CAN MACROECONOMIC FUNDAMENTALS PREDICT THE PERFORMANCE OF COMMERCIAL BANKS?

by

DEVSHREE ANGRISH

(Under the Direction of Christopher Todd Stivers)

ABSTRACT

The objective of this thesis is to evaluate the relative significance of macroeconomic fundamentals in predicting the performance of commercial banks in the United States. The performance of commercial banks is measured by the aggregate Return on Average Assets (ROA) of U.S. commercial banks from 1987-2007. I conduct an empirical investigation to explain the relation between macroeconomic fundamentals and commercial banks' performance, and show how shocks to macroeconomic fundamentals affect forecast of commercial banks' performance. The empirical analysis is performed using U.S. macroeconomic data and financial data from U.S. commercial banks. The results show that except for gross domestic product, all the macroeconomic fundamentals significantly predict the performance of commercial banks and can therefore be used by policy makers to measure the effect of macroeconomic policy shocks on the condition of the commercial banks.

INDEX WORDS: Macroeconomic Fundamentals, Commercial Banks' Performance, ROA, Recursive VAR, Riegle-Neal Interstate Banking and Branching Efficiency Act of 1994.

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DEDICATION

This thesis is dedicated to my parents for all their hard work, commitment and the sacrifices they have made in their own lives to give their three daughters good education and good life.

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I would like to thank my parents for everything. I fall short of words when it comes to thanking my parents. I thank God for having me such wonderful and supporting parents. My wholehearted thanks goes to my committee members Dr. Stivers, Dr. Warren and Dr. Moore for their wonderful guidance and support. I am deeply grateful to all of them for being so kind and helpful. I am deeply humbled by the extent of the support and commitment they gave me towards the successful completion of my thesis. I am so grateful to my elder sisters Parul and Deepshikha for their love, motivation and for being always there for me no matter what (and for having their homes in California and finding me a great place for spending every summer vacation!). I am very thankful to my dearest friends Anna and Sharon for their constant motivation and encouragement and for making my stay both in UGA and in Athens extremely joyful and memorable. I am very thankful to Dr. Leiva, Dr. Sandifer and Dr. Trandel for their tremendous support and several opportunities they gave me to develop and enhance my teaching skills. Working for them as a Graduate Teaching Assistant, was a wonderful experience and I feel very lucky to get to work with such nice and friendly people. I am very thankful to some of the best faculty in UGA I got the opportunity to take classes with and broaden my knowledge horizon and enhance my research skills both in Economics and in Finance. I am very thankful to Dr. Quick and Dr. Domizi from whom I learned and build the foundation on how to effectively teach. I am very thankful and deeply humbled to Dr. Quick for his guidance and support. I am so thankful to Hashai for all his love, care and support and for being the most precious and the significant force in my life.

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CHAPTER 1

INTRODUCTION

The recent financial crisis[1] in the United States and its implications for both the U.S. macro economy and the global economy proves the interdependence between the real and monetary sectors of the economy. The current financial problem in the U.S. originates from persistently poor standards practiced in granting home loans by several U.S. banks in the recent past. Large-scale bad debts and foreclosures, followed by the downturn in the real estate market, resulted in the accumulation of bad assets by several banks and their insurers. The financially struggling firms called for the federal government to intervene with a rescue package and devise an economic stimulus plan to resuscitate ailing financial institutions.

The objective of the federal government to provide the bailout package was not just to prevent potential enormous bank failures across the country but also to prevent the damage from spreading to the manufacturing and service sectors. However, the slowdown in economic activity had already begun before the financial bubble burst in September 2008. This was evident from the reduction in output, massive job cuts, and widespread hiring reductions experienced throughout the country. As a result, financial institutions experienced a high rate of default on loans and debt. Thus, the condition of commercial banks significantly affects the condition of the economy and, in turn, is affected by the condition of the economy. Figures 1and 2 show the time series for the aggregate Return on Average Assets of U.S. commercial banks' (U.S. ROA) growth rate, the U.S. GDP growth rate, inflation, effective federal funds interest rate and a broad

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[1] For a discussion of the recent financial crisis, see Levitt, September 18, 2008, New York Times.

trade weighted exchange index[2], from 1987 to the current period. The shaded areas in each of the figures represent the period during which the U.S. economy went through recession. One can clearly see that, starting at the end of third and the beginning of the fourth quarter in 2007, all of the variables are breaking away from their trends. All the variables considered are showing a distinct pattern of either a steep fall or a steep rise around almost the same time period. An important fact to observe is that this is the time period when the U.S. economy began to experience an acute financial crisis and a severe economic recession. Thus, there exists a relation between the U.S. financial sector's performance (measured here in terms of commercial banks' performance) and how the real U.S. economy is performing (measured in terms of the rate of growth of GDP, inflation, the interest rate, and a broad trade weighted exchange index).

This thesis studies the relation between macroeconomic fundamentals and the financial condition of U.S. commercial banks. This relation is very important from a policy perspective. If macroeconomic fundamentals are found to be highly significant in predicting the condition of commercial banks, then it would help policy makers to know the effect of economic policy shocks on the condition of commercial banks in the current and in the subsequent periods. This research can help policy makers decide what macroeconomic factors to use to improve the condition of the commercial banks. The results of this thesis could be extended to the question of asset valuation in banking sector. Macroeconomic fundamentals might prove to be very crucial in predicting the present discounted value of the returns from investments of commercial banks. The time period for my study is from 1987 Quarter 1 to 2007 Quarter 4[3]. My research centers on

[2] Federal Reserve Bank of St. Louis, Economic Data-FRED defines Trade Weighted Exchange Index: Broad as "A weighted average of the foreign exchange value of the U.S. dollar against the currencies of a broad group of major U.S. trading partners. Broad currency index includes the Euro Area, Canada, Japan, Mexico, China, United Kingdom, Taiwan, Korea, Singapore, Hong Kong, Malaysia, Brazil, Switzerland, Thailand, Philippines, Australia, Indonesia, India, Israel, Saudi Arabia, Russia, Sweden, Argentina, Venezuela, Chile and Colombia".

[3] More discussion on the time period chosen follows in section 3 on data description.

June 1 1997, the day when the Riegle-Neal Interstate Banking and Branching Efficiency Act of 1994[4] became effective and removed barriers for interstate bank branching[5]. Since the commercial banks' earnings and therefore assets are likely to be effected the most during a financial crisis, to measure the condition of the commercial banks, I follow Neely and Wheelock (1997) and use the aggregate Return on Average Assets (ROA) of U.S. commercial banks. ROA is a ratio of banks' net earnings during a calendar year to the average of their total assets during the current and previous year. For studying the significance of macroeconomic fundamentals, I consider four macroeconomic variables namely; Gross Domestic Product (GDP), the inflation, the federal funds interest rate, and a broad trade weighted exchange rate index.

I use a broad trade weighted exchange index because it reflects the value of U.S. dollar against the currencies of its major trading partners. If the value of U.S. dollar appreciates, it is expected to improve the condition of commercial banks' by increasing the return on international investments made by commercial banks' and their industrial borrowers engaged in international trade and investments. I use inflation in my study since literature suggests that an increase in inflation by reducing real returns on investments can adversely affect the condition of financial sector by increasing credit market frictions[6]. Inflation also reduces the value of domestic currency which reduces the purchasing power of personal income and increases the demand for credit. This increase in demand for credit combined with low rate of growth of GDP and massive job cuts increases the risk of high rate of default on personal loans and home loans borrowed from commercial banks, thus adversely affecting the condition of commercial banks. I use GDP

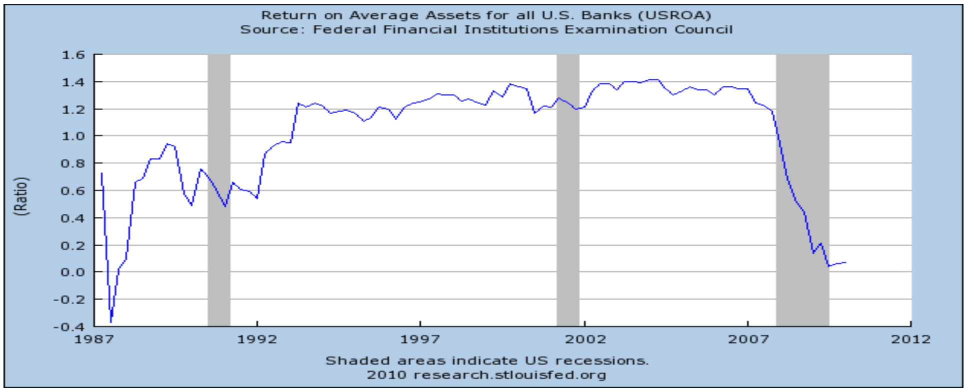
[4] Riegle-Neal Interstate Banking and Branching Efficiency Act of 1994 - Title I: Interstate Banking and Branching - Amends the Bank Holding Company Act of 1956 to authorize the Board of Governors of the Federal Reserve System (the Board) to permit an adequately capitalized and adequately managed bank holding company to acquire existing out-of-State banks, subject to State age law. (Source: The Library of Congress, Thomas).

[5] For more on Riegle-Neal Interstate Banking and Branching Efficiency Act, see Mulloy and Lasker (1995).

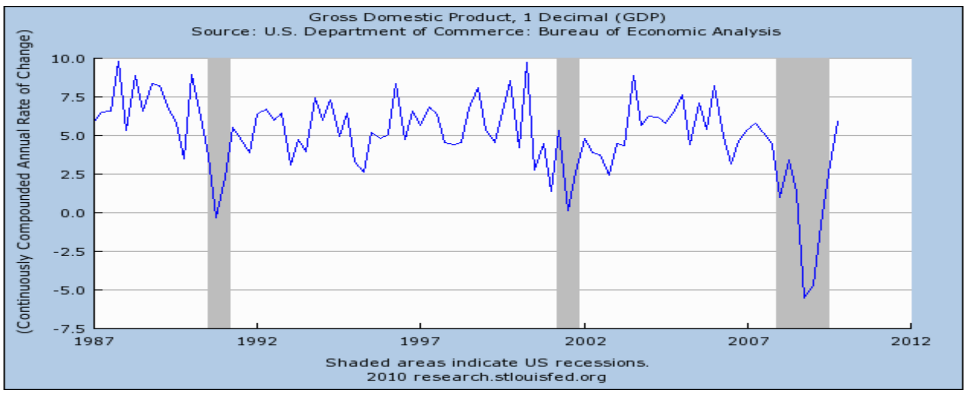
[6] For more see Boyd et al. (2001).

as another macroeconomic fundamental because of its relation with demand for money. An increase in domestic income increases the transactionary demand for money which increases inflation and is expected to adversely affect the commercial banks' performance through increasing credit market frictions and reducing the purchasing power of the personal income and domestic currency (here U.S. Dollar). I take federal funds interest rate because it affects the cost of funds available to banks for lending purposes.

