# Macroeconomics Shocks and Stability in Malaysian Banking System; A Structural VAR Model

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**Abstract**   Negative effects of 1997 financial crisis in Malaysia, such as other emerging countries, led to the development and restructuring of financial system in this country. Hence many big firms and corporations to provide their required funds shift towards newly established markets like stock and bond markets. Under these conditions, many banks maintained their profitability by attracting new customers especially Small and Medium size Entrepreneurs (SMEs) and increased their loans and credits to the household sector. Now a significant share of loans has been given to the household sector and SMEs and this feature caused the banking system to become more vulnerable against external and internal shock. So, increasing unemployment and reducing income for any reason will be a threat for banks by Default risk. Thus, anticipated effects of macro-economic shocks on banks' operation are more important to policy makers and bankers. Hence in this study, a Structural Vector Autoregressive (SVAR) model is employed to show how a macroeconomic shock effects on Non-Performing Loan changes (NLP) as a credit risk indictor in Malaysian commercial banking system for period of 1997-2012. The designed Model is called AB model that is limited based on IS-LM theory. According to results the demand and supply shock have negative and monetary shock has positive effects on NPL ratio. Mean while simultaneous effects of monetary and demand shocks are more than supply shocks effects but the supply shocks' impact is more persistent. Comparison response of NPL ratio with capital ratio shows that the commercial banks against domestic shocks are safe and adequate capital to deal with the risks arising from internal shocks in the economy are considered. The results of this study can help policy makers to pursue suitable monetary policies and decrease banks failing in front of any macroeconomic shocks.

**Keywords**   Banking, Macroeconomics, Credit Risk, Structural VAR

## 1. Introduction

Development of financial markets, economic globalization and the expansion of banking activities has led to a close relationship between economic conditions and the operation of banks. Banking crises in different countries during last decades and their negative effects on host and other economies make it necessary to examine the relationship between macroeconomic variables and banks' behaviour and operation. On the other hand banks have an important role in the monetary policy transmission. Hence understanding of the relationship between macroeconomic indicators and the performance of banking system is so important for economists.

Negative effects of 1997 financial crisis in Malaysia, such as other emerging countries, led to develop and restructure of financial system in this country. Thereafter many big firms and corporations to provide their required funds shifted from banking system towards newly established markets like stock and bond markets. Under these conditions, many banks maintained their profitability by attracting new customers especially Small and Medium size Entrepreneurs (SMEs) and increased their loans and credits to the household sector. Now a significant share of loans has been given to the household sector and SMEs [1] and this feature caused the banking system to become more vulnerable against external and internal shocks.

SMEs established by bank loans are very sensitive to shocks and macroeconomic volatility like constraint on banks' credit and international trade. So it is possible that any alteration in government policies make SMEs encounter in/directly with several problems like decrease in sale and production and liquidity crisis. Finally they cannot continue their activity and make default on loans that cause more limitation in bank credits. On the other hands, due to the limitation of the funds and credit risk control banks may

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[1]. Household debts in Malaysia as a proportion of GDP have increased to 76.6% at end of 2011. Also based on Asian Development Bank's (ADB) study the share of SMEs in GDP and industrial employment in Malaysia was respectively 17.4 and 59 percent in 2012.

restrict their financing roles. All these problems reduce the level of total products, employments and economic growth. Increasing unemployment and reducing disposable income for any reason will be a threat for banks by Default risk.

