Title
Essays on Interaction Among Asset Returns and Diversification Benefits

Author
Kumar, Rama Shankar

Publication Date
2013

Peer reviewed|Thesis/dissertation

UNIVERSITY OF CALIFORNIA
RIVERSIDE

Essays on Interaction Among Asset Returns and Diversification Benefits

A Dissertation submitted in partial satisfaction
of the requirements for the degree of

Doctor of Philosophy

in

Economics

by

Rama Shankar Kumar

August 2013

Dissertation Committee:
Prof. Marcelle Chauvet, Chairperson
Prof. Aman Ullah
Prof. Anil Deolalikar

The Dissertation of Rama Shankar Kumar is approved:

Committee Chairperson

University of California, Riverside

Acknowledgements

At this moment when I complete my PhD thesis in Economics from University of California Riverside, I remember my first school in my native village, Nisarpura from Bihar in India. Most basic necessities used to be missing from the school at that time; but some minor improvements are visible in recent times. However, I remember the teacher from the same village, Mr. Nawal Kishore Sharma, who still encourages and generates academic curiosity among students in the village. Starting from there, I feel extremely honored to get an opportunity to experience this world-class research environment at University of California, Riverside. The most notable experience for me in this PhD program is the interaction with faculties and scholars. They equipped me with various research methodologies to explore scientific truth, and their extreme humility in spite of their vast knowledge taught me to stay humble in life. It would not have been possible to thrive in my doctoral without precious support of these persons.

First of all, I gratefully and sincerely thank my advisor, Dr. Marcelle Chauvet, Professor of Economics at University of California, Riverside, who enriched me with her deep understanding of financial economics, macro-econometrics and other associated aspects. Her constant encouragement and support even during my extreme lows during the program provided me the impetus to complete the program. I would also take this opportunity to thank my committee member, Dr. Anil Deolalikar, whose knowledge in Development Economics; especially households' behavior encouraged me to study society and its social aspects. His support and advice always kept me on the path of

completing PhD program, whenever I digressed from it. I can never forget my another committee member, Dr. Aman Ullah, whose immense econometrics knowledge helped me in quantitative economics, and his humility and simplicity will always teach me to stay humble in life. I am extremely grateful to Dr. Prasantta Pattanaik, whose guidance and philosophical thoughts enriched me immensely to develop a systemic and analytical approach to economic research.

I would also like to thank my fellow PhD students in the program at University of California, Riverside; whose friendship made my living easy at the campus and interaction with them enriched my understanding. I would also like to mention my roommates from Bangladesh, who never made me feel outsider in their group and their constant support in my academic endeavor.

I would be missing if I do not thank my family members, particularly, my parents who dreamt big about me and remained as pillars of support for me; my all four sisters, brother-in-laws, their children and my distant uncles (Kariman and Akhileshwar Singh) who supported my father during his illness in my absence. I would particularly thank my eldest sister, who took some conscious decisions for the family on my behalf and shouldered important responsibilities of the family during my absence.

Dedicated to my parents, Siya Ram Sharma and Kalwati Devi

To my eldest sister, Sumitra Devi and

To my teacher from the village, Mr. Nawal Kishore Sharma

ABSTRACT OF THE DISSERTATION

Essays on Interaction Among Asset Returns and Diversification Benefits

by

Rama Shankar Kumar

Doctor of Philosophy, Graduate Program in Economics
University of California, Riverside, August 2013
Prof. Marcelle Chauvet, Chairperson

The recent financial crisis associated with the collapse of the US housing market led to a drastic decline in the stock market and in securitized real estate indices. On the other hand, the price of US Treasury bonds moved up for a short span of time. The first chapter investigates the links and trade-offs among several assets such as stocks, bonds, securitized and residential real estate. It also examines periods in which time deposits offer the best investment opportunity given the market risk-return. Structural vector autoregressive models (SVAR) are used to study the role of residential real estate risk in explaining the relationship among these asset returns. Some interesting results are

revealed by the analysis, which sheds light on investors' portfolio diversification and asset allocation decisions. Among other results, the paper finds a 'flight to safety' phenomenon, whereby a rise in real estate risk induces investors to move from risky assets (stocks, securitized and residential real estate) to safer markets (bonds and time-deposits).

During the recent global financial, various assets witness extreme movements – US and emerging nations' stock (BRIC) indices suffered drastic decline; price of gold and US bonds witnessed consistent upward trend; and extreme upward movement in oil prices in the beginning of crisis, followed by extreme decline in oil prices in later stage of crisis. These movements indicate some linkages among asset returns. In the second chapter, we attempt to decipher such links or trade-off among asset returns. We attempt to investigate the role of risk and uncertainty from financial markets in explaining pair-wise relationships between two asset returns by using structural vector autoregressive (SVAR). During the periods of the rise in default risk in financial markets, gold and bonds act as safe-haven, but this property of gold is extremely short-lived. The returns on BRIC stocks generally respond similar to US stocks in response to the rise in risk or uncertainty from US financial markets, indicating minimum diversification benefits from BRIC stocks during periods of high risk or uncertainty in US financial markets. Oil also does not provide diversification benefits against US stocks during high financial risk and high uncertainty environment.

Table of Contents

Chapter 1

Chapter 2

List of Figures

Chapter 1

Chapter 2

List of Tables

Chapter 1

Chapter 2

Chapter 1: Flight to Safety:
An Interaction Among Stock, Bond and Real Estate Markets

Abstract

The recent financial crisis associated with the collapse of the US housing market led to a drastic decline in the stock market and in securitized real estate indices. On the other hand, the price of US Treasury bonds moved up for a short span of time. This paper investigates the links and trade-offs among several assets such as stocks, bonds, securitized and residential real estate. It also examines periods in which time deposits offer the best investment opportunity given the market risk-return. A structural vector autoregressive model (SVAR) is used to study the role of residential real estate risk in explaining the relationship among these asset returns. Some interesting results are revealed by the analysis, which sheds light on investors' portfolio diversification and asset allocation decisions. Among other results, the paper finds a '*flight to safety'* phenomenon, whereby a rise in real estate risk induces investors to move from risky assets (stocks, securitized and residential real estate) to safer markets (bonds and time-deposits). By the same token, a rise in financial risk and uncertainty forces investors to flee from stocks and securitized real estate to bonds and residential real estate. Surprisingly, a rise in term-premium, unlike real estate risk, leads investors to move from time-deposits to residential real estate assets.

1. Introduction

The collapse of the housing market led to a sharp decline in stock indices and securitized real estate indices. Housing prices as measured by Case-Shiller index declined 23 percent by the end of 2008 from the peak of July 2006. In the peak of the crisis the US stock market index (S&P 500) fell 37% in 2008 while the US securitized real estate dropped 18 percent in 2007, and 37 percent in 2008 (US NAREIT).[1] In the midst of the crisis, on the other hand, the price of US Treasury bonds went up for a short span of time.

The above events led to an extensive literature investigating the links between the collapse of US housing market and the recent financial crisis of 2007-2009.[2] Several factors in various combinations are found to relate the financial crisis to the housing market collapse, such as weaker credit standards that induced higher US mortgage lending and housing bubble; financial innovations as mortgage-backed securities; higher leverage that allowed firms and households to hold debt more than their capacity; prolonged period of low interest rates between post-2001 recession and the housing market collapse; and poor financial regulations, among several others.[3]

"Don't put all your eggs in one basket," is the one of the most famous quotes in favor of portfolio diversification. Investors are constantly trying to improve portfolios' performance through increasing returns and reducing risks. They attempt to reduce

---

[1] US National Association of Real Estate Investment Trusts.

[2] Shiller (2008) provides an overview on the origins of the financial crisis and how it is linked to collapse of the housing market.

[3] Bernanke (2010); Duca et al. (2010); Chauvet and Huang (2010) among many others.

systemic risk through portfolio diversification and asset allocation. Given that stocks, long-term government bonds, securitized and residential real estate account for a dominant share in investors' portfolios, information about the correlations among these asset returns proves to be useful in investors' diversification and asset allocation decisions.

The recent crisis indicates that risk from residential real estate market might have a contagion effect to stocks, bonds and securitized real estate markets. The goal of this paper is to investigate the extent to which real estate risk gets transferred to other assets in the economy. First, the paper aims to find a variable that represents real estate risk. Next, in this context, the paper focuses on answering the following questions: what is the role of real estate risk in explaining a potential '*flight to safety'*, that is relationship among returns over assets?[4] How does real estate risk affect aggregate level of time deposits in the economy, which is one of the safest existing assets? Is the impact of real estate risk on asset returns qualitatively similar in the presence of other financial factors such as term premium, default premium, stock market uncertainty? Does securitized real estate provide diversification benefits similar to residential real estate in the event of a rise in real estate risk or rise in financial risk and uncertainty? An investigation of the '*flight to safety'* phenomenon that answers these questions is relevant to investors for their portfolio diversification and asset allocation decisions; to policy makers in their policy response decisions; and to researchers in general.

[4] Flight to safety refers to phenomenon when investors transfer their investments from risky assets (stocks, etc.) to safer assets (bond, time-deposit, etc.); inducing corresponding price change, leading to negative correlation between two asset classes.

Although, there exists a vast literature on flight-to-safety phenomenon, to the best of our knowledge, the role of real estate risk in explaining the relationship between assets is investigated only in Yang and Zhao (2012) and in this paper.[5] Yang & Zhou, (2012) consider mortgage spread (i.e. the difference between 30-year prime mortgage and 30-year Treasury bond yield) to measure real estate risk from prime mortgage market.[6] This series is used to study the role of real estate risk in explaining the relationship among securitized real estate, stocks, and corporate bonds. However, they do not find a clear dynamical pattern among these assets.

This paper contributes to the literature in several ways. First, this is one of the most comprehensive studies investigating the role of real estate risk in explaining the relationship among four assets: stock returns, bond returns, securitized and residential real estate returns. Differently from Yang and Zhou (2012), this paper considers residential real estate returns and time deposits in order to explain correlation among asset returns and the flight-to-safety phenomenon in the context of real estate risk. In particular, we examine the effect of real estate risk in explaining one of the safest investments – time deposits at the aggregate level. The inclusion of time deposits unveils some novel findings related to the duration and intensity of the response of assets to an increase in real estate risk – which leads investors to flee from risky assets such as stocks,

---

[5] Next section discusses closely associated literature review.

[6] We consider the mortgage spread as Real Estate Risk form prime mortgage market or real estate risk in general in this paper.

securitized and residential real estate to safer assets such as Treasury bonds and time deposits.[7]

Second, this paper analyzes the flight-to-safety phenomenon by using a structural vector autoregressive model (VAR) (Sims (1986)). Structural VAR has been extensively used in the analysis of monetary and fiscal policy, national and international business cycles, etc. To the best of our knowledge, this framework has never been used to analyze the role of real estate risk factor in explaining the relationship among asset returns.

Third, this paper investigates the role of real estate risk in explaining *'flight to safety'* (or relationship among asset returns) in the presence of financial market risks and uncertainty measured by variables such as default premium, term premium, stock market uncertainty and inflation. This analysis provides clear distinction between the effect of real estate risk and that of other financial risks and uncertainty on the relationship among various asset returns.

Fourth, this paper contributes by providing an analysis on the difference between diversification benefits of securitized real estate and residential real estate in the event of a rise in the real estate risk (or financial risks and uncertainty). This augments investors in their portfolio diversification and asset allocation decisions.

Finally, this paper analyzes the effect of real estate risk, other financial risks and uncertainties individually on business cycle variables such as industrial production and unemployment rate in the economy. It augments to understand the worse impact of

[7] Bekaert et al. (2010) explains about proxy for time-deposit.

different risks (real estate and financial) and financial uncertainties on output level and unemployment rate in the economy in terms of duration and magnitude.

The analysis in this paper yields several interesting findings. First, we find that stock, securitized and residential real estate respond negatively to an increase in real estate risk, while bond returns and time-deposits respond positively. That is, an increase in real estate risk supports the phenomenon ‘flight to safety’, where investors move from risky markets such as stocks, securitized and residential real estate returns to safer assets such as bonds and time deposits.

Interestingly, until the recent crisis, real estate asset was considered one of the safest assets. However, with the boom and bust in this market, the risk of this asset has increased substantially.

Second, we find that the impact of real estate risk on the four asset returns studied remains qualitatively similar in the presence of other measures of financial risks. The empirical findings suggest that an increase in risk or uncertainty in the financial markets – as measured by the default-premium, term-premium and stock market volatility – leads to a strong negative stock-bond trade-off and securitized real estate and bond correlation (e.g. Chen, Roll, & Ross, (1986); Fama and French, (1989); Connolly, Stivers and Sun (2005) etc.).

Notably, the residential real estate returns respond positively to financial risks and uncertainty. That is, residential real estate is still a safer asset compared to securitized real estate and stocks in the face of financial risk, although not in comparison to government bonds or time-deposits.

Finally, in contrast to real estate risk, an increase in financial risk and uncertainty do not force investors to keep assets in time deposits for long. They still have the option to earn higher return in residential real estate market. Thus, a rise in financial risk and uncertainty (esp. term premium) leads to shorter duration of contraction in the economy as compared to that of rise in real estate risk.

The remainder of the paper is organized as follows: section 2 reviews the literature; section 3 presents the data and variables; section 4 discusses the model and identification; section 5 reports the results; section 6 conducts robustness analysis, and finally section 7 concludes this paper.

2. Literature:

The flight-to-safety literature (relationship among asset returns) is extensively researched due to its importance to investors, policymakers and researchers. The literature can be classified broadly in three strands. The first strand investigates correlation between returns over two or more assets. The purpose is to decipher which two asset returns move together or move in opposite directions. Shiller, Beltratti (1992) and Campbell, Ammer (1993) document positive stock-bond correlation using asset pricing model. They argue that this positive correlation is due to the common discount factor. However, both the papers implicitly assume that the relationship between stock and bond returns remain constant over time due to constant discount factor present in their models. Bekaert, Engstrom and Grenadier (2010) overestimate the positive stock-bond correlations in asset pricing model with stochastic discount factor.

Liu et al. (1990) investigate integration versus segmentation between real estate and financial markets using asset pricing approach and report that the US securitized real estate market integrates with the stock market, while US private commercial real estate market is segmented from the stock market. Ling and Naranjo (1999), further, confirms that US securitized real estate (US REITs[8]) markets are integrated with the stock market and the degree of such integration has significantly increased during 1990's.

The second strand of literature investigates about asymmetry in the correlation between asset returns over time or states in the economy such as recession and expansion. Several studies (Li, (2002); Gulko, (2002); Connolly, Stivers and Sun (2005)) document that the correlation between stock and bond exhibits considerable time-variation. Guildolin and Timmerman (2006, 2007) provide different sophisticated econometric models to describe and forecast dynamic stock-bond correlation with the objective of optimal asset allocation and diversification. Huang and Zhong (2011) explain the diversification benefits of three asset classes – commodity, securitized real estate, and inflation-protected securities using dynamic conditional correlation model.

Glascock, Lu and So (2000) report bivariate cointegration of the REIT and SP 500 indices during 1992-1996, but not during 1972-1991. They also suggest bivariate cointegration between REITs and bond market during first subperiod but not during the second subperiod. Their results suggest diminishing diversification benefits of REITs to stock market investors after 1992. Based on a bivariate GARCH model, Cotter and Stevenson (2006) confirm that REIT-stock correlations have increased during 1999 to

[8] Securitized real estate and Real Estate Investment Trust (REIT) will be used interchangeably.

2005. Using DCC-GARCH model, Huang and Zhong (2011) argue that during the period from 1999 to 2005, conditional correlation between US REITs and stocks remains not only positive but also follows a positive trend, whereas correlation between US REITs and US bonds fluctuates around zero.

The third strand of the literature attempts to find out the driving forces behind correlations between returns over two or more assets. A branch of this strand [Campbell and Ammer, (1993); Bekaert et al. (2007); Engle, Ghysels, and Sohn, (2008)] examines output growth, inflation and unemployment rate as economic sources of stock-bond return co-movements. Another branch, investigating interaction between stock and bond (REITs), identifies default and term premiums as financial market-based macroeconomic indicators in driving asset prices (Chen Roll and Ross, (1986); Fama and French, (1989, 1993); Ling and Naranjo, (1999); Yang and Zhou (2012)). The significant and negative relation between stock market volatility index (VIX) and stock-bond co-movements implies “flight to safety,” where investors switch from the risky asset (stocks) to a safe haven (bond), in times of increased uncertainty, inducing corresponding price changes, and thus leading to negative correlation between stock and bond returns [Connolly, Stivers, and Sun, (2005)].

3. Data:

3.1 Description of variables and their sources[9]:

The index return data come from three sources. Stock and Bond index returns are from Center for Research in Security Prices: S&P500 total return index $(Stock\ Return)$ and 10-year Treasury bond return$(Bond\ Return)$. The data on securitized real estate return - US Equity Real Estate Investment Trust total return index $(Sec\ Real\ Est\ Return)$ come from National Association of Real Estate Investment Trust. The residential real estate return data – return on Shiller and SP500 20 cities index $(Res\ Real\ Est\ Return)$ come from online resources of Robert Shiller.

Other economic variables such as unemployment rate $(Unemp)$ and inflation rate $(inflation)$ as 12-month change in consumer price index are collected from US Bureau of Labor Statistics. Industrial production (IP) data come from Federal Reserve, St Louis. The remaining variables are constructed using data from Center for Research in Security prices and Federal Reserve:

1) Time Deposits $(Time\ Deposit)$ are measured as the difference between level of M2 and M1, where M2 and M1 are aggregate levels of money supply in the economy. The growth rate of M2 net of M1 is used to replace business cycle variable in SVAR analysis of risk, uncertainty and monetary policy (Bekaert, Duca, & and Hoerova, 2010).

[9] The bracket terms are abbreviations for names of variables used in this paper.

2) Term Premium $(Term\ Prem)$ is measured as the difference between 10-year government bond yield and 3-month Treasury bill rate. It indicates the long term business condition in the economy.

3) Default Premium $(Def\ Prem)$ is measured as the difference between BAA bond and AAA bond yields. It reflects short term business condition in the economy. During weaker economic conditions, the chance of default for lower ranked bonds increases, which leads to higher default premium.

4) Real Estate Risk $(PRes\ Real\ Est\ Risk)$ is measured as the difference between 30-year prime mortgage rate and 30-year Treasury bond yield. It reflects prime mortgage sector of the real estate market. It represents risk factor from residential real estate sector, but it is also be used to analyze its effect on securitized real estate market. This variable is named as mortgage spread, and used as the instrument to measure risk of default in the real estate market (Yang and Zhao, (2012)).

5) Subprime Residential Real Estate Risk $(SPRes\ Real\ Est\ Risk)$ is measured as the difference between 6-month London Interbank Offered Rate[10] plus 6 percent and 30-year government bond yield. In the economic commentary (Schwitzer and Venkatu, (2009)), the relation between 6-month libor rate and adjustable-rate mortgages (ARM) interest rate is presented in detail. Libor rate plus 6 percent is considered as the proxy for the subprime mortgage rate. This proxy variable is constructed to measure the risk of default in subprime mortgage market.

---

[10] 6-month London Interbank Offered Rate is famously termed as Libor Rate.

6) S&P500 Volatility Index (VIX) capture stock market volatility in the economy. It is often referred as the fear index, reflecting uncertainty in the market.

The sample period spans from January, 1990 to December 2010. All variables are monthly; based on the end of month data and seasonally adjusted and made stationary for the VAR analysis, when required.

3.2 Summary Statistics:

Table 1.1 confirms that securitized real estate provide the highest monthly mean return (1.03 percent), but also experiences highest volatility during course of twenty years between 1990 to 2010. The residential real estate returns provide the lowest monthly average return (0.25 percent) over twenty years, but with least volatility. It is startling to find that monthly mean return on 10-year Treasury bond and S&P-500 are almost equal at 0.60 percent for the period of 20 years, but not surprisingly stock index suffers from higher volatility to that of bond index. Not only have the average annual stock returns been poor over last 10 years, but relative to long-term bonds, stocks looks mediocre over the last 20, 30, and even 40 years.[11]

The correlation matrix provided in Table 1.2 provides the evidence of strong and positive correlation (0.54) between stock and securitized real estate returns. It also indicates that default premium and term premium are negatively correlated to stocks and securitized real estate, where as it is positively correlated to bond returns. The real estate risk $(PRes\ Real\ Est\ Risk)$ is negatively correlated to three asset returns except bond

[11] Ibbotson and Chen (2011)

returns. Figure 1.1 confirms that out of three recessions in last 20 years, only during the recent recession of 2007-2009, the real estate risk maintains an upward trend. It also shows the rising trend in default premium $(Def\ Prem)$ and term premium $(Term\ Prem)$, stock market volatility (VIX) during the last recession; indicating increase in risk and uncertainty in financial market.

4. Model and Identification

The analysis begins with a five-variable VAR on business cycle variable $(Time\ Deposit)$, stock market returns $(Stock\ Return)$, residential real estate returns $(Res\ Rea\ Est\ Return)$, 10-year Treasury bond returns $(Bond\ Return)$ and residential risk factor $(PRes\ Real\ Est\ Risk)$, using monthly data for the United States from January 1990 to December 2010. The purpose of the analysis is to analyze the interaction among four asset returns; with emphasis on responses of stock, bond and real estate returns to positive shock in risk from the real estate market$(PRes\ Real\ Est\ Risk)$; and to positive shock in risks from financial market such as default-premium, term-premium, stock market uncertainty etc.

We define Z_t as the (5×1) vector of five variables as discussed above, where $(Time\ Deposit)_t$ is differenced to be stationary and residential real estate return is seasonally adjusted:

$$Z_t = [(Time\ Deposit)_t,\ (Res\ Real\ Est\ Return)_t,\ (Bond\ Return)_t,\ (Stock\ Return)_t,\ (PRes\ Real\ Est\ Risk)_t]'$$

.

Consider the following structural VAR (SVAR)[12]:

$$A\, Z_t = D + \theta\, Z_{t-1} + \epsilon_t \qquad (1)$$

where A is a 5×5 full rank matrix, D is 5×1 matrix of constants and $E[\epsilon_t\ \epsilon_t'] = I$. The main interest is to decipher the responses of asset returns and time-deposits to structural shocks ϵ_t.

At the first step, reduced-form VAR is estimated as

$$Z_t = E + B\, Z_{t-1} + e_t \qquad (2)$$

where, E denotes $A^{-1}D$; B denotes $A^{-1}\theta$ and $e_t = C\ \epsilon_t$ with $C = A^{-1}$ The error terms e_t in equation (2) are composites of underlying structural shocks ϵ_t. The variance-covariance matrix of the reduced-form residuals is defined as $\sum = E[(C\epsilon_t)\ (C\ \epsilon_t)'] = C\ C'$.

The problem of identifying the structural model is to take the observed values of e_t and restrict the system so as to recover ϵ_t as $\epsilon_t = A\ e_t$. Thus, it requires restricting the system so as to (i) recover the various ϵ_t and (ii) preserve the assumed error structure concerning independence among various ϵ_t shocks. Using OLS, the variance-covariance matrix $\sum$ can be obtained from equation (2) as

$$\sum = \begin{bmatrix} \sigma_1^2 & \sigma_{12} & \dots\dots & \sigma_{1n} \\ \sigma_{21} & \sigma_2^2 & \dots\dots & \sigma_{2n} \\ \dots & \dots & \dots\dots & \dots \\ \sigma_{n1} & \sigma_{n2} & \dots\dots & \sigma_n^2 \end{bmatrix} \qquad (3)$$

[12]Literature on SVAR can be obtained from Sims (1980, 1986); Bernanke (1986); and Applied Econometric Time Series, 2nd Edition by Walter Enders (2003).

Since the variance-covariance matrix $\sum$ is symmetric, it contains $(n^2 + n)/2$ distinct elements. The matrix A contains $(n^2 - n)$ unknowns because its diagonal elements are all unity. Apart from $(n^2 - n)$ unknowns from A, there is another set of $'n'$ unknown values of $var(\epsilon_t)$ for each variable in Z_t. Thus, there are total n^2 unknown values in structural model and we have only $(n^2 + n)/2$ known values retrieved from $\sum$. Hence, we require $n(n-1)/2$ restrictions to identify the system. In general, for VAR of order k with N variables, we need $(k+1)n^2$ coefficients to identify, but we can estimate only $k\, n^2 + n(n+1)/2$ coefficients.

In this specific case of first-order VAR with five variables in equation(1) and (2) is helpful to reflect the problem of identification in estimation process of structural VAR: equation (2) provides 45 coefficients in the matrices B and $\sum$, but equation (1) consists of 55 unknowns. Thus, we need 10 restrictions on the VAR to identify the system. We have used formal selection criteria to select the correct order (k) of the VAR. We use formal selection criteria to select the correct order (k) of the VAR before specifying the restrictions required for structural identification of the VAR. We provide those selection criteria at the end of this section.

Before specifying required restrictions; another issue in the identification of SVAR containing asset prices and monetary measures is the order of variables in the vector Z_t; as there exist simultaneity problems when identifying the response of monetary measures and asset prices to news. The studies on VAR [Goodhart and Hoofman (2001); Giuliodori (2005)] that analyze the importance of housing have typically assumed that house prices are restricted from responding immediately to monetary policy shocks. The studies mentioned above, on the interaction between monetary policy and housing prices have ignored other asset prices like stock, but if included, maintained the recursive order for the VAR, so that asset prices react with a lag to monetary policy.[13] Thus, returns on assets are placed above real estate risk in Z_t assuming that asset prices react with a lag to real estate risk $(PRes\ Real\ Est\ Risk)$.

The order among asset returns in Z_t is maintained by placing residential real estate returns first; bond returns second; stock returns at the bottom among asset returns.[14] We have changed the order among asset return variables in Z_t, while estimating different VARs but there are no significant variations in the response of different asset returns to structural shocks in risk factor from real estate$(PRes\ Real\ Est\ Risk)$.[15]

The studies [Sims (1980, 1986); Svensson (1997); Christiano, Eichenbaum, and Evans (1999); Christiano, Eichenbaum, and Evans (2005)], investigating relationship between business cycle variables (output and inflation) and monetary policy have found out that macroeconomic variables do not react contemporaneously to shocks in monetary policy measures; whereas monetary policymaker might respond immediately to macroeconomic news. The shock in monetary policy measures pass through macroeconomic variables slowly due to nominal rigidities. Following the above literature, we place business cycle variables $(Time\ Deposit)$ above the risk factor from

---

[13] Goodhart and Hofmann (2001)

[14] We assume residential real estate returns do not react contemporaneously to bond or stock price shock; and bond returns do not react simultaneously to stock price shocks.

[15] Results are not provided in the paper but can be provided upon request.

the real estate market $(PRes\ Real\ Est\ Risk)$ by assuming that business cycle variables react with a lag to shock in real estate risk $(PRes\ Real\ Est\ Risk)$. We further assume a lag in the effect of asset price shocks (stock, bond and residential real estate) on business cycle variables $(Time\ Deposit)$ [Goodhart & and Hofmann, 2001].

Finally, the variables in vector Z_t can be arranged by placing business cycle variable$(Time\ Deposit)$, followed by asset returns with real estate risk factor $(PRes\ Real\ Est\ Risk)$ at the end. This captures the fact that business cycle variables and asset returns responds with a lag to shocks in real estate risk. The order of the asset returns among themselves is already discussed above. To complete the specific structural identification in five-variable SVAR, we impose exclusion restrictions on short run (contemporaneous) responses by setting coefficients in A to zero. Effectively, this imposes ten exclusion restrictions on the cotemporaneous matrix A:

$$A = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{bmatrix} \qquad (4)$$

The imposition of the ten short-run restrictions as above through matrix A completes the identification of structural VAR. The identification scheme also satisfies both necessary and sufficient for the identification of structural vector autoregressive system [Rubio-Ramirez, Waggoner and Zha (2009)].