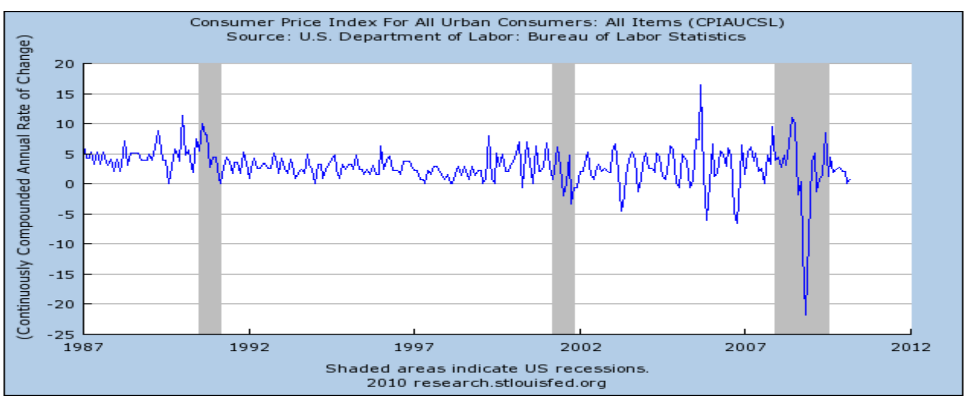
An increase in the federal funds interest rate would increase the cost of funds available to banks and would result in increased credit rationing. This is expected to adversely affect banks' performance by adversely affecting the performance of their industrial borrowers due to increase in the cost of funds available from banks for capital formation. The reduction in the availability of funds from banks reduces capital formation in the industry and contributes to the slowdown in the economic activity and is expected to adversely affect the commercial banks' performance. The thesis is organized as follows: Chapter 2 presents the literature review followed by data description in Chapter 3; Chapter 4 describes the hypothesis and empirical methodology; Chapter 5 presents the estimated model. Chapter 6 discusses the summary statistics, the correlation coefficients and the VAR regression results; Chapter 7 presents the Granger causality (Wald) Test results and their analysis; Chapter 8 presents the forecast error variance decomposition results and their analysis; Chapter 9 presents the impulse response functions and their analysis and Chapter 10 concludes.



Time Series Graph for U.S. ROA Growth Rate



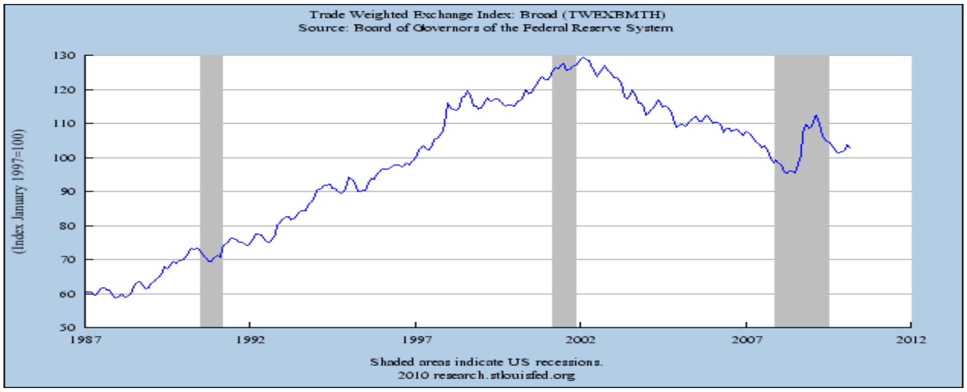
Time Series Graph for U.S. GDP Growth Rate



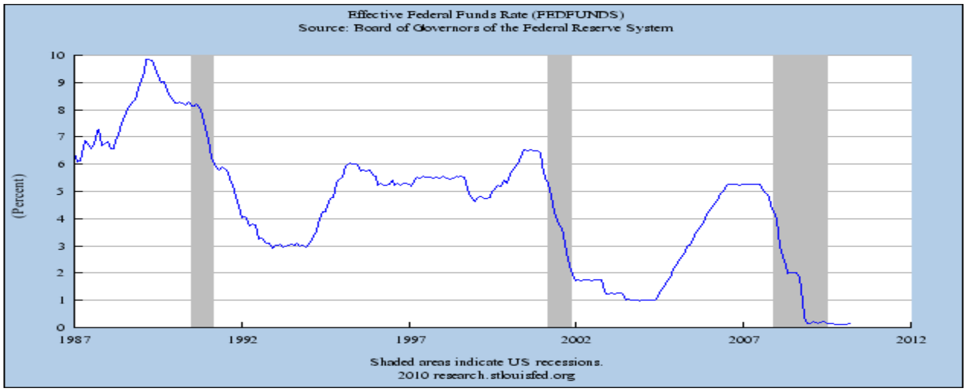
Time Series Graph for Inflation

Figure 1: Time Series Graphs

Source: Economic Data-FRED, Economic Research, Federal Reserve Bank of St. Louis.



Time Series Graph for Trade Weighted Exchange Index



Time Series Graph for Federal Funds Interest Rate

Figure 2: Time Series Graphs (Continued)

Source: Economic Data-FRED, Economic Research, Federal Reserve Bank of St. Louis.

CHAPTER 2

LITERATURE REVIEW

Most of the papers that study the effect of macroeconomic fundamentals focus on their impact on stock returns. Among the macroeconomic fundamentals, the most often studied subject is the impact of inflation on stock returns, especially during a stock market crisis. For instance, Boyd et al (2001) study the impact of inflation on financial sector performance. They empirically test the predictions made in the previous literature (for instance, by Huybens and Smith (1998, 1999) and Choi et al. (1996)) that through the mechanism of credit market frictions, even predictable increases in the rate of inflation can adversely affect the ability of the financial sector to allocate resources efficiently which, in turn can adversely affect both the financial sector's performance and also real economic activity.

Boyd et al. (2001) find a statistically and economically significant relation between inflation and both banking sector development and equity market activity. In particular, they find a discrete drop in financial sector performance for high inflation countries (inflation rate exceeding 15 percent). Chang and Velasco (2001) develop a financial crisis model for emerging markets. Aguiar and Broner (2006) use effective interest rates and the exchange rate as macroeconomic fundamentals, and examine the relation between asset prices and macroeconomic fundamentals during a currency crisis in emerging markets. They find that (1) investors discount large exchange-rate depreciations during a crisis and (2) interest rate sensitivity plays a significant role in determining stock performance during a crisis.

Neely and Wheelock (1997) measure the effect of state per capita income on state bank earnings from 1946-95 and from 1981-95. They estimate a pooled time series cross sectional regression of state level condition of banks on the current and previous year's percentage changes in state per capital income. They find that state per capita income has statistically a strong, positive effect on state bank earnings, although the effect is economically small. They find that the significant differences in banks' performance across states witnessed during 1980's and early 1990's can be attributed to differences in the economic conditions of the states during the same time period.

The authors suggest that their findings with regard to the dependence of state bank earnings on states' economic condition would change if the period of analysis were taken beyond June 1, 1997. They predict that the implementation of the Riegle-Neal Interstate Banking and Branching Efficiency Act of 1994; starting June 1, 1997, would make U.S. banks less dependent on local economic conditions as it allowed the banks to diversify their portfolios across the states. My research can be considered as an extension of Neely and Wheelock's work, as I test their hypothesis about the behavior of U.S. banks around the year 1997. However the difference between my thesis and Neely and Wheelock's paper lies in the time period, the variables considered, and the method applied in studying the relation between the condition of the banks and the macroeconomic fundamentals.

CHAPTER 3

DATA DESCRIPTION

For the empirical analysis I collected data from the Federal Reserve Economic Database (FRED). To measure the financial condition of commercial banks, I follow Neely and Wheelock and use the aggregate Return on Average Assets (ROA) of U.S. commercial banks. The reason I use ROA is because, ROA is the ratio of the net earnings during a calendar year to the average of the total assets during the current and previous year. Thus, when a financial crisis occurs during a calendar year, the first thing that is most likely to be adversely affected is the banks’ net earnings and therefore banks’ average assets during the same calendar year. The net effect on ROA could be that ROA falls or remains unchanged. However as we can see from figure 1 for U.S. ROA growth rate, the ROA fell during the financial crisis, both in 1987 and in 2008.

The ROA data are available on a quarterly basis in the FRED database, and I convert its unit of measurement from a ratio to a percentage growth rate and annualize the same. To study the effects of macroeconomic fundamentals, I use four macroeconomic variables, namely the U.S. GDP, inflation, the federal funds interest rate and broad, trade weighted exchange index. I take quarterly data on Gross Domestic Product (GDP) and annualize the percentage log difference of GDP to arrive at the continuously compounded annual rate of growth of GDP. To estimate inflation, I use monthly data on the Consumer Price Index of All Urban Consumers (All items), take its quarterly average, and annualize the percentage log difference of the consumer price index. The effective Federal Funds Rate is available on a monthly basis and I use it directly, after taking its quarterly average. Similarly the Trade Weighted Exchange Index is available on a monthly basis and I generate its quarterly average and annualize its percentage log difference to arrive at the Trade Weighted Exchange Index Growth Rate, referred to as the exchange rate[7] below. Thus, the entire dataset is made uniform with respect to temporal frequency and unit of measurement before beginning the empirical analysis. In the set of macroeconomic fundamentals, I use the broad trade weighted exchange index because if the currency, here the U.S. dollar, appreciates in value, it increases the returns on U.S. assets and makes U.S. investments more profitable both in the U.S. as well as abroad where U.S. assets are traded. In addition, currency appreciation also increases the inflow of investments into the domestic financial market both from within the country (by avoiding the flight of capital) and abroad, which also has the tendency to affect the interest rate and inflation.