Accordingly in order to make better economic policies to improve the SMEs' share from GDP growth, as the driving engine of the economy, with maintaining the quality of the banking system, it is important to investigate the interaction between banks operation such as credit risk and macroeconomic shocks such as monetary policy, aggregate demand and supply shocks. In 1997 the average mine of total capital to risk weighted assets ratio in commercial banks was 6 percent. After 1997 financial crisis the banks increased their capital ratio and during the period (1998 – 2012) equal to minimum 10.62% (2008) and a maximum of 15.7 per cent in 2010 (See Figure (1)). Compared with the NPL ration during this period, it seems that banks have enough adjusted their capital with risky conditions. But given the current state banks, a measure of the health of the banking system to macroeconomic shocks is essential.
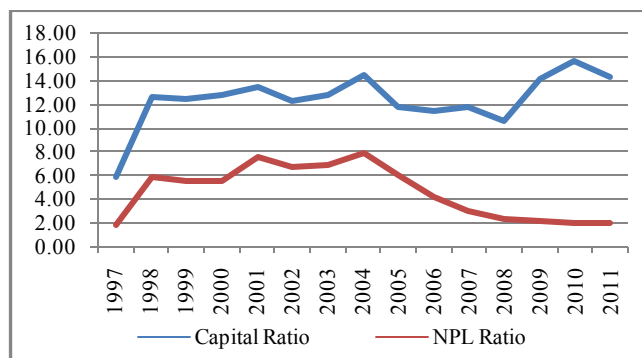


**Figure (1).** NPL ratio and Capital ratio in Malaysian aggregate commercial banking system

Hence in this study, a Structural Vector Autoregressive (SVAR) model is employed to show how a macroeconomic shock effects on Non-Performing Loan changes (NLP) as a credit risk indictor in Malaysian commercial banking system for period of 1997-2012. The results of this study can help policy makers to pursue suitable monetary policies and decrease banks failing in front of any macroeconomic shocks. In the next sections, it will be referred to the literature and background of study. Then referring briefly look at macroeconomic indicators and banking system features in Malaysia. The next part belongs to introduce the SVAR model and finally the model is run on the Malaysian macroeconomics and banking system variables and the results are analysed in order to implication of the model.

## 2. Theoretical Background and Literature

After Wilson[21] who examined the relationship between the probability of default of financial institution with a group of macroeconomic variables under distress condition, a wide range of studies have done about different credit risk models

and relationship between risk factors in different macro environment situation. Some of these researches have gotten the Non-Performing Loans (NPL) ration to total asset as a credit risk indicator. Since based on risk models it can be selected different type of risk indicators, so in literature review in line with the purpose of study it has tried to point out that researches which used the NPL as a risk indicator It is notable that studies in this area are called stress test that have done in order to test healthy of banking system in front of different macroeconomic shocks. The literature in this area has divided in two groups. The first set of studies are called sensitivity test that examine the effects of a shocked variable on risk without any interdependence to other risk factors (See[3];[7],[11],[17],[20] and[22]).

The other groups of researches are scenario analyses that use a combination of comprehensive economic and financial information to assess systematically the risk. Most of these studies have a top down approach that means they used aggregate finance and economic data (See[6],[8],[10],[12], and[20]). According to results of these studies the gross domestic products (GDP) growth always and real interest rate sometime have indirectly negative effects on NPL ratio. Also unemployment, consumer price index (CPI) and real exchange rate influence on loan quality. In these studies the Vector Auto Regressive models is the most important method to accesses interaction between macroeconomic and financial variables. This model has been used widely to understand dynamics behaviour of macroeconomic variables in front of each other's change, since the[19] done an initial study in this regard.

One of the drawbacks of VAR models is the lack of theoretical background about the connection between the variables and only it makes a statistical relationship between them. Initially[4],[5] and[18] and then[9] and[13] suggest usage of predefinetion structures based on theories to overcome this limitation. In this paper the AB model that disigned by[2] is used to make theoretical restriction and structural VAR model. This model has been used in so many studies such as[1],[14],[15] and[16]. The most important theory to create restriction in these studies is the IS-LM models. Based on aggregate demand and supply and also money market equations and the economic policies behind these equations the sign of coefficient between macroeconomic variables in VAR model can be determined.

## 3. Data and Methodology (SVAR Model)

The foundation of the SVAR model in this study is IS-LM model that has an important role on the policy makers and academicians decisions. Model includes variables like output (y) and price (p), money stock (m) and interest rate (r). The reasons for including these variables are: (a) basic macroeconomic models developed in the Keynesian idea include these variables; (b) theoretical predictions discussed above involve dynamic interactions among these variables. On the other hand GDP, interest rate and consumer price

index based on literature and imperial studies are the most important macroeconomic variables that affect on banks' loan quality that here its' indicator is the Non-Performing Loan (NPL) to total loan ration for aggregate commercial banking system. Also the transmission role of banks in monetary policies is another reason to add this variable to the model.