We do the similar structural vector analysis for securitized real estate returns i.e. equity real estate investment trust returns $(Sec\ Real\ Est\ Return)$. The effort is to resolve the issue – “Do securitized real estate returns respond in the same way as residential real estate returns to shocks in the risk from the real estate sector?" We also try to relate the securitized real estate with other asset markets in the context of response to shocks in risk factor from real estate. The variable $(Res\ Real\ Est\ Return)$ is replaced by $(Sec\ Real\ Est\ Return)$ in the structural VAR analysis. In this analysis, the order of variables in vector Z_t remains unchanged except the order of asset returns among themselves. We keep bond returns first, followed by stock returns and securitized real estate return at the end. We even change orders among assets and find out no significant change in responses from different asset returns due to positive shock in real estate risk $(PRes\ Real\ Est\ Risk)$. We provide our main results in the form of impulse-response function (IRF) in the next section, estimated in the usual way for both structural VAR systems.

4.1 Reduced-form statistics, 5-Varible VAR

[with Z = Time Deposit, Res Real Est Return, Bond Return, Stock Return, Res Real Est Risk]:

As mentioned above, we provide formal selection criteria to select the correct order (k) of the VAR system with residential real estate returns$(Res\ Real\ Est\ Return)$. Table 1.3 reports some reduced-form VAR statistics. It produces three lag-selection criteria: Akaike (AIC), Hannan-Quinn (HQIC) and Schwarz (SBIC). While SBIC selects lag one; HQIC selects VAR with two lag length, AIC selects VAR with three lag length. We focus on the results based on three lag VAR in the next section. Table 1.4 reports Granger Causality tests. We find strong overall Granger causality in four equations except in the stock market return. In the time-deposits equation, all four variables are significant at 5% level. Three variables except bond return are significant at 5% are in the equation of residential real estate returns. While residential real estate return and real estate risk (PRes Real Est Risk) are not significant in the bond return equation, stock return and time-deposits are predicting bond return significantly at 5% level. Although, other variables are not significant in anticipating stock return, but time-deposit is marginally significant at 10% level. There exists strong overall Granger causality in real estate risk (PRes Real Est Risk) equation, but only bond return is highly significant at 5 percent level and other variables are not significant.

4.2 Reduced-form statistics for 5-Variables VAR

[where Z = Time Deposit, Bond Return, Stock Return, Sec Real Est Return, Res Real Est Risk]:

Table 1.5 reports some reduced-form statistics, required for the selection of correct order (k) of the VAR system. While SBIC and HQIC select lag one, AIC selects lag length of order two. We focus on the results based on the two-lag VAR in the following section. As above, Table 1. 6 reports Granger Causality tests. We find strong overall Granger causality in four equations at 5% level of significance and at 10% significance level in stock market return equation. Three variables except securitized real estate returns $(Sec\ Real\ Est\ Return)$ are significant at 5% in the equation for time-deposits. All four variables are predicting securitized real estate returns at 5% level of significance. As above, there exists overall Granger causality in real estate risk (PRes Real Est Risk) equation, but only bond return is highly significant at 5 percent level and other variables are not significant. In the equation for bond return, only stock return (Stock Return) is significant at 10 percent level. Although overall Granger causality exists only at 10 percent level of significance, real estate risk (PRes Real Est Risk) is significant in predicting stock return (Stock Return) at 10 percent level.

5. Results :

5.1 Structural Evidence for 5-Variable SVAR,

[where variables in Z are ordered as Z = Time Deposit, Res Real Est Return, Bond Return, Stock Return, Res Real Est Risk]

The investigation relies on impulse-response response functions (IRFS) to explain the main results. The primary interest of the paper is to find out how other variables respond to shocks in real estate risk (PRes Real Est Risk). Figure 1.2A provides impulse response functions (IRF) of four asset returns to one standard deviation positive shock in real estate risk (PRes Real Est Risk). A one standard deviation positive shock in real estate risk (PRes Real Est Risk) leads time-deposits $(Time\ Deposit)$ to increase by 2 percent in 5 months in this model with short run restrictions. Although, the positive response of time-deposits increases rapidly within first 7 months, it starts giving up the positive effect after 7 months. The positive response from time-deposits remains between 1 percent and 2 percent for close to 20 months. The response remains positive for more than 50 months but it is significant only up to 28 months. Thus, increase in the real estate risk forces investors in the economy to look for safest mode of investment such as time deposits. The increase in the risk from real estate sector by one standard deviation keeps investors out of risky asset markets for long time up to 50 months or more.

The responses of asset returns such as residential real estate returns, bond returns and stock returns are also presented in Figure 1.2A in the form of impulse response functions. A one standard deviation positive shock in real estate risk (PRes Real Est Risk) lowers residential real estate return (Res Real Est Return) by 0.05 in 5 months and it remains negative for more than 40 months. It remains significant only upto 18 months. The stock returns respond negatively to a positive shock in real estate risk (PRes Real Est Risk) after an initial positive response in first month. The maximum negative effect is 0.24 in 3 months. Although stock returns remain negative for more than 40 months, the negative response of stock returns remains significant up to 27 months. Thus, an increase in the real estate risk leads to decrease in both residential real estate return and stock market return. The magnitude of negative response from residential real estate returns to shock in real estate risk is lower in comparison with negative response from stock return. This indicates that rise in real estate risk affects stock returns worse than that of residential real estate returns. The real estate risk factor contributes to make the correlation between stock and residential real estate returns positive. The bond returns respond positively to positive shock in real estate risk (PRes Real Est Risk). The bond returns remain positive for around 10 months but significant up to 7 months only. The responses of bond returns to positive shock in real estate risk are completely opposite to responses of other two asset returns (stock and residential real estate). This contributes towards negative correlation between bond returns and returns of any of other two asset market returns (stock and residential real estate markets).

The negative responses of risky assets such as stock and residential real estate to increase in real estate risk (PRes Real Est Risk) are the manifestation of the outcome that investors are driven away from risky markets. The increase in the real estate risk forces investors to look for safer destinations of investment like bond market, time deposits at banks. The positive responses of time-deposits and bond returns to increase in real estate risk support the above argument. The investors might look for alternative markets like commodity markets or other international markets during the periods of higher risks in the domestic real estate market. This paper is not considering those markets in the analysis. The increase in real estate risk drives the investors out of risky assets for significantly longer duration around 40 months as compared to significant positive response from bond returns for around 7 months. This movement of investors from risky assets to safe heavens like government bond market and time deposits in banks during periods of high risk environment is termed as "flight-to-safety".

The main result is that increase in real estate risk (PRes Real Est Risk) has significant and negative effect on residential real estate and stock returns in the medium-run; contributing towards positive correlation between stock and residential real estate returns. The magnitude of decline in residential real estate returns is lower than that of stock returns. The real estate risk affect bond returns significantly in the opposite direction and for short period as compared to other two assets (stock and residential real estate). This contributes towards negative correlation between bond returns and returns of any of other two asset market returns (stock and residential real estate markets). An increase in real estate risk is also followed by positive responses from time deposits for extended period. This confirms the movement of investors from risky assets to safe heavens like government bond market and time deposits in banks during periods of high risk environment is termed as “flight-to-safety”.

The effect of real estate risk (PRes Real Est Risk) is not only statistically significant but also economically significant. Figure 1.2B provides structural variance decomposition of four variables – three asset market returns and time-deposits due to various shocks. The shocks in real estate risk account for more than 80% of structural variance in time-deposits and stock returns at horizons longer than 10 months. It also accounts for around 10% variance in residential real estate returns and around 30% for bond returns at horizons longer than 10 months. In section 5, the paper analyzes the response of asset returns to positive shock in real estate risk (PRes Real Est Risk) along with other risk factors such as default-premium, term-premium, stock market uncertainty in 6-variables structural VARs to check the robustness of these responses from asset returns to real estate risk shocks in presence of other factors from financial markets.

5.2 Structural Evidence for 5-variable SVAR

[where variables in Z are ordered as Z = Time Deposit, Bond Return, Stock Return, Sec Real Est Return, Res Real Est Risk]:

We also investigate 5-variables SVAR by replacing the residential real estate with securitized real estate returns. The purpose is to analyze the diversification benefits of securitized real estate market in the event of rise in the real estate risk. It is evident from Fig 3A that stocks and securitized real estate returns respond negatively to the rise in real estate risk. The magnitude and the length of negative responses from both stock and securitized real estate returns to positive shock in real estate risk are similar; indicating strong positive correlation between stock and securitized real estate returns. The negative response of residential real estate returns is lower in magnitude as compared to negative response of stock returns; indicating positive but weaker correlation between stock and residential real estate returns. Thus, residential real estate works as a better diversifier in comparison with securitized real estate in the event of rising real estate risk.

Assuming only four assets, during the period of rising real estate risk, the best option for short-term investors is to park their investment in government bonds; whereas long-term investors can opt for time-deposits. The investors might also look for other safe avenues such as commodity markets (gold or oil) and international markets during the period of rising real estate risk. This paper does not include these markets in the analysis. Figure 1.3B indicates the economic significance of real estate risk in explaining variance in asset returns. It provides structural variance decomposition of four variables – three asset market returns and time-deposits due to various shocks. The shocks in real estate risk account for more than 80% of structural variance in time-deposits and stock returns at horizons longer than 10 months. The real estate risk also document more than 15 percent variation in bond and residential real estate returns.

6. Robustness

In this section, we have considered several types of robustness checks: 1) general identification 2) measurement of real estate risk; 3) measurement of business cycle variables; 4) Other channels: stock market uncertainty (VIX), default-premium, term-premium.

General Identification:

For all 5 and 6 variables structural VAR in the robustness checks, we have followed certain guidelines. In vector Z_t, we have maintain following order among variables – business cycle variables (Time Deposits, Industrial Production, Unemployment Rate and Inflation) at the top, followed by asset returns (Res Real Est Return, Bond, Stock, Sec Real Est Return), further followed by risk-premium variables (Term Prem, Default Prem, Pres Real Est Risk, SPRes Real Est Risk) and at the end stock market uncertainty (VIX). The explanations for such order among business cycle, asset returns and risk-premium variables are provided in section 3. The stock market uncertainty is kept at the end following Bekaert et al (2010). The orders of variables among their respective categories (business cycle, asset returns, and risk-premiums) are changed during investigation and there are no qualitative differences in the main results for the effect of real estate risk on various assets. The lag-length for each SVAR is selected depending upon three criteria mentioned in section 3. We have also tested for longer VAR lag-length, maintaining necessary and sufficient conditions for global identifications; again the results remain qualitatively similar. Detailed results will be available upon request.

6.1 Measurement of real estate risk:

In 5-Variable SVAR with order of variables within Z as [Z = Time Deposit, Res Real Est Return, Bond Return, Stock Return, Res Real Est Risk], we replace the real estate risk from prime mortgage market[16] with proxy for subprime real estate risk. It is evident from Figure 1.4 that an increase in subprime real estate risk is followed by negative response from stock and residential real estate returns, whereas bond returns respond positively. Again time deposits also respond positively after a small decline in the beginning. Thus, we get the qualitatively similar effects on asset returns for the proxy of subprime real estate risk.

6.2 Measurement of Business Cycle Variables*:*

In 5-Variable SVAR with order of variables within Z as [Z = Time Deposit, Res Real Est Return, Bond Return, Stock Return, Res Real Est Risk], we replace time deposits with the log-difference of industrial production in the first case. We conduct the similar SVAR analysis. Figure 1.5 shows that there is no qualitative change in the effect of real estate risk on various assets, but industrial production remains negative for more than 50 months due to a positive shock in real estate risk. In case two, we replace time deposits with difference of unemployment rate and conduct similar SVAR analysis. Figure 1.6 indicates that there is no qualitative change in the effect of prime real estate risk on asset returns, but the responses from unemployment variable remain positive for

[16] Real estate risk from Prime Mortgage Market is treated as risk from real estate market in general.

around 30 months for a positive shock in prime real estate risk. The positive effect on unemployment and negative effect on industrial production for extended period due to rise in real estate risk prolongs a recessionary situation in the economy.

In the third case, we have included one more variable into above 5-variables SVAR and made it 6-variables SVAR with order of variables within Z as [Z = Time Deposit, Inflation, Res Real Est Return, Bond Return, Stock Return, Res Real Est Risk]. Again, Figure 1.10A confirms that the main results concerning the effect of real estate risk on asset returns remain qualitatively similar. Figure 1.10B indicates that positive shock in inflation leads to decline in both stock and bond returns leading to positive correlation between stock and bond for first 3 months. This investigation does not show any clear pattern in the responses of two asset returns (bond and stock) due to shock in inflation. An increase in inflation tends to raise discount rates, and hence, is bad news for the bond market. However, the impact of increase in inflation on stocks is ambiguous, as both expected future cash flows and the discount rates are likely to be affected. Illamen (2003) finds that at high levels of inflation, changes in the discount rates dominate the changes in cash flow expectations, thereby inducing positive stock-bond correlation. The negative response of time-deposits to positive shock in inflation supports the fact that investors do not want to hold assets in time-deposits if there is increase or expectation of increase in inflation.

6.3 Other Channels:

In three different 6-variable SVAR, the paper investigates the role of real estate risk in presence of three risk factors (Def Prem, Term Prem and VIX) from financial markets individually. In the first case, we have 6-variable SVAR with Z as [Z = Time Deposit, Res Real Est Return, Bond Return, Stock Return, Res Real Est Risk, VIX]. We conduct the similar SVAR investigation and find from Figure 1.7A that there are no qualitative changes in the main results regarding effect of real estate risk on asset returns. Further, Figure 1.7B indicates that an increase in stock market uncertainty (VIX) is followed by short-lived (first 5 months) positive response from bond returns, whereas stock returns remain negative for first 3 months before entering into positive zone. Thus, stock market uncertainty contributes to strong negative correlation between stock and bond for short span of time [Connolly, Stivers, & Sun, (2005)]. The positive shock in stock market uncertainty is also followed by positive response from residential real estate returns for more than 40 months, whereas time-deposits remain positive only for 10 months. Thus, it supports flight-to-safety phenomenon, where the rise in the stock market uncertainty forces investors to flee from risky assets (stocks) to bonds and residential real estate. They do not hold assets in time-deposits for long during high stock market uncertainty because residential real estate proves to be a safer market during that period.

In the second case, we analyze 6-variables SVAR with Z as [Z = Time Deposit, Res Real Est Return, Bond Return, Stock Return, Def Prem, Res Real Est Risk] and find from Figure 1.8A that effect of the real estate risk on different assets remain the same. Further, from Figure 1.8B, we find that a positive shock to default premium is followed by negative responses from stock returns and positive responses from bond returns. Thus, higher default premium in the financial market leads to negative stock-bond correlation for longer time period as compared to negative correlation due to stock market uncertainty [(Fama & French, (1989, 1993)]. Higher default premium is followed by positive response from residential real estate return for more than 30 months. Thus, higher default-premium forces investors to move from risky stocks to safer markets such as bond and residential real estate, supporting flight-to-safety phenomenon. Investors do not hold time-deposits for long as they can allocate their assets into residential real estate sector; even though positive response from bond returns is short-lived (7 months).

In the third case, we analyze 6-variables SVAR with Z as [Z = Time Deposit, Res Real Est Return, Bond Return, Stock Return, Term Prem, Res Real Est Risk] and find from Figure 1.9A that effect of prime real estate risk on different assets remain the same qualitatively with slight variation in duration of the responses from various assets. Figure 1.9B indicates that the rise in the term-premium is followed by negative response from stock returns and positive response from bond returns. The term-premium contributes to strong negative correlation between stock and bond returns and for the longest period in comparison with default-premium, stock market uncertainty or real estate risk. The positive shock in term-premium is also followed by strong positive response from residential real estate returns and strong negative response from time-deposits, lasting for more than 50 months. This suggests that investors flee from risky stocks and move to bond and residential real estate markets. The persistent and strong positive responses from residential real estate returns due to the rise in term-premium induce investors to take risk and withdraw money from time-deposits for investment in residential real estate markets.

Finally, we have also done the similar robustness tests for 5-variable[17] SVAR and 6-variables SVAR models involving securitized real estate returns instead of residential real estate returns. The investigation follows the same general guidelines mentioned above except that order among asset returns is maintained as bond at the top, followed by stock and securitized real estate at the end. Although, any change in order among asset returns do not affect the main results significantly. Figures [1.11A, 1.12A, 1.13A, 1.14A] confirm that the effect of positive shock in real estate risk on bond returns, stock returns and time-deposits remains qualitatively similar and securitized real estate returns responds similar to stock returns, leading to strong and positive correlation between stock and securitized real estate returns.

In contrast to positive responses from residential real estate returns, the securitized real estate returns respond in negative to positive shocks in risks (Term Prem, Def Prem) or uncertainty (VIX) from the financial markets. Figures [1.11B, 1.12B, 1.13B and 1.14B] support the above statement. This confirms that rise in risks or uncertainty in real estate or financial markets contribute to positive correlation between securitized real estate and stock returns. There are no diversification opportunities in the securitized real estate markets in the event of rise in real estate risk or rise in risks and uncertainty from the financial markets.

[17] Results for 5-Variable SVAR involving securitized real estate returns instead of residential real estate returns can be obtained upon request.

7. Conclusions

This study explores the role of risk from real estate sector in explaining flight-to safety phenomenon or relationship among asset returns. The study confirms that a positive shock in real estate risk is followed by negative responses from stock, securitized and residential real estate returns, whereas bond returns respond positively. The negative response from the residential real estate returns is the least in terms of magnitude in comparison with responses from other asset returns due to rise in real estate risk, whereas positive effect on bond return is the shortest.

The rise in real estate risk contributes towards positive pair-wise correlations among three asset returns (stock, securitized and residential real estate) but negative correlation between bond return and any of other three assets. We also find that time deposits at aggregate level respond positively to an increase in real estate risk. The negative correlation between bond returns and any of other three asset returns and positive responses of time deposits due to increase in real estate risk support the phenomenon 'flight to safety', where investors move from risky markets (stocks, securitized or residential real estate) to safer avenues (bonds or time deposits); manifesting into corresponding price changes. The rise in the real estate risk force investors to park their investment in time-deposits for the longest time period as compared to rise in any risk or uncertainty factor from financial markets.

The investigation supports Connolly, Stivers, & Sun, (2005), where they document that investors move from stocks to bonds during periods of high stock market uncertainty (VIX); manifesting corresponding price changes in the markets. Further, we also find in this paper that default-premium and term-premium contribute to negative correlation between stock-bond [Fama and French, (1989, 1993)]. The negative stock-bond correlation due to term-premium lasts the longest and the negative correlation due to stock market uncertainty phases out the quickest.

An increase in risk or uncertainty in financial markets is followed by positive response from residential real estate market. Thus, an increase in risk or uncertainty in financial markets forces investors to move from stocks, securitized real estate market to bond and residential real estate markets. In contrast to real estate risk, the persistent and strong positive effect on residential real estate returns due to the rise in term-premium (worsening of long-term fundamentals in the financial markets) induces investors to take risk and withdraw money from time-deposits for investment in residential real estate markets.

The positive effect on unemployment and negative effect on industrial production for extended period due to rise in real estate risk prolongs a recessionary situation in the economy. There are no diversification opportunities in the securitized real estate markets in the event of rise in real estate risk or rise in risks and uncertainty from the financial markets.

The responses from asset returns (bond and stock) to rise in inflation do not present a clear pattern. An increase in inflation tends to raise discount rates, and hence, is bad news for the bond market. However, the impact of increase in inflation on stocks is ambiguous, as both expected future cash flows and the discount rates are likely to be affected. Illamen (2003) finds that at high levels of inflation, changes in the discount rates dominate the changes in cash flow expectations, thereby inducing positive stock-bond correlation.

Finally, there are various scopes for future research in this area. It would be more interesting to include commodity markets such as gold and oil; equity markets from emerging economies such as China, India in the analysis. This will provide a better idea about the diversification choices in the event of rise in the real estate risk or rise in risks and uncertainty from the financial market. It would be fruitful if the underlying forces can be analyzed in the context of asymmetry in the pair-wise correlation between assets. The investigation for variables representing risk from subprime mortgage market and their role in explaining relationship between returns over various assets is another unexplored area, which requires future research attention.

Appendix

Table 1.1: Summary statistics of Asset Returns

	Stock	Bond	Sec Real Est Return	Res Real Est Return
Mean	0.631971	0.605224	1.034644	0.259426
Std. Dev.	4.365958	2.035525	5.646621	0.934368
Skewness	-0.63307	-0.07849	-0.81806	-0.65546
Kurtosis	4.101067	4.147471	11.70134	3.796173

Fig 1.1: Risk-Premiums and Stock Volatility

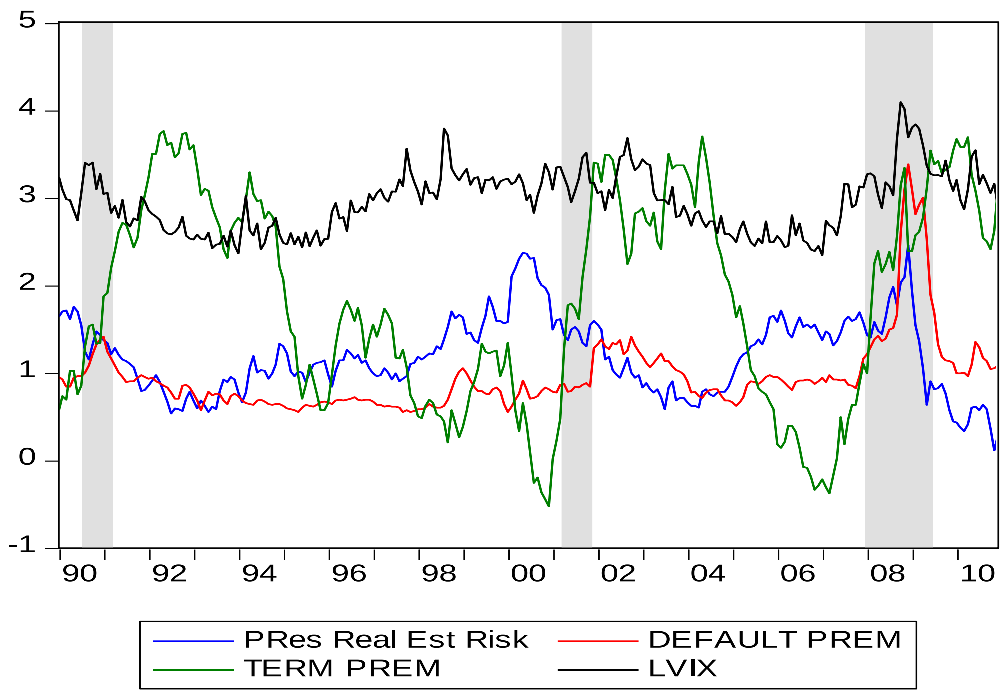


Table 1.2: Correlation Matrix

	Stock	Bond	Sec Real Est Return	Res Real Est Return	IP	Time Deposit	Unemp	Term Prem	Def Prem	PRes Real Est Risk	SPRes Real Est Risk	VIX
Stock	1											
Bond	-0.03	1										
Sec Real Est Return	0.542	0.014	1									
Res Real Est Return	0.06	-0.04	0.151	1								
IP	-0.1	-0.06	-0.034	0.141	1							
Time Deposit	-0.09	-0.06	-0.001	-0.146	0.786	1						
Unemp	0.053	0.001	0.106	-0.234	-0.31	0.289	1					
Term Prem	-0.05	-0.03	0.04	0.008	-0.32	0.068	0.731	1				
Default Prem	-0.14	0.017	-0.113	-0.408	0.196	0.547	0.4	0.285	1			
PRes Real Est Risk	-0.15	0.089	-0.17	-0.132	0.32	0.036	-0.641	-0.65	0.178	1		
SPRes Real Est Risk	-0.01	0.024	-0.118	-0.122	0.243	-0.1	-0.714	-0.94	-0.167	0.771	1	
VIX	-0.36	0.104	-0.336	-0.187	0.24	0.322	0.111	0.057	0.634	0.278	0.02	1

Table 1.3: Five-Variable VAR results (Lag-Length Selection)

(Time Deposit, Res Real Est Return, Bond, Stock, PRes Real Est Risk)

Lag	AIC	SC	HQ
0	22.30304	22.37534	22.33217
1	16.7506	17.18439*	16.92536
2	16.59229	17.38758	16.91270*
3	16.56279*	17.71957	17.02884
4	16.65038	18.16865	17.26206
5	16.71503	18.5948	17.47235
6	16.7975	19.03876	17.70047
7	16.86293	19.46569	17.91154
8	16.92661	19.89086	18.12085
9	16.95889	20.28463	18.29876
10	17.00491	20.69214	18.49043

*** indicates lag order selected by the criterion (5% level of significance)**
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 1.4: Granger Causality: Five-Variable VAR results
(Time Deposit, Res Real Est Return, Bond, Stock, PRes Real Est Risk)

Equation		Chi-sq	Df	Prob.
Time Deposit	**Res Real Est Return**	8.712506	3	0.0334
Time Deposit	**Bond**	19.41547	3	0.0002
Time Deposit	**Stock**	11.06876	3	0.0114
Time Deposit	**PRes Real Est Risk**	7.851113	3	0.0492
	All	51.51801	12	0.0000
Res Real Est Return	**Time Deposit**	15.18035	3	0.0017
Res Real Est Return	**Bond**	2.145898	3	0.5427
Res Real Est Return	**Stock**	10.07200	3	0.0180
Res Real Est Return	**PRes Real Est Risk**	8.459544	3	0.0374
	All	35.32367	12	0.0004
Bond	**Time Deposit**	7.567365	3	0.0559
Bond	**Res Real Est Return**	0.877002	3	0.8310
Bond	**Stock**	16.74838	3	0.0008
Bond	**PRes Real Est Risk**	0.978674	3	0.8064
	All	24.41972	12	0.0178
Stock	**Time Deposit**	6.090523	3	0.1073
Stock	**Res Real Est Return**	0.839761	3	0.8399
Stock	**Bond**	0.793245	3	0.8511
Stock	**PRes Real Est Risk**	5.291929	3	0.1516
	All	13.14450	12	0.3586
PRes Real Est Risk	**Time Deposit**	0.196415	3	0.9782
PRes Real Est Risk	**Res Real Est Return**	3.772173	3	0.2871
PRes Real Est Risk	**Bond**	28.14795	3	0.0000
PRes Real Est Risk	**Stock**	5.126851	3	0.1627
	All	38.40044	12	0.0001

Table 1.5: Five-Variable VAR results (Lag-Length selection)
(Time Deposit, Bond, Stock, Sec Real Est Return, PRes Real Est Risk)

Lag	AIC	SC	HQ
0	25.79435	25.86665	25.82347
1	23.02588	23.45967*	23.20064*
2	22.88455*	23.67983	23.20495
3	22.90823	24.06501	23.37427
4	22.93956	24.45784	23.55125
5	22.96959	24.84935	23.72691
6	23.04165	25.28291	23.94461
7	23.11273	25.71548	24.16133
8	23.15713	26.12137	24.35137
9	23.19536	26.5211	24.53524
10	23.28487	26.9721	24.77039

*** indicates lag order selected by the criterion (5% level of significance)**
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 1.6: Granger Causality: Five-Variable VAR results
(Time Deposits, Bond, Stock, Sec Real Est Return, PRes Real Est Risk)

Equation		Chi-sq	df	Prob.
Time Deposit	**Bond**	13.44485	2	0.0012
Time Deposit	**Stock**	7.966919	2	0.0186
Time Deposit	**Sec Real Est Return**	1.497304	2	0.4730
Time Deposit	**PRes Real Est Risk**	8.784869	2	0.0124
	All	37.29023	8	0.0000
Bond	**Time Deposit**	3.717298	2	0.1559
Bond	**Stock**	5.134843	2	0.0767
Bond	**Sec Real Est Return**	3.212883	2	0.2006
Bond	**PRes Real Est Risk**	0.191145	2	0.9089
	All	21.59076	8	0.0057
Stock	**Time Deposit**	3.331892	2	0.1890
Stock	**Bond**	0.135269	2	0.9346
Stock	**Sec Real Est Return**	3.219043	2	0.2000
Stock	**PRes Real Est Risk**	5.568745	2	0.0618
	All	14.88188	8	0.0615
Sec Real Est Return	**Time Deposit**	9.749999	2	0.0076
Sec Real Est Return	**Bond**	6.584437	2	0.0372
Sec Real Est Return	**Stock**	14.77243	2	0.0006
Sec Real Est Return	**PRes Real Est Risk**	6.058858	2	0.0483
	All	46.02800	8	0.0000
PRes Real Est Risk	**Time Deposit**	0.914656	2	0.6330
PRes Real Est Risk	**Bond**	25.68447	2	0.0000
PRes Real Est Risk	**Stock**	0.481994	2	0.7858
PRes Real Est Risk	**Sec Real Est Return**	3.636531	2	0.1623
	All	38.96992	8	0.0000