I use inflation as another macroeconomic variable since it captures monetary policy behavior, with 'tight' monetary policy (and a high federal funds interest rate) being reflected in a low or less than double-digits level of inflation. Inflation can affect the financial condition of commercial banks in more than one way. It not only reduces the real return on banks assets' but it also reduces the purchasing power of personal income. With a low rate of growth of GDP and high rates of layoffs, inflation can result in a high default rate on loans from banks. The latter can result in higher rates of foreclosures and the accumulation of bad assets by banks, lending to deterioration in their financial condition. I use U.S. GDP because of its relation with the demand for money. An increase in GDP reflects an increase in the output, income or expenditure of the entire economy. The increased income in the hands of people increases the transaction demand for money, which can result in higher rates of inflation, which as explained above, can affect the condition of the commercial banks. I use the federal funds interest rate since it affects the cost of

[7] The exchange rate referred here in the paper is the growth rate of 'broad' trade weighted exchange index and should not be confused with exchange rate used in general terminology which is the relative price of 'a' country's currency with respect to 'another' country's currency.

funds to the banks. A low interest rate means that banks can lend to consumers, manufacturers, etc. at lower rates that can help increase the investment, production and income in the economy and thereby improve the overall performance of banks. Thus, all five variables included in my study are inter-related. The difference lies in the magnitude of the economic and statistical significance of each of the macroeconomic variables in affecting the condition of the banks and in making forecasts and inferences. I conduct the analysis for three time periods: quarter 1, 1987 to quarter 4, 2007 (model 1); quarter 1, 1987 to Quarter 2, 1997 (model 2) and Quarter 3, 1997 to Quarter 4, 2007 (model 3).

The year 1987 is very important because of several economic and financial developments that took place in that year. In October 1987, there was a global financial crisis that witnessed a large stock market crash around the world. In addition, as Neely and Wheelock highlight, from 1987 to 1989 there were more than 200 bank failures in the U.S., partly attributable to acute bank distress in energy-producing states during that period. I end my analysis in 2007 since that is the last full calendar year before the financial markets crashed in 2008. The year 1997 is important since beginning 1st June 1997; the banks were allowed to have interstate branches. Thus, Model 1 is a combination of two distinct time periods with regard to banks' expected financial conditions. Model 2 represents a period when banks' earnings were highly influenced by states economic condition. Finally, model 3 represents a period when banks earnings were expected to be less dependent on states economic condition due to the opportunity to diversify their loan portfolios and deposit bases across state boundaries.

CHAPTER 4

HYPOTHESIS AND EMPIRICAL METHODOLOGY

Even though the banks are expected to be less dependent on state per capita income ex-post 1997 quarter 2, they cannot be independent of gross domestic income and other macroeconomic factors. This is because, no matter how many interstate branches banks set up, they are still within the national boundary and are therefore be expected to be relatively more (or at least not less) affected by macroeconomic factors in the second period as compared to the first period, when state economic conditions significantly influenced the condition of state commercial banks. Thus, on the basis of the relations among all the variables explained in section 3, I expect all macroeconomic fundamentals to predict the financial conditions of commercial banks in the post-1994 implementation period.

Among all the macroeconomic factors, I expect the trade weighted exchange index to be the most important factor in predicting the performance of commercial banks. This is because all U.S. commercial bank behavior is expected to be highly influenced by large commercial banks with average assets in billions of dollars. These large commercial banks are expected to make investments in assets both within the U.S. and abroad. The relative value of the U.S. dollar with regard to its major trading partners directly affects the return on average assets of large commercial banks which make foreign investments. Thus, I expect the trade weighted exchange index to affect the financial condition of U.S. commercial banks by affecting the earnings of large U.S. multinational banks. Though, the correlation coefficient between U.S. ROA growth rate and exchange rate is almost negligible (=-0.0745), it will be interesting to look at the VAR results and see whether even with low correlation, can exchange rate help predict the commercial banks' performance. While the objective of my paper is to study the role of macroeconomic fundamentals in predicting the performance of commercial banks, it is evident that the performance of commercial banks also affects the behavior of macroeconomic fundamentals. Therefore, the most credible way to capture the dynamics involved in my multivariable study is to use a Vector Autoregression (VAR) model where each variable is explained both by its own lagged values as well as the lagged values of all other variables being considered. Since the variables under consideration are expected to be correlated with each other, I apply Recursive VAR[8]. To estimate a recursive VAR, I follow Stock and Watson (2001) and first estimate the reduced form VAR and report the results from the Granger causality Wald test. I then perform a Factor Error Variance Decomposition of the estimated model. Finally, I present and discuss the Impulse Response Functions of the macroeconomic shocks on commercial banks performance.

[8] For more on VAR, see Stock and Watson (2001).

CHAPTER 5

ESTIMATED MODEL

The estimated reduced form VAR *(p)* equation in general notation is:

$$Y_t \quad = \quad A_0 + A_1 Y_{t-1} + A_2 Y_{t-2} + A_3 Y_{t-3} + ...+ A_p Y_{t-p} + \varepsilon_t \qquad (5.1)$$

Where, Y_t is $n \times 1$ vector consisting of all the *'n'* variables being considered, A_0 is $n \times 1$ vector of intercept terms, p is the lag length, A_p is $n \times n$ matrix of coefficients, ϵ_t is a $n \times 1$ vector of white noise error terms. The expanded matrix notation for the reduced form VAR with n variables and p lags is given by:

$$\begin{bmatrix} y_{1,t} \\ y_{2,t} \\ y_{3,t} \\ \vdots \\ y_{n,t} \end{bmatrix} = \begin{bmatrix} A_{10} \\ A_{20} \\ A_{30} \\ \vdots \\ A_{n0} \end{bmatrix} + \begin{pmatrix} {}_1a_{11} & {}_1a_{12} & \cdots & {}_1a_{1n} \\ {}_1a_{21} & {}_1a_{22} & \cdots & {}_1a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ {}_1a_{n1} & {}_1a_{n2} & \cdots & {}_1a_{nn} \end{pmatrix} \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \\ y_{3,t-1} \\ \vdots \\ y_{n,t-1} \end{bmatrix} + \begin{pmatrix} {}_2a_{11} & {}_2a_{12} & \cdots & {}_2a_{1n} \\ {}_2a_{21} & {}_2a_{22} & \cdots & {}_2a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ {}_2a_{n1} & {}_2a_{n2} & \cdots & {}_2a_{nn} \end{pmatrix} \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \\ y_{3,t-1} \\ \vdots \\ y_{n,t-1} \end{bmatrix}$$

$$+ \begin{pmatrix} {}_3a_{11} & {}_3a_{12} & \cdots & {}_3a_{1n} \\ {}_3a_{21} & {}_3a_{22} & \cdots & {}_3a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ {}_3a_{n1} & {}_3a_{n2} & \cdots & {}_3a_{nn} \end{pmatrix} \begin{bmatrix} y_{1,t-3} \\ y_{2,t-3} \\ y_{3,t-3} \\ \vdots \\ y_{n,t-3} \end{bmatrix} + ... + \begin{pmatrix} {}_pa_{11} & {}_pa_{12} & \cdots & {}_pa_{1n} \\ {}_pa_{21} & {}_pa_{22} & \cdots & {}_pa_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ {}_pa_{n1} & {}_pa_{n2} & \cdots & {}_pa_{nn} \end{pmatrix} \begin{bmatrix} y_{1,t-p} \\ y_{2,t-p} \\ y_{3,t-p} \\ \vdots \\ y_{n,t-p} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \\ \varepsilon_{3,t} \\ \vdots \\ \varepsilon_{n,t} \end{bmatrix} \qquad (5.2)$$

Since I am using a quarterly data, I use four lags to obtain white noise error terms. With $n = 5$ and $p = 4$, each of the n equations will have $n*p = 20$ coefficients and a constant term. The reduced form VAR taking all the variables considered can therefore be written in matrix form as:

$$\begin{bmatrix} USROAGrowthRate_t \\ ExchangeRate_t \\ Inflation_t \\ USGDPGrowthRate_t \\ InterestRate_t \end{bmatrix} = \begin{bmatrix} A_{10} \\ A_{20} \\ A_{30} \\ A_{40} \\ A_{50} \end{bmatrix} + \begin{pmatrix} {}_1a_{11} & {}_1a_{12} & {}_1a_{13} & {}_1a_{14} & {}_1a_{15} \\ {}_1a_{21} & {}_1a_{22} & {}_1a_{23} & {}_1a_{24} & {}_1a_{25} \\ {}_1a_{31} & {}_1a_{32} & {}_1a_{33} & {}_1a_{34} & {}_1a_{35} \\ {}_1a_{41} & {}_1a_{42} & {}_1a_{43} & {}_1a_{44} & {}_1a_{45} \\ {}_1a_{51} & {}_1a_{52} & {}_1a_{53} & {}_1a_{54} & {}_1a_{55} \end{pmatrix} \begin{bmatrix} USROAGrowthRate_{t-1} \\ ExchangeRate_{t-1} \\ Inflation_{t-1} \\ USGDPGrowthRate_{t-1} \\ InterestRate_{t-1} \end{bmatrix}$$

$$+ \begin{pmatrix} {}_2a_{11} & {}_2a_{12} & {}_2a_{13} & {}_2a_{14} & {}_2a_{15} \\ {}_2a_{21} & {}_2a_{22} & {}_2a_{23} & {}_2a_{24} & {}_2a_{25} \\ {}_2a_{31} & {}_2a_{32} & {}_2a_{33} & {}_2a_{34} & {}_2a_{35} \\ {}_2a_{41} & {}_2a_{42} & {}_2a_{43} & {}_2a_{44} & {}_2a_{45} \\ {}_2a_{51} & {}_2a_{52} & {}_2a_{53} & {}_2a_{54} & {}_2a_{55} \end{pmatrix} \begin{bmatrix} USROAGrowthRate_{t-2} \\ ExchangeRate_{t-2} \\ Inflation_{t-2} \\ USGDPGrowthRate_{t-2} \\ InterestRate_{t-2} \end{bmatrix}$$

$$+ \begin{pmatrix} {}_3a_{11} & {}_3a_{12} & {}_3a_{13} & {}_3a_{14} & {}_3a_{15} \\ {}_3a_{21} & {}_3a_{22} & {}_3a_{23} & {}_3a_{24} & {}_3a_{25} \\ {}_3a_{31} & {}_3a_{32} & {}_3a_{33} & {}_3a_{34} & {}_3a_{35} \\ {}_3a_{41} & {}_3a_{42} & {}_3a_{43} & {}_3a_{44} & {}_3a_{45} \\ {}_3a_{51} & {}_3a_{52} & {}_3a_{53} & {}_3a_{54} & {}_3a_{55} \end{pmatrix} \begin{bmatrix} USROAGrowthRate_{t-3} \\ ExchangeRate_{t-3} \\ Inflation_{t-3} \\ USGDPGrowthRate_{t-3} \\ InterestRate_{t-3} \end{bmatrix}$$

$$+ \begin{pmatrix} {}_4a_{11} & {}_4a_{12} & {}_4a_{13} & {}_4a_{14} & {}_4a_{15} \\ {}_4a_{21} & {}_4a_{22} & {}_4a_{23} & {}_4a_{24} & {}_4a_{25} \\ {}_4a_{31} & {}_4a_{32} & {}_4a_{33} & {}_4a_{34} & {}_4a_{35} \\ {}_4a_{41} & {}_4a_{42} & {}_4a_{43} & {}_4a_{44} & {}_4a_{45} \\ {}_4a_{51} & {}_4a_{52} & {}_4a_{53} & {}_4a_{54} & {}_4a_{55} \end{pmatrix} \begin{bmatrix} USROAGrowthRate_{t-4} \\ ExchangeRate_{t-4} \\ Inflation_{t-4} \\ USGDPGrowthRate_{t-4} \\ InterestRate_{t-4} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \\ \varepsilon_{3,t} \\ \varepsilon_{4,t} \\ \varepsilon_{5,t} \end{bmatrix} \qquad (5.3)$$