Since the main objective of this paper is to investigate the relationship between the NPL ratio and the macro variables; thus, in the model just related variables into NPL ratio have been selected. On the other hand due to the limitations of the data, entering additional variables causing the Matrix Algebra problems and coefficients is not possible to estimate. There for the money stock (M) is omitted from model. Also none of the empirical studies about NPL does not include the money stuck as explanatory variables. So our variables are defined follow:

Y: Real GDP

P: Inflation (based on consumer price index),

R: Money market interest rate,

NPL: Non-Performing Loan ratio to total loans

(Aggregate commercial banks)

(LOG of Y (LY) has been used)

Table (1) and figures (2&3) show description from statistics of variables.

**Table (1).**

|  | GDP growth | LY | p | R | NPL |
|---|---|---|---|---|---|
| Mean | 4.413 | 11.628 | 4.226 | 7.123 | 4.64 |
| Median | 5.600 | 11.629 | 4.081 | 6.500 | 5.5 |
| Maximum | 8.900 | 11.768 | 10.389 | 11.100 | 7.9 |
| Minimum | -7.400 | 11.489 | -5.992 | 4.880 | 1.9 |
| Std. Dev. | 4.173 | 0.0913 | 4.331 | 1.893 | 2.198 |
| Observations | 15 | 15 | 15 | 15 | 15 |

**Source.** Calculated by author based on data extracted from the World Bank and BankScope
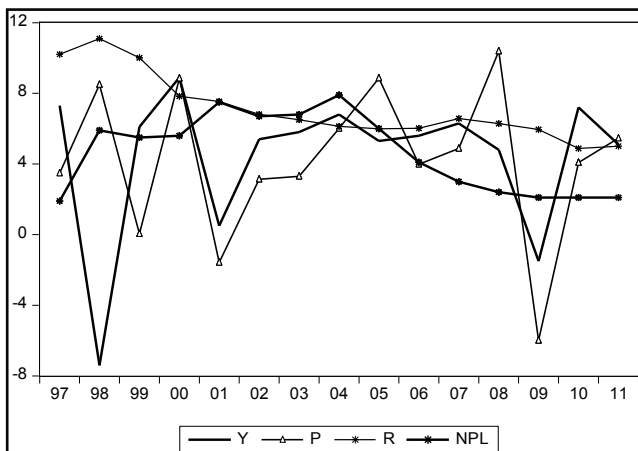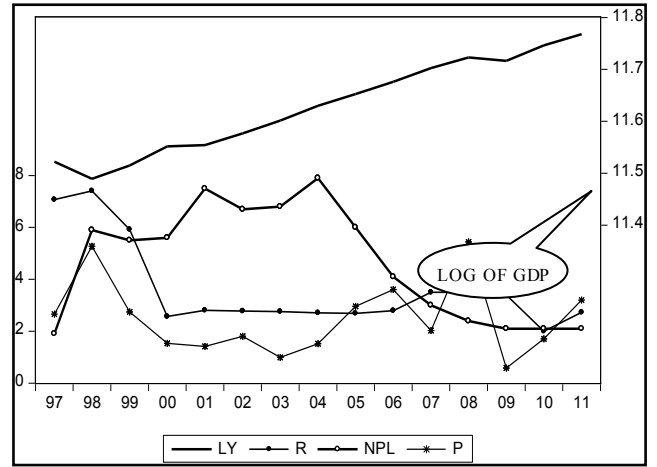


**Figure (2).** trend of GDP growth, inflation, Interest rate and NPL ratio in Malaysia (1997-2011)



**Source:** World'Bank, Bankscope and Bnaks' annual reports

**Figure (3).** trend of GDP (LOG), inflation, interest rate and NPL ratio in Malaysia (1997-2011)

As can be seen the GDP growth in three stages (1998, 2001 and 2009) has been a significant decline which in both 1998 and 2001 led to the NPL ratio increase dramatically and in 2009 caused to stop its reducing process. It seems that the GDP has reverse effects on NPL ratio that results of the literature also confirm it. Also inflation and lending rate have trend in same direction with NPL ratio. But some fluctuations in the studied period make it difficult to predict a positive relationship between these variables. Hence the results of an econometric model can make clear the kind of this connection.

