

# A SMALL SCALE MACROECONOMETRIC MODEL OF EXTERNAL DEBT, EXCHANGE RATE AND MONETARY POLICY RULE. THE CASE OF INDONESIA

G. SUJANA BUDHIASA

## ABSTRAK

*Pengembangan model ekonomi makro berskala kecil sedang menjadi focus perhatian banyak pemodel makro ekonomi dewasa ini. Pemodelan ekonomi makro berskala kecil ini telah di pelopori oleh Agveli (1977), Batini dan Haldane (1999) untuk pengembangan pendekatan ekonomi makro moneter. Gagasan John B Taylor (1993) tentang monetary policy rule telah membangkitkan minat banyak negara untuk meng-adopsi Taylor rule bagi kepentingan praktek pengendalian Bank Sentral.*

*Taylor (1993) dalam gagasannya mempergunakan pendekatan policy rule tingkat suku bunga sebagai reaction function untuk mendapatkan sasaran akhir inflasi dan output, dengan mengabaikan peranan exchange rate sebagai bagian penting yang menentukan keseimbangan ekonomi makro khususnya bagi negara dengan perekonomian yang semakin terbuka.*

*McCallum dan Nelson (1998) dan sejumlah penulis lain telah mengembangkan inflation targeting framework dengan mempergunakan exchange rate sebagai anchor menggantikan peranan tingkat suku bunga. Dalam konteks pengembangan small macroeconomic model, terdapat semacam consensus bahwa para peneliti menyusun pemodelan Philip curve, aggregate demand dan fungsi lost function untuk mendeteksi kerugian minimal apabila dilaksanakan sasaran akhir untuk menetapkan inflasi yang rendah, dengan akibat terjadinya kerugian pada potensi produksi dan kesempatan kerja untuk berkembang tumbuh.*

*Meskipun pemodelan small scale macroeconomic mencapai consensus, namun peneliti tidak memiliki keseragaman pendapat tentang muatan variabel makro ekonomi dari ketiga system persamaan sebagaimana disebutkan diatas, termasuk praktek penggunaannya, masih terdapat varitas penggunaan small simple macroeconomic model, sebaliknya terdapat sejumlah peneliti yang lebih memandang perlunya perluasan small scale macroeconomic pada tingkat medium. Peneliti pertama, melihat policy rule dari sisi praktis untuk kepentingan praktek Bank Sentral, sedangkan type peneliti kedua, untuk melihat lebih jauh dampak dari kebijakan moneter terhadap sektoral ekonomi makro tertentu.*

*Penelitian ini merupakan langkah awal untuk melihat kemungkinan peran serta exchange rate sebagai penentu tingkat inflasi, terutama dari deficit yang terjadi pada neraca pembayaran, serta pada akhirnya berdampak pada perdagangan ekspor dan import sebagai bagian dari aggregate demand yang akan memposisikan output potensial.*

*Secara teoritis, peningkatan aggregate demand akan membentuk heating economics, sehingga Bank Sentral dapat melakukan intervensi di pasar valuta. Dengan menaikkan cadangan devisa, Bank Indonesia bisa berharap akan terjadinya apresiasi rupiah yang akan membuat barang impor menjadi lebih murah, atau sebaliknya meningkatkan peran aggregate demand melalui jalur nilai tukar untuk mengekang permintaan barang impor melalui langkah depresiasi.*

*Berdasarkan hasil analisis regresi, ditemukan adanya trend tentang peranan nilai tukar terhadap inflasi secara tidak langsung. Meskipun demikian, secara keseluruhan pengujian model ekonometrik masih jauh dari sempurna, sehingga memerlukan langkah perbaikan penelitian lanjutan secara lebih mendalam, dengan mempergunakan pendekatan logaritma.*

**Kata kunci:** model ekonomi makroekonometrik berskala kecil, nilai tukar, neraca pembayaran,

## **Inflation Targeting Framework Transmission of McCallum and Nelson.**

The development a small scale macroeconomic model has become a fashionable macroeconomic modeling as pioneering by Aghevli (1977) in fiscal policy and inflation, and Batini & Haldane (1999) in monetary policy rules. Indonesia is one of emerging market countries that has advantages in adopting the small scale macroeconomic model, especially for the current issues of inflation targeting framework that popularized by John B. Taylor (1993), dealing with the central bank law of Bank Indonesia on the new task for stabilizing the domestic currency, so that the new law of Bank Indonesia might be appropriate to adopt inflation targeting framework (Taylor, 2000).