Here the subscript shown before the coefficient refers to the respective lag. For example [${}_1a_{11}$] is the coefficient a_{11} for lag 1, [${}_4a_{14}$] is the coefficient a_{14} for lag 4 and so on. With 5 variables and 4 lags, there will be 5 equations and each of the equations will have 20 coefficients and an intercept term. The resulting equation for the U.S. ROA Growth Rate at time period t as a dependent variable and the lagged values (lags = 1, 2, 3, 4) of the U.S. ROA Growth Rate, Exchange Rate, Inflation, GDP Growth Rate, and Interest Rate as the independent variables can be written as:

$$
\begin{aligned}
&USROAGrowthRate_t = \\
&A_{10} + {}_1a_{11}USROAGrowthRate_{t-1} + {}_1a_{12}ExchangeRate_{t-1} + {}_1a_{13}Inflation_{t-1} + \\
&{}_1a_{14}USGDPGrowthRate_{t-1} + {}_1a_{15}InterestRate_{t-1} + \\
&{}_2a_{11}USROAGrowthRate_{t-2} + {}_2a_{12}ExchangeRate_{t-2} + {}_2a_{13}Inflation_{t-2} + \\
&{}_2a_{14}USGDPGrowthRate_{t-2} + {}_2a_{15}InterestRate_{t-2} + \\
&{}_3a_{11}USROAGrowthRate_{t-3} + {}_3a_{12}ExchangeRate_{t-3} + {}_3a_{13}Inflation_{t-3} + \\
&{}_3a_{14}USGDPGrowthRate_{t-3} + {}_3a_{15}InterestRate_{t-3} + \\
&{}_4a_{11}USROAGrowthRate_{t-4} + {}_4a_{12}ExchangeRate_{t-4} + {}_4a_{13}Inflation_{t-4} + \\
&{}_4a_{14}USGDPGrowthRate_{t-4} + {}_4a_{15}InterestRate_{t-4} + \varepsilon_{1,t}
\end{aligned}
\tag{5.4}
$$

CHAPTER 6

SUMMARY STATISTICS, CORRELATION COEFFIECIENTS AND VAR

The first step in using VAR analysis is to report the Granger Causality Wald Test results, followed by the Factor Error Variance Decomposition and the Impulse Response Functions. The objective of these tests is to analyze the relation among the variables. Table 1 presents the summary statistics for all the variables for the period 1987 Quarter 1 to 2007 Quarter 4.

To better understand the true range of values of all the variables considered for the empirical analysis, I present both the raw data and the transformed data in the summary statistics. The most important aspect to analyze in Table 1 is the time period when each of the variables reaches its respective maximum and minimum values. If there is some proximity in the time period when all the variables behave in a distinct pattern, then a strong relation can be expected to exist between them. In the case of U.S. ROA, we observe that it attains its minimum value (-0.37) in 1987 quarter2 and reaches it maximum value (1.41) in 2004 quarter 1.

The trade weighted exchange index attains its minimum value (59.391) in 1988 quarter 1 and its maximum value (129.036) in 2002 quarter 1. Surprisingly, the trade weighted exchange index growth rate attains its minimum value (-14.823%) in 2004 quarter 2 and its maximum value (21.579%) in 1988 quarter 1 which is in distinct contrast to the behavior of U.S. ROA during the same period. The federal funds interest rate reaches its maximum value (9.727%) in 1989 quarter 2 and its minimum value (0.997%) in 2003 quarter 4. The inflation attains its minimum value (-1.512 %) in 2006 quarter 4 and its maximum value (6.850%) in 1990 Quarter 3. The U.S. GDP rate attains its minimum value (-0.010%) in 1990 quarter 4 and its maximum value (2.455%) in 1987 quarter 4. Thus, in the years from 1987 to 1990 there is a clustering of either the peaks or the troughs with regard to all the variables considered. Table 2 presents the correlation coefficient among all the variables. We can see that correlation coefficient between federal funds interest rate and exchange rate (0.2761) and inflation (0.4384) are significant along with the correlation coefficient between U.S. GDP growth rate and U.S. ROA growth rate (0.2339) is significant. Thus, there is no issue of multicollinearity in my study. In order to understand the underlying co-movements among all the variables, I present the VAR analysis in the following chapters. Research suggests that VAR regression coefficients are less informative and usually go unreported.[9] I present in Tables 3, 4 and 5 the VAR regression coefficients only for equation (iv) in the text, with the U.S. ROA Growth Rate at time period t as the dependent variable which is regressed on its own lagged values and the lagged values of the exchange rate, the inflation, U.S. GDP growth rate, and the federal funds interest rate.

[9] Stock and Watson (2001).

Table 1: Summary Statistics

The table presents the summary statistics for the period 1987 Quarter 1 to 2001 Quarter 4. Some observations are lost when the data is transformed for the empirical analysis. Since the minimum value of U.S. ROA in levels is negative, log differencing generates 3 missing values. The federal funds interest rate is used directly as available in the FRED database. For all the remaining variables, I lose one observation each when generating their log differences. One way to avoid losing observations from negative data in U.S. ROA would be to annualize the date in the following manner: $\{\ln(1+ROA)_t - \ln(1+ROA)_{t-1}\}*100*4$.

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
U.S. ROA (in ratio)	84	1.088	0.346	-0.370	1.41
U.S. ROA Growth Rate (in %)	81	19.013	119.199	-184.538	754.828
Trade Weighted Exchange Index	84	97.118	21.435	59.391	129.036
Exchange Rate (in %)	83	2.371	9.134	-14.832	21.58
Inflation (in %)	83	3.051	1.47	-1.512	6.850
U.S. GDP (in $ U.S. Billion)	84	8628.435	2695.279	4613.8	14031.2
U.S. GDP Growth Rate (in %)	83	5.360	1.976	-0.041	9.820
Interest Rate (in %)	84	4.874	2.134	0.997	9.727

Table 2: Correlation Coefficients

The table presents the correlation coefficients between all the variables considered in the analysis.

Dependent Variable	U.S. ROA Growth Rate	Exchange Rate	Inflation	U.S.GDP Growth Rate	Interest Rate
U.S. ROA Growth Rate	1				
Exchange Rate	-0.0745	1			
Inflation	0.0250	-0.0382	1		
U.S. GDP Growth Rate	0.2339	0.1001	0.1374	1	
Interest Rate	0.0925	0.2761	0.4383	0.0893	1

Table 3: VAR results for U.S. ROA Growth Rate as the dependent variable in Model 1

The results presented are obtained from estimating the reduced form VAR with four lags and a constant term in model 1 (1987 Quarter 1 to 2007 Quarter 4). The table presents the results only for equation (iv) in the text, with U.S. ROA Growth Rate$_t$ as a dependent variable regressed on its own and the lagged values of exchange rate, inflation, U.S. GDP growth rate, Interest Rate.

U.S. ROA Growth Rate$_t$	Coefficients	Standard Errors	z	P>|z|	[95% Confidence Interval]	
U.S. ROA Growth Rate						
Lag 1	-0.1929241 $(= {}_1a_{11})$	0.0967382	-1.99	0.046	-0.3825275	-0.0033207
Lag 2	-0.241449 $(= {}_2a_{11})$	0.0961737	-2.51	0.012	-0.4299462	-0.0529521
Lag 3	-0.146320 $(= {}_3a_{11})$	0.0541227	-2.7	0.007	-0.2523989	-0.0402417
Lag 4	0.2280669 $(= {}_4a_{11})$	0.0402838	5.66	0	0.1491121	0.3070217
Exchange Rate						
Lag 1	-0.4144635 $(= {}_1a_{12})$	0.5486376	-0.76	0.45	-1.489773	0.6608464
Lag 2	-0.3763874 $(= {}_2a_{12})$	0.5243591	-0.72	0.473	-1.404112	0.6513376
Lag3	1.3754 $(= {}_3a_{12})$	0.4997003	2.75	0.006	0.3960052	2.354794
Lag 4	0.1849118 $(= {}_4a_{12})$	0.5170358	0.36	0.721	-0.8284597	1.198283
Inflation						
Lag 1	-1.287151 $(= {}_1a_{13})$	3.501402	-0.37	0.713	-8.149773	5.57547
Lag 2	-3.098181 $(= {}_2a_{13})$	3.211144	-0.96	0.335	-9.391907	3.195544
Lag 3	-0.5846223 $(= {}_3a_{13})$	3.129769	-0.19	0.852	-6.718856	5.549612
Lag 4	3.363016 $(= {}_4a_{13})$	3.378105	1.00	0.319	-3.257949	9.983981
U.S. GDP Growth Rate						
Lag 1	-2.287923 $(= {}_1a_{14})$	2.462324	-0.93	0.353	-7.11399	2.538143
Lag 2	-0.850984 $(= {}_2a_{14})$	2.751441	-0.31	0.757	-6.243709	4.541742
Lag 3	0.9150073 $(= {}_3a_{14})$	2.732173	0.33	0.738	-4.439953	6.269968
Lag 4	5.663468 $(= {}_4a_{14})$	2.733765	2.07	0.038	0.3053864	11.02155
Interest Rate						
Lag 1	4.41414 $(= {}_1a_{15})$	15.43659	0.29	0.775	-25.84102	34.6693
Lag 2	-46.72301 $(= {}_2a_{15})$	27.97155	-1.67	0.095	-101.5462	8.100227
Lag 3	29.88066 $(= {}_3a_{15})$	28.73069	1.04	0.298	-26.43046	86.19177
Lag 4	6.697423 $(= {}_4a_{15})$	15.06065	0.44	0.657	-22.82092	36.21576
Constant	9.235443 $(= A_{10})$	25.53505	0.36	0.718	-40.81233	59.28321

Table 4: VAR results for U.S. ROA Growth Rate as the dependent variable in Model 2

The results presented are obtained from estimating the reduced form VAR with four lags and a constant term in model 2 (1987 Quarter 1 to 1997 Quarter 2). The table presents the results only for equation (iv) in the text, with U.S. ROA Growth Rate$_t$ as a dependent variable regressed on its own and the lagged values of exchange rate, inflation, U.S. GDP growth rate, Interest Rate.