## 4. Econometrics Model

While the main aim is investigation the relationship between macroeconomic variables and bank loan quality, so that this relationship is modelled within a general equilibrium framework in which major macroeconomic variables interact contemporaneously and over time. If it is assumed that each variable be contemporaneously correlated with others variables and also related to lagged level of itself and other variables, so the system of equation for this relationship can be designed as the following:

$$Y_t = -a12\ P_t - a13\ R_t - a14\ NPL_t + \sum_{i=1}^{4} \lambda_{1i} X_{i,t-1} + b_{11} \nu_{1t}$$

$$P_t = -a21\ Y_t - a23\ R_t - a24\ NPL_t + \sum_{i=1}^{4} \lambda_{2i} X_{i,t-1} + b_{22} \nu_{2t}$$

$$R_t = -a31\ Y_t - a32\ p_t - a34\ NPL_t + \sum_{i=1}^{4} \lambda_{3i} X_{i,t-1} + b_{33} \nu_{3t}$$

$$NPL_t = -a41\ Y_t - a42\ P_t - a43\ R_t + \sum_{i=1}^{4} \lambda_{4i} X_{i,t-1} + b_{44} \nu_{4t}$$

That, $X_{1...4}$ are respectively Y, P, R and *NPL*. $\nu_{it}$ is the structural shocks of independent variables. This matrix can be written in the other shape:

$$\begin{bmatrix} 1 & a_{12} & a_{13} & a_{14} \\ a_{21} & 1 & a_{23} & a_{24} \\ a_{31} & a_{32} & 1 & a_{34} \\ a_{41} & a_{42} & a_{43} & 1 \end{bmatrix} + \begin{bmatrix} Y_t \\ P_t \\ R_t \\ NPL_t \end{bmatrix} =$$

$$\begin{bmatrix} 1 & \lambda_{12} & \lambda_{13} & \lambda_{14} \\ \lambda_{21} & 1 & \lambda_{23} & \lambda_{24} \\ \lambda_{31} & \lambda_{32} & 1 & \lambda_{34} \\ \lambda_{41} & \lambda_{42} & \lambda_{43} & 1 \end{bmatrix} \begin{bmatrix} Y_{t-1} \\ P_{t-1} \\ R_{t-1} \\ NPL_{t-1} \end{bmatrix}$$
$$+ \begin{bmatrix} b_{11} & o & o & o \\ o & b_{22} & o & o \\ o & o & b_{33} & o \\ o & o & o & b_{44} \end{bmatrix} \begin{bmatrix} v_{1t} \\ v_{2t} \\ v_{3t} \\ v_{4t} \end{bmatrix}$$

This is SVAR or primitive VAR. Following the AB-model[2] restrictions for A and B is combined, so that the model for innovations becomes $A\varepsilon = Bv$. To achieve this combination initially the reduce form of model is extracted:

$$\begin{bmatrix} Y_t \\ P_t \\ R_t \\ NPL_t \end{bmatrix} = \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} \\ \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} \\ \beta_{31} & \beta_{32} & \beta_{33} & \beta_{34} \\ \beta_{41} & \beta_{42} & \beta_{43} & \beta_{44} \end{bmatrix} \begin{bmatrix} Y_{t-1} \\ P_{t-1} \\ R_{t-1} \\ NPL_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \end{bmatrix}$$