According to the new law, Bank Indonesia is obliged to announce the inflation plan at the beginning of the year to the public. Alamsyah, Agung and Zulverdy (2001), point-out that Bank Indonesia has become implemented the inflation targeting framework because it was obligated by the new law of Bank Indonesia.

Practical of inflation targeting framework (ITF) in many countries adopted Taylor modified monetary policy rules with using many anchors. Svensson (1999) argued that because uncertain of some economic variables behavior, using interest rate as single anchor as recommended by Taylor rules can be robustness.

Bank Indonesia has been practical many anchors in implementing the inflation targeting framework. Aulia Pohan (2006) states that only 4 anchors have effectively as monetary policy variables that can be used by Bank Indonesia for implementing inflation targeting framework in Indonesia.

Debelle (1999) argued that East Asian Countries economic condition differs with some developed countries. Using IMF data publications, He found that East Asian Countries economy have more opened compared with developed countries, so that East Asian Countries have greater opportunity to use exchange rates as an important anchor rather than using interest rate as reaction function that typically known as Taylor monetary policy rule. Aulia Pohan (2008) found that only 4 anchors have significant macroeconomic variables in affecting inflation control in Indonesia

This paper is intends to study the role of exchange rates behavior and its impact on trade

balance, and pass-through to inflation process in Indonesia, using a small scale macroeconomic approach based on Kara and Nelson (2006) small macroeconomic model with focusing on exchange rates as the key anchor. Although some monetary policy rules has different monetary anchors, but with the same target goals as to manage sustainable economic growth with low inflation.

The recent development of monetary policy rule has become greater expansion in some way. John B. Taylor published the important concept in monetary policy rules as an operational model for supporting the central bank in conducting inflation target. As mentioned above, new concept of Taylor's monetary policy today is known as Taylor rules. The Taylor rule is applied in more then 20 countries today for managing the inflation target with interest rates as single anchor.

However, application of Taylor rule in some countries is still in position of academic debate. As a matter of facts, the uncertainty of output gap, international trade, and other important macroeconomic behavior can be considers as key factors with modification of Taylor rule is needed ( Svensson, 1999).

Debelle (1998) argued that exchange rates have more significant role compared with other macroeconomic variables. As mentioned above, Debelle (1998) used data report of IMF indicates that East Asian Countries economy includes Indonesia is greater opened compared with developed countries. As a consequently, movements in the exchange rate play a much more prominent in East Asian economy. Exchange rate is become important in transmission channel for monetary policy, because exchange rate volatility have first order effects on the traded sectors of the open economic system (Debelle, 1998).

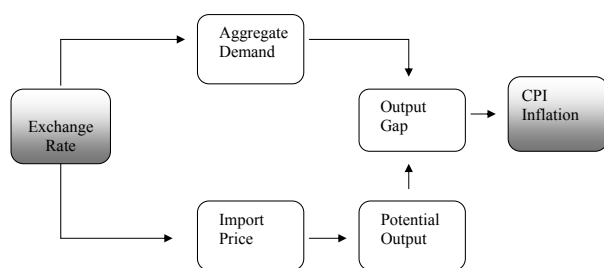
The central bank must be considered exchange rates as the important anchor in monetary policy objective function, because its effect directly to output and inflation. The central bank will therefore respond to the exchange rate changes because of their large impact on output and inflation. The greater response will be done, for the more open the economy.

McCallum and Nelson (1999) recommended the nominal income targeting as the instrument of monetary policy rule. They states that interest rate can not take function properly to support sustain-

able economic growth with low inflation. Figure 2 represent the transmission monetary rule of McCallum and Nelson.

Allsopp, Kara and Nelson (2006) studied exchange rate as the reaction function of inflation targeting for United Kindom, as the next development of McCallum and Nelson monetary policy rule. The Mechanism of transmission of exchange rate as single anchor in monetary policy rule approaches can be captured in figure 1 as below,

Figure 1 : Transmission Mechanism of Monetary Policy rule MacCallum & Nelson Monetary Rule



Sources : McCallum & Nelson (1999)

Figure 1 is monetary policy rule using exchange rate as single anchor for stabilizing inflation as main goal of monetary policy rule. Figure 1 also represent the role of exchange rate as main anchor for maintain sustainable economic growth with low inflation as the same monetary inflation targeting of Taylor rule (1993). This model as represent in figure 1 as the alternative monetary policy rule for Indonesia as emerging market country.