Figure 1.2A: Structural-form IRFs for the 5-variable VAR
[Time Deposit, Res Real Est Return, Bond, Stock, PRes Real Est Risk]
(Impulse: PRes Real Est Risk)

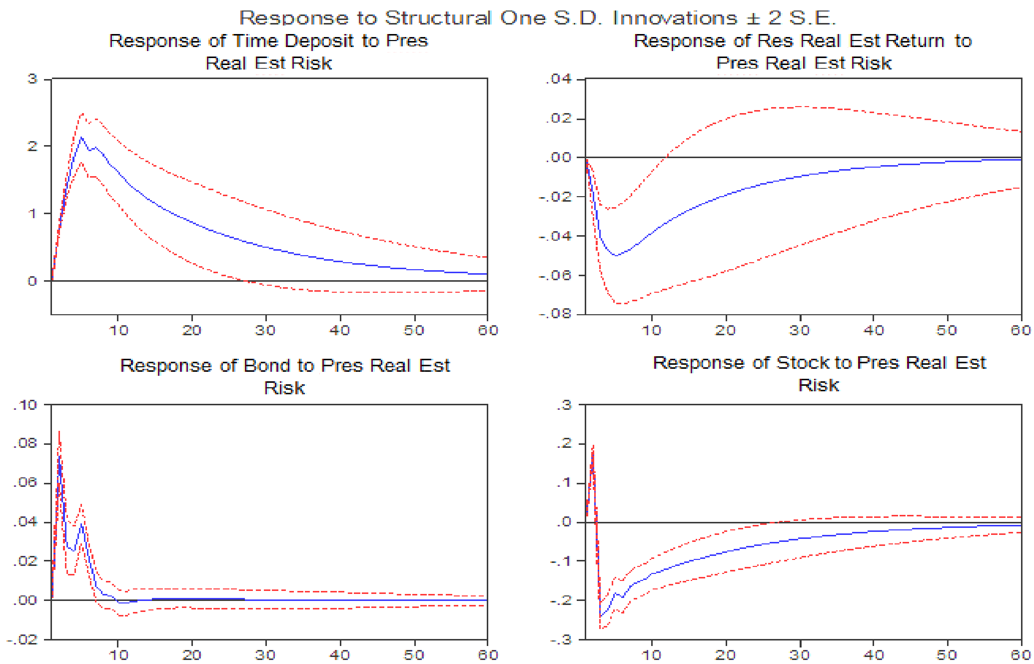


Figure 1.2B: Structural Variance Decomposition for 5 variables in VAR
[Time Deposits, Res Real Est Return, Bond, Stock, PRes Real Est Risk]

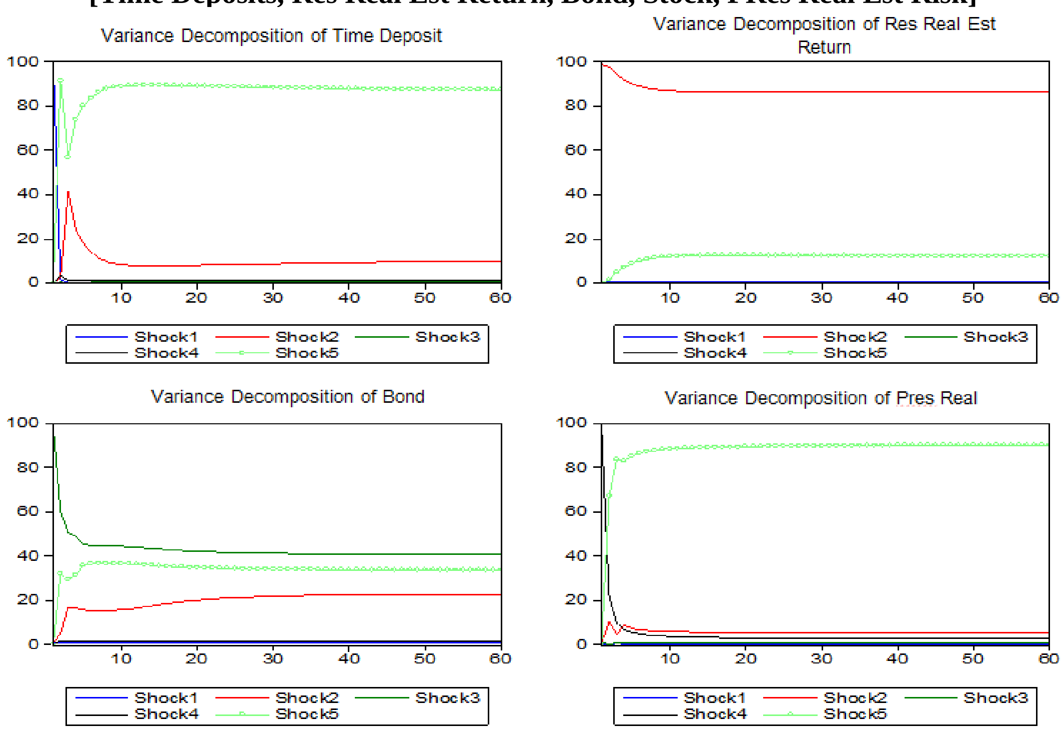


Figure 1.3A: Structural-form IRFs for the 5-variable VAR
[Time Deposits, Bond, Stock, Sec Real Est Return, PRes Real Est Risk]
(Impulse: PRes Real Est Risk)

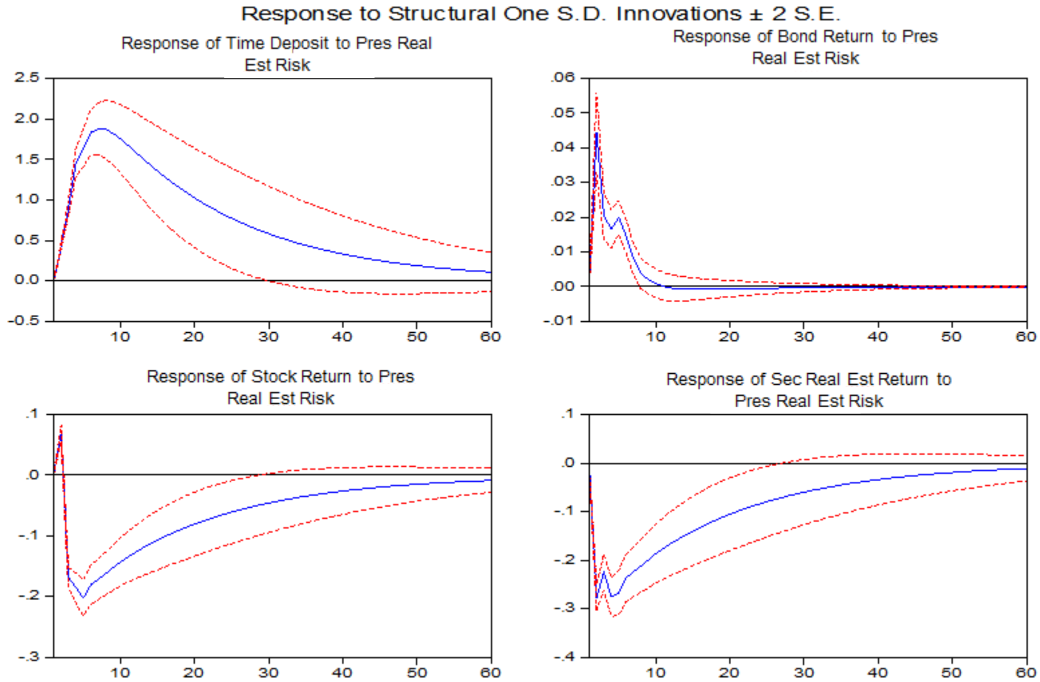


Figure 1.3B: Structural Variance Decomposition for 5 variables in VAR
[Time Deposits, Bond, Stock, Sec Real Est Return, PRes Real Est Risk]

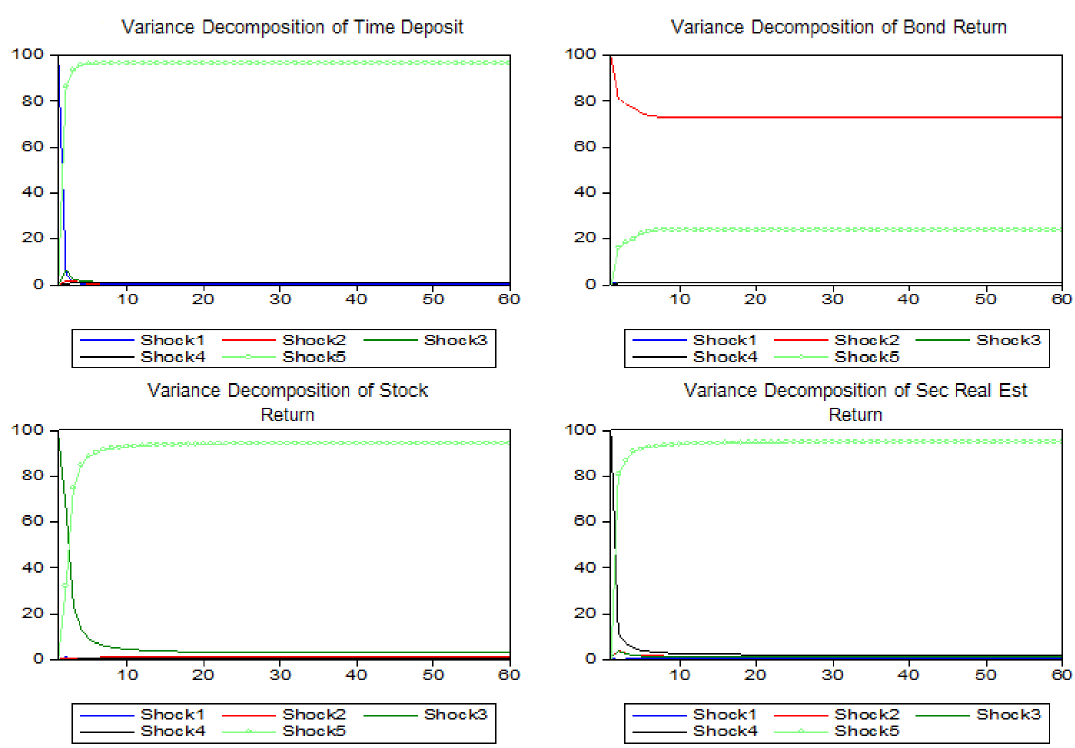


Figure 1.4: Structural-form IRFs for the 5-variable VAR [Time Deposit, Res Real Est Return, Bond, Stock, SPRes Real Est Risk] (Impulse: SPRes Real Est Risk)

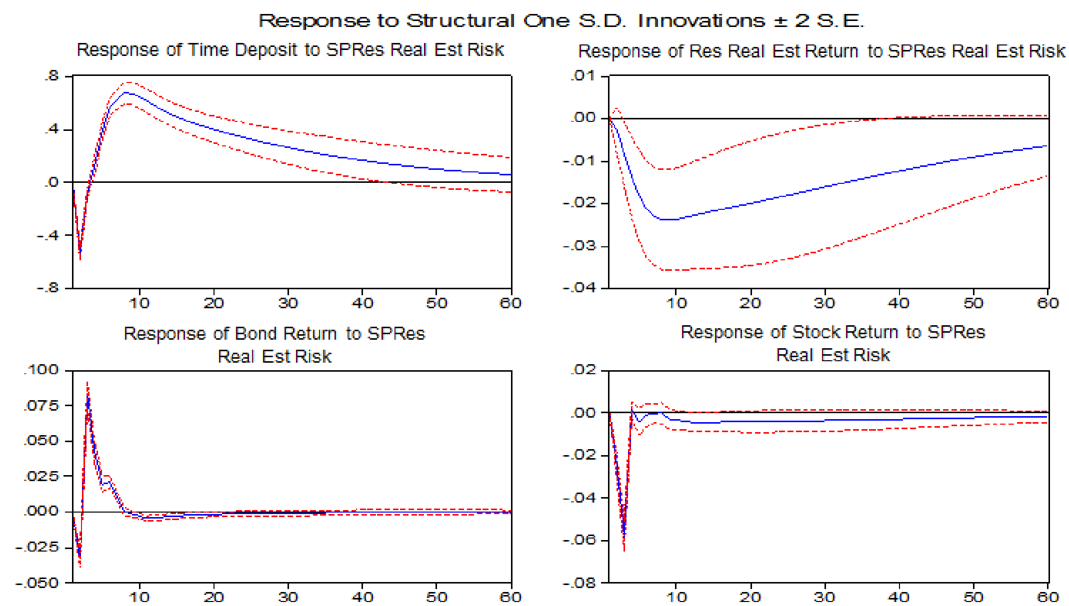


Figure 1.5: Structural-form IRFs for the 5-variable VAR [IP, Res Real Est Return, Bond, Stock, PRes Real Est Risk] (Impulse: PRes Real Est Risk)

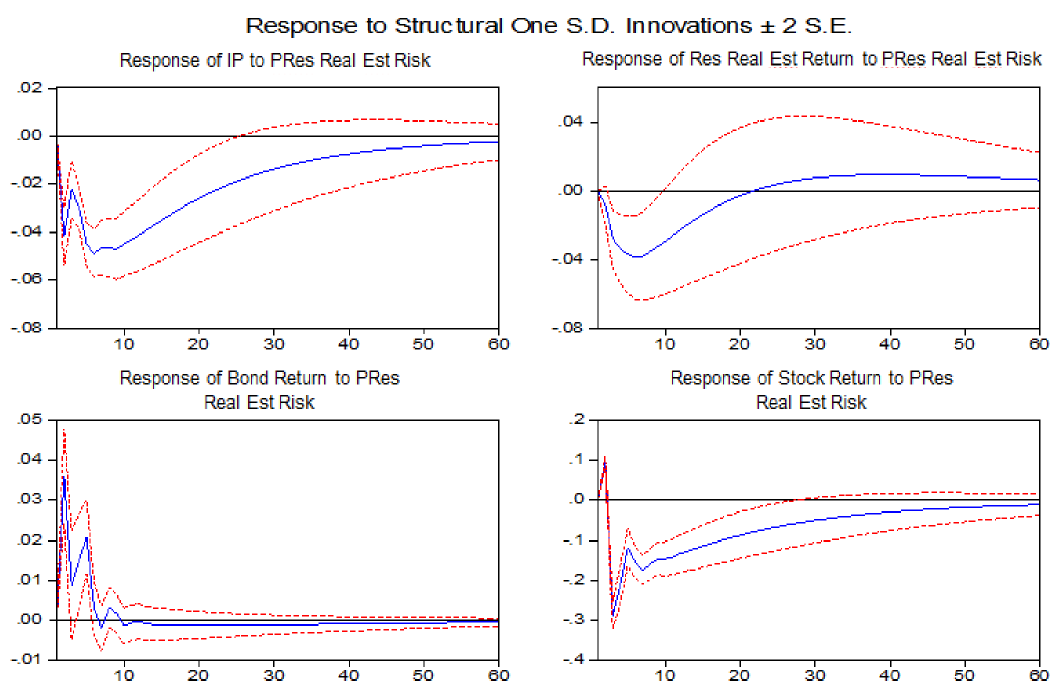


Figure 1.6: Structural-form IRFs for the 5-variable VAR [Unemp, Res Real Est Return, Bond, Stock, PRes Real Est Risk] (Impulse: PRes Real Est Risk)

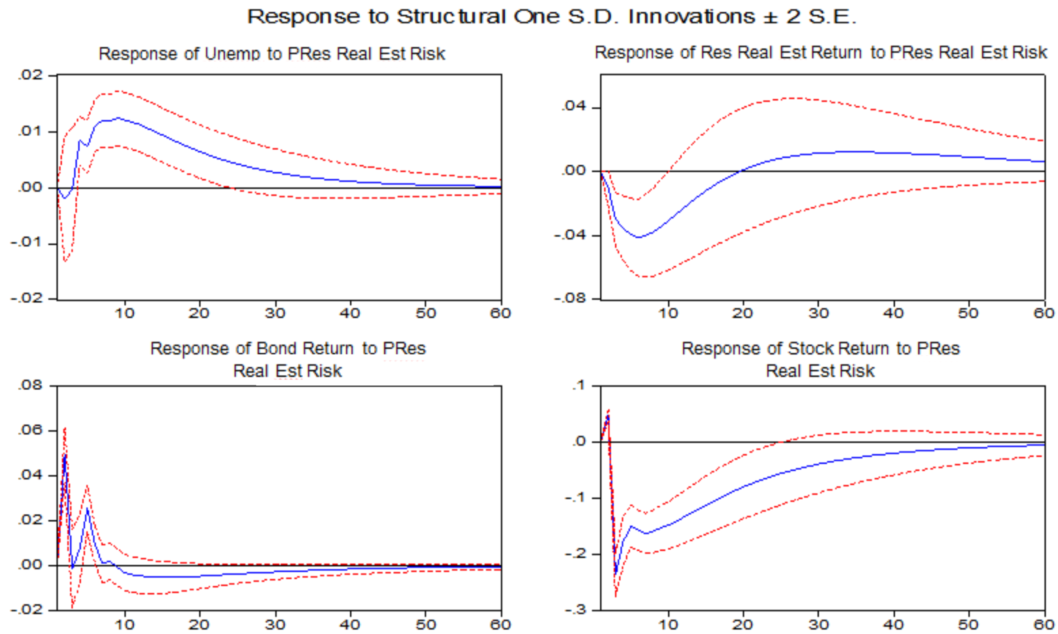


Figure 1.7A: Structural-form IRFs for the 6-variable VAR [Time Deposit, Res Real Est Return, Bond, Stock, PRes Real Est Risk, VIX] (Impulse: PRes Real Est Risk)

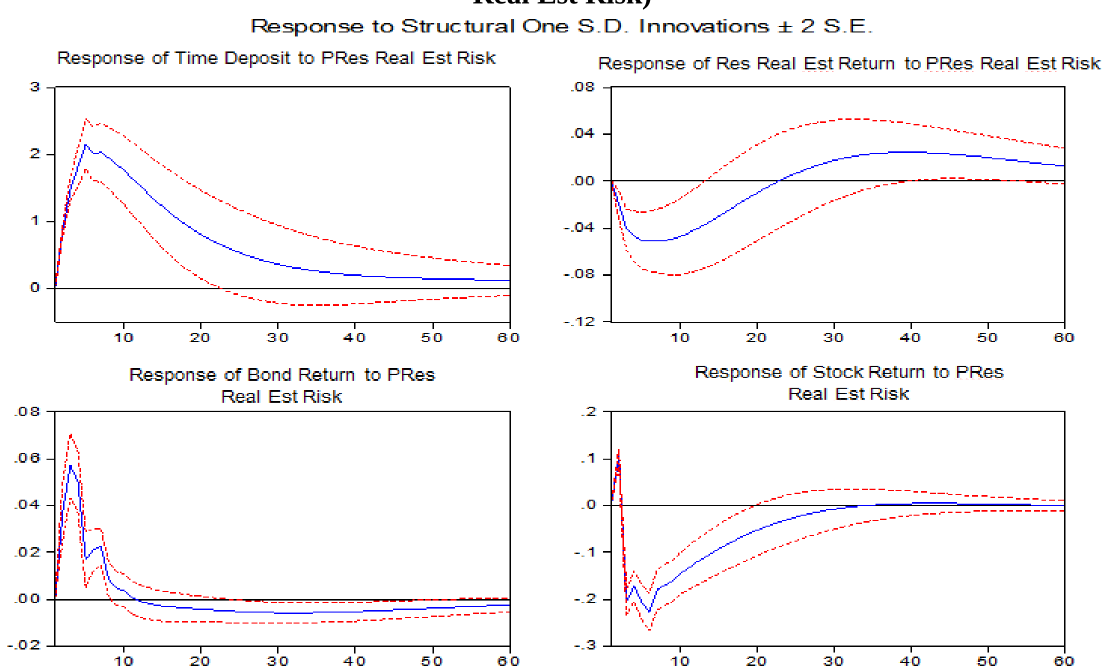


Figure 1.7B: Structural-form IRFs for the 6-variable VAR
[Time Deposit, Res Real Est Return, Bond, Stock, SPRes Real Est Risk, VIX]
(Impulse: VIX)

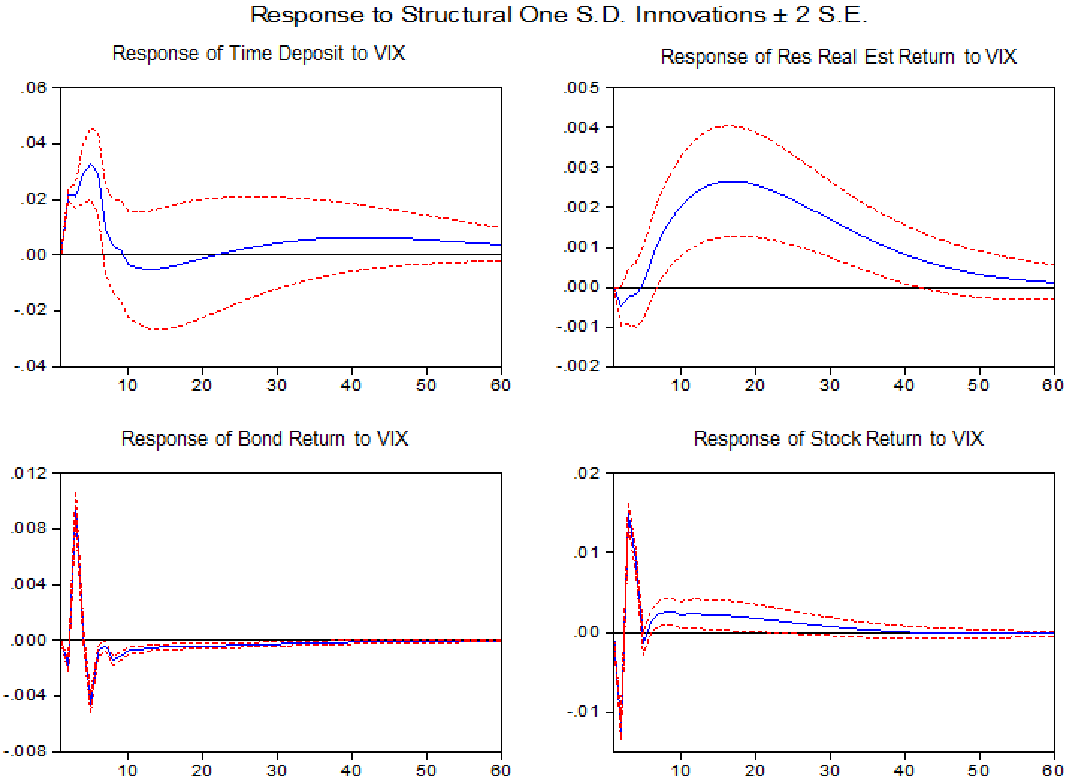


Figure 1.8A: Structural-form IRFs for the 6-variable VAR
[Time Deposit, Res Real Est Return, Bond, Stock, Def Prem, PRes Real Est Risk]
(Impulse: PRes Real Est Risk)

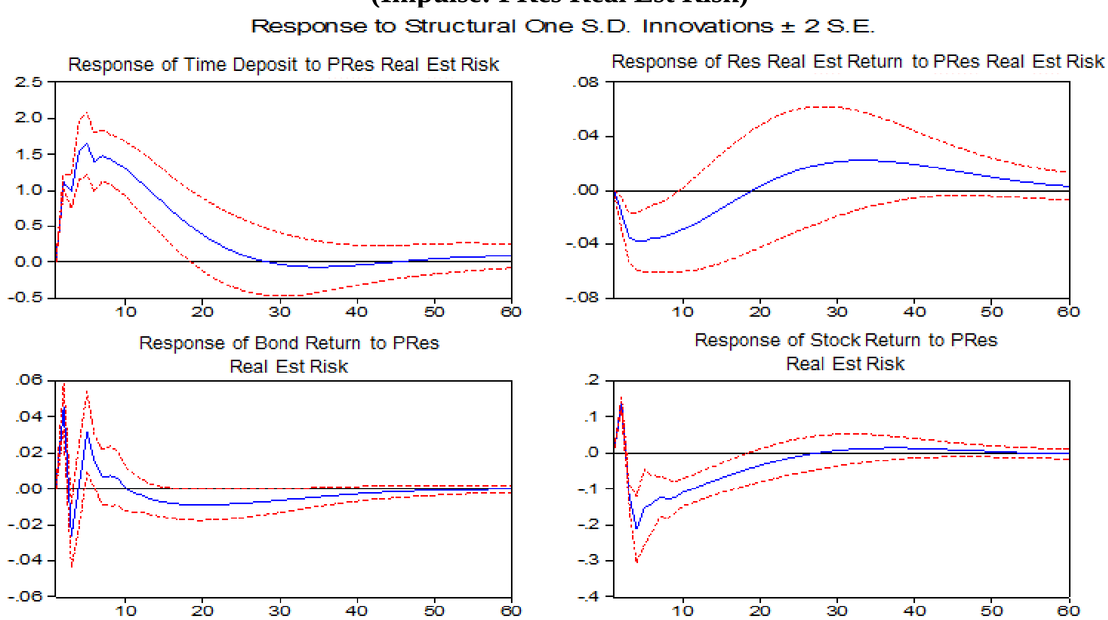


Figure 1.8B: Structural-form IRFs for the 6-variable VAR
[Time Deposit, Res Real Est Return, Bond, Stock, Def Prem, PRes Real Est Risk]
(Impulse: Def Prem)

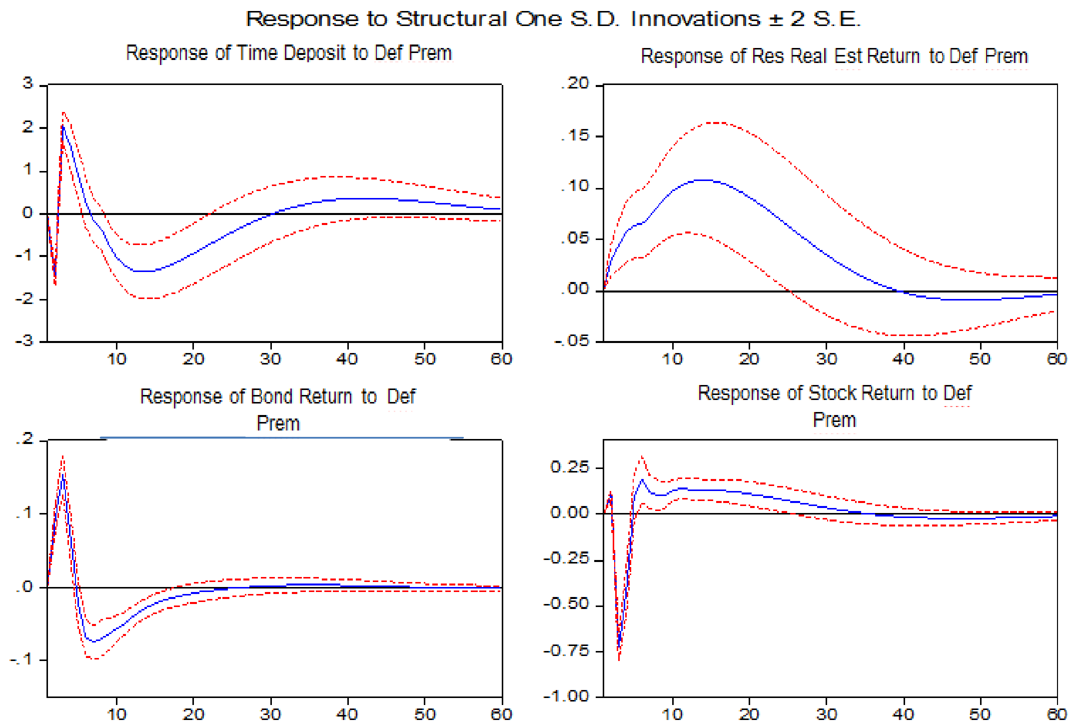


Figure 1.9A: Structural-form IRFs for the 6-variable VAR
[Time Deposit, Res Real Est Return, Bond, Stock, Term Prem, PRes Real Est Risk]
(Impulse: PRes Real Est Risk)