U.S. ROA Growth Rate$_t$	Coefficients	Standard Errors	z	P>|z|	[95% Confidence Interval]	
U.S. ROA Growth Rate						
Lag 1	-0.1710667 $(= {}_1a_{11})$	0.0996141	-1.72	0.086	-0.3663067	0.0241733
Lag 2	-0.3124611 $(= {}_2a_{11})$	0.0974959	-3.2	0.001	-0.5035496	-0.1213725
Lag 3	-0.2368018 $(= {}_3a_{11})$	0.0480956	-4.92	0	-0.3310674	-0.1425362
Lag 4	0.311404 $(= {}_4a_{11})$	0.0328777	9.47	0	0.2469649	0.375843
Exchange Rate						
Lag 1	-1.088248 $(= {}_1a_{12})$	0.8052565	-1.35	0.177	-2.666521	0.4900262
Lag 2	-2.112346 $(= {}_2a_{12})$	0.6773666	-3.12	0.002	-3.43996	-0.7847316
Lag 3	1.42867 $(= {}_3a_{12})$	0.6465387	2.21	0.027	0.1614775	2.695862
Lag 4	-1.08874 $(= {}_4a_{12})$	0.6254966	-1.74	0.082	-2.31469	0.1372112
Inflation						
Lag 1	-7.684732 $(= {}_1a_{13})$	6.880065	-1.12	0.264	-21.16941	5.799948
Lag 2	-13.39962 $(= {}_2a_{13})$	5.097733	-2.63	0.009	-23.39099	-3.408243
Lag 3	-10.51277 $(= {}_3a_{13})$	5.415681	-1.94	0.052	-21.12731	0.1017683
Lag 4	-9.893036 $(= {}_4a_{13})$	5.988093	-1.65	0.099	-21.62948	1.84341
U.S. GDP Growth Rate						
Lag 1	-12.8526 $(= {}_1a_{14})$	4.267701	-3.01	0.003	-21.21714	-4.488056
Lag 2	5.707782 $(= {}_2a_{14})$	4.722192	1.21	0.227	-3.547545	14.96311
Lag 3	1.250989 $(= {}_3a_{14})$	5.161892	0.24	0.809	-8.866134	11.36811
Lag 4	5.789656 $(= {}_4a_{14})$	4.324701	1.34	0.181	-2.686602	14.26591
Interest Rate						
Lag 1	20.30882 $(= {}_1a_{15})$	21.36471	0.95	0.342	-21.56525	62.18288
Lag 2	-110.947 $(= {}_2a_{15})$	37.47313	-2.96	0.003	-184.393	-37.50102
Lag 3	80.29263 $(= {}_3a_{15})$	41.81792	1.92	0.055	-1.66899	162.2543
Lag 4	16.55204 $(= {}_4a_{15})$	24.7479	0.67	0.504	-31.95296	65.05703
Constant	123.984 $(= A_{10})$	31.43627	3.94	0	62.37003	185.5979

Table 5: VAR results for U.S. ROA Growth Rate as the dependent variable in Model 3

The results presented are obtained from estimating the reduced form VAR with four lags and a constant term in model 3 (1997 Quarter 3 to 2007 Quarter 4). The table presents the results only for equation (iv) in the text, with U.S. ROA Growth Rate$_t$ as a dependent variable regressed on its own and the lagged values of exchange rate, inflation, U.S. GDP growth rate, Interest Rate.

U.S. ROA Growth Rate$_t$	Coefficients	Standard Errors	z	P>|z|	[95% Confidence Interval]	
U.S. ROA Growth Rate						
Lag 1	0.0540011 $(= {}_1a_{11})$	0.1730699	0.31	0.755	-0.2852096	0.3932118
Lag 2	-0.0206765 $(= {}_2a_{11})$	0.1619983	-0.13	0.898	-0.3381874	0.2968343
Lag 3	-0.1308066 $(= {}_3a_{11})$	0.1539305	-0.85	0.395	-0.4325049	0.1708918
Lag 4	0.292932 $(= {}_4a_{11})$	0.191107	1.53	0.125	-0.0816309	0.6674948
Exchange Rate						
Lag 1	-0.0851268 $(= {}_1a_{12})$	0.4095053	-0.21	0.835	-0.8877425	0.7174888
Lag 2	0.921088 $(= {}_2a_{12})$	0.3588858	2.57	0.01	0.2176847	1.624491
Lag 3	-0.0949936 $(= {}_3a_{12})$	0.3751643	-0.25	0.8	-0.8303022	0.6403149
Lag 4	1.134277 $(= {}_4a_{12})$	0.4064082	2.79	0.005	0.3377311	1.930822
Inflation						
Lag 1	0.5508949 $(= {}_1a_{13})$	2.091261	0.26	0.792	-3.547902	4.649692
Lag 2	-1.354287 $(= {}_2a_{13})$	1.868783	-0.72	0.469	-5.017034	2.30846
Lag 3	0.6573533 $(= {}_3a_{13})$	1.868705	0.35	0.725	-3.005242	4.319949
Lag 4	5.751957 $(= {}_4a_{13})$	1.865904	3.08	0.002	2.094852	9.409061
U.S. GDP Growth Rate						
Lag 1	-0.1176582 $(= {}_1a_{14})$	1.443844	-0.08	0.935	-2.947541	2.712225
Lag 2	-2.692516 $(= {}_2a_{14})$	1.569672	-1.72	0.086	-5.769017	0.3839837
Lag 3	2.243437 $(= {}_3a_{14})$	1.697636	1.32	0.186	-1.083869	5.570743
Lag 4	1.722732 $(= {}_4a_{14})$	1.821393	0.95	0.344	-1.847132	5.292596
Interest Rate						
Lag 1	-1.586172 $(= {}_1a_{15})$	9.901063	-0.16	0.873	-20.9919	17.81955
Lag 2	6.236912 $(= {}_2a_{15})$	18.49628	0.34	0.736	-30.01513	42.48895
Lag 3	-25.19195 $(= {}_3a_{15})$	18.60316	-1.35	0.176	-61.65347	11.26957
Lag 4	15.04485 $(= {}_4a_{15})$	9.822066	1.53	0.126	-4.206042	34.29575
Constant	-3.30086 $(= A_{10})$	21.07871	-0.16	0.876	-44.61436	38.01264

CHAPTER 7

GRANGER CAUSALITY (WALD) TEST

The Granger causality (Wald) test shows whether the coefficient measuring the relation between the lagged value of the regressor and the dependent variable is zero. Tables 6-8, present the Granger causality test results for all three models. The results show the p-values associated with the F-statistics for the Wald test for the null hypothesis that the lagged values of each of the endogenous variables does not Granger cause the dependent variable (does not enter the reduced form equation for the dependent variable).

We start the analysis with the exchange rate (or the rate of growth of a broad trade weighted exchange index). Since the broad trade weighted exchange index measures the value of the U.S. currency relative to all its trading partners, it is expected to be the most exogenous among all the macroeconomic factors considered and is therefore ordered first among all macroeconomic factors. We notice that even though the U.S. ROA growth rate does not help predict the exchange rate in any of the three models (p-values = 0.343, 0.515, 0.128), the exchange rate helps to predict the U.S. ROA growth rate both in model 2 (p-value = 0.000) and in model 3 (p-value = 0.003).

Thus, we can infer that if the value of the U.S. currency changes (either appreciates or depreciates), it affects the condition of commercial banks by affecting the rate of growth of the return on average assets in both the periods before and after the 1994 Act implementation on June 1, 1997. The relation between inflation and the U.S. ROA growth rate shows that, while inflation helps predict the U.S. ROA growth rate in model 2 (p value = 0.005) and in model 3 (p value = 0.014), the U.S. ROA growth rate, helps predict the inflation only in model 3 (p-value = 0.014). Thus, with regard to inflation, we can infer that inflation has been an important factor in predicting the condition of commercial banks both before the 1994 act implementation in 1997 and after. As explained before, the reason for the importance of inflation in predicting the condition of commercial banks lies in the role of inflation as an indirect tax that reduces the purchasing power of personal income.

In addition, as the literature suggests, rising inflation reduces the real returns on assets and creates credit market frictions. This, amidst a low rate of growth of income, job cuts, and a recruitment freeze among results in a huge default rate on the part of both banks' commercial and non commercial borrowers. The relation between the U.S. ROA growth rate and the U.S. GDP growth rate shows that while in model 2 (period 1987 quarter 1 to 1997 quarter 2) both the U.S. ROA growth rate (p-value = 0.000) and the U.S. GDP growth rate (p-value = 0.000) help predict each other, in model 3 (period 1997 quarter 3, to 2007 quarter 4) neither the U.S. ROA growth rate (p-value=0.287) nor U.S. GDP growth rate (p = 0.406) help predict each other. Thus, after the inter-state banking and branching efficiency act of 1994 became effective, the condition of commercial banks became less predictable from U.S. domestic income.

Similarly, even U.S. domestic income became less predictable from the condition of the commercial banks in the post 1997 period. The federal funds interest rate helps predict the U.S. ROA growth rate both in model 2 (p-value = 0.000) and in model 3 (p-value = 0.006) and itself is predicted by the latter both in model 2 (p-values = 0.026) and in model 3 (p-value = 0.042). This result is reasonable since as explained before, the federal funds interest rate affects the cost of borrowing for banks and that affects the net returns on average assets of all banks concerned. Thus the results in model 3 show that all the variables except the U.S. GDP growth rate help predict the U.S. ROA growth rate. Hence, the null hypothesis that U.S. macroeconomic fundamentals (except U.S. GDP) does not Granger cause the condition of the commercial banks is unambiguously rejected. The results remain same even if I change the order of the variables.

Table 6: Granger Causality (Wald) Test for Model 1

The results presented are the p-values associated with the F-statistics for the Wald test for null hypothesis that the lagged values of each of the endogenous variables does not Granger cause the dependent variable (does not enter reduced form equation for the dependent variable) in Model 1 (1987 Quarter 1 to 2007 Quarter 4). The results are read column-wise.