### Model Building

The small scale macroeconomic model (SSMM) is needed in order to understand how the national economy of one country is work. In constructing an appropriate one small scale macroeconomic model, this model is developed with some considerations. Firstly, the model is build for supporting alternative tools of Large Macroeconomic Model of ModBI. Secondly, small scale macroeconomic model (SSMM) is focusing on single anchor as policy rule as the key variable for managing the inflation targeting framework (ITF) and connecting with some key policy variables as supporting information of other macroeconomic links. Finally, the small scale macroeconomic model is developed for supporting analytical tools

in improving sustainable economic growth with low and stable inflation. The SSMM macroeconomic model can be detail as below,

$$R^* = R - P \dots\dots\dots (1.1)$$

$$R = \pi_0 + \pi_1 Y + \pi_2 (M / P) \dots\dots\dots (1.2)$$

$$P = \gamma_0 + \gamma_1 ex + \gamma_2 P^* \dots\dots\dots (1.3)$$

$$ex = \beta_0 + \beta_1 M + \beta_2 R^* + \beta_3 Y^* + \beta_4 L + \beta_5 D \dots\dots (1.4)$$

$$D_t = D_{t-1} + CAD \dots\dots\dots (1.5)$$

$$CAD = \alpha_0 + \alpha_1 P^* + \alpha_2 Y^* - \alpha_3 L \dots\dots\dots (1.6)$$

$$Y = \delta_0 + \delta_1 R + \delta_2 (M / P) + \delta_3 G + \delta_4 ex \dots\dots (1.7)$$

Where:

- R\* = real interest rates
- R = nominal interest rates
- P\* = percentage change in P
- P = domestic price
- ex = exchange rate defined as domestic currency units of foreign currency
- D<sub>t</sub> = current external debt
- CAD = current account deficit
- M = money supply
- Y\* = real income
- G = government expenditure
- L = world price of a barrel of crude oil (\$ USD)

The monetary policy rule approach of SSMM model that organized by McCallum and Nelson monetary policy rule (1999) is based on exchange rate as single anchor for implementing inflation targeting framework for emerging economy countries using econometric methods as the analysis tools for estimation. The small scale macroeconomic model of McCallum & Nelson monetary policy rule is explained below based on transmission mechanism as captured in figure 1.

The equation (1.1) represent general equation of small macroeconomic model (SSMM) that followed by behavior equation as captured in equation (1.2), (1.3) and (1.4). Equation (6) is captured the domestic interest rate as function of real national income and real money supply. Equation (1.2) is represented the relationship between the relative prices and exchange rates. The rises of exchange rate value can be analogy with raising domestic price level. Equation 1.3) is known as purchasing power parity theory that will be examined using empirical data of Indonesian economy.

Equation (2.1) is attempted to represent the major determinants of the current deficit by expressing it as a function of relative prices, income and price of oil. It can be states that a relatively higher price level at home will tend to reduce exports and there-

fore increasing the current account deficit. On the same time, a higher price of oil is expected to have an adverse impact on the CAD for net oil exports and positively for net oil importers.

Equation (2.2) is incorporated the external debt and the world price of oil as an explanatory variables in exchange rate determination. The equation (4) represent the relationship between money supply and domestic currency depreciation pass-through to inflation. When economy is worked with low inflation and with no restriction policy of international capital mobility, the rises of domestic interest rate affect directly the capital inflows and at the same time appreciated the domestic currency. If the country imposed the restriction policy for international capital mobility, the rises of domestic interest rates have different result to domestic economy. The rise of domestic interest rate will be affect strongly to inflation expectations and have the negative effect to the domestic currency value.

Equation (2.3) represented the real national income as function of real domestic interest rates, the real money supply, government expenditure and foreign exchange rates. Theoretically can be states that for higher domestic interest rate will be reduced autonomous investment and therefore will be lower national product. On the other hands, interest rate might be drop using monetary supply shock, and make national product rises but with higher inflation. As can be notes, the rises of government expenditure will create job and production but with depreciating foreign currency rates, that will be expected in the second step to increase exports and national income.

## Econometric Methodology

Econometric analysis tools is considered as analytical tools in forecasting a small scale macroeconomic model (SSMM) for Indonesia. The model is analysis using econometric methods with two stages least square (2 TLS). Gujarati (2003) defined two stages regression as the regression model with structural form that contain endogenous and predetermined variables. The regression coefficient resulting from two stages least square equation model is known as structural parameters.

Equation (1.3) is price equation as the reduced form equation of the structural model design of small scale macroeconomics.  $\gamma_1$ ,  $\gamma_2$  dan  $\gamma_3$  is the associated reduced form coefficient, that also can

be interpreted as impact or short run multipliers. Equation (1.3) is the second stages of equation (1.2) as the main structure of regression. The same positions also captured as reduced form equation for equation (1.4) as the reduced form of main regression of (1.3). The whole processes of econometric methods that popularized as structural equation model.