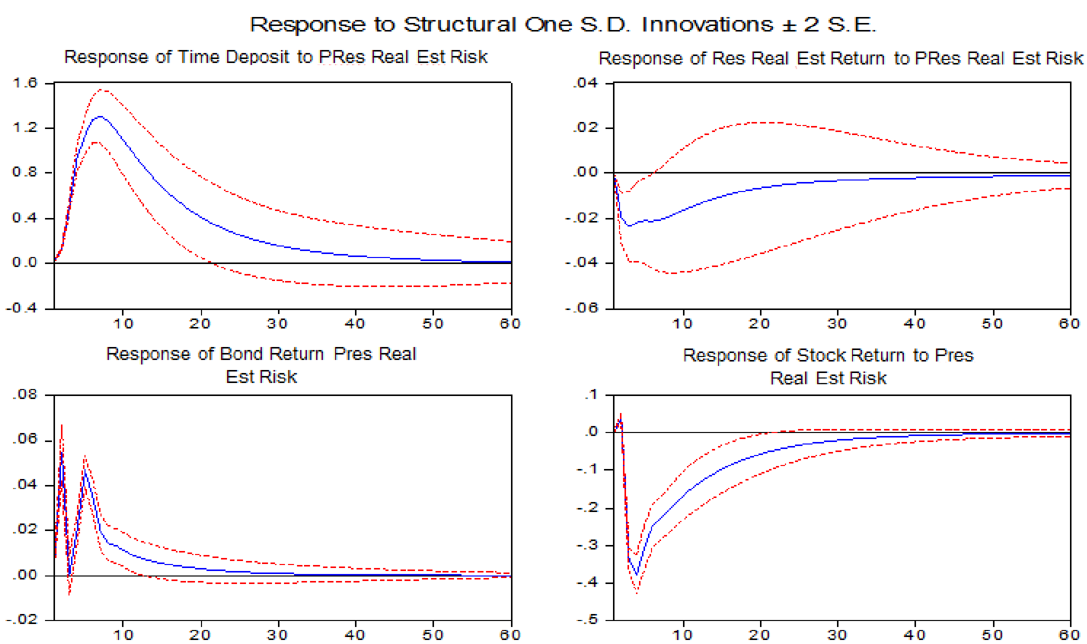


Figure 1.9B: Structural-form IRFs for the 6-variable VAR [Time Deposit, Res Real Est Return, Bond, Stock, Term Prem, PRes Real Est Risk](Impulse: Term Prem)

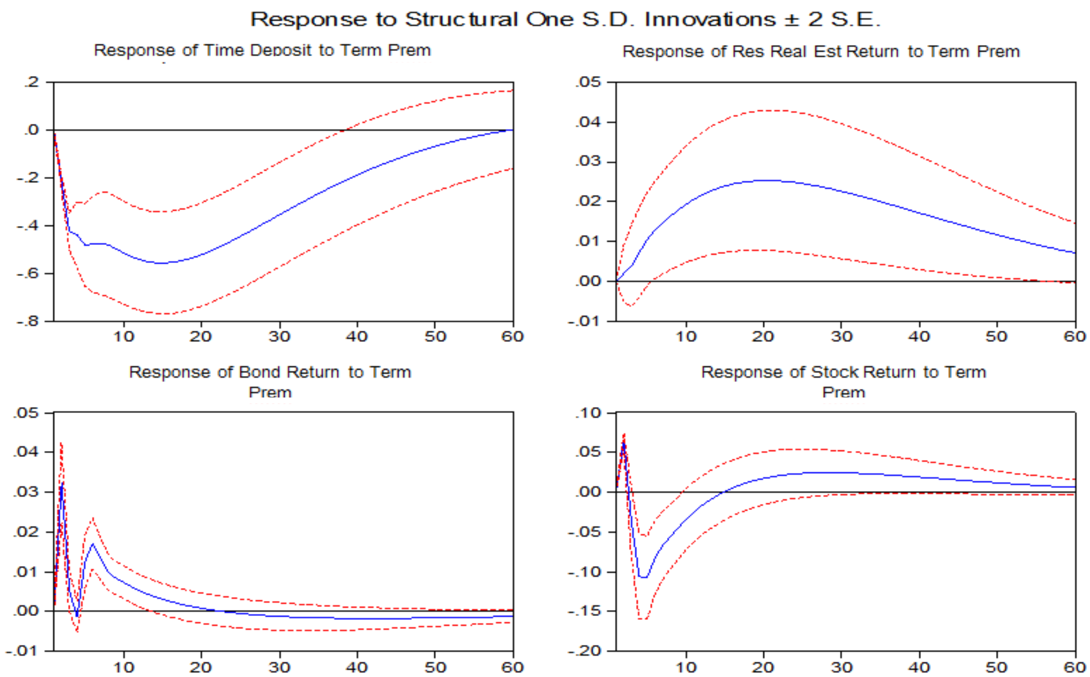


Figure 1.10A: Structural-form IRFs for the 6-variable VAR [Time Deposit, Inflation, Res Real Est Return, Bond, Stock, PRes Real Est Risk] (Impulse: PRes Real Est Risk)

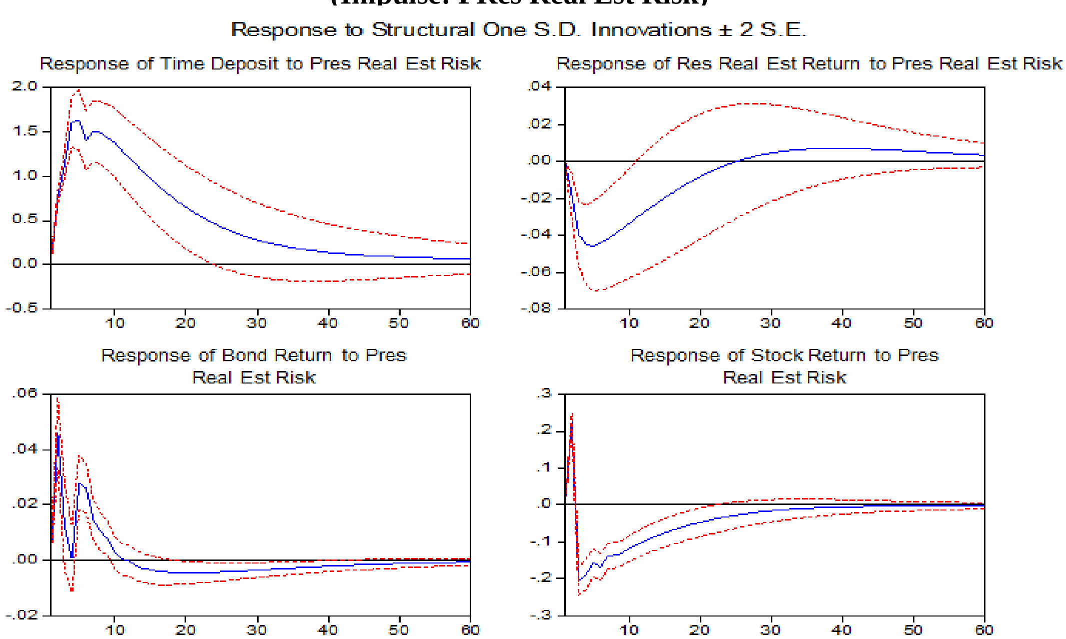


Figure 1.10B: Structural-form IRFs for the 6-variable VAR
[Time Deposit, Inflation, Res Real Est Return, Bond, Stock, PRes Real Est Risk]
(Impulse: Inflation)

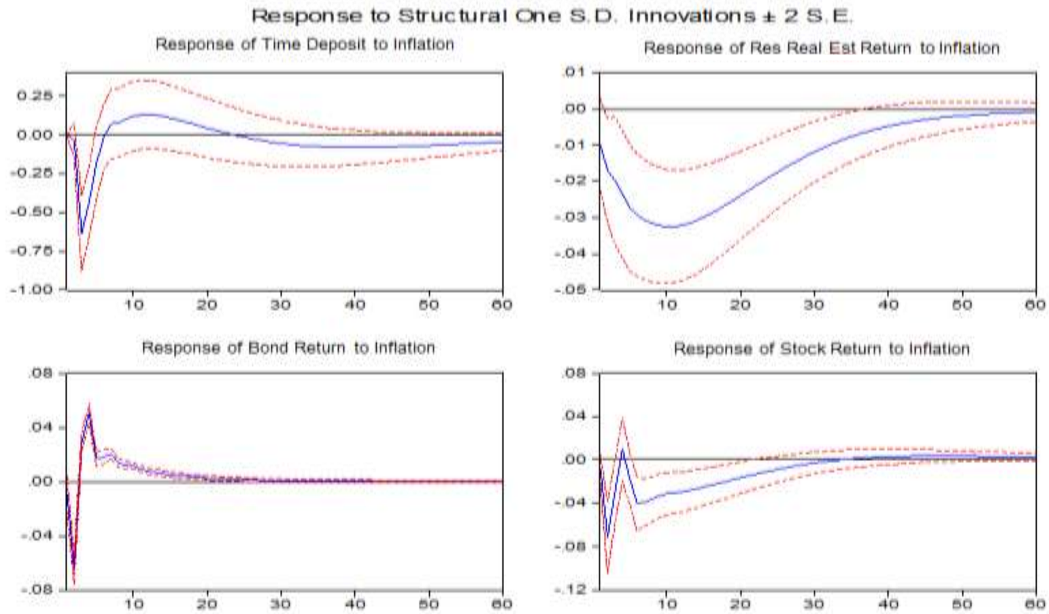


Figure 1.11A: Structural-form IRFs for the 6-variable VAR
[Time Deposit, Bond, Stock, Sec Real Est Return, PRes Real Est Risk, VIX]
(Impulse: PRes Real Est Risk)

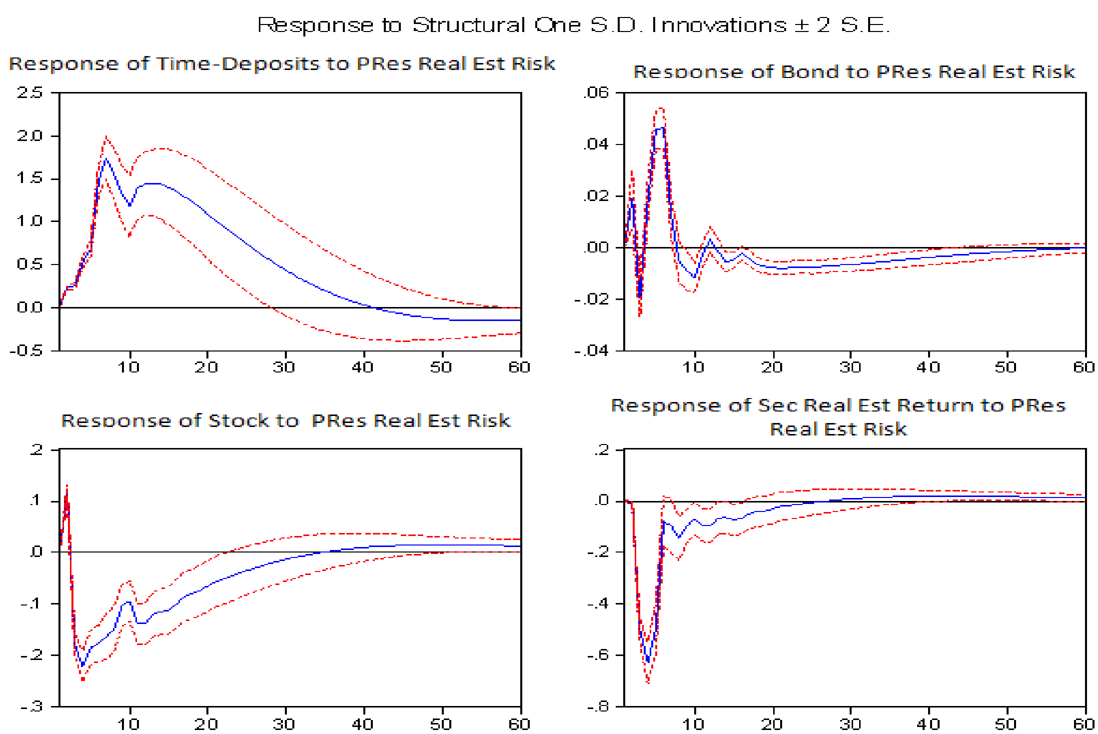


Figure 1.11B: Structural-form IRFs for the 6-variable VAR [Time Deposit, Bond, Stock, Sec Real Est Return, PRes Real Est Risk, VIX] (Impulse: VIX)

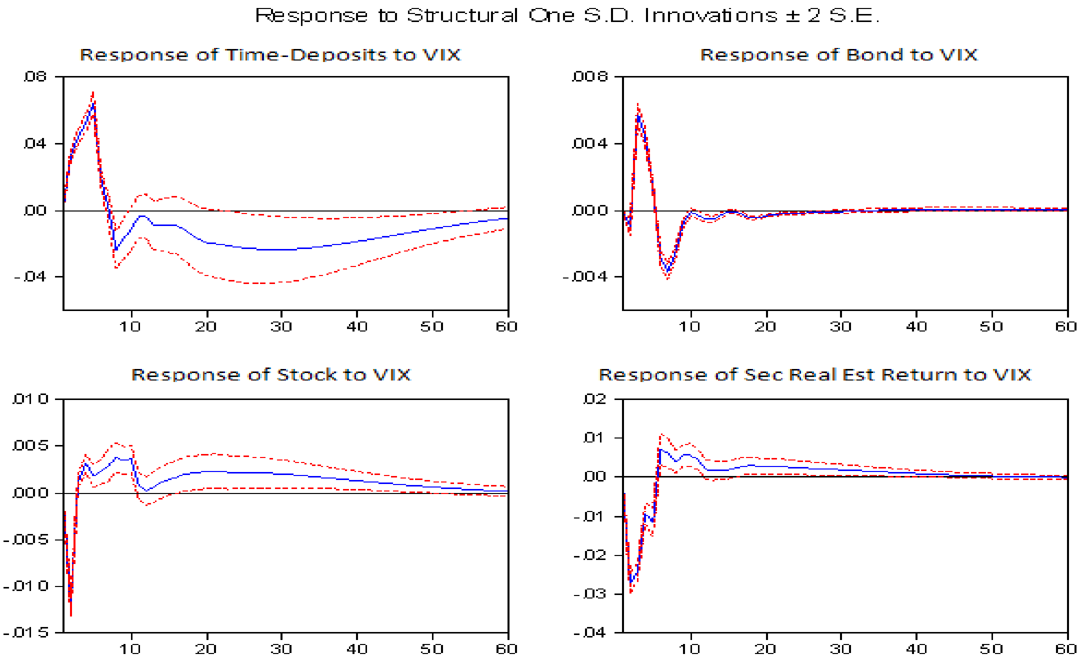


Figure 1.12A: Structural-form IRFs for the 6-variable VAR [Time Deposit, Bond, Stock, Sec Real Est Return, Def Prem, PRes Real Est Risk] (Impulse: PRes Real Est Risk)

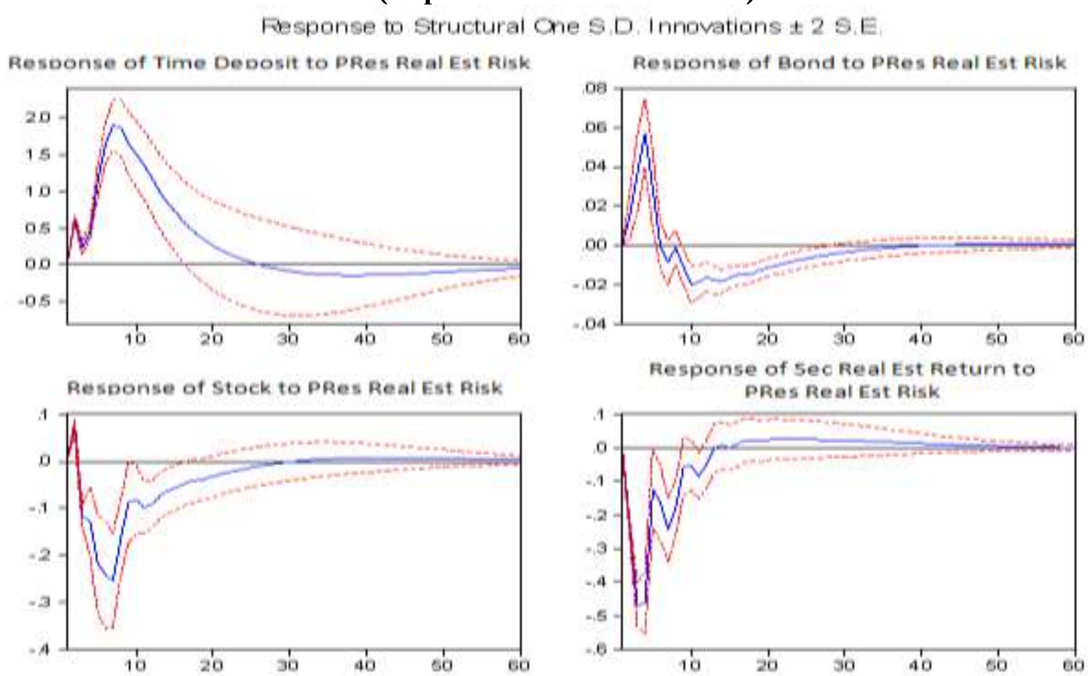


Figure 1.12B: Structural-form IRFs for the 6-variable VAR
[Time Deposit, Bond, Stock, Sec Real Est Return, Def Prem, PRes Real Est Risk]
(Impulse: Def Prem)

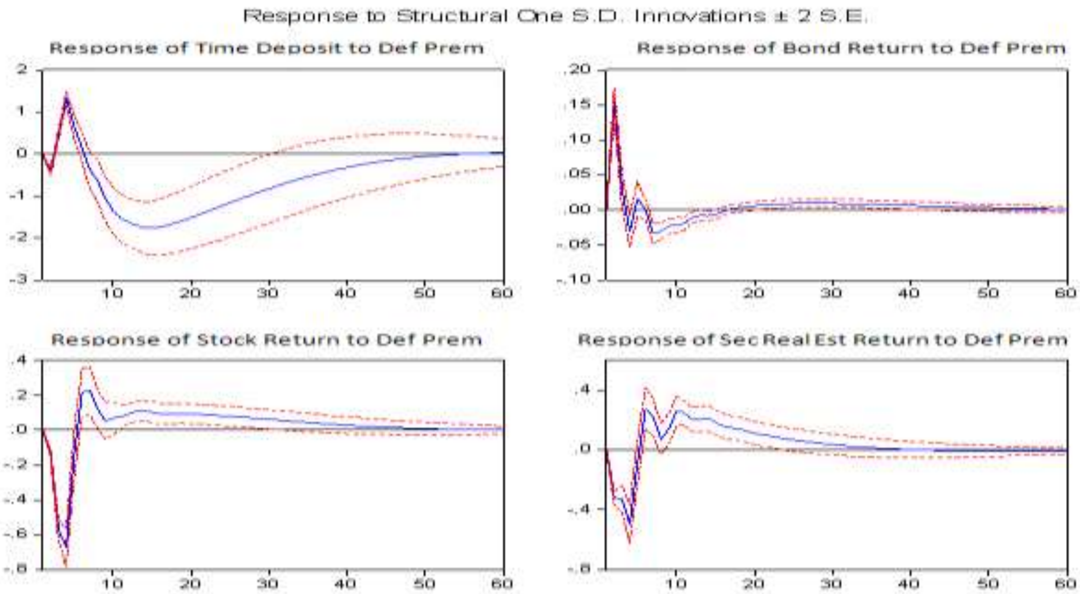


Figure 1.13A: Structural-form IRFs for the 6-variable VAR
[Time Deposit, Bond, Stock, Sec Real Est Return, Term Prem, PRes Real Est Risk]
(Impulse: PRes Real Est Risk)

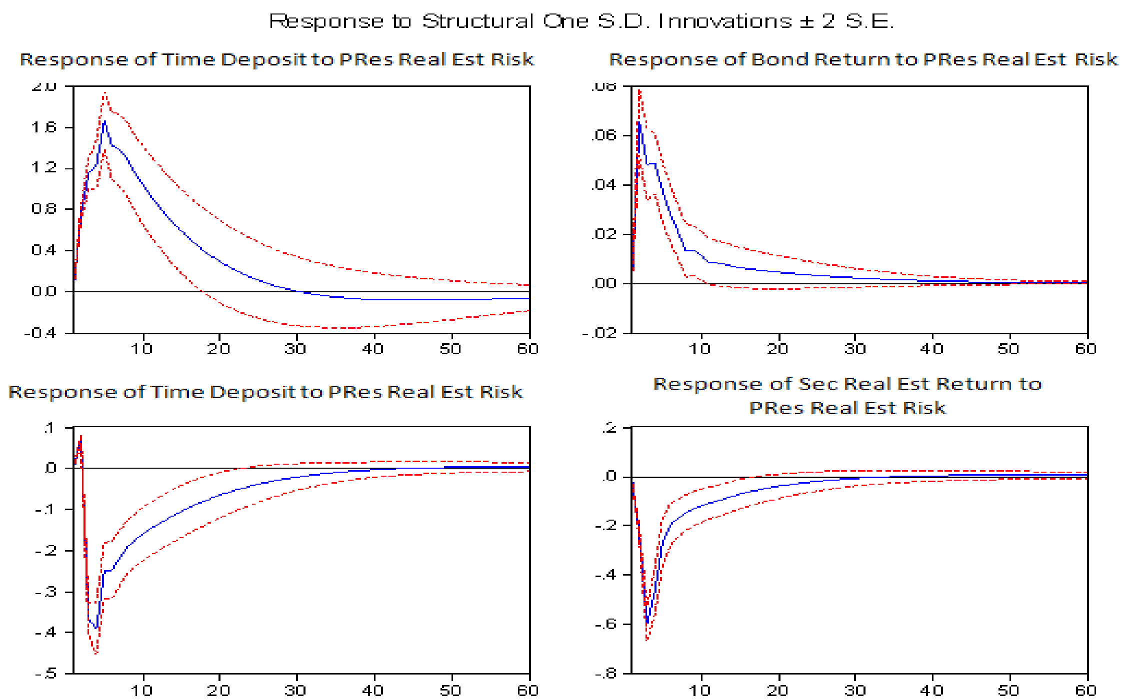


Figure 1.13B: Structural-form IRFs for the 6-variable VAR [Time Deposit, Bond, Stock, Sec Real Est Return, Term Prem, PRes Real Est Risk] (Impulse: Term Prem)

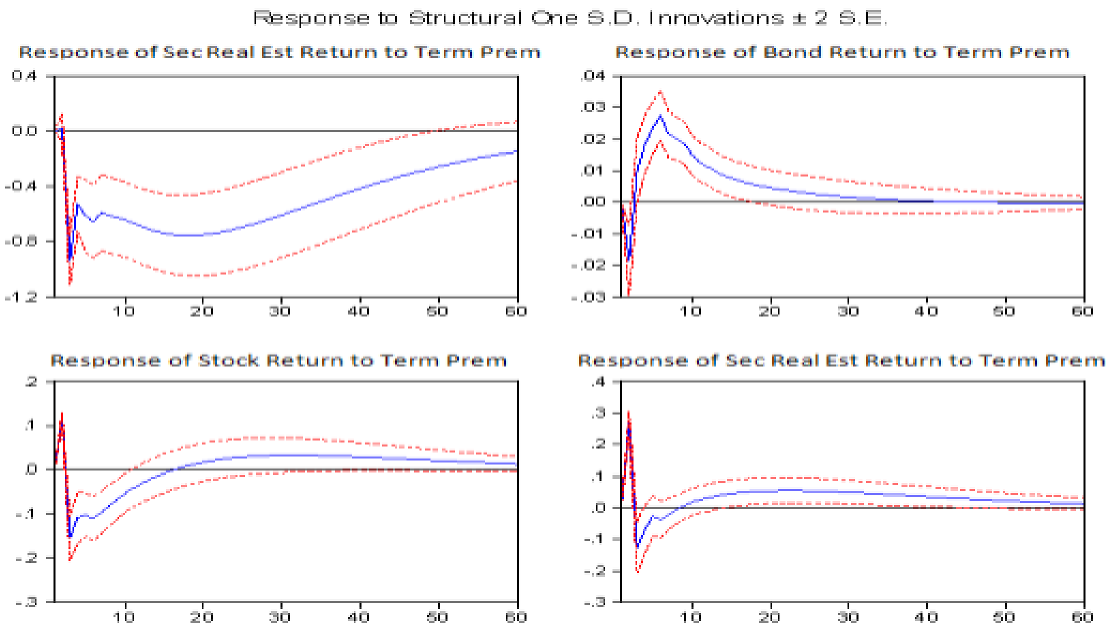


Figure 1.14A: Structural-form IRFs for the 6-variable VAR [Time Deposit, Inflation, Bond, Stock, Sec Real Est Return, PRes Real Est Risk] (Impulse: PRes Real Est Risk)

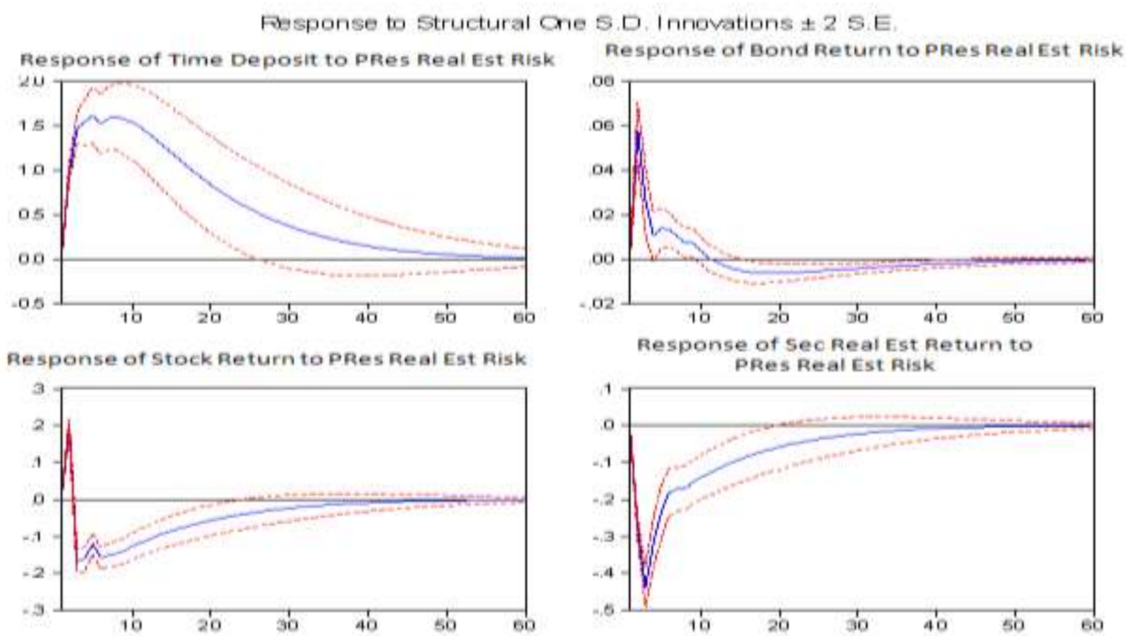
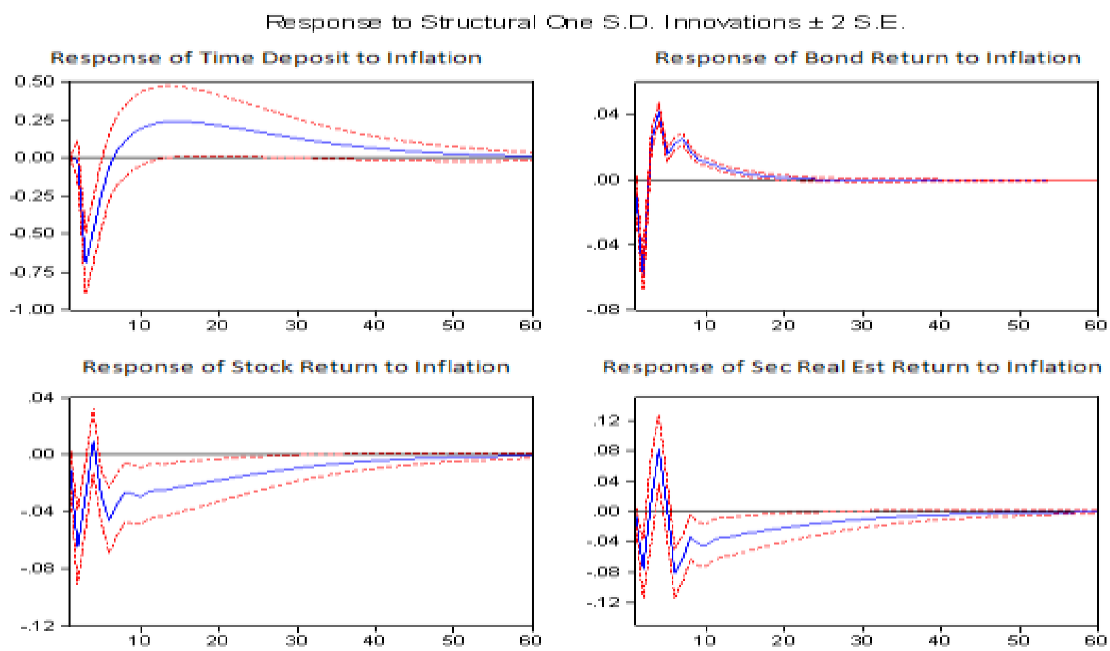


Figure 1.14B: Structural-form IRFs for the 6-variable VAR [Time Deposit, Inflation, Bond, Stock, Sec Real Est Return, PRes Real Est Risk] (Impulse: Inflation)



Chapter 2: An Interaction Among US Stock, US Bond, BRIC Stock and Commodities' Returns

Abstract

During the recent global financial, various assets witness extreme movements – US and emerging nations' stock (BRIC) indices suffered drastic decline; price of gold and US bonds witnessed consistent upward trend; and extreme upward movement in oil prices in the beginning of crisis, followed by extreme decline in oil prices in later stage of crisis. These movements indicate some linkages among asset returns. We attempt to decipher such links or trade-off among asset returns. We attempt to investigate the role of risk and uncertainty from financial markets in explaining pair-wise relationships between two asset returns by using structural vector autoregressive (SVAR). The investigation reveals some interesting strategies for possible portfolio diversification during periods of rising risk and uncertainty in financial risk. During the periods of the rise in default risk in financial markets, gold and bonds act as safe-haven, but this property of gold is extremely short-lived. The returns on BRIC stocks generally respond similar to US stocks in response to the rise in risk or uncertainty from US financial markets, indicating minimum diversification benefits from BRIC stocks during periods of high risk or uncertainty in US financial markets. Oil also does not provide diversification benefits against US stocks during high financial risk and high uncertainty environment.