Dependent Variable	U.S. ROA Growth Rate	Exchange Rate	Inflation	U.S. GDP Growth Rate	Interest Rate
U.S. ROA Growth Rate	0	0.343	0.755	0.016	0.079
Exchange Rate	0.048	0	0.467	0.494	0.423
Inflation	0.742	0.498	0	0.669	0.610
U.S. GDP Growth Rate	0.193	0.230	0.149	0	0.000
Interest Rate	0.002	0.095	0.071	0.988	0
R^2	0.4902	0.3681	0.4390	0.2851	0.9863

Table 7: Granger Causality (Wald) Test for Model 2

The results presented are the p-values associated with the F-statistics for the Wald test for null hypothesis that the lagged values of each of the endogenous variables do not Granger cause the dependent variable (does not enter the reduced form equation for the dependent variable) in Model 2 (1987 Quarter 1 to 1997 Quarter 2). The results are read column-wise.

Dependent Variable	U.S. ROA Growth Rate	Exchange Rate	Inflation	U.S. GDP Growth Rate	Interest Rate
U.S. ROA Growth Rate	0	0.515	0.232	0.000	0.026
Exchange Rate	0.000	0	0.025	0.102	0.003
Inflation	0.005	0.004	0	0.004	0.000
U.S. GDP Growth Rate	0.000	0.006	0.279	0	0.000
Interest Rate	0.000	0.004	0.008	0.001	0
R^2	0.8728	0.6550	0.8271	0.6721	0.9927

Table 8: Granger Causality (Wald) Test for Model 3

The results presented are the p-values associated with the F-statistics for the Wald test for null hypothesis that the lagged values of each of the endogenous variables do not Granger cause the dependent variable (does not enter reduced form equation for the dependent variable) in Model 3 (1997 Quarter 3 to 2007 Quarter 4). The results are read column-wise.

Dependent Variable	U.S. ROA Growth Rate	Exchange Rate	Inflation	U.S. GDP Growth Rate	Interest Rate
U.S. ROA Growth Rate	0	0.128	0.031	0.406	0.042
Exchange Rate	0.003	0	0.011	0.455	0.323
Inflation	0.014	0.811	0	0.292	0.288
U.S. GDP Growth Rate	0.287	0.007	0.071	0	0.004
Interest Rate	0.006	0.063	0.136	0.406	0
R^2	0.5320	0.5435	0.5377	0.3858	0.9869

CHAPTER 8

FORECAST ERROR VARIANCE DECOMPOSITION

A Forecast Error Variance Decomposition (FEVD) shows how a specific error shock in a variable affects the percentage of the variance of the error in forecasting the U.S. ROA Growth Rate using the Cholesky decomposition. Tables 9-11 present the results from FEVD analysis. I limit the reporting of FEVD results to 8 quarters or 2 years though the complete set of results consists of all 24 quarters, the time over which the impulse response tends to fade away, as depicted in the IRF graphs[10]. As we would expect, the own lagged values of U.S. ROA growth rate capture most of percentage of the variance of the error made in forecasting U.S. ROA growth rate. However, it is interesting to examine which factors other than own lagged values of U.S. ROA growth rate are significant in forecast error variance decomposition among the set of macroeconomic fundamentals considered in the analysis.

The results clearly show that, as the forecast horizon increases, there is a persistent increase in the percentage of the variance of the error made in the forecast of the condition of commercial banks due to the exchange rate in all three models (from 6.54% to 8.8% in model 1, from 18.4% to 29.9% in model 2 and from 8.8% to 15.37% in model 3). Also, the exchange rate accounts for a fairly high percentage of the forecast error variance in all three models relative to all other macroeconomic variables. The federal fund interest rate accounts for almost 9% and 16% in the forecast error of U.S. ROA growth rate in model 2 and model 3 respectively. If we combine the forecast error of the exchange rate and federal fund interest rate (in quarter 8), either in model 2 (~39%) or in model 3 (~32), they together account for more than 30% of the error

[10] For those interested in examining the complete set of results reported for all 24 quarters, please contact the author.

made in the forecast of U.S. ROA growth rate in both the models. Another interesting phenomenon is that while the U.S. GDP growth rate accounted for almost 18% (in quarter 8) of the variance of the error in the forecast of the U.S. ROA growth rate in model 2, this value falls to almost 5% (in quarter 8) in model 3. The percentage of the variance of the error in the forecast of U.S. ROA growth rate attributable to inflation increases as we move from model 2 (2.15% in quarter 4 and 5.1% in quarter 8) to model 3 (1.34% in quarter 4 and 7.8% in quarter 8), though the change is not as numerically significant as the fall in the forecast error attributable to U.S. GDP growth rate. Thus the behavior of all the macroeconomic variables follows symmetrically with the Granger Causality test results discussed above, and the condition of U.S. commercial banks can be predicted by all macroeconomic variables except the U.S. gross domestic product in model 3.

Table 9: FEVD (%) for U.S. ROA Growth Rate for Model 1

The table presents the Forecast Error Variance Decomposition in the percentage of the variance of the error made in forecasting U.S. ROA Growth Rate in Model 1 (1987 Quarter 1 to 2007 Quarter 4) with Forecast Standard Errors in parenthesis.. It is calculated using the Cholesky decomposition. The results show how a specific error shock in a variable affects the percentage of the variance of the error made in forecasting U.S. ROA Growth Rate. Results are reported here only for 8 forecast horizons (8 steps) or 2 years though the complete set of results consists of all 24 quarters, the time over which the impulse response tends to fade away, as depicted in IRF graphs.

Forecast Horizon	U.S. ROA Growth Rate	Exchange Rate	Inflation	U.S. GDP Growth Rate	Interest Rate
1	100 (3.1e-17)	0 (0)	0 (0)	0 (0)	0 (0)
4	82.5446 (.067201)	6.5395 (.050323)	0.8802 (.01757)	2.0462 (.023427)	7.9895 (.049708)
8	76.4664 (.081295)	8.7968 (.061095)	2.7715 (.034448)	4.3142 (.035101)	7.6511 (.046661)

Table 10: FEVD (%) for U.S. ROA Growth Rate for Model 2

The table presents the Forecast Error Variance Decomposition in the percentage of the variance of the error made in forecasting U.S. ROA Growth Rate in Model 2 (1987 Quarter 1 to 1997 Quarter 2) with Forecast Standard Errors in parenthesis. It is calculated using the Cholesky decomposition. The result shows how a specific error shock in a variable affects the percentage of the variance of the error made in forecasting U.S. ROA Growth Rate. Results are reported here only for 8 forecast horizons (8 steps) or 2 years though the complete set of results consists of all 24 quarters, the time over which the impulse response tends to fade away, as depicted in IRF graphs.

Forecast Horizon	U.S. ROA Growth Rate	Exchange Rate	Inflation	U.S. GDP Growth Rate	Interest Rate
1	100 (4.8e-17)	0 (0)	0 (0)	0 (0)	0 (0)
4	55.444 (.100059)	18.3948 (.08568)	2.1543 (.028632)	19.2659 (.084839)	4.7411 (.048459)
8	38.4834 (.104916)	29.8816 (.101171)	5.099 (.036746)	17.8633 (.084264)	8.6727 (.057592)

Table 11: FEVD (%) for U.S. ROA Growth Rate for Model 3

The table presents the Forecast Error Variance Decomposition in the percentage of the variance of the error made in forecasting U.S. ROA Growth Rate in Model 3 (1997 Quarter 3 to 2007 Quarter 4) with Forecast Standard Errors in parenthesis. It is calculated using the Cholesky decomposition. The results shows how a specific error shock in a variable affects the percentage of the variance of the error made in forecasting U.S. ROA Growth Rate. Results are reported here only for 8 forecast horizons (8 steps) or 2 years though the complete set of results consists of all 24 quarters, the time over which the impulse response tends to fade away, as depicted in IRF graphs.

Forecast Horizon	U.S. ROA Growth Rate	Exchange Rate	Inflation	U.S. GDP Growth Rate	Interest Rate
1	100 (2.9e-17)	0 (0)	0 (0)	0 (0)	0 (0)
4	71.5246 (.10457)	8.8063 (.067081)	1.338 (.026312)	5.2829 (.055699)	13.0482 (.070271)
8	54.604 (.1109)	15.3736 (.084829)	7.8044 (.055555)	5.9328 (.050705)	16.2853 (.079101)

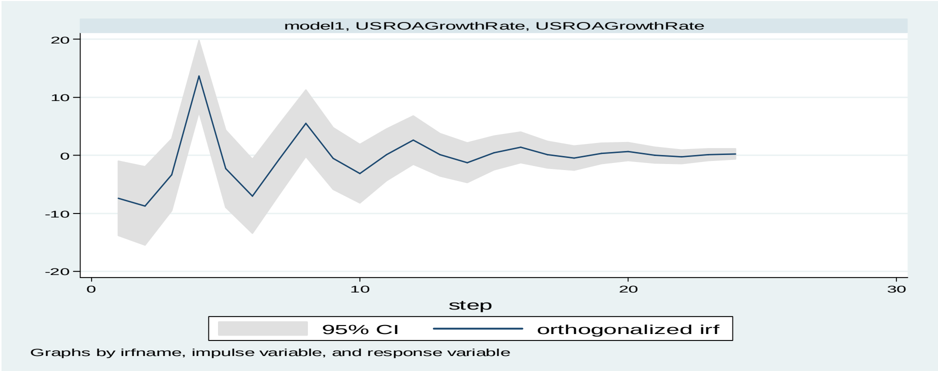
CHAPTER 9

IMPULSE RESPONSE FUNCTIONS

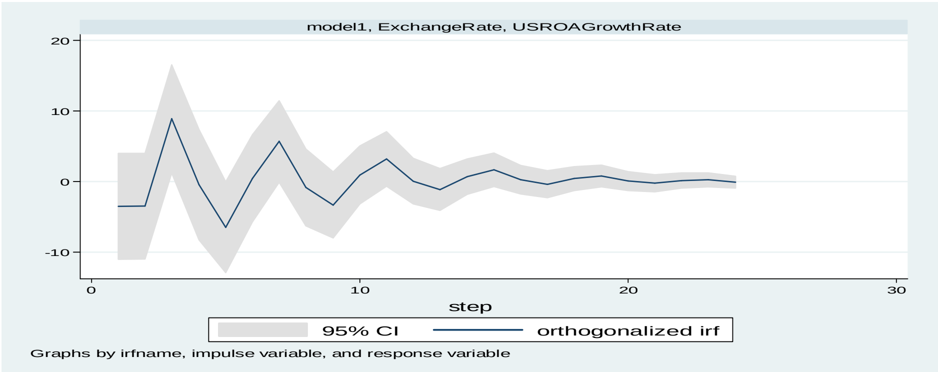
Stock and Watson (2001): "Impulse Responses trace out the response of current and future values of each of the variables to a one-unit increase in the current value of one of the VAR errors assuming that this error returns to zero in subsequent periods and that all other errors are equal to zero". Figures 3-8 show the Orthogonalized Impulse Response Function (IRFs) graphs for models 1, 2 and 3 respectively. The IRF graphs depict the response of U.S. ROA growth rate to a one percentage point increase (impulse) in U.S. ROA growth rate and each of the macroeconomic variables being considered. Also shown are the 95% confidence interval standard error bands for each of the IRFs.

