed target value of exchange rate indicates that real exchange rate should be depreciated by 1.7 percent. Equation (9) shows that the optimal MCI for the fourth quarter of 2005 corrected the actual MCI deviation from zero in the third quarter of 2005. At the same time, the combined effects of interest rates and exchange rate had fulfilled the interest rate parity, in which the real target appreciation equals the difference between real foreign and real domestic interest rates explained in equation (11) (see Appendix 1 for deriving equation (10)).

$$MCI_{2005:4}^{optimal} = b_1.\Delta r_{2005:4} + b_2.\Delta e_{2005:4} \quad (9)$$

$$= 0.080394(1.931602) + 0.05034(-1.68929)$$

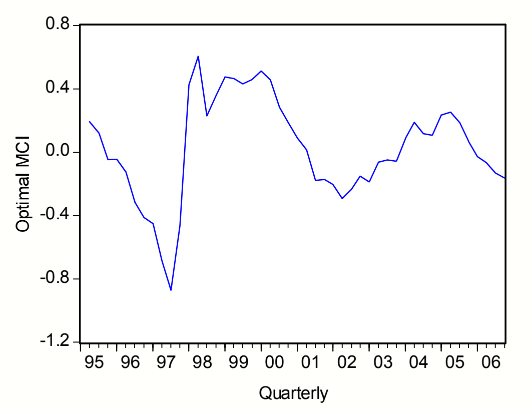
$$= 0.07025$$

$$\Delta e_{t+1}^{target} = r_{t+1}^{target} - r_{t+1}^f \quad (10)$$

$$\Delta e_{2005:4}^{target} = r_{2005:4}^{target} - r_{2005:4}^f = -1.68929 = 2 - (1.93160 + 1.75769) \quad (11)$$

The changes in operating targets can be illustrated in Appendix 2. Double-digit quarterly changes of real interest rates and exchange rate during the economy crisis and recovery periods match the expected outcome. This may because that actual MCI kept distance from reaching optimum. However, the rest of the periods shared single-digit and smaller quarterly changes, as actual MCI closed to the optimum. Thereby changes in operating targets are recommended. Interestingly, the optimal MCI in Figure 9 has offset the deviations of actual MCI in Figure 8.

Figure 9: Optimal monetary conditions index for Malaysia



The results that close to expectations can be expounded as reasons below. A first reason may lie in the fact that Central Bank of Malaysia has followed a rational monetary policy approach. In the periods with relatively low output gap, the central bank followed a policy that closes to optimal policy. This signifies that central bank further the efficient instrumental adoption to minimize the deviation of the output gap. Generally, the results of the instrument rules in this framework can be considered optimal safely. In other words, the uncertainty of the target values for certain period does not mean the model outcomes are inaccessible, or the target values spell out the central bank to apply the political guiding when closer to expectation.

There are few limitations come to light whilst by using an optimal monetary policy based on the concept of the MCI, where the rules for central bank operating target comes from derivation. The model follows the simplicity modeling of the transmission process, which assumes only interest rates, exchange rate and lag values influence the output gap. The relatively low of output elasticities of interest rates and exchange rate compared with the lag values illustrated the empirical estimation may bear some external effects. The model also does not include other important exogenous measures, such as factor prices, fiscal policy, regulation altering and technological changes. In addition, the influence of interest rates and exchange rate are relatively small to actually target the output gap. Consequently, all the facts above must result in model outcomes. Thus, the outcomes would suggest exceptional efforts taken by central bank to close the output gap within one period under ceteris paribus assumptions. In other words, the derived results are optimal in the model, which is suitable for well-interpreting the outcomes instrument rules. Moreover, the model could be extended by tolerating deviations from the monetary policy targets.

In this section, the combination of empirical estimations of the MCI and the estimations of the instrument rules from the optimal monetary policy framework has explained which particular targets should have been targeted during the periods of observations.

6. Conclusion

The main concern of this paper is to derive monetary policy rules for the use of the instruments under consideration of the internal and external equilibrium. The results of the instrumental rules led to the internal equilibrium that the domestic requirements for monetary conditions are met. This internal equilibrium is compatible with an inflation targeting approach allowing deviations in the case of shocks. Besides the inflation targeting approach, central bank is able to target external equilibrium without neglecting foreign capital market. The strategy of restrictions on the internalization of the domestic currency allows central bank to target exchange rate path determined by ensuring interest rate parity permanently. It can avoid speculative capital flows.

The estimating of the weights of the MCI and calculating of the MCI are constructive to shape the optimal monetary policy model. The combination of the empirical estimations of the MCI and the theoretical model of optimal monetary policy smoothed the progress of planning specific monetary policy rules. The results of the estimation are in conformity with the expectation and they are economically meaningful.