1. Introduction

The recent global financial global crisis led to drastic decline in stock indices across the world. In 2008 only, the stock indices in US (SP500) declined 37 percent, stock indices of each BRIC countries witnessed sharper decline of much more than 50 percent.[18] The crude oil spot prices also witnessed the most volatile period in 2008 in the history of oil market, reaching a record highest of $ 147 per barrel in July 2008 and dropping to below $ 60 per barrel in November, the same year. The volatility in US equity market increased comprehensively and option implied volatility (VIX) reached record levels.[19] The coordinated effort of US government and US central bank lead to federal fund rate around zero percent in an effort to avoid severe downturn in the economy.

Strong demand for US government bonds during the period of the recent financial crisis fueled upward trend in bond prices along with associated downturn in bond yield. During this time period, corporate bond spreads such as default-premium and term-premium increased substantially indicating rise in risk from financial markets.[20] Gold spot prices hit its the then record of high of over $1000 per ounce in March 2008, and continued with its upward trend to reach its record highest of $1895 per ounce in September 2011.

---

[18] See Figure 2.1 for any co-movement among asset returns. The term 'BRIC' refers to a group of four emerging nations consisting of Brazil, Russia, India and China.

[19] See Figure 2.2 for Chicago Board Options Exchange Market Volatility Index (VIX) and its trend over time.

[20] Refer to figure 2.3. Default-premium indicates short term risk of default and term-premium represents long-term risk of getting invested into long-term investments over short-term investments. We define and describe them further in section 2.

The above examples indicate some linkages among four categories of assets such as US stocks, emerging nations' stocks (BRIC stocks), US bonds, and commodities (gold, oil). Any information regarding relation (or correlation) between returns on two different assets can be helpful to investors in portfolio diversification. For example, if the returns from two assets tend to be correlated (positively or negatively), especially during periods of rising risks or uncertainty in the financial markets, it provides some opportunities to investors for portfolio diversification.

These opportunities for portfolio diversification based on information regarding the relation between returns on two assets attract interests of many researchers to enquire the relation between returns on any of two assets. The wide-spread interest in this issue led to vast literature in this area, but researchers mainly focus on bivariate relation between two assets returns.

The earlier studies focused their attention on investigating bivariate relationship between two asset returns. However, major research in this area investigates the relation between US stock returns with returns on some other assets such as US bonds, Emerging Nations' stocks, oil and gold. For example, Barsky (1989) indicates strong state-dependent co-movement between US stock and US bond returns. Fleming et al. (1998) provide empirical evidence of strong linkages across US stock and bond markets, particularly due to volatility spillovers.

The earlier literature examining relation between US stocks and stocks from developing nations indicates the potential benefits of international portfolio diversification and shows the superiority of portfolios that are composed of both US domestic stocks and stocks from developing nations.[21] However, the recent works based on various empirical methodologies suggest that correlations of global stock returns (US and developing or emerging nations) have increased in the recent periods as a result of increasing financial integration, leading to lower diversification benefits especially in the longer term.[22] There is a growing literature, which investigate the relation between financial assets and commodities. Baur and Lucey (2010) and Baur McDermott (2010) document that gold is an effective hedge for stocks and act as safe-haven in extreme market conditions.

This paper contributes to this literature of examining pair-wise relationship between two different asset returns on three important fronts. First, this is one of the most comprehensive studies investigating the role of risks and uncertainty from financial markets in explaining the relationship among four categories of assets such as US stocks, emerging nations' stocks (BRIC stocks), US bonds, and commodities (gold, oil) consisting of 8 assets, if we consider stock indices of BRIC nations individually.[23] The information regarding relationship between two asset returns during periods of rising financial risk and uncertainty can be extremely helpful in portfolio diversification and asset allocation.

Second, the inclusion of time deposits (at the aggregate level) as a variable in the analysis provides some important insights regarding the behavior of investors in periods

[21] Levy and Sarnat (1970) and Errunza (1997)

[22] Forbes and Rigobon (2002); Aloui, Riadh et al. (2010)

[23] We provide formal definitions of risk and uncertainty variables from financial markets in section 2, while explaining data.

of higher financial risks and uncertainty.[24] We examine the effect of the rise in financial risks and uncertainty on time deposits, which reveals information regarding the movement of investors from more risky assets such as stocks, gold and others to time deposit (safer asset) during periods of high financial risk or uncertainty. Such movement of investors is termed as flight to safety in the literature.

Third, this comprehensive analysis of cross relation between different assets is performed by using a structural vector autoregressive model.[25] Structural VAR has been extensively used in the analysis of monetary and fiscal policy, national and international business cycles. To the best of our knowledge, this framework has never been used to analyze the role of risks or uncertainty from financial markets in explaining the relationship among asset returns.

The results of the analysis show that US stock returns and oil returns are positively correlated during periods of high risk or high uncertainty in financial markets, indicating no diversification benefits in oil returns against US stock returns in extreme conditions of high financial risk and high uncertainty.

In contrary to US stock returns, gold reacts negatively to the rise in default risk in financial markets, indicating diversification opportunities in gold against US stocks. However, the property of gold as safe haven during periods of high default risk is short-lived. The returns on BRIC stocks are generally positively correlated with returns on US stocks during periods of high financial risk or uncertainty, except for periods of high

[24] Bekaert et al. (2010) explains about proxy for time-deposit.

[25] Sims (1986)

term-premium, when BRIC stocks provide diversification opportunity against US stocks for short span of time (3 months). There is no significant effect on time deposit due to any increase in uncertainty (L_VIX) in financial market.

The remainder of the paper is organized as follows: section 2 reviews the literature; section 2 presents the data and variables; section 3 discusses the model and identification; section 4 reports the results; section 5 conducts robustness analysis, and finally section 6 concludes this paper.

2. Data Description

Our sample period spans from January, 1993 to May, 2013. All variables are monthly; based on the end of month data and seasonally adjusted and made stationary for the VAR analysis, when required. The source of all data series is Global Financial Data.[26] The investigation in this paper involves returns on three major groups of assets, namely US financial assets (US stocks and US bonds), Emerging Nations' stocks (BRIC stocks), and commodities (Gold and Oil).[27] We consider Standard and Poor's 500 index (S&P500), USA 10-Year Government Bond Total Return Index to represent US stocks and bonds respectively. Stock indices of BRIC countries are considered to represent stocks of Emerging Nations. We include stock indices such as Brazil Bolsa de Valores de Sao Paulo (Bovespa Total Return Index), Russia AK&M Composite Index (AK&M Composite), Bombay SE Sensitive Index (Sensex), and Sanghai SE Composite Index

[26] The access to Global Financial Data is available through University of California, library.

[27] BRIC represents a group of emerging countries with high GDP growth, which includes Brazil, Russia, India and China.

(SSE Composite) to represent stock markets of Brazil, Russia, India and China respectively.

Gold spot price per ounce and West Texas Intermediate Oil Spot Price per barrel are considered to represent gold and oil markets. Prices or indices representing all assets are converted to US dollars if required. Asset returns are calculated by taking log difference of the price series for all assets. The abbreviations used for asset returns such as US stock returns, US bond returns, gold returns, oil returns are given as SP500_RETURN, USBOND_RETURN, GOLD_RETURN, and OIL_RETURN respectively.

Apart from different return series, we utilize some other variables such as industrial production, time-deposit, default-premium, term-premium, and stock market volatility index in our analysis. The construction of these variables is provided below; when we define major variables used in our analysis.[28]

1) Returns on BRIC stocks (BRICSTOCK_RETURN) are calculated as the average of returns on the above mentioned stock indices of Brazil, Russia, India and China. The weights given to stock index of each BRIC member are equal.

2) Time Deposit (TIMEDEPOSIT) is measured as the difference between level of M2 and M1, where M2 and M1 are aggregate levels of money supply in the economy. Time

[28] The bracket terms are abbreviations for names of variables used in this paper.

deposits are one of the safest assets, when risk or uncertainty is high in financial markets. We utilize growth rate of time deposits in SVAR models.[29]

3) Industrial Production (IP) is used as one of the business cycle variables similar to time deposits. We utilize the growth rate of or seasonally adjusted industrial production in our analysis.

4) Term Premium (TERM_PREMIUM) is calculated as the difference between 10-year government bond yield and 3-month Treasury bill rate. It indicates risk in long-term investment in the economy. The nominal return on long-term investment is uncertain; investors may require compensation for this risk. Investors might be more risk-averse during recessions than in booms and demand higher compensation, raising term premium during recessionary periods.

5) Default Premium (DEF_PREMIUM) is measured as the difference between Moody's Corporate BAA bond and AAA bond yields. It is referred as compensation to investors to hold risky assets in comparison to risk-free assets. Defaults are more likely during recessions, so rise in term premium is an indicator that credit markets expects economic downturn. It reflects short term business condition in the economy.

6) S&P500 Volatility Index (L_VIX) capture stock market volatility in the economy. It is often referred as the fear index, reflecting uncertainty in financial markets.

Table 2.1 indicates that mean monthly returns on stock indices of BRIC countries are the highest (0.399 percent), followed by returns on oil (0.29 percent), returns on gold

[29] Bekaert, Duca, & and Hoerova (2010) utilize growth rate of M2 net of M1 to replace business cycle variable in SVAR analysis of risk, uncertainty and monetary policy

(0.27 percent), US 10-year government bond returns (0.22 percent) and US stock returns (0.22 percent) in that order. However, assets with high mean returns seem also suffer from high volatility. Referring to Table2.1, returns on BRIC stock indices and oil experience highest volatility, followed by gold returns, US stock returns, and US 10-year government bond returns in that order.

The unconditional correlation matrix provided in Table 2.2 provides the evidence of strong positive correlation (0.57) between US stocks and BRIC stock returns. The positive co-movement between US stocks and BRIC stocks indicate lower diversification benefits in BRIC stocks against that of US stocks. The positive correlation of 0.18 between returns on US stocks and oil reduces hedging opportunities against US stocks. In contrast, US stock returns have strong negative correlation (-0.18) with US bond returns and low correlation (0.020) with returns on gold. This indicates opportunities for diversification in US bonds and gold returns in particular against US stocks.

3. Model and Identification

We start our investigation with a 5 variable Vector Autoregression (VAR) containing business cycle variable (TIMEDEPOSIT), returns on US 10-year Treasury bond (USBond_Return), returns on emerging nations' stocks (BRICSTOCK_RETURN), returns on US stocks (SP500_RETURN) and log of stock market volatility index (L_VIX). Further, we replace stock market uncertainty (L_VIX) with other variables representing financial risk such as default premium (DEF_PREMIUM) and term premium (TERM_PREMIUM) and perform the similar analysis.

The analysis focuses on the impulse responses of different asset returns owing to positive shocks to variables such as stock market uncertainty (L_VIX), default premium (DEF_PREMIUM) and term premium (TERM_PREMIUM). We interpret relationship among asset returns depending upon their responses to rise in such risk or uncertainty in the financial markets.

We define $\mathrm{Z_t}$ as (5×1) vector consisting of five variables as discussed above, where growth rate in $\mathrm{(TIMEDEPOSIT)_t}$ is considered to make it stationary for VAR estimation.

$$\mathrm{Z_t = [(TIMEDEPOSIT)_t,\ (USBOND\_Return)_t, (BRICSTOCK\_Return)_t,}$$
$$\mathrm{(SP500\_Return)_t, (L\_VIX)_t]'}$$

We analyze following structural VAR (SVAR)[30]:

$$\mathrm{A\,Z_t = D + \theta\,Z_{t-1} + \epsilon_t} \qquad (1)$$

where A is a 5×5 full rank matrix, D is 5×1 matrix of constants and $\mathrm{E[\epsilon_t\,\epsilon_t'] = I}$. We are mainly interested in analyzing the responses of asset returns and time deposits to shocks in structural shocks ϵ_t.

The reduced-form VAR(5) is estimated in the first step as

$$\mathrm{Z_t = E + B\,Z_{t-1} + e_t} \qquad (2)$$

where, E denotes $\mathrm{A^{-1}D}$; B denotes $\mathrm{A^{-1}\theta}$ and $\mathrm{e_t = C\,\epsilon_t}$ with $\mathrm{C = A^{-1}}$ The error terms $\mathrm{e_t}$ in equation (2) are composites of underlying structural shocks ϵ_t. The variance-covariance matrix of the reduced-form residuals is defined as

$$\sum = \mathrm{E[(C\epsilon_t)\ (C\,\epsilon_t)'] = C\,C'}.$$

[30]Literature on SVAR can be obtained from Sims (1980, 1986); Bernanke (1986); and Applied Econometric Time Series, 2nd Edition by Walter Enders (2003).

The identification of structural VAR is an issue. We need to take the observed values of e_t and restrict the system so as to recover ϵ_t as $\epsilon_t = A\, e_t$. First, it requires restricting they system to recover various ϵ_t. Second, the assumed error structure concerning independence among various ϵ_t shocks need to be maintained.

Using OLS, the variance-covariance matrix $\sum$ can be obtained from equation (2) as

$$\sum = \begin{bmatrix} \sigma_1^2 & \sigma_{12} & \dots\dots & \sigma_{1n} \\ \sigma_{21} & \sigma_2^2 & \dots\dots & \sigma_{2n} \\ \dots & \dots & \dots\dots & \dots \\ \sigma_{n1} & \sigma_{n2} & \dots\dots & \sigma_n^2 \end{bmatrix} \tag{3}$$

Since the variance-covariance matrix $\sum$ is symmetric, it contains $(n^2 + n)/2$ distinct elements. The matrix A contains $(n^2 - n)$ unknowns because its diagonal elements are all unity. Apart from $(n^2 - n)$ unknowns from A, there is another set of $'n'$ unknown values of $\mathrm{var}(\epsilon_t)$ for each variable in Z_t. Thus, there are total n^2 unknown values in structural model and we have only $(n^2 + n)/2$ known values retrieved from $\sum$. Hence, we require $n(n-1)/2$ restrictions to identify the system. In general, for VAR of order k with N variables, we need $(k+1)n^2$ coefficients to identify, but we can estimate only $k\, n^2 + n(n+1)/2$ coefficients. Hence, the number of lag-lengths does not determine the number of restriction required. However, we select lag-length (k) for VAR estimation based on formal selection criteria such as Akaike (AIC), Hannan-Quinn (HQIC) and Schwarz (SBIC). In this specific case of five variable structural VAR (5), we require 10 restrictions.

However, the issue of order among variables included in structural VAR needs to be ascertained before we move on to impose restrictions in SVAR models. The order of variables is important as there might be simultaneity problems among variables included in models.

Our structural VAR analysis involve mainly three categories of variable – business cycle variable (TIME_DEPOSIT and IP), asset returns (USSTOCK_RETURN, USBOND_RETURN, BRICSTOCK_RETURN, GOLD_RETURN, OIL_RETURN) and uncertainty or risk-premiums (L_VIX, DEF_PREMIUM, TERM_PREMIUM). The order of three different groups of variables needs to be ascertained in structural VAR analysis.

In the study related to interaction between business cycle variables and asset prices, Goodhart and Hoofman (2001) indicate that business cycle variables react with some lag in response to shock in asset returns. Several studies on VAR, while analyzing the importance of asset prices (housing or stock prices) typically assume that asset prices are restricted from responding immediately to monetary policy shocks.[31]

Further, several studies investigating relationship between business cycle variables (output and inflation) and monetary policy indicate that aggregate macroeconomic variables do not react contemporaneously to shock in monetary policy, whereas macroeconomic news are responded instantly by policymakers.[32] The shock in monetary policy measures pass through macroeconomic variables slowly due to nominal rigidities. There is evidence of close association between risk or uncertainty variables with

[31] Goodhart and Hoofman (2001); Giuliodori (2005);

[32] Sims (1980, 1986); Svensson (1997); Christiano, Eichenbaum, and Evans (1999); Christiano, Eichenbaum, and Evans (2005)

monetary policy measures.[33] Hence, in structural VAR estimation, we place business cycle variables above variables representing risk-premiums or uncertainty.

Finally, following the above literatures on interaction among three categories of variables, namely business cycle, asset returns and risk (or uncertainty), we arrange variables in Z_t by placing business cycle variable (TIMEDEPOSIT, IP) at the top, followed by asset returns (USSTOCK_RETURN, USBOND_RETURN, BRICSTOCK_RETURN, GOLD_RETURN, OIL_RETURN) and uncertainty or risk-premiums or uncertainty (L_VIX, DEF_PREMIUM, TERM_PREMIUM).

The above mentioned order among variables in vector Z_t assumes that business cycle and asset return variables react with a lag to shock to risk or uncertainty variables, and business cycle variables react with a lag to shock in asset returns. Whenever, we utilized more than one variable from one category in any VAR estimation, we investigated intensively by changing the order among variables from the same category. We did not find any significant variations in responses of various asset returns to any shock in risk-premiums and uncertainty.

After resolving the order among various categories of variables in vector Z_t, we impose exclusion restrictions on short run (contemporaneous) responses by setting some coefficients in ‘A’ equal to zero. Effectively, such restrictions impose ten exclusion restrictions on the cotemporaneous matrix A:

[33] Whaley (200); Bekaert, Duca et al. (2010)

$$A = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{bmatrix} \quad (4)$$

The imposition of the ten short-run restrictions as above through matrix A completes the identification of structural VAR. The identification scheme also satisfies both necessary and sufficient for the identification of structural vector autoregressive system[34]

4. Results

The investigation relies on impulse-response response functions (IRFS) to explain the main results. The primary interest of the paper is to find out how asset returns and time deposit respond to shocks in risks or uncertainty (DEF_PREMIUM, TERM_PREMIUM, L-VIX) from financial markets. We use structural VAR consisting of 5 variables in this section and consisting of 6 variables in the next section dealing with robustness analysis.

We start our investigation by performing a reduced form VAR(5) analysis consisting of 5 variables. As mentioned above we utilize formal lag-selection criteria such as Akaike (AIC), Hannan-Quinn (HQIC) and Schwarz (SBIC) to select optimal lag length. We adopt similar lag-length criteria in VAR(6), when we perform robustness in next section. We also perform stability analysis of every VAR system by ensuring that all roots are inside the unit circle. For different VAR models with different combination of variables, the selection criteria indicate 3 lags at maximum. Table 2.3 is provided as an example for

[34] Rubio-Ramirez, Waggoner and Zha (2009)

the first VAR estimation consisting of 5 variables, where maximum lag of 2 is optimal depending on all three criteria of lag selections. [35]

4.1 Structural Evidence for SVAR,

where variables in Z are ordered as [Z = TIMEDEPPSIT, USBOND_RETURN, BRICSTOCK_RETURN, SP500_RETURN, L_VIX]

In this 5-variables SVAR analysis, we replace variable representing uncertainty in the financial markets (L_VIX) with other variables representing risk (DEF_PREMIUM, TERM_PREMIUM) from financial markets and perform, keeping other four variables the same. Thus, we estimate 3 different SVAR(5) consisting of 5 variables. These risk and uncertainty variables from financial markets generally raise during recessionary periods in US economy.[36] We are mainly interested in how BRIC stock returns respond to positive shock (or rise) in risk and uncertainty from US financial markets. Depending upon reactions from different asset returns in response to positive shocks in financial risk and uncertainty, we comment on relationship among returns from different assets, indicating possible portfolio diversification opportunities.

The first 5-variables SVAR model involves uncertainty (L_VIX) from US financial markets. Fig 2.3 provides impulse responses functions of three asset returns and time deposits to one standard deviation positive shock in uncertainty (L_VIX) from US financial markets. A one standard deviation positive shock in uncertainty (L_VIX) from

---

[35] Results of lag-selection criteria are not provided for other models used in this analysis, but can be obtained for each VAR estimation on request.

[36] See Figure 2.2

US financial markets is followed with significant and positive response from USBOND_RETURN between months 3 and 5. The responses from US stock returns (SP500_RETURN) and BRIC stock returns are similar, being negative for first 3 months and positive after 3 months, indicating strong positive relation between BRIC and US stock returns.

However, the decline in BRIC stock returns due to rise in uncertainty (L_VIX) is deeper as compared to that of US stock returns. The rise in financial uncertainty (L_VIX) also leads to negative correlation between US bond returns and US stock (BRIC stock) returns; indicating some diversification benefit in US bonds against US and BRIC stocks. There is no significant effect on level of time deposits at macro level in US economy due to the rise in uncertainty (L_VIX) in US financial markets.

The second 5-variables SVAR involves default risk (DEF_PREMIUM) from US financial markets. Fig 2.4 provides impulse responses functions of three asset returns and time deposits to one standard deviation positive shock in risk of default (DEF_PREMIUM) from US financial markets. A one standard deviation positive shock in default risk (DEF_PREMIUM) from US financial markets is followed with significant and positive response from US bond returns for first 4 months. The rise in default risk from US financial markets lead to negative response from both US and BRIC stock returns for first 4 months. However, BRIC stock returns recover after 4 months and remain positive between months 4 to 10.

Following such responses from BRIC and US stock returns for first 4 months, there seems strong positive correlation between US and BRIC stock returns due to the rise in default risk from US financial markets, indicating no diversification benefits from BRIC stocks against US stocks in such conditions.[37] However, there exist some diversification benefits in BRIC stocks against US stocks for few months after first 4 months. Bond returns in US market again provide some diversification against US and BRIC stocks during periods of any such rise in default risk. The rise in default premium (DEF_PREMIUM) leads to significant decline in time deposits for more than 10 months, indicating that investors are still not risk-averse, they are investing in some other avenues.[38]

The third SVAR model involves term-premium (TERM_PREMIUM) in place of stock market volatility (L_VIX). Figure 2.5 provides impulse responses functions of three asset returns and time deposits to one standard deviation positive shock in long-term investment risk (TERM_PREMIUM) from US financial markets. The rise in term premium refers to higher risk in long-term investments in US financial markets. The responses from US treasury bonds and BRIC stock returns are positive for first 5 months in response to the rise in term premium, whereas US stock returns respond negatively. Hence, BRIC stock and US bond returns are negatively related to US stock returns in periods of rising term-premium, indicating opportunities of diversification benefits during such situations.

[37] Aloui et al. (2011) indicate that BRIC stocks and US stocks are closely related during extreme conditions due to contagion effect.

[38] There can be other asset markets apart from assets involved in this analysis, which might be providing positive returns during the period of high default risk.

4.2 **Structural Evidence for SVAR**

where variables in Z are ordered as [Z = TIMEDEPPSIT, USBOND_RETURN, GOLD_RETURN, SP500_RETURN, L_VIX]

We replace the variable BRIC stock returns with gold returns and perform similar analysis as above i.e. starting the first SVAR with L_VIX and replace it with default premium in the second model and replace L_VIX with term-premium for the third model. Figure 2.6 provides impulse responses functions of three asset returns and time deposits to one standard deviation positive shock in uncertainty (L_VIX) from US financial markets. There are qualitatively no differences in response of assets or time deposits to positive shock in uncertainty from financial markets. The responses from gold and US stock returns (SP500_RETURN) are similar, negative for first 5 months, and positive after 5 months, indicating positive correlation between US stock and gold return. There is no significant effect on time deposit.

In the second model, all other variables remain the same, except L_VIX is replaced by DEF_PREMIUM. Figure 2.7 provides impulse responses functions of three asset returns and time deposits to one standard deviation positive shock in default risk (DEF_PREMIUM) from US financial markets. The important result is the positive response from gold returns. The response of gold returns remains positive between months of 2 to 5, indicating gold as a safe haven, when there is increase in risk of default from financial markets. However, safe-haven property is short-lived.[39]

---

[39] Baur and Lucey (2010) provide the same result, where gold act as safe haven in extreme stock market condition, but this property of gold is short-lived.

In the third model, we replace L_VIX with TERM_PREMIUM, keeping all other variables the same. Figure 2.8 provides impulse responses functions of three asset returns and time deposits to one standard deviation positive shock in term-premium (TERM_PREMIUM) from US financial markets. Gold returns respond negatively for first 3 months and positive between months 3 to 5. The responses from bond and US stock returns same to such positive shock in term-premium. The persistent negative response from time deposit for more than 20 months indicate that the rise in risk in long-term investment (TERM_PREMIUM) do not deter investors to invest in other assets, which is outside the scope of the analysis in this paper.

4.3 **Structural Evidence for SVAR**

where variables in Z are ordered as [Z = TIMEDEPPSIT, USBOND_RETURN, OIL_RETURN, SP500_RETURN, L_VIX]

We replace the variable (GOLD_RETURN) with (OIL_RETURN) and perform the similar analysis using three SVAR models. Figures (2.9, 2.10 and 2.11) indicate that the responses from variables such as US bond returns, US stock returns (SP500_RETURN) and time deposits to a positive shock in any of three risk or uncertainty variables are qualitatively similar to results obtained earlier in sections 4.1 and 4.2. However, it is important to point out that oil returns respond similar to that of US stock returns (SP500_RETURN) to positive shock in risk or uncertainty from US financial markets, indicating strong positive correlation between oil and US stock returns during extreme stock market conditions.