The first thing to notice among all the IRFs graphs is that they are all stable as they tend to converge to zero by the time 24th quarter is reached (six years). The IRFs of U.S. ROA growth rate to a federal fund interest rate shock shows that in all three models the U.S. ROA growth rate tends to fall with an unexpected one percentage increase in federal fund interest rate, and hit the zero level for the first time much later in the model 3 than in model 2. Thus U.S. ROA growth rate goes well along our hypothesis of it being affected more by macroeconomic variables in the ex-post June 1, 1997 period. We can interpret the other graphs accordingly.

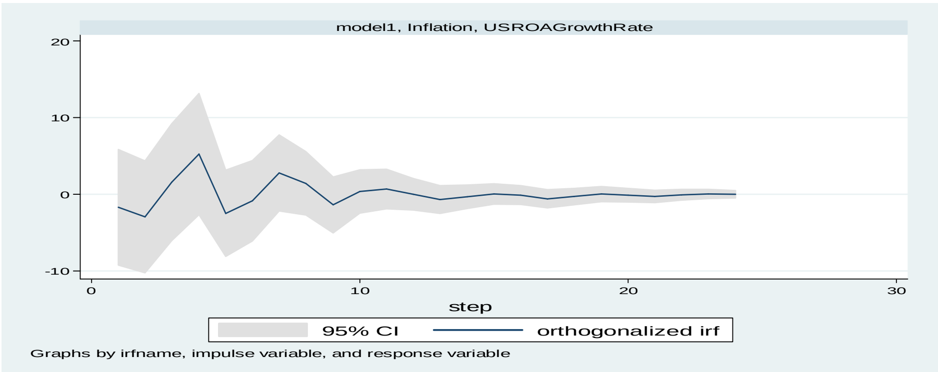
One interesting aspect to look at is the behavior of the U.S. ROA growth rate to U.S. GDP growth rate, where the former rises (though still being in negative range) in model 2, but falls in model 3 with an unexpected shock in the latter. The behavior of the U.S. ROA growth rate relative to the U.S. GDP growth rate can be taken as a hint towards increased portfolio diversification of U.S. bank assets outside the national territories. This implication appears stronger once we look at the relation between the U.S. ROA growth rate and the exchange rate in the Granger causality Wald test, that show that the return on average assets of all U.S. commercial banks can be predicted more from the foreign exchange value of the U.S. Dollar against the broad group of U.S. major trading partners, and less by U.S. domestic income.



U.S. ROA Growth Rate shock to U.S. ROA Growth Rate in Model 1

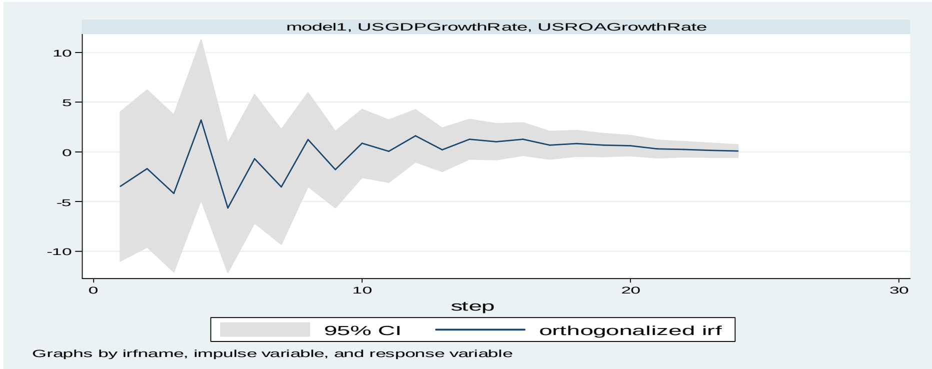


Exchange Rate shock to U.S. ROA Growth Rate in Model 1

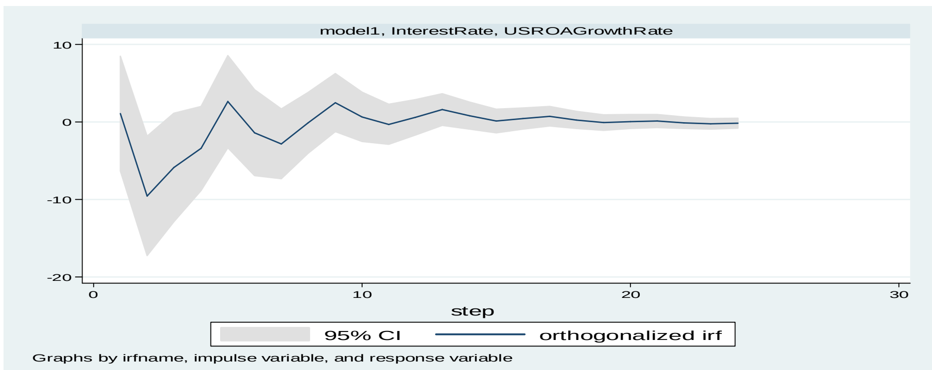


Inflation shock to U.S. ROA Growth Rate in Model 1

Figure 3: Orthogonalized Impulse Response Functions in Model 1

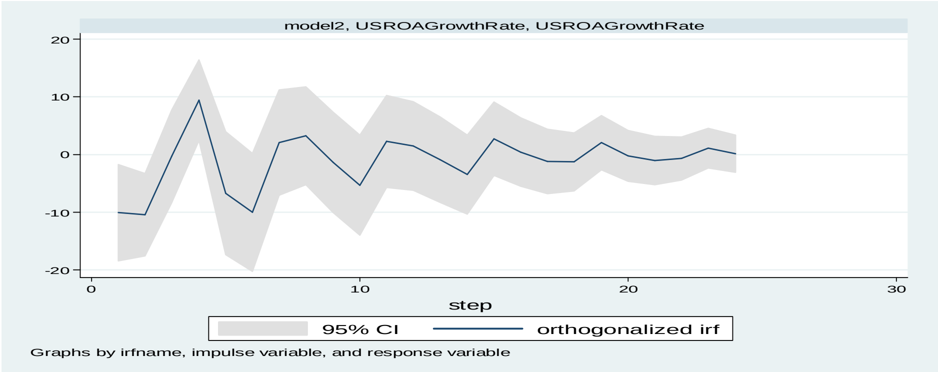


U.S. GDP Growth Rate shock to U.S. ROA Growth Rate in Model 1

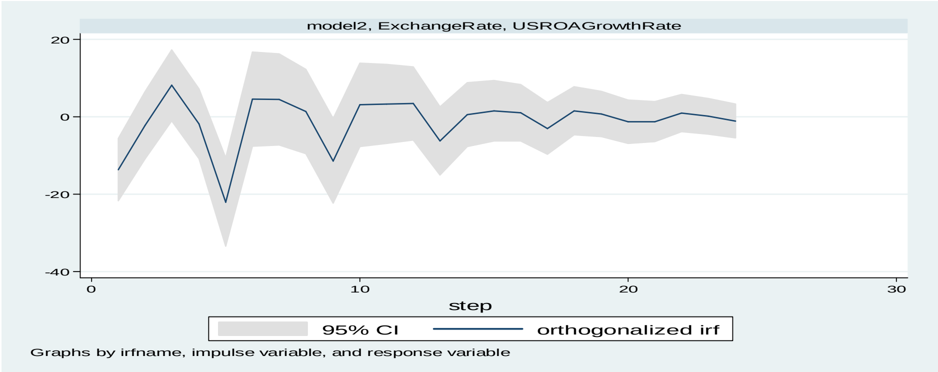


Interest Rate shock to U.S. ROA Growth Rate in Model 1

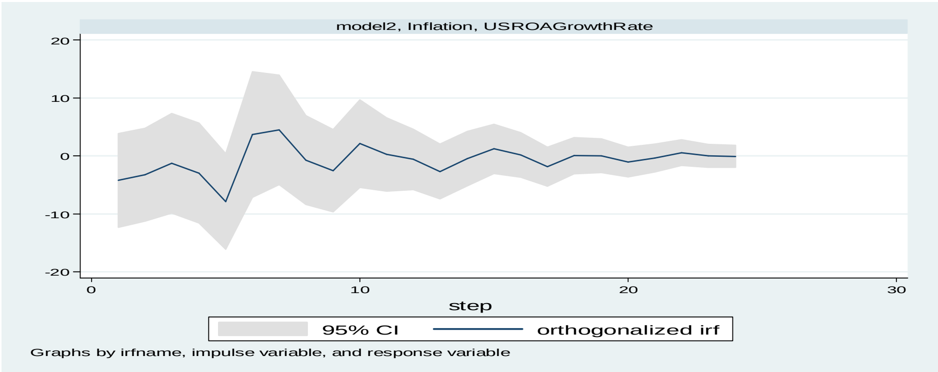
Figure 4: Orthogonalized Impulse Response Functions in Model 1 (Continued)