This is the reduced form of the model that can be compared with the original model and combination of $A\varepsilon = Bv$ is extracted:

$$\begin{bmatrix} 1 & a_{12} & a_{13} & a_{14} \\ a_{21} & 1 & a_{23} & a_{24} \\ a_{31} & a_{32} & 1 & a_{34} \\ a_{41} & a_{42} & a_{43} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \end{bmatrix}$$
$$= \begin{bmatrix} b_{11} & o & o & o \\ o & b_{22} & o & o \\ o & o & b_{33} & o \\ o & o & o & b_{44} \end{bmatrix} \begin{bmatrix} v_{1t} \\ v_{2t} \\ v_{3t} \\ v_{4t} \end{bmatrix}$$

If the amount of variables is K so that there are altogether $2K^2$ elements in the structural form matrices, and the maximum identifiable parameters in these matrices is $K(K + 1)/2$, we need $2K^2 - K(K + 1)/2$ further restrictions for exact identification. Accordingly the number of extra needed restriction in this study is 32-10 = 22. Meanwhile 12 restriction in matrix B (equal to zero) and 4 restriction in matrix A (equal to one) are clear so it is necessary to identify only 8 more restriction that can be extracted from theories.

# 5. Policy Identification Based on Theory

## 5.1. Monetary Policy

A linear function relating the monetary policy instrument to the information set available to the central bank. Monetary policy shocks ($v_{3t}$) is identify as innovations to the monetary policy instrument given a set of conditioning variables. The monetary policy instrument is the interest rate and the conditioning variables for the feedback rule include the contemporaneous lagged values of all the variables included in the model. Since output and prices are not observed by the central banks when they use a monetary policy, it can only adjust interest rate immediately to changes in money stock.

One of the other assumptions in this regard, can be related to relationship between quality of bank loans (NPL ratio) and interest rate. This is evident that change in NPL does not directly affect the volatility of interest rates. Since banks

through the transitional role can affect on monetary policy performance; So to counteract the negative effects of the banking system in response to cope with the NPL, the interest rate may be changed on the recommendation of economists. Hence it can be said that the interest rate does not change directly by any change in NPL ratio. Based on these restrictions the equation of interest rate is equal to:

$R_t = \sum_{i=1}^{4} \lambda_{3i} X_{i,t-1} + b_{33} v_{3t}$
a31=0     a32=0     a34=0

## 5.2. Aggregate Demand

One of the assumptions of IS-LM model is that price level is given and thus does not change in response to demand shocks. On demand side it is allowed movement of price due to favourable or adverse supply shocks. Especially in developing countries price is not contemporaneously influenced by other variables in the system but by the adverse supply shocks will increase price. So that there are three restrictions in price equation:

$P_t = -a21 \, Y_t + \sum_{i=1}^{4} \lambda_{3i} X_{i,t-1} + b_{33} v_{3t}$
a24 = 0     a23=0     - a21 < 0

## 5.3. Aggregate Supply

Since real output can only respond to monetary policy shocks with the lag thus aggregate supply is identified as a function of the lagged values of all the variables in the model. So that supply equation is equal to:

$Y_t = -a13 \, R_t + \sum_{i=1}^{4} \lambda_{1i} X_{i,t-1} + b_{11} v_{1t}$
a12=0     – a13 $R_t$ < 0     a14= 0

Apart from the restrictions imposed by the New Keynesian model, it can also be applied to other constraints about relationship between bank risk indicator (NPL ratio) and other variables. Based on empirical studies, change in output has contemporaneous negative effect on NPL ratio. And any increasing in interest rate has simultaneously positive effects on NPL ratio. In relation to price shocks, it is noteworthy that the different results of the studies in this regard have been issued; thus the expected sign of the coefficient on this variable will be assigned preferably the estimated results of model. So the NPL ratio function can be wrote such as:

$NPL_t = -a41 \, Y_t - a42 \, P_t - a43 \, R_t + \sum_{i=1}^{4} \lambda_{4i} X_{i,t-1} + b_{44} v_{4t}$
-a41 < 0   – a42 = !   – a43 > o