The main results of the analysis are that US stock returns and oil returns are positively correlated during periods of high risk or high uncertainty in financial markets, indicating almost no diversification benefits in oil returns against US stock returns. In contrary to US stock returns, gold reacts negatively to the rise in default risk in financial markets, indicating diversification opportunities in gold against US stocks. However, the property of gold as safe haven during periods of high default risk is short-lived.

The returns on BRIC stocks are generally positively correlated with returns on US stocks during periods of high financial risk or uncertainty, except for periods of high term-premium, when BRIC stocks provide diversification opportunity against US stocks for short span of time (3 months). There is no significant effect on time deposits due to any increase in uncertainty (L_VIX) in financial market. However, persistent negative responses of time deposit to any positive shock in default-premium or term-premium indicate that investors do not become risk-averse due to such adverse shock; instead they invest in some other assets during such periods of high risks.

5. Robustness

In this section, we have considered two types of robustness checks: 1) general identification and measurement of business cycle variables; 2) other channels.

5.1 General Identification and Measurement of Business Cycle Variables

For all 5 and 6 variables structural VAR in the robustness checks, we have followed certain guidelines. In vector Z_t, we have maintain following order among variables – business cycle variables (TIMEDEPOSIT, IP) at the top, followed by asset returns

(USSTOCK_RETURN, USBOND_RETURN, BRICSTOCK_RETURN, GOLD_RETURN, OIL_RETURN), and risk or uncertainty (DEFAULT_PREMIUM, TERM_PREMIUM, L_VIX) from US financial markets in that order. The explanations for such order among business cycle, asset returns and risk or uncertainty are provided in section 3. The orders of variables among their respective categories (business cycle, asset returns, and risk or uncertainty) are changed during investigation and there are no qualitative differences in the main results for the effect of risk or uncertainty on various asset returns.

We also used IP in place of TIMEDEPOSIT in various SVAR analyses and found no qualitative difference in responses of various assets to positive shock in risk or uncertainty variables. The lag-length for each SVAR is selected depending upon three criteria mentioned in section 3. We have also tested up to VAR lag-length of 3, maintaining necessary and sufficient conditions for global identifications; the results remain qualitatively similar. Detailed results can be available upon request.

5.2 Other Channels

We include two variables out of three risk and uncertainty variables (L_VIX, DEF_PREMIUM and TERM_PREMIUM) in SVAR(5) to make it SVAR(6) analysis. We provide impulse responses from those 9 models, 3 each from the combination of variables mentioned in sections 4.1, 4.2 and 4.3. Figures (starting from 2.12A to 2.26) mention various combinations and order of variables included in Z for SVAR(6) analysis along with impulse response functions of asset returns and time deposits to positive shock in financial risks and uncertainty (DEF_PREMIUM, TERM_PREMIUM and L_VIX).

The results from these SVAR(6) are not qualitatively different from results discussed in section 4.

6. Conclusions

The paper is an attempt to investigate the role of risk and uncertainty from financial markets in explaining the pair-wise relationship between different assets; consequently examining potential portfolio diversification benefits of assets against US stocks.

The main results of the analysis are that US stock returns and oil returns are positively correlated during periods of high risk or high uncertainty in financial markets, indicating no diversification benefits in oil returns against US stock returns in extreme conditions of high financial risk and high uncertainty.

In contrary to US stock returns, gold reacts negatively to the rise in default risk in financial markets, indicating diversification opportunities in gold against US stocks. However, the property of gold as safe haven during periods of high default risk is short-lived. The returns on BRIC stocks are generally positively correlated with returns on US stocks during periods of high financial risk or uncertainty, except for periods of high term-premium, when BRIC stocks provide diversification opportunity against US stocks for short span of time (3 months). There is no significant effect on time deposit due to any increase in uncertainty (L_VIX) in financial market.

However, persistent negative responses of time deposit to any positive shock in default-premium or term-premium indicate that investors do not become risk-averse due to such adverse shock; instead they invest in some other assets during such periods of high risks.

The analysis encourages investigating non-linear relationship between different asset returns in future research based on risk and uncertainty from financial markets. It also encourages investigating the relationship of US stocks with other assets such as real estate during periods of high financial risks and uncertainty, and potential diversification benefits in real estates against US stocks.

Table 2.1 Summary Statistics

	SP500 RETURN	USBOND RETURN	BRICSTOCK RETURN	GOLD RETURN	OIL RETURN
Mean	0.222564	0.223192	0.399982	0.279033	0.296884
Maximum	4.443119	3.970436	21.70502	6.947176	13.4275
Minimum	-8.06209	-3.210165	-20.65275	-8.292901	-16.98824
Std. Dev.	1.943651	0.95172	3.92158	1.96667	4.056203

Table 2.2 Unconditional Correlation Matrix

	SP500 RETURN	USBOND RETURN	BRICSTOCK RETURN	GOLD RETURN	OIL RETURN
SP500_RETURN	1.000	-0.179	0.573	0.020	0.184
USBOND_RETURN	-0.179	1.000	-0.234	0.144	-0.159
BRICSTOCK_RETURN	0.573	-0.234	1.000	0.203	0.227
GOLD_RETURN	0.020	0.144	0.203	1.000	0.204
OIL_RETURN	0.184	-0.159	0.227	0.204	1.000

Table 2.3 Lag Selection Criteria for SVAR model

Lag	AIC	SC	HQ
0	12.20288	12.27927	12.23372
1	10.13804	10.59641*	10.32308*
2	10.12234*	10.96267	10.46158
3	10.18729	11.40959	10.68073
4	10.28514	11.88941	10.93277
5	10.33673	12.32298	11.13857
6	10.40004	12.76825	11.35607
7	10.44303	13.19322	11.55326
8	10.60092	13.73307	11.86534
9	10.69428	14.20840	12.11291
10	10.79299	14.68908	12.36581

* indicates lag order selected by the criterion
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion
LR: sequential modified LR test statistic (each test at 5% level)

Figure2.1 Asset Prices (Log values)

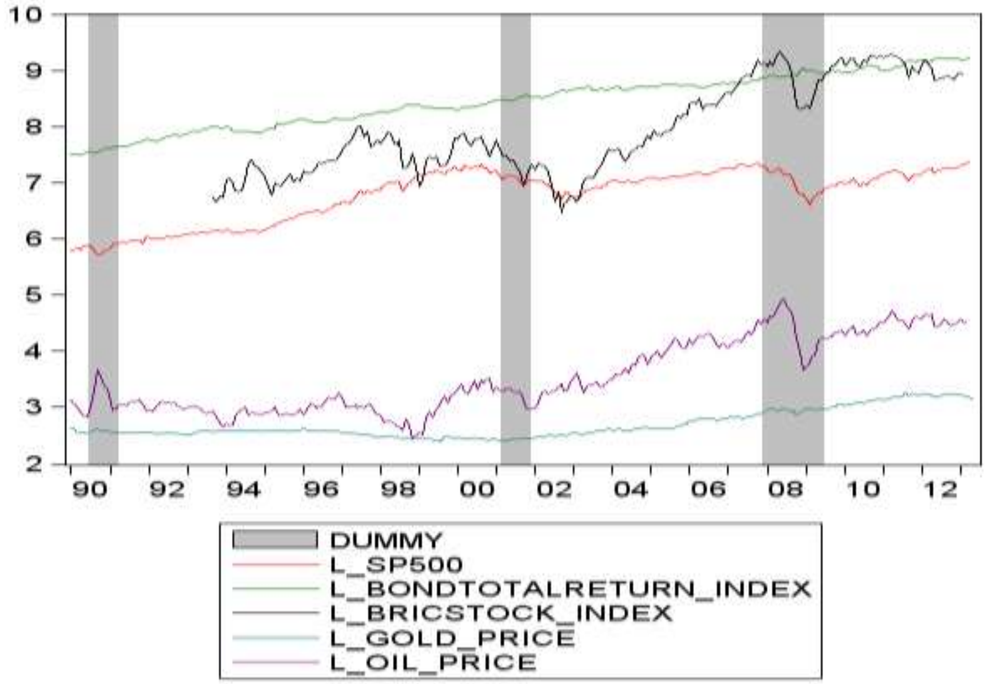


Figure 2.2 Variables representing Risk and Uncertainty

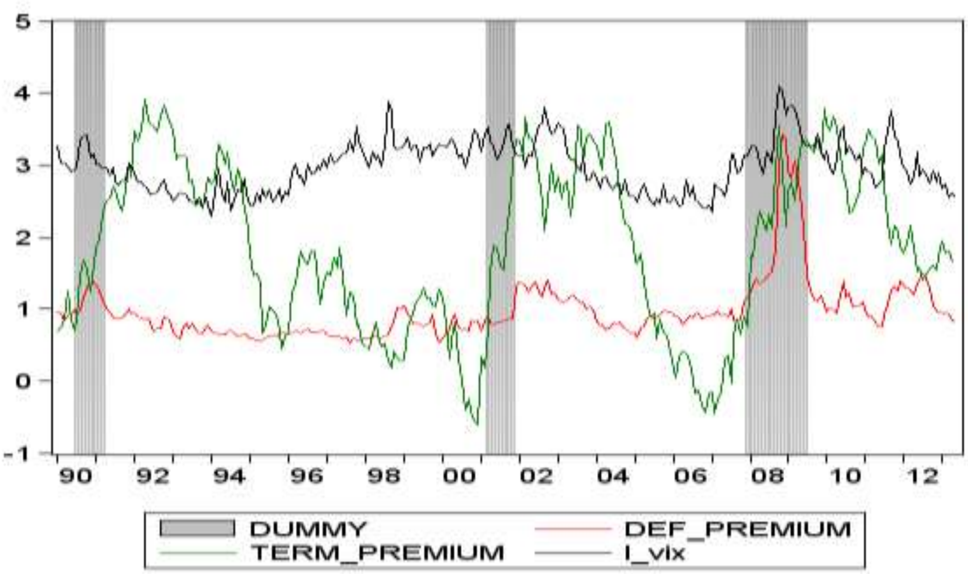


Figure 2.3 Structural-form IRFs for SVAR(5) to Impulse from (L_VIX)
[Timedeposit, USBond_Return, BRICStock_Return, SP500_Return, L_VIX]

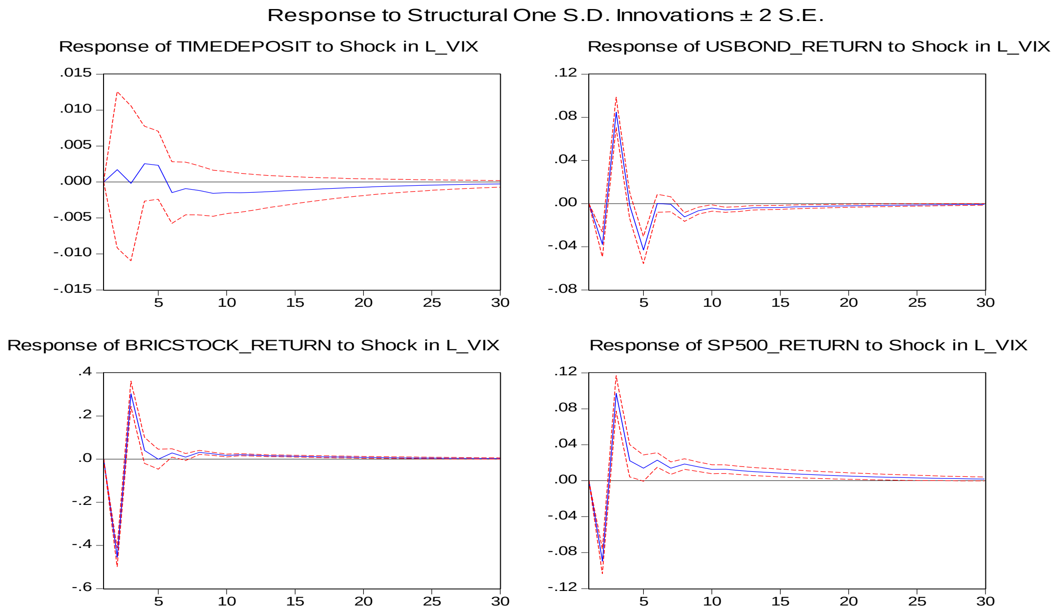


Figure 2.4 Structural-form IRFs for SVAR(5) to Impulse from (Def_Premium)
[Timedeposit, USBond_Return, BRICStock_Return, SP500_Return, Def_Premium]

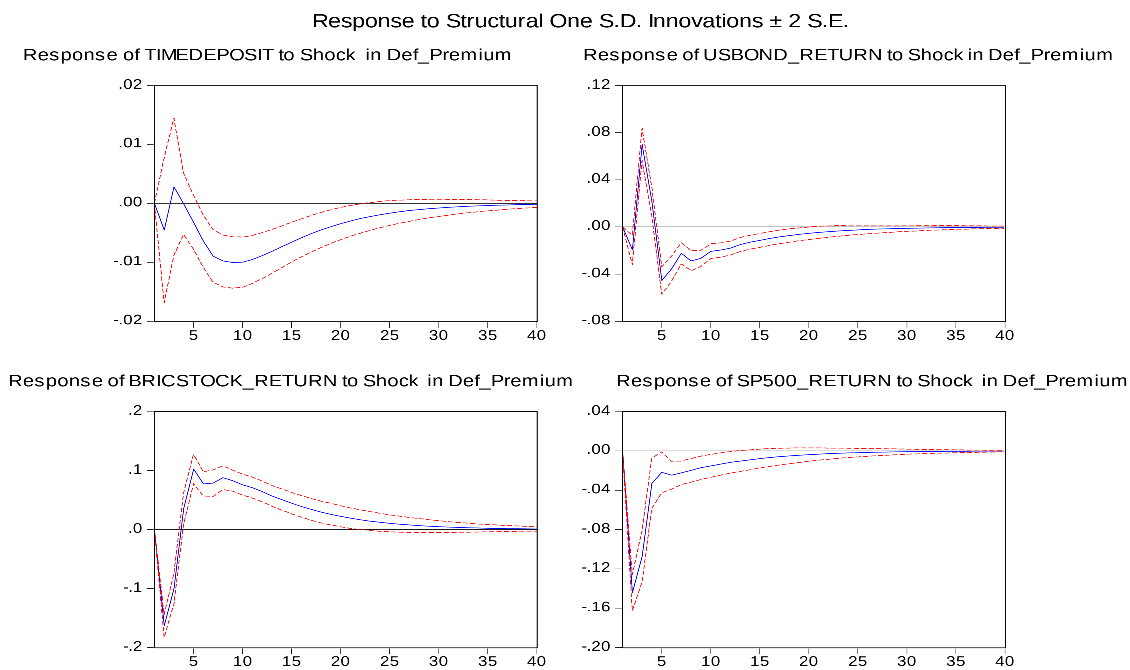


Figure 2.5 Structural-form IRFs for SVAR(5) to Impulse from (Term_Premium) [Timedeposit, USBond_Return, BRICStock_Return, SP500_Return, Term_Premium]

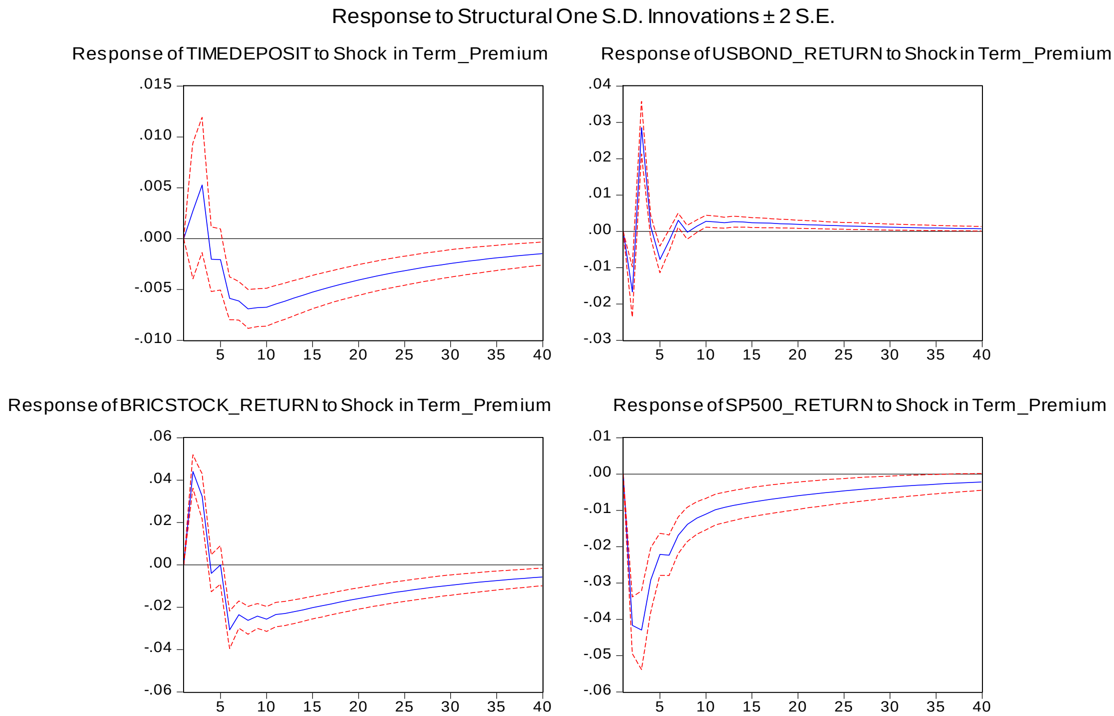


Figure 2.6 Structural-form IRFs for SVAR(5) to Impulse from (L_VIX) [Timedeposit, USBond_Return, Gold_Return, SP500_Return, L_VIX]

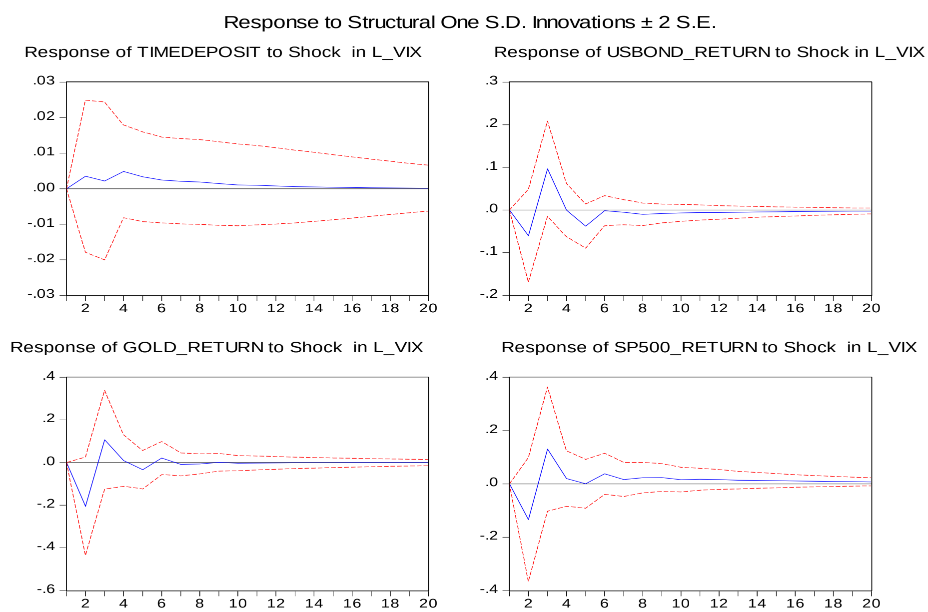


Figure 2.7 Structural-form IRFs for SVAR(5) to Impulse from(Def_Premium) [Timedeposit, USBond_Return, Gold_Return, SP500_Return, Def_Premium]

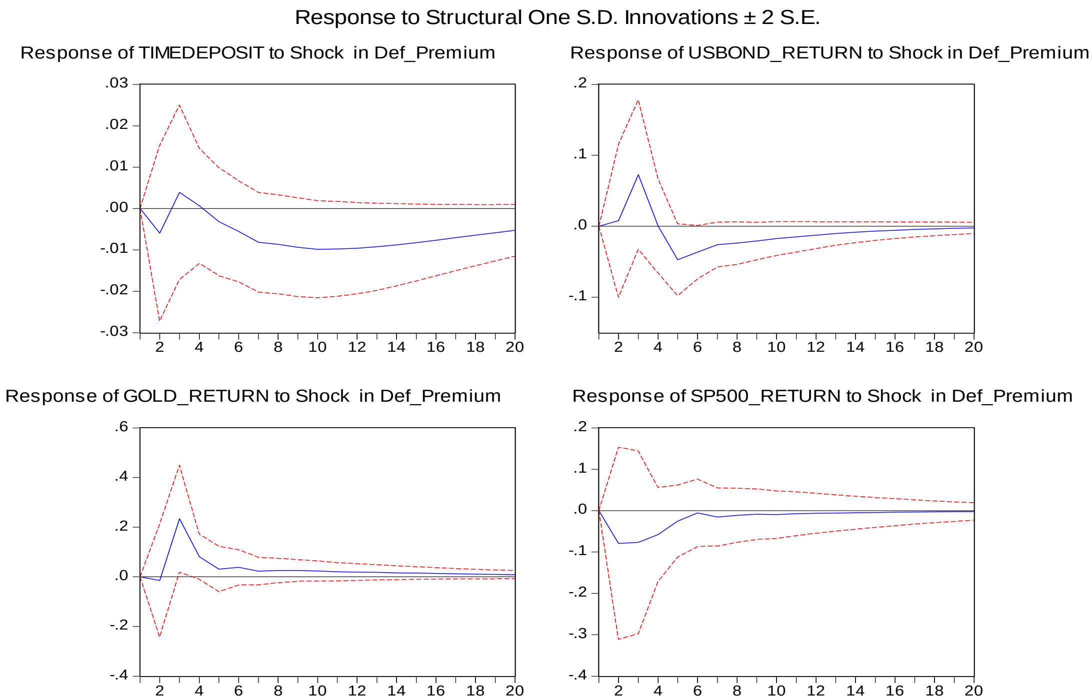


Figure 2.8 Structural-form IRFs for SVAR(5) to Impulse from(Term_Premium) [Timedeposit, USBond_Return, Gold_Return, SP500_Return, Term_Premium]

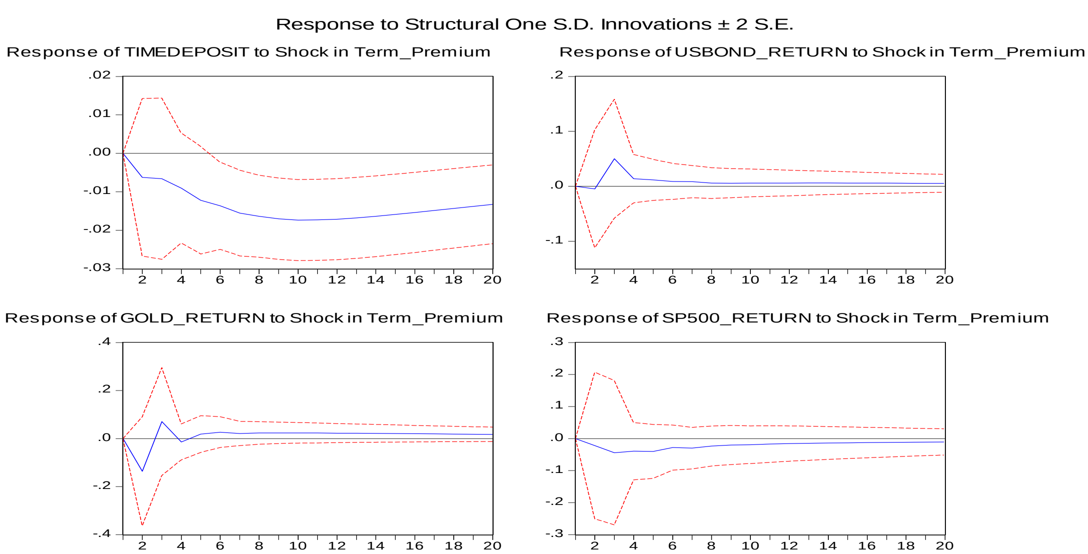


Figure 2.9 Structural-form IRFs for SVAR(5) to Impulse from(L_VIX) [Timedeposit, USBond_Return, Oil_Return, SP500_Return, L_VIX]

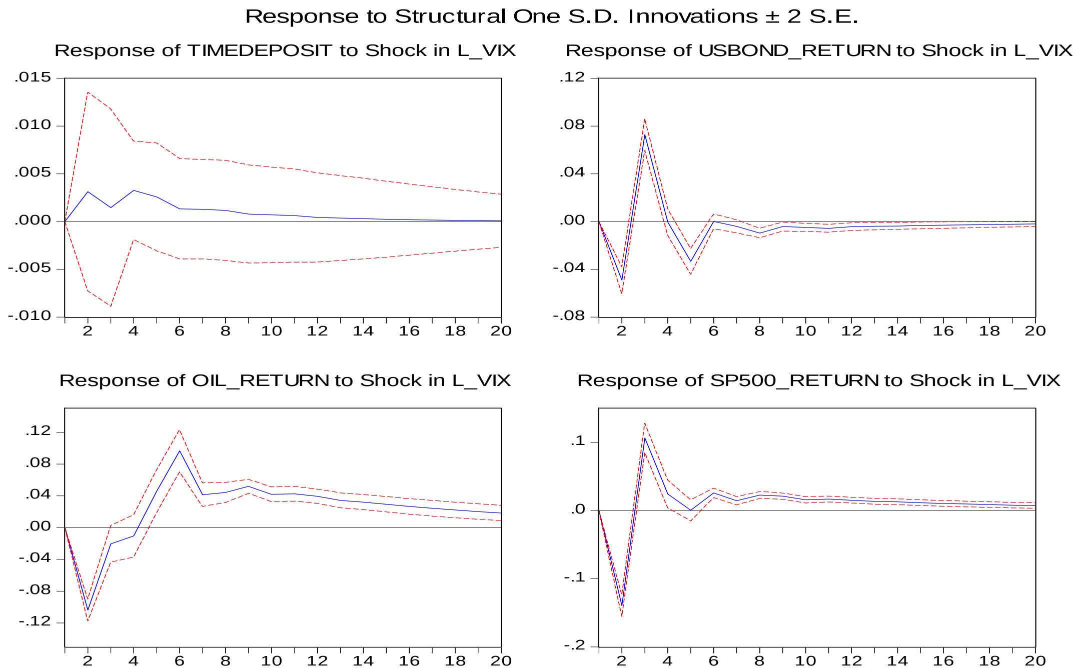


Figure 2.10 Structural-form IRFs for SVAR(5) to Impulse from(Def_Premium) [Timedeposit, USBond_Return, Oil_Return, SP500_Return, Def_Premium]