However, the serious problem of structural equation systems is the identification condition. Gujarati (2003), Johnston (1991), Pyndick & Rubinfeld (1992) and Greene (2003) recommended using formulation rule of identification as below,

1. If  $K - k > m - 1 \rightarrow$  the equation is over-identified
2. If  $K - k = m - 1 \rightarrow$  the equation is exactly identified
3. If  $K - k < m - 1 \rightarrow$  the equation is under identified
4. If  $K - k < m - 1 \rightarrow$  the equation is un-identified

The second problem of simultaneous equation model is the simultaneity problem that might be produced the inconsistent parameter and in-efficient parameter. Simultaneity problem arises because some of regression coefficients are endogenous and likely to be correlated with the error term. The simultaneity problem also occurs because of exogenous and endogenous distinction that sometimes with controversial complication (Greene, 2003), Enders (2004).

Using Klein Model 1, Greene (2003) have simulated Klein model in less information and fully information compared with GMM and FIML methods. The estimation result are different each-others.

## Estimation result.

Regression estimated of the SSMM model based on macroeconomic quarterly data as enclosed at Appendix A and B. All the regression variables are take form in logarithmic based 10. The regression results are presented in Appendix C until Appendix H. The first step of regression estimated is the sources of regression model, and at the second turn would estimated the reduce form regression. Model is divided into two groups, as header at equation (1) and equation (2). The regression model is calculated using Minitab 14. The regression estimation is represented at figure 1.3 as below,

**Figure 2** : Regression result of SSMM Model Interest Rate (R)

Nbr.	Variable estimated	Coefficient	t-test	R <sup>2</sup>	DW-Test
1	National income Y	- 0.18399	-2.39	53.9	0.18
2	Money supply M1	- 0.15004	-2.91	53.9	0.18

As indicated in figure 3 that national income (Y) and money supply ( $M_1$ ) is significant with 5% level t test, so that interest rates can be determined by monetary aggregate and national income. However, the model still indicates the low value of coefficient of determination  $R^2$  that only 0.53. Therefore, the model must be added some others variables for increasing information needed of the model.

**Figure 3** : Regression result of SSMM Model Reduced form Domestic Price (P)

Nbr.	Variable estimated	Coefficient Estimated	t-test	R <sup>2</sup>	DW-Test
1	Exchange rates Ex	2.75	2.07	16.3	0.66

Figure 3 represent the reduced form of interest rate model, and take place exchange rates as determinant in changing the domestic price P. Regression result indicates a significant t test with 5% level, so it can be said that exchange rates have significantly power in influencing the domestic price of Indonesian economy. However, its still have a statistical problems because of low value at  $R^2$ .

**Figure 4** : Regression result of SSMM Model Reduced form of Exchange Rates

Nbr.	Variable estimated	Coefficient Estimated	t-test	R <sup>2</sup>	DW-Test
1	Money supply M1	- 0.1610	- 0.85	0.62	1.38
2	Real interest rate R*	0.0880	0.60		
3	Real National income Y*	0.3730	2.15		
4	World oil price L	0.0740	3.80		
5	Cuurent external debt Dt	-0.1887	-0.45		

Figure 4 indicates reduce form regression that replace the position of exchange rate variable become the dependent variable at reduce form position that take as function of money supply  $M_1$ , Real interest rate  $R^*$ , real national income  $Y^*$ , world price L and current external debt Dt. According to figure 5, there are five coefficients are significant with 5% level t test. Only real national income  $Y^*$  and world price L is significant with 5% level t test. Hence, recommendation can not provide of all the parameters that indicated not significant with 5% t test criteria.

**Figure 5** : Regression result of SSMM Model Curent External Debt Dt

Nbr.	Variable estimated	Coefficient Estimated	t-test	R <sup>2</sup>	DW-Test
1	Lag External debt LagDt	0.00000099	0.82	10.9	0.86
2	Current Account CA	0.0000045	1.47		

Figure 5 represent the second group of the model that examined the current external debt as function of its lag time and current account (CA). However, the regression found only current account variable is significant with 5% level t test criteria. This model also lack of information of adding some variables because coefficient determination R is too low.

**Figure 6** : Regression result of SSMM Model Reduced form of Current Account (CA)

Nbr.	Variable estimated	Coefficient Estimated	t-test	R <sup>2</sup>	DW-Test
1	Real domestic price P*	- 5858	- 0.53	0.52	1.64
2	Real National income Y*	- 4288	- 0.22		
3	World price of Oil L	- 26262	- 3,68		

Figure 6 is reduced form regression that related with figure 5. The current account CA is dependent variable as function of real domestic price  $P^*$ , real national income  $Y^*$  and world price of oil L. According to figure 7, only world price of oil indicates significantly with 5% t test criteria. Hence, it can not concluded the role of real domestic price  $P^*$  and real national income  $Y^*$  as key variables in forcing the change of current account variables, because the value of t is less then t tables.