Based on restrictions the $A\varepsilon = Bv$ will be:

$$\begin{bmatrix} 1 & 0 & a_{13} & 0 \\ a_{21} & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ a_{41} & a_{42} & a_{43} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \end{bmatrix} = \begin{bmatrix} b_{11} & o & o & o \\ o & b_{22} & o & o \\ o & o & b_{33} & o \\ o & o & o & b_{44} \end{bmatrix} \begin{bmatrix} v_{1t} \\ v_{2t} \\ v_{3t} \\ v_{4t} \end{bmatrix}$$

# 6. Estimation Results

Before model estimation, initily the stationery of variables has been tested. According to results of ADF unit root test the LOG of GDP and inflation are stationary with trend. Also the money market intrest rate and NPL ratio

with out trend and intercept are stationary. So that level variables are used to estimate the model. The model was estimated on LOG of GDP (LY), inflation based consumer price index (p), money market inerest rate and NPL ratio. Also model was estimated with replasing GDP growth by LY seperatly. In both model the parametrs of A matrix shows that any Supply shock (shock on GDP) and demand shock (shock to inflation) have a negative effect on NPL and monetary shock (shocks on interest rate) has positive effects on NPL ratio (seeTable (2)).

**Table (2).**   Estimated A matrix the (..) is the P-Value

|      | ly                    | p                  | r                     | NPL |
|------|-----------------------|--------------------|-----------------------|-----|
| ly   | 1                     | 0                  | **-0.00071** (0.8590) | 0   |
| p    | **2.094642** (0.9660) | 1                  | 0                     | 0   |
| r    | 0                     | 0                  | 1                     | 0   |
| NPL  | **45.00801** (0.0008) | **0.591812** (0)   | **-1.13899** (0)      | 1   |

It should be added that the coefficients in matrix A, merely confirm effects of incoming structural shocks on the other variables, and how they might be changed.[2] The impuls response grahps can show these effects clearly. Since the coefficients of the model that includes the LY is more meaningful than the coefficients of the model is developed by GDP growth, so that the impulse respone graph is extracted from first one. According to the figure (4) the systematic response to one standard deviation (S.D.) supply shock (shock to LY) led to 0.44 unit increase in NPL ratio.

The negative effect of this shock is continued until next year, but with less intensity (0.18 unit increasing in NPL ratio). It is notable that the estimated results of the model included GDP growth instead LY also refer to a negative impact of aggregate supply on NPL ratio. But statistically significant coefficients are lower.
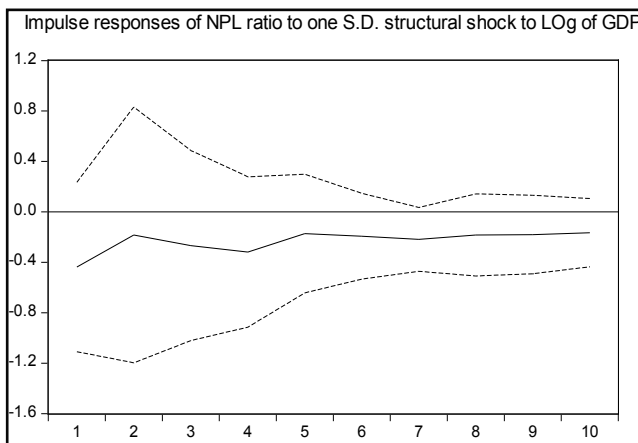


**Figure (4).**

As it is indicated in figure (5) the response to one S.D. (1.9 units) monetary contractionary policy shock (shock to interest rate) causes to 0.77 unit contemporaneous increasing in NPL ratio. High interest rate in the short time leads to banks' credit customers cannot have access to new funding sources and consequently increase the credit default in banking system. On the other hand the higher interest rates will lead to lower demand for new credits and thus the impact on the NPL ratio will be negatively in later years.
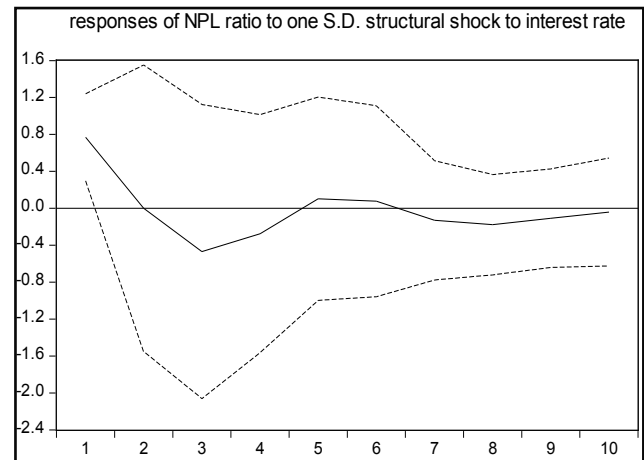