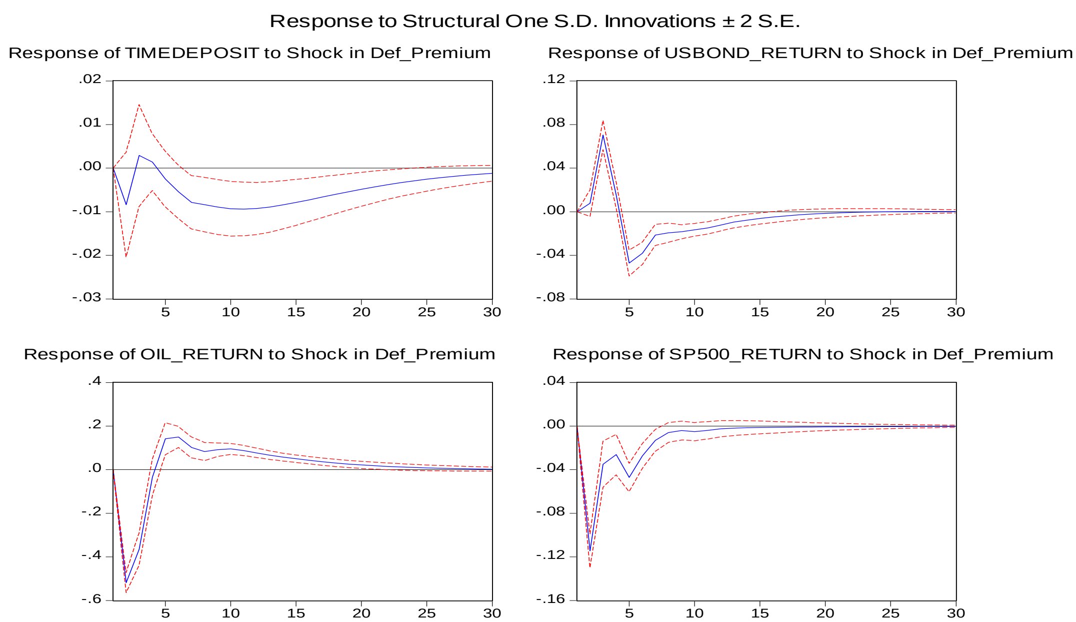


Figure 2.11 Structural-form IRFs for SVAR(5) to Impulse from(Term_Premium) [Timedeposit, USBond_Return, Oil_Return, SP500_Return, Term_Premium]

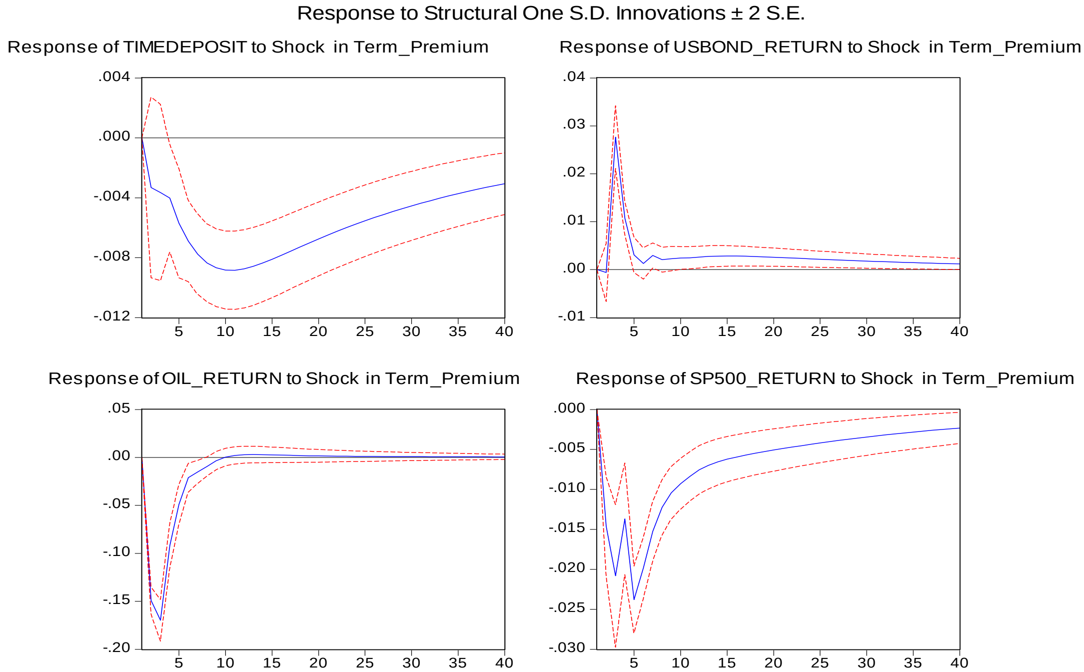


Figure 2.12A Structural-form IRFs for SVAR(6) to Impulse from(Def_Premium) [Timedeposit, USBond_Return, BRICStock_Return, SP500_Return, Def_Premium, L_VIX]

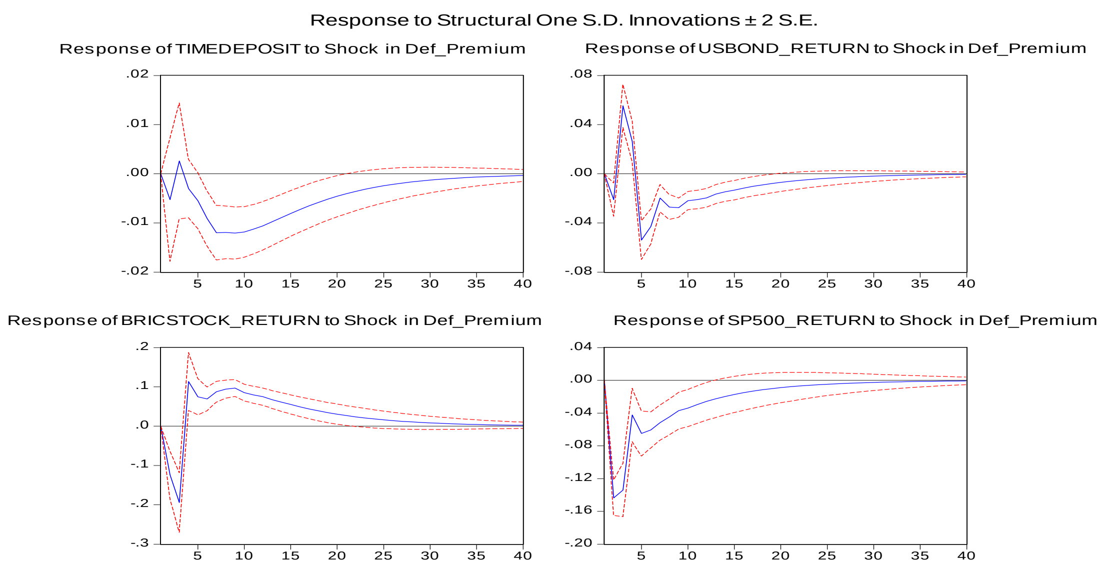


Figure 2.12B Structural-form IRFs for SVAR(6) to Impulse from(L_VIX)
[Timedeposit, USBond_Return, BRICStock_Return, SP500_Return, Def_Premium, L_VIX]

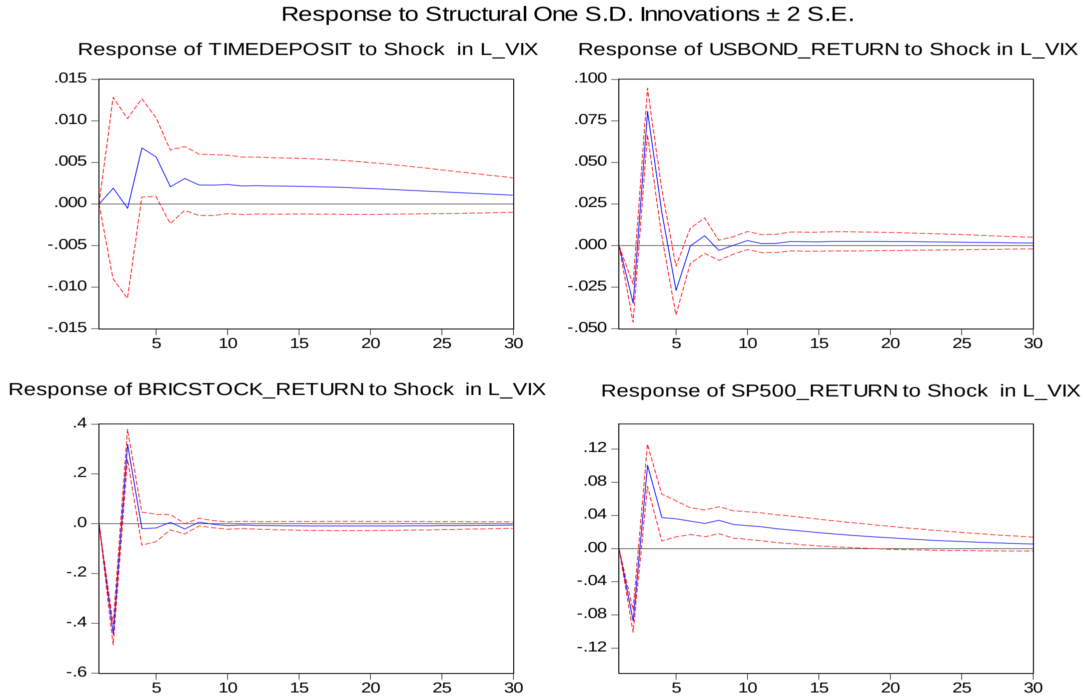


Figure 2.13A Structural-form IRFs for SVAR(6) to Impulse from(Term_Premium)
[Timedeposit, USBond_Return, BRICStock_Return, SP500_Return, Term_Premium, L_VIX]

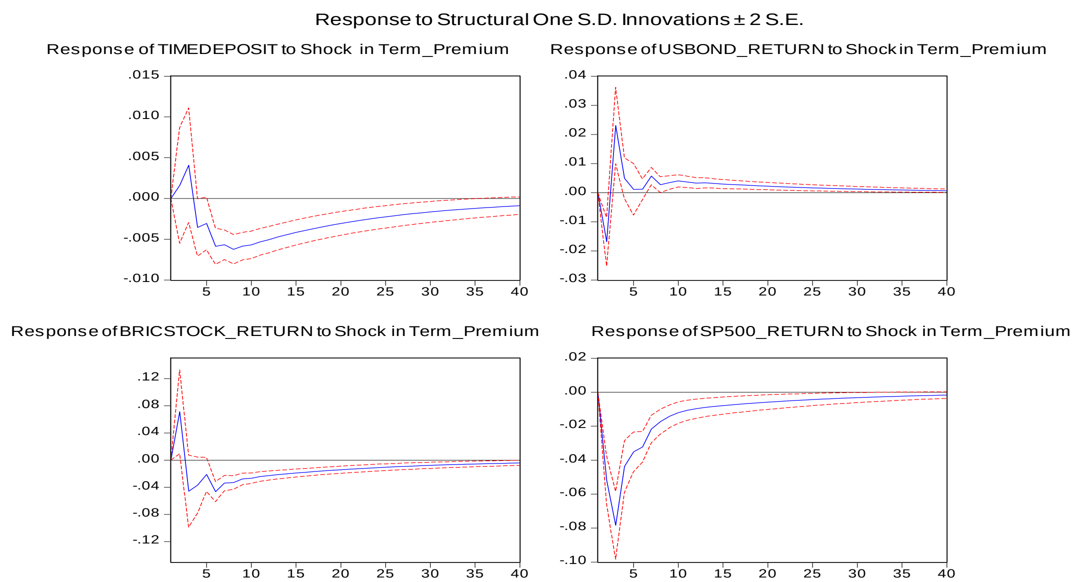


Figure 2.13B Structural-form IRFs for SVAR(6) to Impulse from(L_VIX) [Timedeposit, USBond_Return, BRICStock_Return, SP500_Return, Term_Premium, L_VIX]

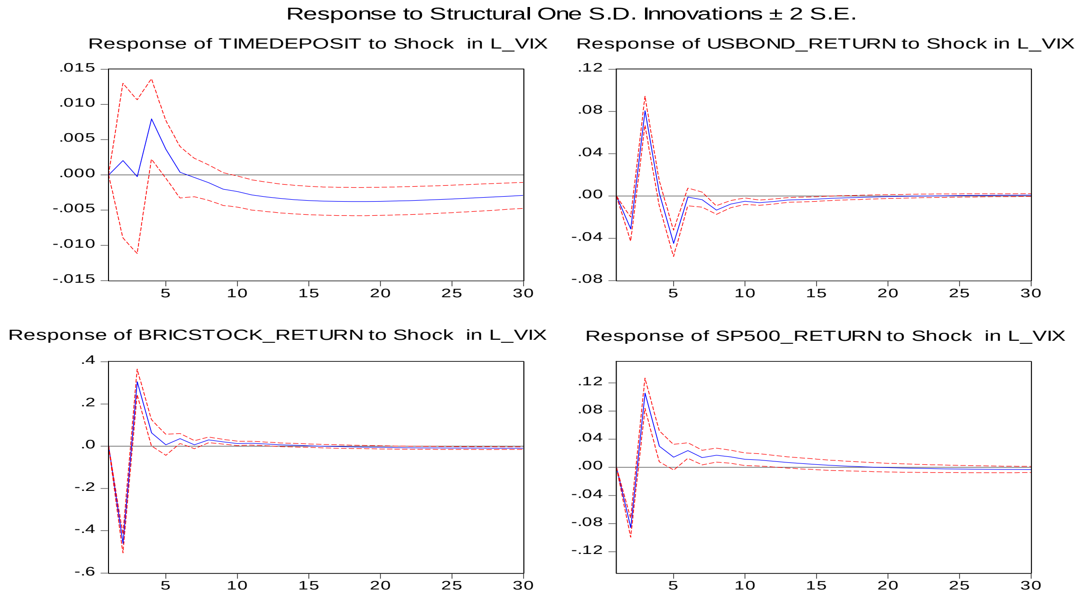


Figure 2.14A Structural-form IRFs for SVAR(6) to Impulse from(Def_Premium) [Timedeposit, USBond_Return, BRICStock_Return, SP500_Return, Def_Premium, Term_Premium]

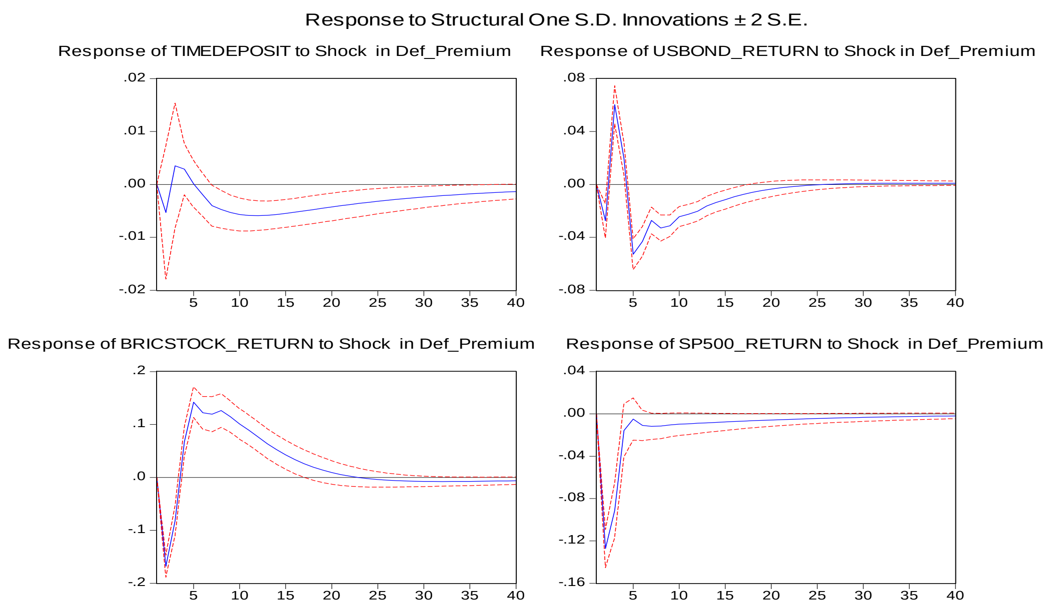


Figure 2.14B Structural-form IRFs for SVAR(6) to Impulse from(Term_Premium) [Timedeposit, USBond_Return, BRICStock_Return, SP500_Return, Def_Premium, Term_Premium]

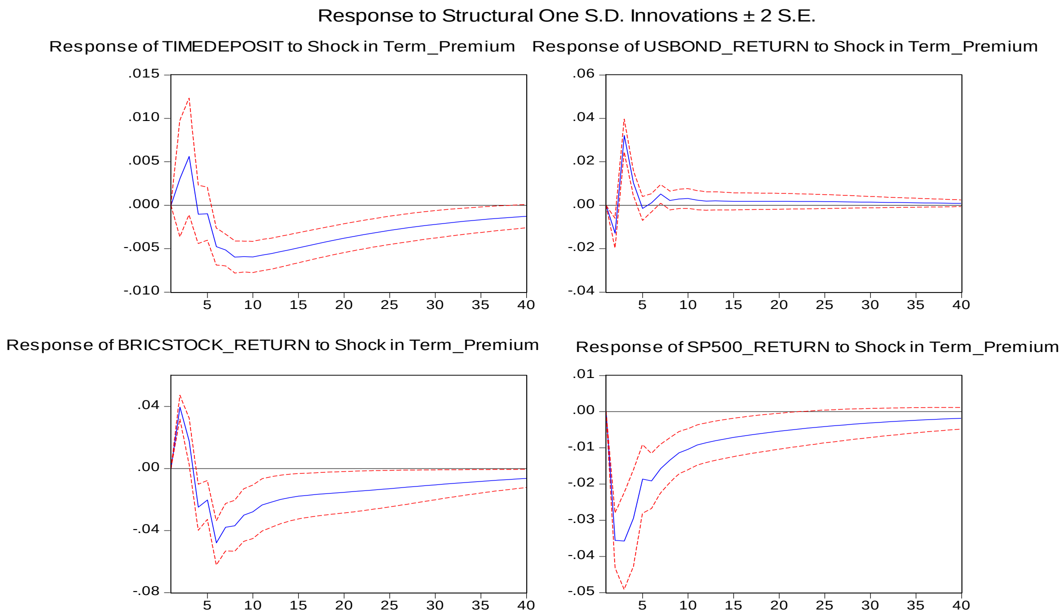


Figure 2.15A Structural-form IRFs for SVAR(6) to Impulse from(Def_Premium) [Timedeposit, USBond_Return, Gold_Return, SP500_Return, Def_Premium, L_VIX]

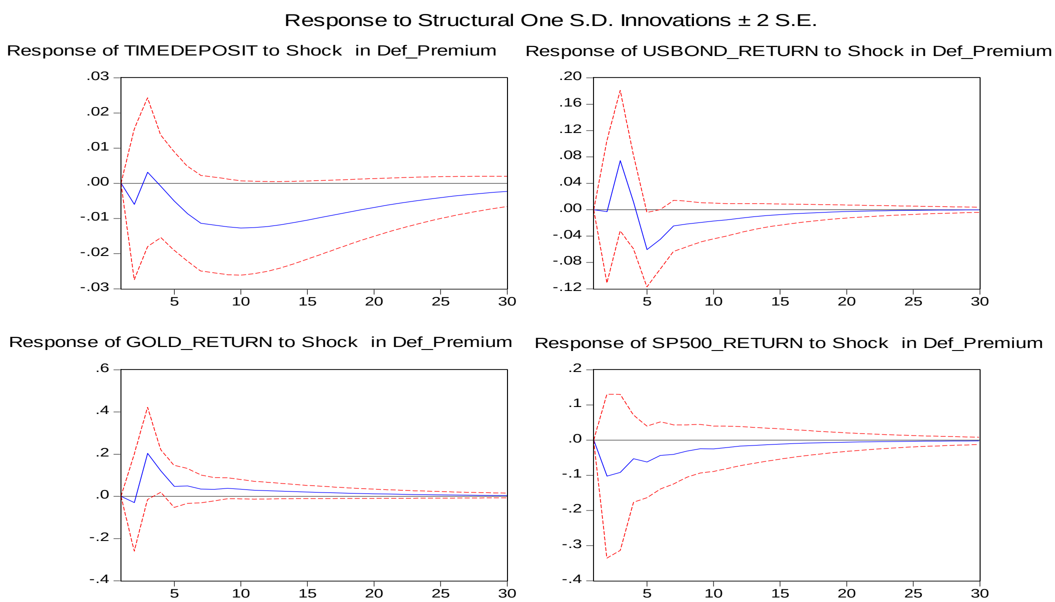


Figure 2.15B Structural-form IRFs for SVAR(6) to Impulse from(L_VIX) [Timedeposit, USBond_Return, Gold_Return, SP500_Return, Def_Premium, L_VIX]

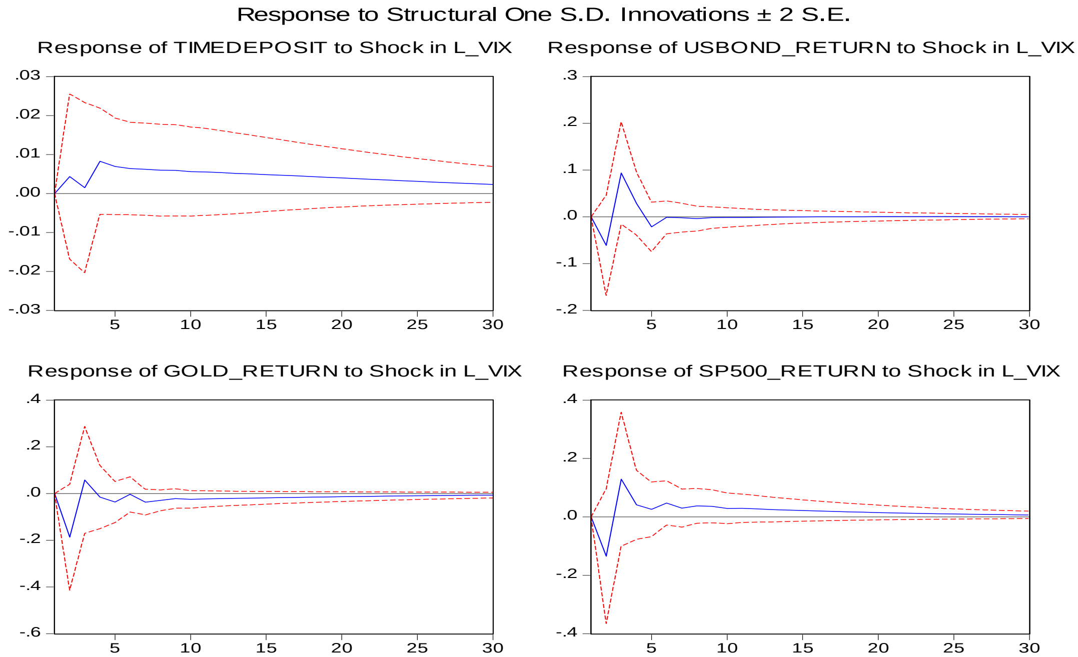


Figure 2.16A Structural-form IRFs for SVAR(6) to Impulse from(Term_Premium) [Timedeposit, USBond_Return, Gold_Return, SP500_Return, Term_Premium, L_VIX]

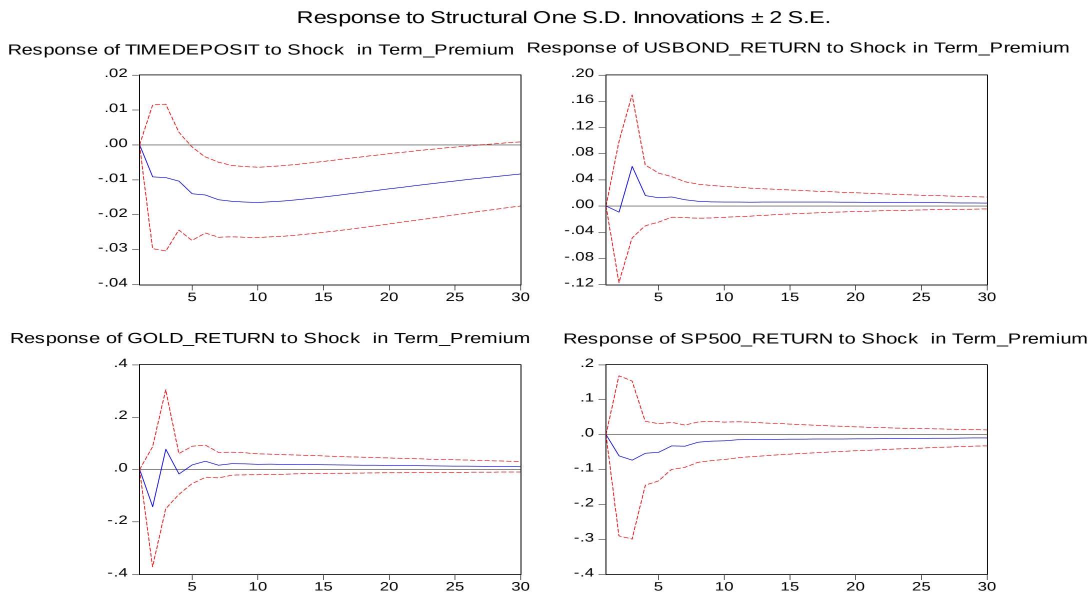


Figure 2.16B Structural-form IRFs for SVAR(6) to Impulse from(L_VIX) [Timedeposit, USBond_Return, Gold_Return, SP500_Return, Term_Premium, L_VIX]

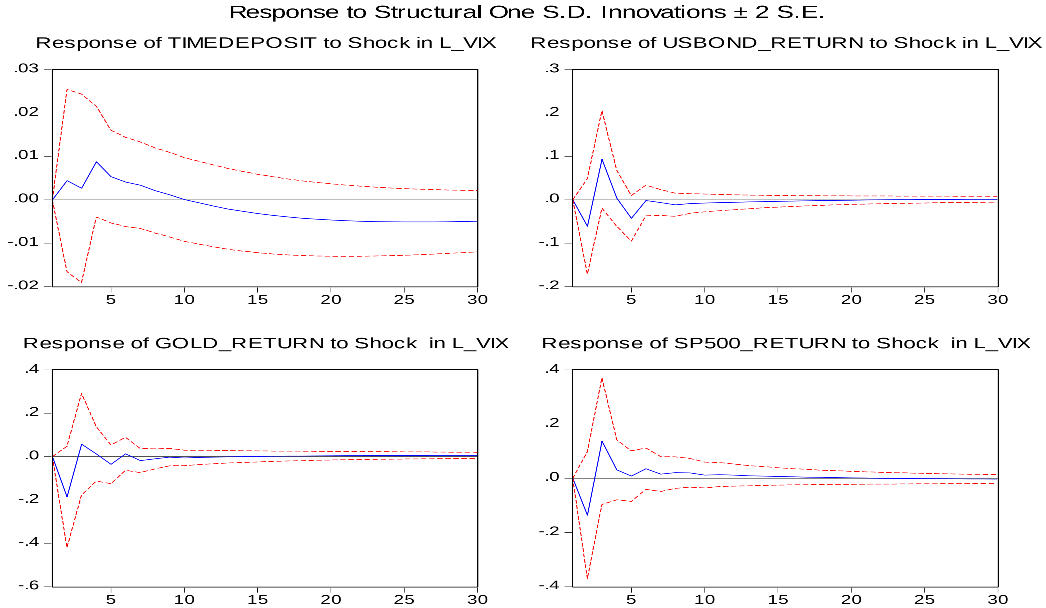


Figure 2.17A Structural-form IRFs for SVAR(6) to Impulse from(Def_Premium) [Timedeposit, USBond_Return, Gold_Return, SP500_Return, Def_Premium, Term_Premium]

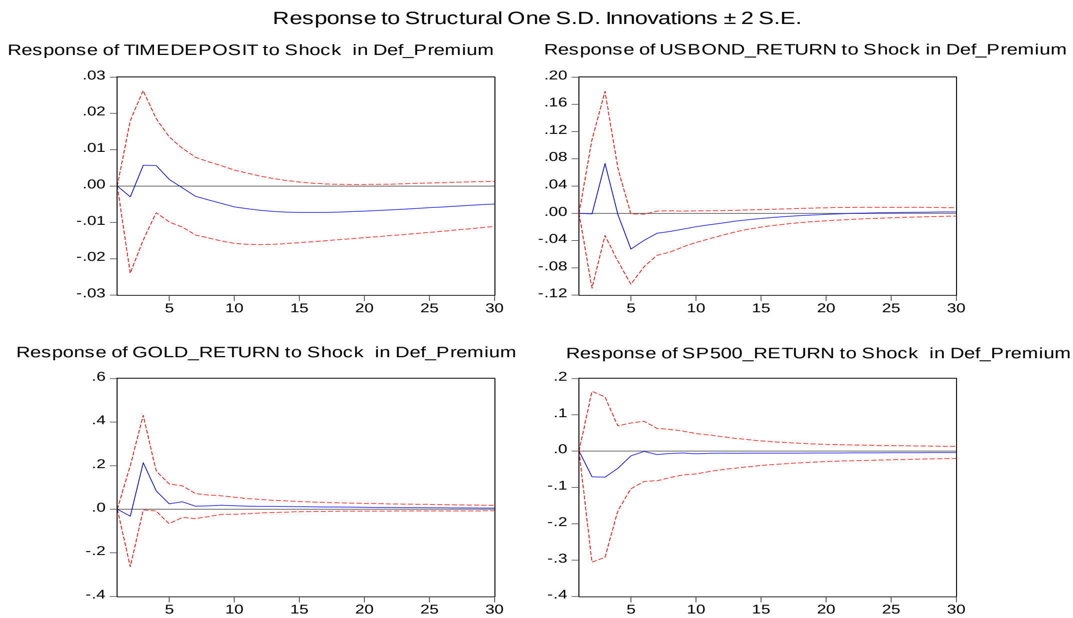


Figure 2.17B Structural-form IRFs for SVAR(6) to Impulse from(Term_Premium) [Timedeposit, USBond_Return, Gold_Return, SP500_Return, Def_Premium, Term_Premium]