## Conclusion

The model have still constraint with some important aspects especially at position of coefficient of determination that become too low of all the model, although the most of coefficient are supporting with t calculation that were found greater than t tables. This statistical constraint will be questioning for adopting other econometric methods in the next research activities. Its might be notes that the low of coefficient determination  $R^2$  could be occurs because of using two stages regressions that might be not suitable for the data quarterly that used. The model needed some testing procedure as recommended by Greene (2003), with Hausman specification Test.

This research at least have some indications for supporting the role of exchange rates as the key policy in small macroeconomic model of Indonesia. The strong value of t calculation compared with t

tables would be guidance as statistical signal for supporting the final conclusion of exchange rates as key macroeconomic variable in managing macroeconomic coordination for improving sustainable economic growth in Indonesia in the future. In finding the best signs and goodness of fit of the SSMM model, the next research must be organized for using logarithm value or elasticity approached that might be more suitable in improving statistical test combined with some extents in macroeconomic variables of the models.

## Reference

- Alamsyah Halim, Judha Agung and D. Zukverdy (2001), *Towards implementation of Inflation Targeting In Indonesia*, Bulletin of Indonesian Economic Studies, ANU, Canberra.
- Arreaza Adriana, Enid Blanco and Micquel Dorta (2003), *A Small Scale Macroeconometric Model for Venezuela*, Central the studios, Venezuela. Available at SSRN.COM.
- Aulia Pohan (2008), *Kerangka Kebijakan Moneter & Implementasinya di Indonesia*. Raja Grafindo Persada, Jakarta.
- Batini, N and Haldane, AG (1999), *Forward-Looking Rules for Monetary Policy*, in Taylor John B, (ed), *Monetary Policy Rules*, Chicago : Univ. of Chicago and NBER.
- Bagchi, Deborah, G.E. Chortareas and S.M. Miller(2004), *The real exchange rate in small open developed economies, Evidence from cointegration analysis*. The Economic Record.
- Billmeier, Andreas and Bonato, Leo (2002), *Exchange rate pass-through and monetary policy in Croatia*. IMF Staff papers. Washington DC.
- Enders, Walter (2004), *Applied Econometric Time Series*, New York, Wiley.
- Greene, William H (2003), *Econometric Analysis*. Fifth edition. Upper Saddle River, New Jersey.
- Hodrick, Robert J. and Prescott, Edward C. (1997), *Postwar U.S. business cycles, An Empirical Investigation*. Journal of Money, Credit and Banking. February, 1997.
- Johnston, J. (1965), *Econometric Methods*. McGraw-Hill Book Company, Inc. Tokyo.
- Kenneth, G. Stewart (2007), *Introduction to Applied Econometrics*, Univ. of Victoria, Thomson Book Publisher, USA.
- Pindyck, Robert S and Rubinfeld, Daniel L (1976), *Econometric Models and Economic Forecast*. McGraw-Hill Book Company, Inc. Tokyo.
- Tanuwidjaja, Enrico and Keng meng Choy (2005), *Central Bank Credibility and Monetary Policy in Indonesia*, Journal of Policy Modeling.
- Taylor, John B (1999), *A Historical Analysis of Monetary Policy Rules*. In John B. Taylor, ed., *Monetary Policy Rules*, University of Chicago Press.
- Taylor, John B (2003), *Using Monetary Rule in Emerging Market Countries*, Working Papers, Stanford University.

**G. SUJANA BUDHIASA**, kandidat doctor untuk bidang konsentrasi ekonomi makro moneter di Universitas Brawijaya Malang. Dosen jurusan Ilmu Ekonomi FE Unud ini sedang giat-giatnya melakukan penelitian untuk disertasinya yang berjudul Model Ekonomi Makro Monetary Policy Rule untuk Indonesia. Banyak penelitian yang dihasilkannya telah dimuat pada beberapa jurnal nasional, dua tulisan terakhir adalah pada jurnal ilmiah Universitas Islam Malang (UIM) tahun 2007 dengan judul Review Tentang Design Monetary Policy Untuk Indonesia, dan jurnal FE Unud tahun 2009 dengan judul Mencari Design Pengembangan Model Ekonomi Makro yang Relevan dengan Kebutuhan Bank Indonesia (Credibility dan Macroeconomic Performance).  
Telp (+81)558883111. Email: bapak\_age@yahoo.com