**Figure (5).**

As it is evident in third year the effect of one S.D. monetary shocks will be 0.47 units decreasing in NPL ratio. And effects of monetary policy shock gradually fade over the following years.

According to various studies, the effect of demand shocks on bank loan quality (NPL ratio) in different conditions and in some cases was positive and in some others it was negative and there is no single opinion on the results of this shock. In this study one S.D. shock on inflation will has an instantaneous negative effect (-1.1 units) on NPL ratio and over the past two years reduced respectively to -0.7 and -0.2 units (see Fig. (6)). One reason can be the growth value of costumers' property in parallel with the general rise in prices that increase their ability to repay debt. In this situation demand to new credits also will be increased and consequently in the future the NPL ration will be raised as is evident in Fig. (6)
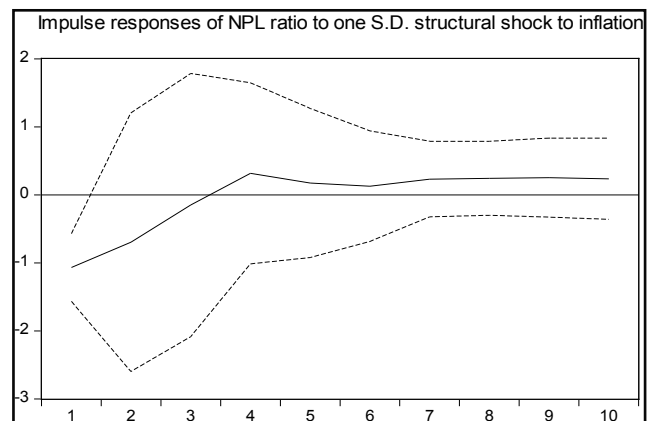


**Figure (6).**

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[2]. Note that in the matrix A, each negative coefficient means that incoming shock has a positive effect on related variable to that coefficient and vice versa.

Based on the results the interest rate and inflation have the positive effects on NPL ratio. One unit increasing in these variables decreases contemporaneously the NPL ratio 1.43 and 0.45 units respectively. As can be seen the immediate effects of changes in interest rate are more than effects of GDP growth and inflation.

## 7. Conclusions

The main purpose of this study is investigating the effects of macroeconomic shocks on commercial banks' loan quality in Malaysian economy. To this end we used a structural VAR (SVAR) model to analyse the response of loan's quality to monetary policy shocks, supply and demand shocks. The most important real economy variable including the real GDP, inflation and interest rate and also NPL ratio as an indicator of loan quality in aggregate banking sector have been used in this model. In order to predicts the macroeconomic shocks' effects some restriction based on IS-LM models applied in model. According to results the simultaneous effects of monetary (interest rate) and demand (inflation) shocks on NPL ratio are more than supply (GDP) shocks effects but the supply shocks' impact is more persistent. Any increasing in GDP and inflation lead to decrease in NPL but effect of inflation is more than GDP. The contemporaneous effect of monetary policy shock (negative) differs from its lag effects (Positive).

Based on macroeconomic shocks effects on NPL ratio and compared with capital ratio in commercial banks it can be said that the banking system (commercial banks) against domestic shocks are safe and adequate capital to deal with the risks arising from internal shocks in the economy are considered. But since Malaysia is a country dependent on the export sector and its financial system is interconnected with international financial markets, it is also important to investigate the effects of external shocks on health of banking system.