The results from this paper raise a number of interesting issues that can be addressed in future works. Firstly, the paper did not address the question of how to reach the targets. Secondly, a further research should include additional regressors into the model. Finally, whether the recommended policy of closing output gaps is suitable followed by central banks or whether central banks should consider other targets remains to be investigated.

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Appendix 1

Deriving Equation (10)

Equation (10) is generally formulated in terms of the uncovered interest parity (UIP) which can be transformed via Fisher equation and simple purchasing power parity (PPP) relation.

The nominal exchange rate according to a simple PPP relation can be presented as below:

$$\Delta s_t = \Delta e_t + \pi_t - \pi_t^f \tag{i}$$

or

$$\Delta e_t = \Delta s_t + \pi_t^f - \pi_t$$

Where Δe_t is the expression for a percentage change in real exchange rate, which equals the percentage change in the nominal exchange rate (Δs_t) plus foreign inflation rate (π_t^f) and minus the domestic inflation rate (π_t). The interest parity (UIP) is defined as follows:

$$i_t = i_t^f + \Delta s_t + \rho_t \tag{ii}$$

or

$$\Delta s_t = i_t - i_t^f - \rho_t$$

Where i_t and i_t^f are domestic and foreign nominal interest rates respectively, and ρ_t denotes a risk premium. The Fisher equation states that the nominal interest rates can be expressed as the sum of the real risk free interest rates plus the inflation rate plus a risk premium:

$$i_t = r_t + \pi_t + \rho_t \tag{iii}$$

Neglecting the risk premium on foreign interest rates, the Fisher equation for the foreign nominal interest rates is:

$$i_t^f = r_t^f + \pi_t^f \tag{iv}$$

Inserting equation (iii) and equation (iv) into equation (ii) yields:

$$\Delta s_t = r_t + \pi_t + \rho_t - r_t^f - \pi_t^f - \rho_t = r_t + \pi_t - r_t^f - \pi_t^f \tag{v}$$

Inserting equation (v) into equation (i) yields:

$$\Delta e_t = r_t + \pi_t - r_t^f - \pi_t^f + \pi_t^f - \pi_t = r_t - r_t^f \tag{vi}$$

Equation (vi) becomes equation (10), if one substitutes the target levels of the interest rates and exchange rate for period $t+1$ into equation (vi):

$$\Delta e_{t+1}^{target} = r_{t+1}^{target} - r_{t+1}^{f} \tag{10}$$

Appendix 2

Ex-post operating target changes for Malaysia

	Target changes of real interest rates	Target changes of real exchange rates
Q2 1995	9.520432	-11.3513
Q3 1995	9.005886	-11.927
Q4 1995	3.429422	-6.37996
Q1 1996	4.289145	-7.69746
Q2 1996	2.062238	-5.73433
Q3 1996	-3.7485	-0.21793
Q4 1996	-6.52768	2.245652
Q1 1997	-7.53952	3.092478
Q2 1997	-16.1702	12.18328
Q3 1997	-18.8617	12.82595
Q4 1997	-6.45599	1.110117
Q1 1998	21.51263	-25.892
Q2 1998	28.51716	-33.5107
Q3 1998	18.44713	-24.8945
Q4 1998	21.93004	-27.8707
Q1 1999	21.23792	-24.4101
Q2 1999	18.8821	-20.887
Q3 1999	15.91609	-16.8288
Q4 1999	16.07175	-16.5443
Q1 2000	17.26047	-17.3577
Q2 2000	14.80891	-14.5532
Q3 2000	10.442	-10.9388
Q4 2000	7.357691	-7.96249
Q1 2001	3.22752	-3.36641
Q2 2001	0.816879	-0.93598
Q3 2001	-4.68319	3.948949
Q4 2001	-4.2896	3.445783
Q1 2002	-6.30857	6.026447
Q2 2002	-10.0834	10.30973
Q3 2002	-7.48671	7.317877
Q4 2002	-3.85758	3.190194
Q1 2003	-5.26926	4.701105
Q2 2003	-1.56652	1.275935
Q3 2003	-0.58784	-0.00847
Q4 2003	-0.86162	0.292395
Q1 2004	3.685352	-4.17229
Q2 2004	6.83924	-7.16365
Q3 2004	4.461339	-4.78574
Q4 2004	3.992936	-4.21463
Q1 2005	7.325613	-7.00896
Q2 2005	8.708467	-8.88505
Q3 2005	6.046045	-5.89948
Q4 2005	1.931695	-1.68939
Q1 2006	-1.06131	1.130637
Q2 2006	-2.07809	2.035421
Q3 2006	-3.97166	3.763945
Q4 2006	-3.58211	2.466218