US ROA Growth Rate shock to US ROA Growth Rate in Model 2

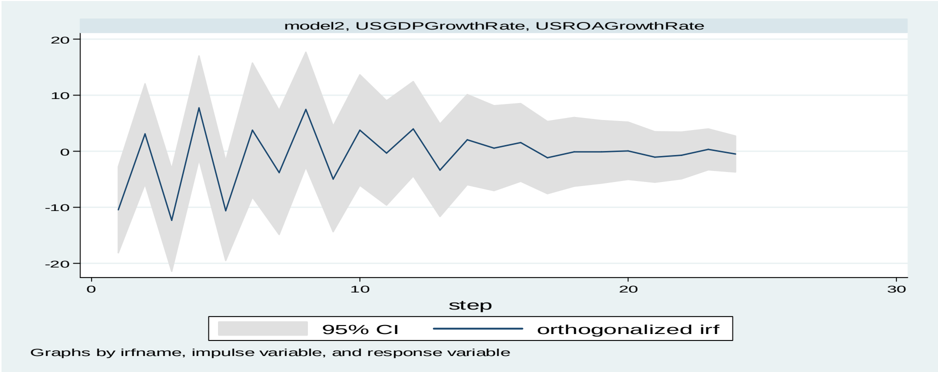


Exchange Rate shock to US ROA Growth in Model 2

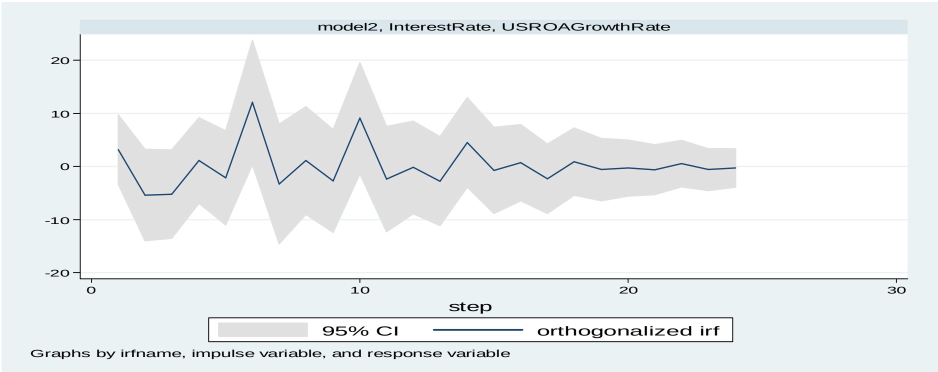


Inflation shock to US ROA Growth Rate in Model 2

Figure 5: Orthogonalized Impulse Response Functions in Model 2

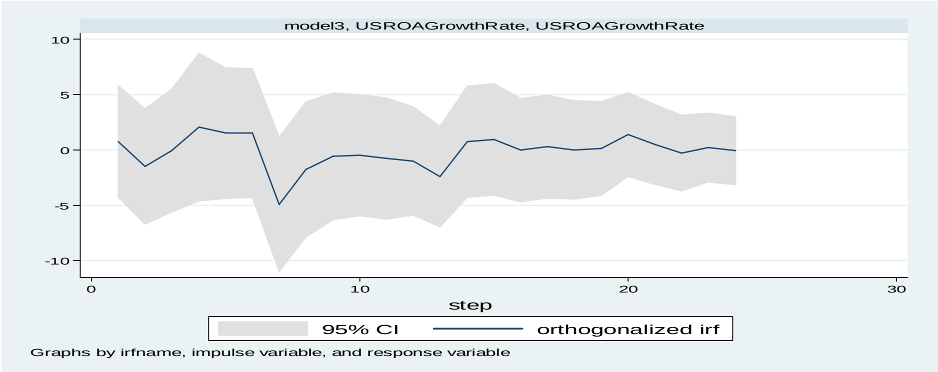


US GDP Growth Rate shock to US ROA Growth Rate in Model 2

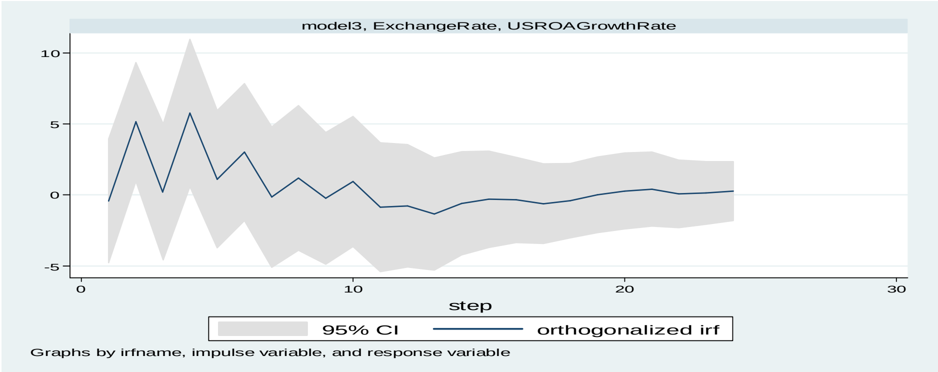


Interest Rate shock to US ROA Growth Rate in Model 2

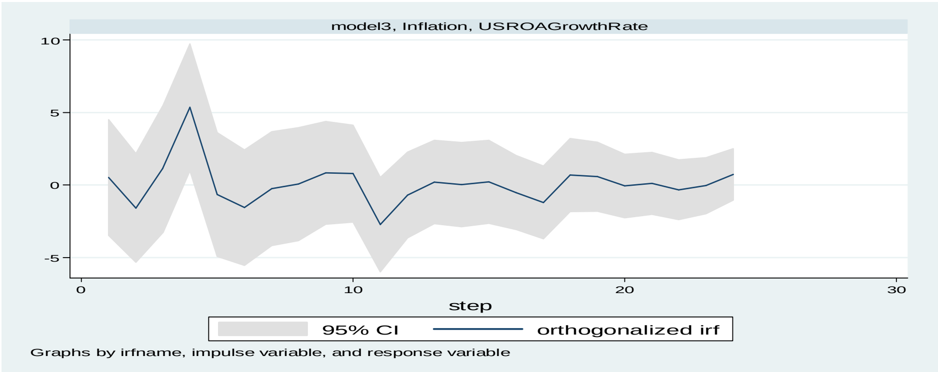
Figure 6: Orthogonalized Impulse Response Functions in Model 2 (Continued)



US ROA Growth Rate shock to US ROA Growth Rate in Model 3

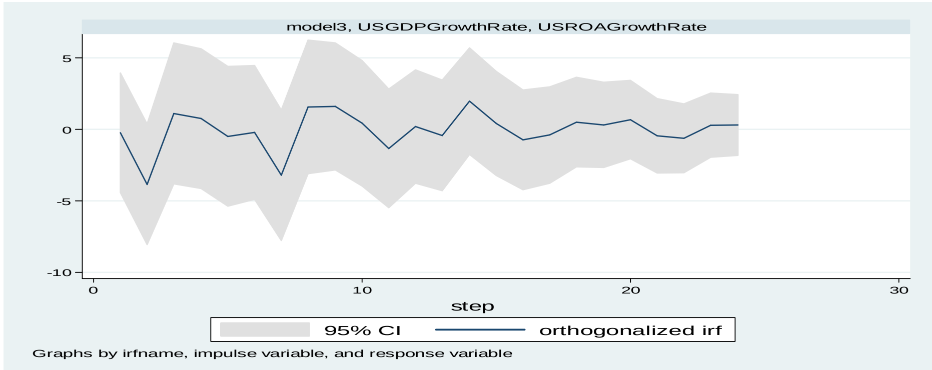


Exchange Rate shock to US ROA Growth in Model 3

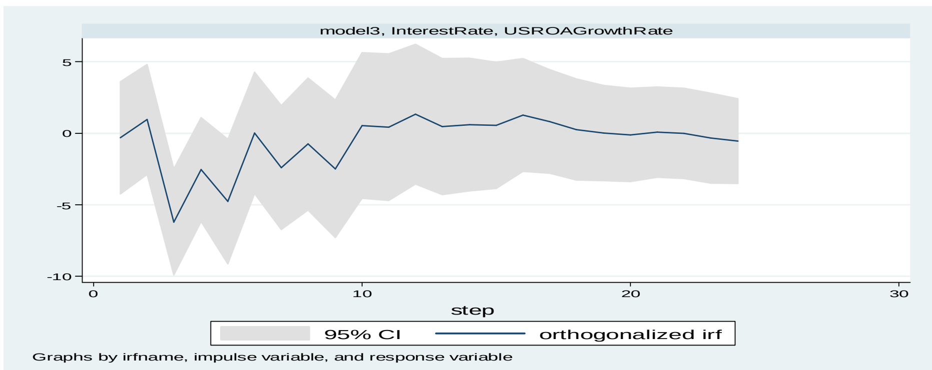


Inflation shock to US ROA Growth Rate in Model 3

Figure 7: Orthogonalized Impulse Response Functions in Model 3



US GDP Growth Rate shock to US ROA Growth Rate in Model 3



Interest Rate shock to US ROA Growth Rate in Model 3

Figure 8: Orthogonalized Impulse Response Functions in Model 3 (Continued)

CHAPTER 10

CONCLUSION

The main objective of this thesis was to evaluate the relative significance of macroeconomic fundamentals in predicting the performance of commercial banks in the United States. The performance of commercial banks is measured, by using the aggregate Return on Average Assets (ROA) of U.S. commercial banks from 1987 quarter 1 to 2007 quarter 4. The macroeconomic fundamentals I use for my thesis are GDP, inflation, the federal funds interest rate and trade weighted exchange index. The focus of my analysis centers on June 1 1997 when the Riegle-Neal Interstate Banking and Branching Efficiency Act, 1994 became effective allowing adequately capitalized and adequately managed bank holding companies to acquire out of state banks subject to state age law.

I conduct the empirical analysis using a recursive VAR for three models, Model 1 (1987 Quarter 1 to 2007 Quarter 4), Model 2 (1987 Quarter 1 to 1997 Quarter 2), and Model 3 (1997 Quarter 3 to 2007 Quarter 4). The hypothesis I test is that even though ex-post the implementation of the 1994 Act, Neely and Wheelock (1997) expect the banks to be less dependent on state economic conditions, these banks cannot escape national economic conditions and thus would become more vulnerable to macroeconomic situation facing the whole country. Thus, I expect the performance of commercial banks to be more predictable from macroeconomic fundamentals after the 1994 Act implementation. The results obtained provide a clear answer to the question posed in the beginning of the paper. Except for gross domestic product, all the macroeconomic variables significantly predict the performance of commercial banks and can be used by policy makers to measure the effect of macroeconomic policy shocks on the condition of the commercial banks. One possibility for future research is whether these results hold when the time period is extended to include the 2007-2009 U.S. recession which exhibited financial crisis and numerous bank failures. Another interesting extension to the research will be to take into consideration the unemployment rate and index of real estate value such as changes in Case-Shiller housing index in the set of explanatory macroeconomic variables. In my future research, for measuring commercial banks' performance, I would like to look at the factors that signal risk and state of the economy like default yield spread and term yield spread.

So far, I have focused on traditional structure of banks, in my future work I would like to look at how the growth of hedge funds, derivatives and several other sophisticated and complex financial instruments that banks today can diversify their portfolio into affect their performance. In particular, it would be interesting to see how hedging against exchange rate fluctuations affects the relation between commercial banks' performance and exchange rate. Another interesting aspect to look at is how the relation between macroeconomic fundamentals and the performance of commercial banks varies with the size of commercial banks, based on the size of their assets. In addition, my paper could be extended to a Logit model of bank failure by estimating the relation between the log odds in favor of a commercial bank's failure and the corresponding macroeconomic fundamentals used in the paper.

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