## REFERENCES

[1] Ahmed, M. "How well does the IS-LM model fit in a developing economy: The case of india". *International Journal of Applied Economics, 2*(1), 90-106, 2005.

[2] Amisano, G., & Giannini, C. "Topics in structural VAR econometrics". *Berlin/Heidelberg,* 1997.

[3] Arpa, M., Giulini, I., Ittner, A., & Pauer, F. "The influence of macroeconomic developments on austrian banks: Implications for banking supervision". *Bis Papers, 1*, 91-116, 2001.

[4] Bernanke, B. S. "*Alternative Explanations of the Money-Income Correlation",* National Bureau of Economic Research Cambridge, Mass, USA, 1986.

[5] Blanchard, O. J., & Watson, M. W.,"Are business cycles all alike? *The american business cycle: Continuity and change"* University of Chicago Press, (pp. 123-180), 1986.

[6] Blaschke, W., Jones, M.,"Stress testing of financial systems: An overview of issues, methodologies and FSAP experiences", *IMF Working Paper,Washington, 01*(8), 2001.

[7] Chiaramonte, L., & Casu, B., "On the relationship between bank CDS spreads and balance sheet indicators of bank risk", *Palgrave Macmillan Studies in Banking and Financial Institutions,* , 94, 2011.

[8] Čihák, M., Heřmánek, J., & Hlaváček, M., "New approaches to stress testing the czech banking sector", *Czech Journal of Economics and Finance (Finance a Uver), 57*(1-2), 41-59, 2006.

[9] Cushman, D. O., & Zha, T., "Identifying monetary policy in a small open economy under flexible exchange rates", *Journal of Monetary Economics, 39*(3), 433-448, 1997.

[10] Gambera, M., "Simple forecasts of bank loan quality in the business cycle.emerging issue series", *Federal Reserve Bank of Chicago, Chicago,* (3), 2000.

[11] Gropp, R., Vesala, J., & Vulpes, G., "Equity and bond market signals as leading indicators of bank fragility", 2002.

[12] Hoggarth, G., Sorensen, S., & Zicchino, L., "Stress tests of UK banks using a VAR approach", Bank of England Working Paper Series 2005.

[13] Kim, S., & Roubini, N., "Exchange rate anomalies in the industrial countries: A solution with a structural VAR approach", *Journal of Monetary Economics, 45*(3), 561-586, 2000.

[14] Koluk, T., & Mehrotra, A., "The impact of chinese monetary policy shocks on east and South-East Asia", *Economics of Transition, 17*(1), 121-145, 2009.

[15] Li, Y. D., İşcan, T. B., & Xu, K., "The impact of monetary policy shocks on stock prices: Evidence from canada and the united states", *Journal of International Money and Finance, 29*(5), 876-896, 2010.

[16] Mehrotra, A. N., "Exchange and interest rate channels during a deflationary era—Evidence from japan, hong kong and china", *Journal of Comparative Economics, 35*(1), 188-210, 2007.

[17] Quagliariello, M., "Are macroeconomic indicators useful in predicting bank loan quality? evidence from italy", *Bank of Italy, Paper Series,* (1), 2003.

[18] Sims, C. A., "Are forecasting models usable for policy analysis?", *Federal Reserve Bank of Minneapolis Quarterly Review, winter*, 3-16, 1986.

[19] Sims, C. A., "Money, income, and causality", *The American Economic Review, 62*(4), 540-552, 1972.

[20] Vazquez, F., Tabak, B. M., & Souto, M., "A macro stress test model of credit risk for the brazilian banking sector", *Journal of Financial Stability, 8*(2), 69-83, 2012.

[21] Wilson, T., "Portfolio credit risk (II): The second part of an article explaining how macroeconomic variables can be used

to assess credit risk", *RISK-LONDON-RISK MAGAZINE LIMITED-, 10*, 56-62, 1997.

[22] Wong, J., Wong, T., & Leung, P., "Predicting banking distress in the EMEAP economies", *Journal of Financial Stability, 6*(3), 169-179, 2010.