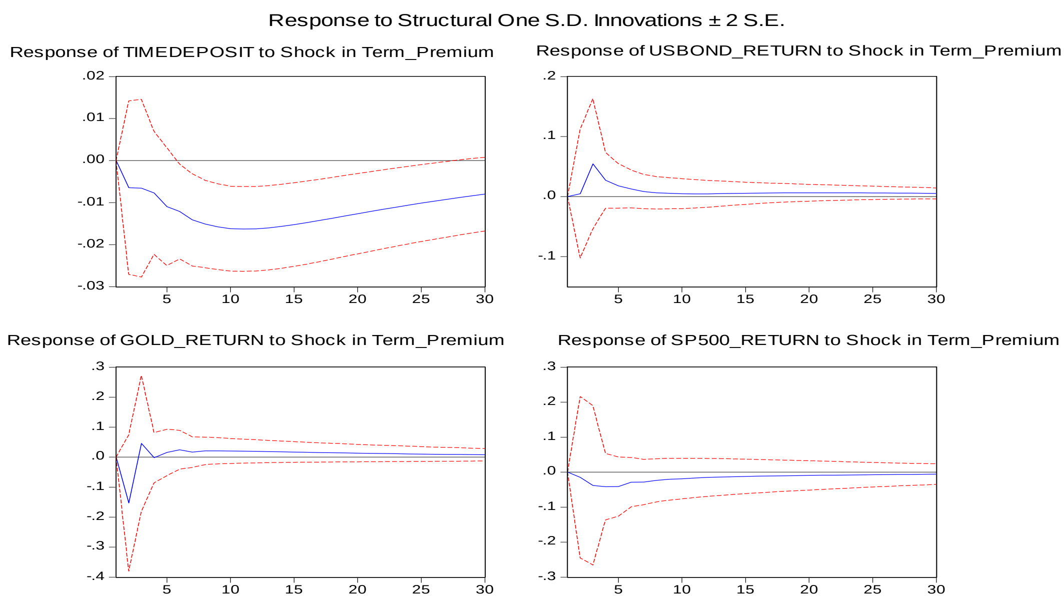


Figure 2.18A Structural-form IRFs for SVAR(6) to Impulse from(Def_Premium) [Timedeposit, USBond_Return, Oil_Return, SP500_Return, Def_Premium, L_VIX]

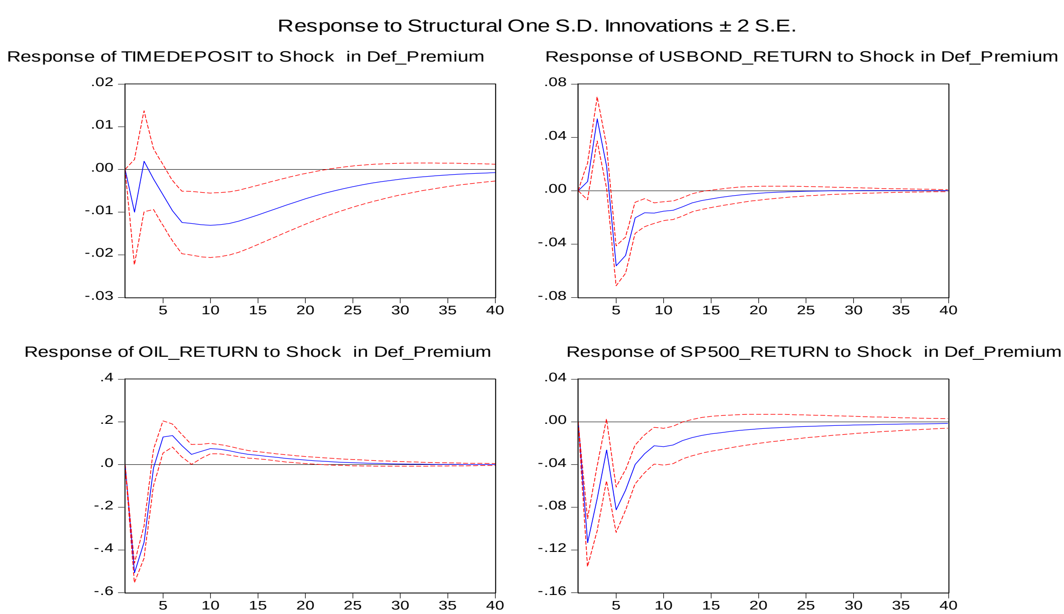


Figure 2.18B Structural-form IRFs for SVAR(6) to Impulse from(L_VIX) [Timedeposit, USBond_Return, Oil_Return, SP500_Return, Def_Premium, L_VIX]

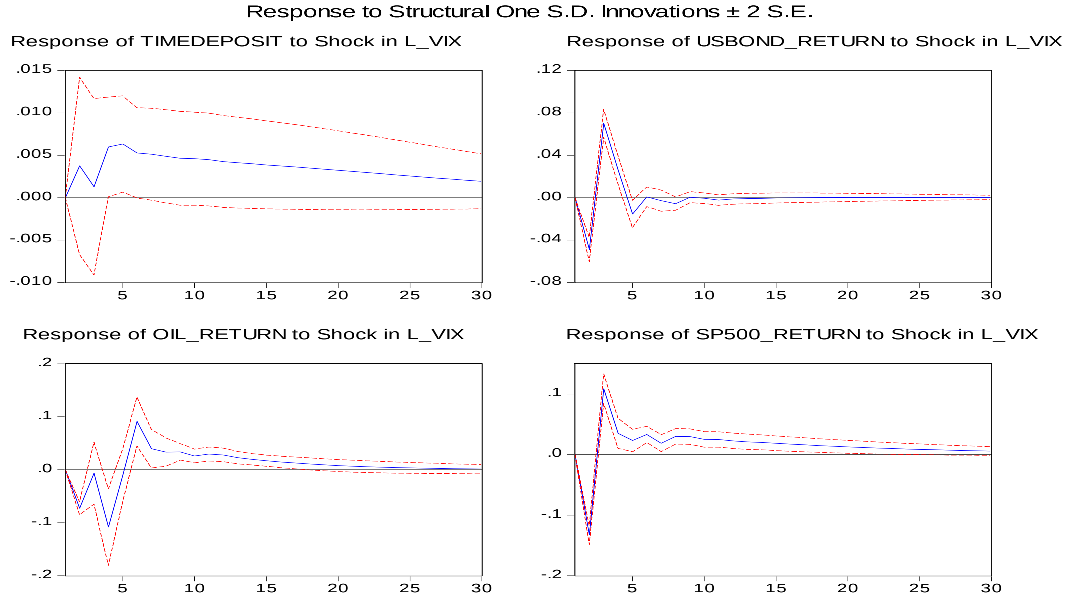


Figure 2.19A Structural-form IRFs for SVAR(6) to Impulse from(Term_Premium) [Timedeposit, USBond_Return, Oil_Return, SP500_Return, Term_Premium, L_VIX]

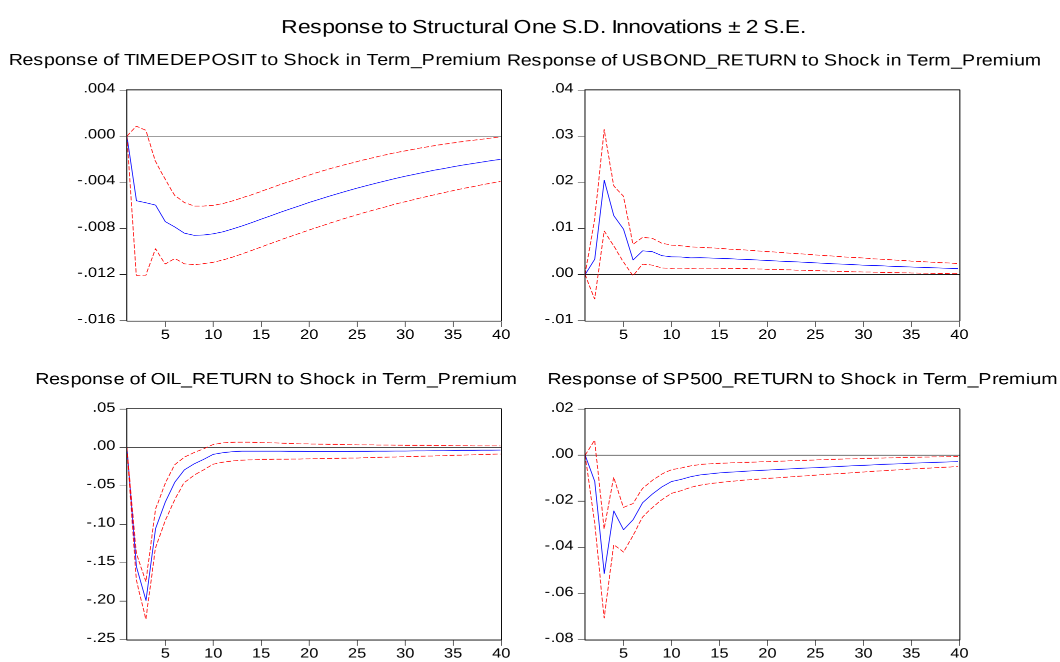


Figure 2.19B Structural-form IRFs for SVAR(6) to Impulse from(L_VIX)
[Timedeposit, USBond_Return, Oil_Return, SP500_Return, Term_Premium, L_VIX]

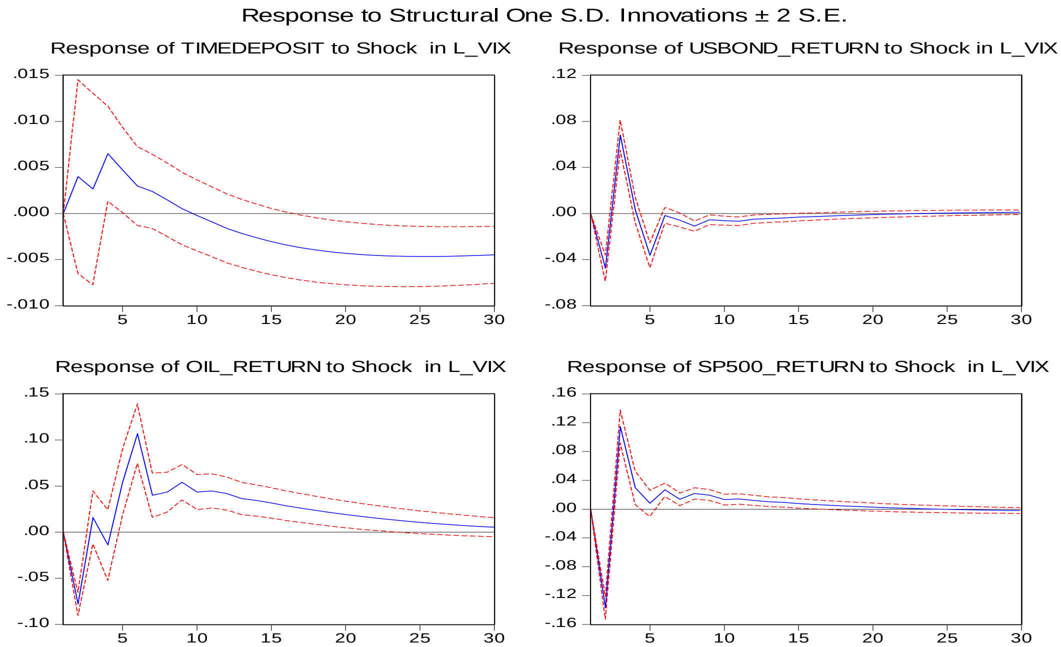


Figure 2.20A Structural-form IRFs for SVAR(6) to Impulse from(Def_Premium)
[Timedeposit, USBond_Return,Oil_Return, SP500_Return, Def_Premium,Term_Premium]

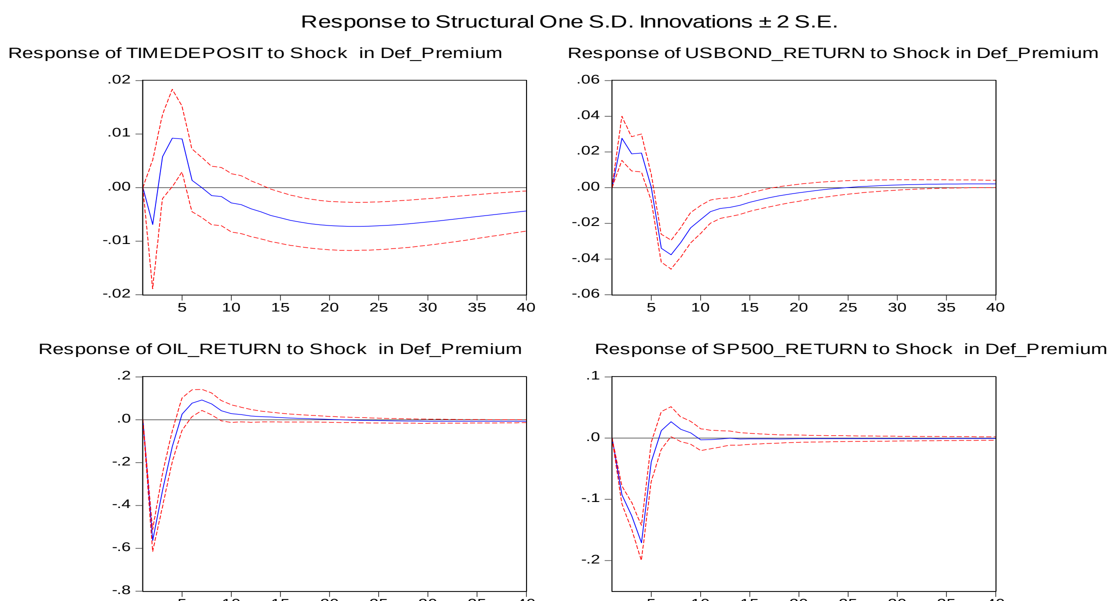


Figure 2.20B Structural-form IRFs for SVAR(6) to Impulse from(Term_Premium) [Timedeposit, USBond_Return,Oil_Return, SP500_Return, Def_Premium,Term_Premium]

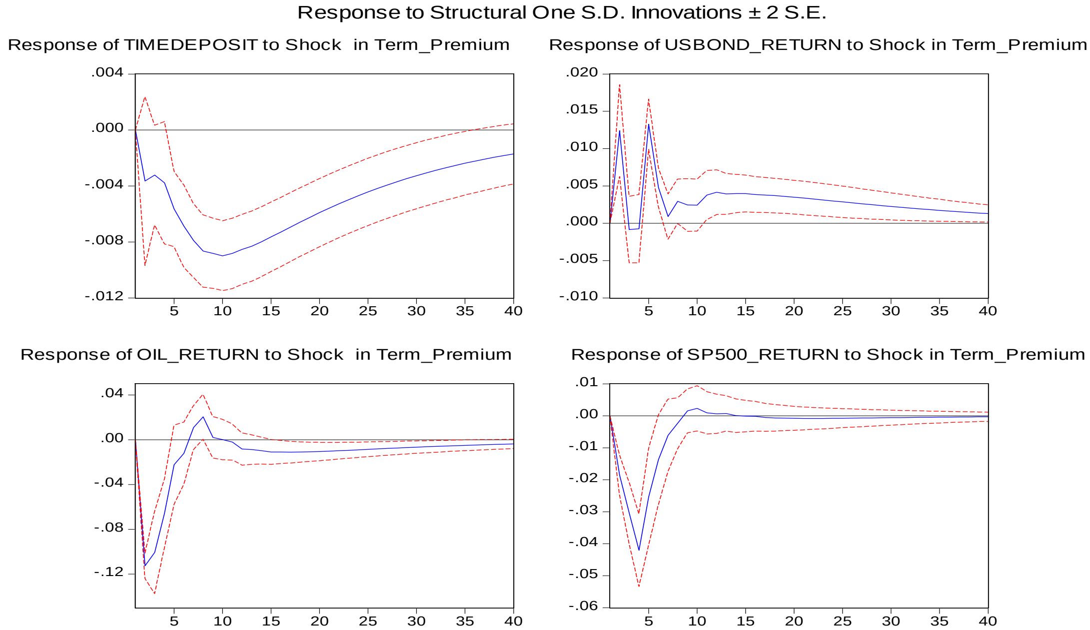


Figure 2.21 Structural-form IRFs for SVAR(6) to Impulse from(L_VIX) [Timedeposit, USBond_Return,Oil_Return, BRICStock_Return, SP500_Return, L_VIX]

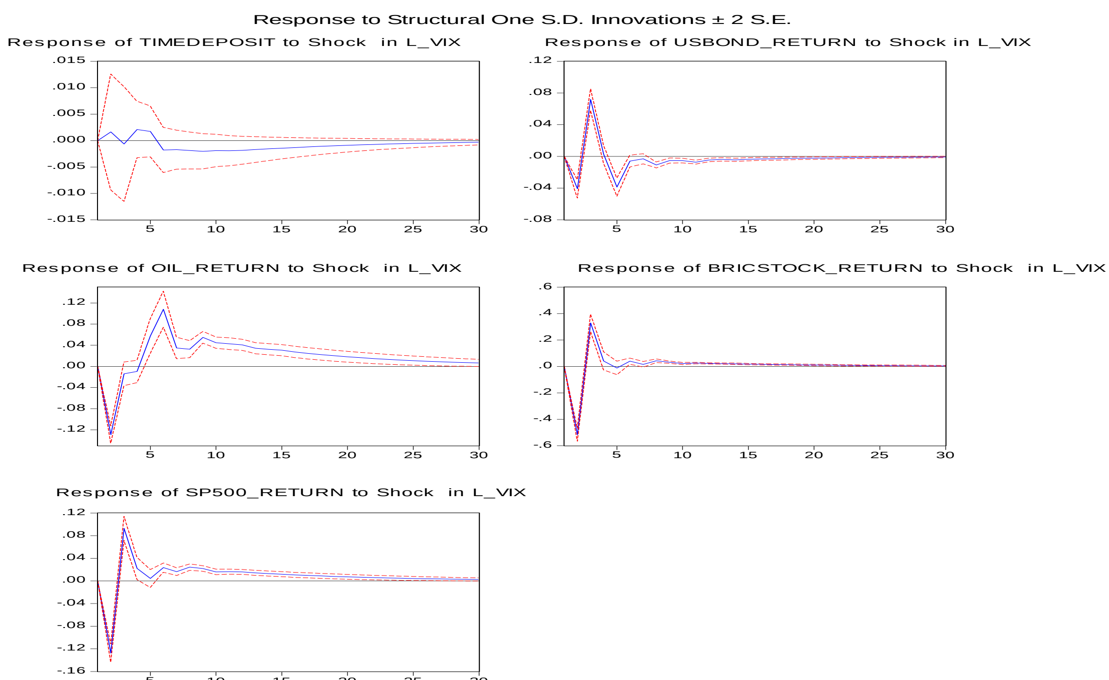


Figure 2.22 Structural-form IRFs for SVAR(6) to Impulse from(Def_Premium) [Timedeposit, USBond_Return,Oil_Return, BRICStock_Return, SP500_Return, Def_Premium]

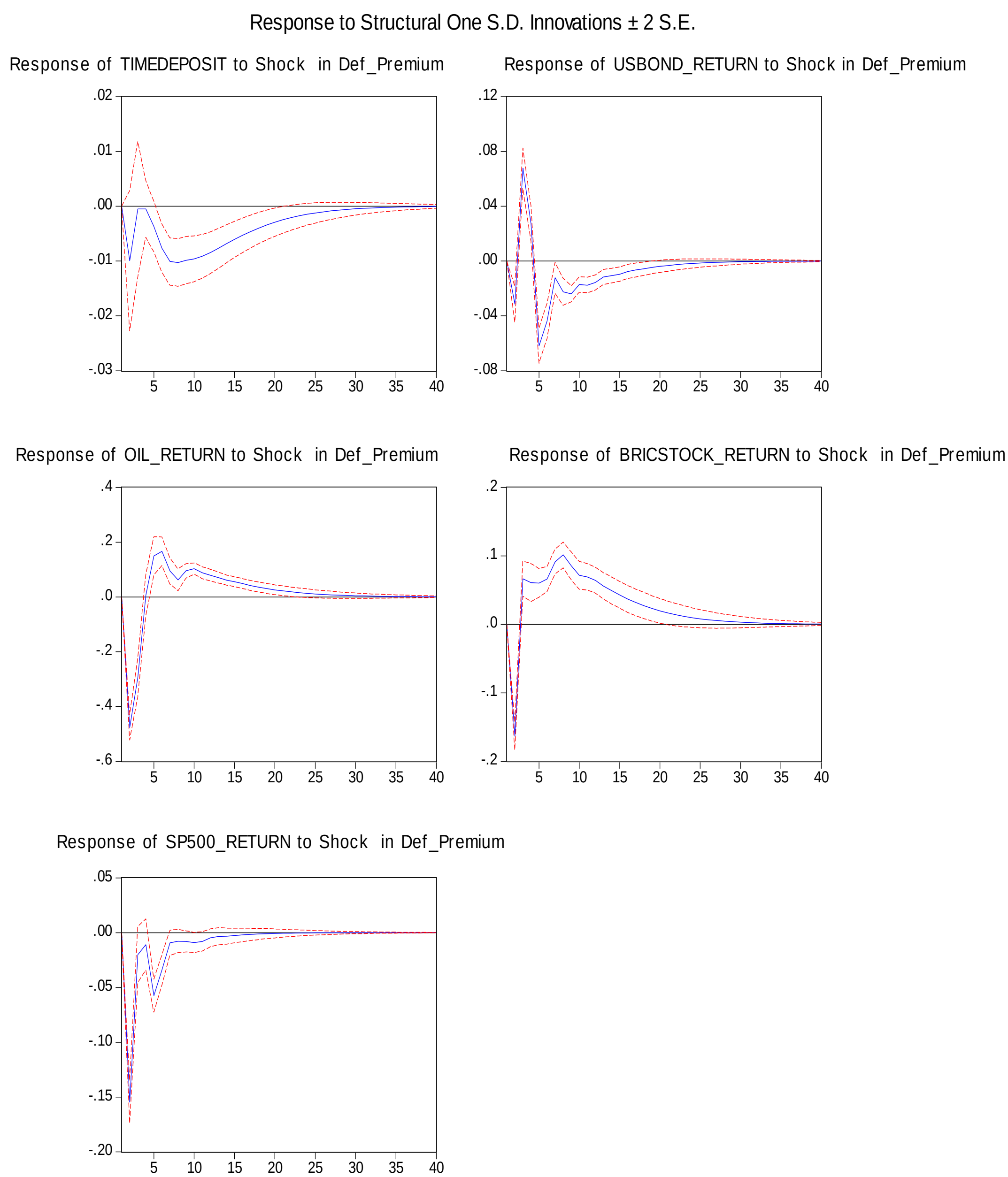


Figure 2.23 Structural-form IRFs for SVAR(6) to Impulse from(Def_Premium) [Timedeposit, USBond_Return,Oil_Return, BRICStock_Return, SP500_Return, Term_Premium]

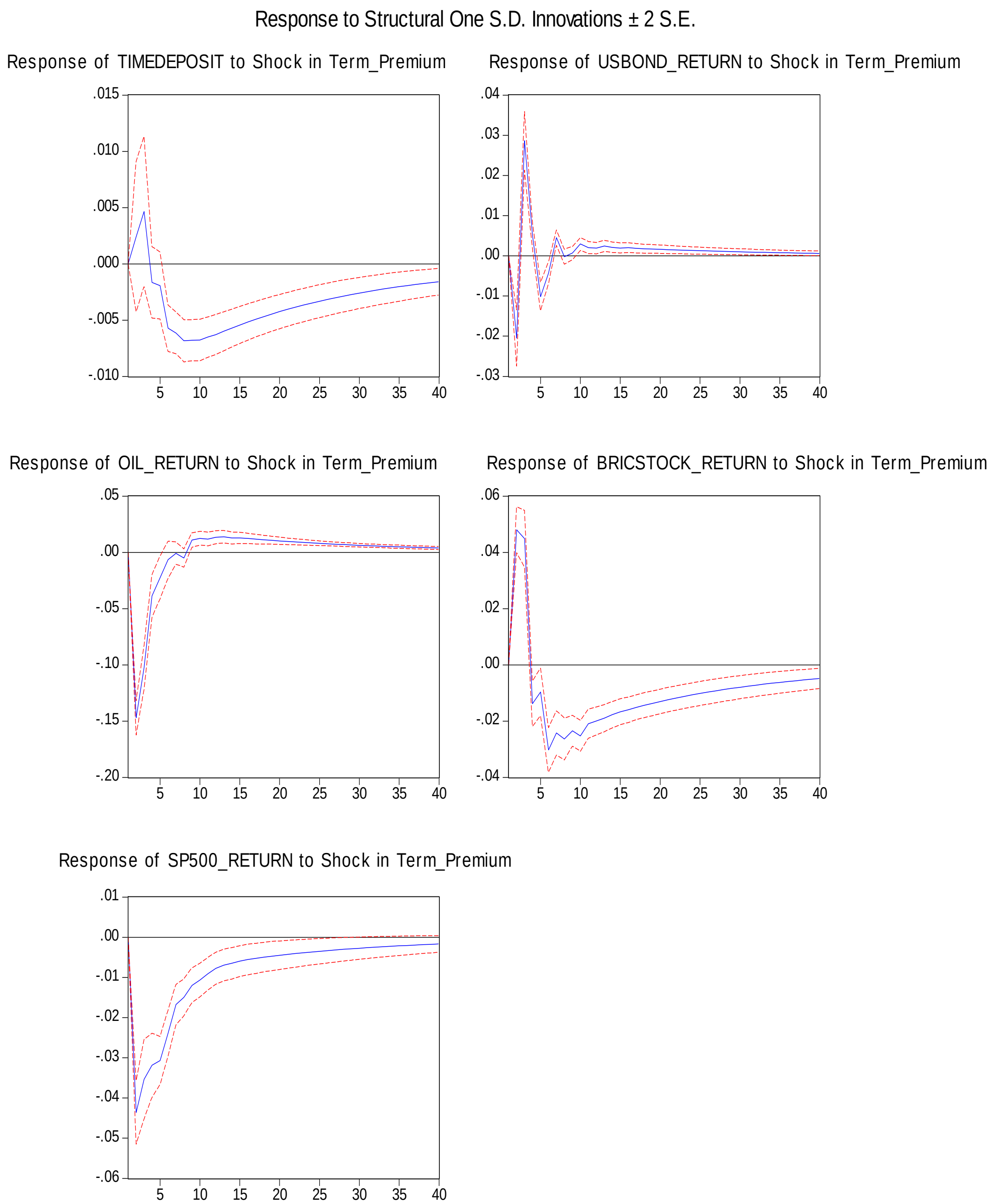


Figure 2.24 Structural-form IRFs for SVAR(6) to Impulse from(L_VIX) [Timedeposit, USBond_Return,Gold_Return, BRICStock_Return, SP500_Return, L_VIX]

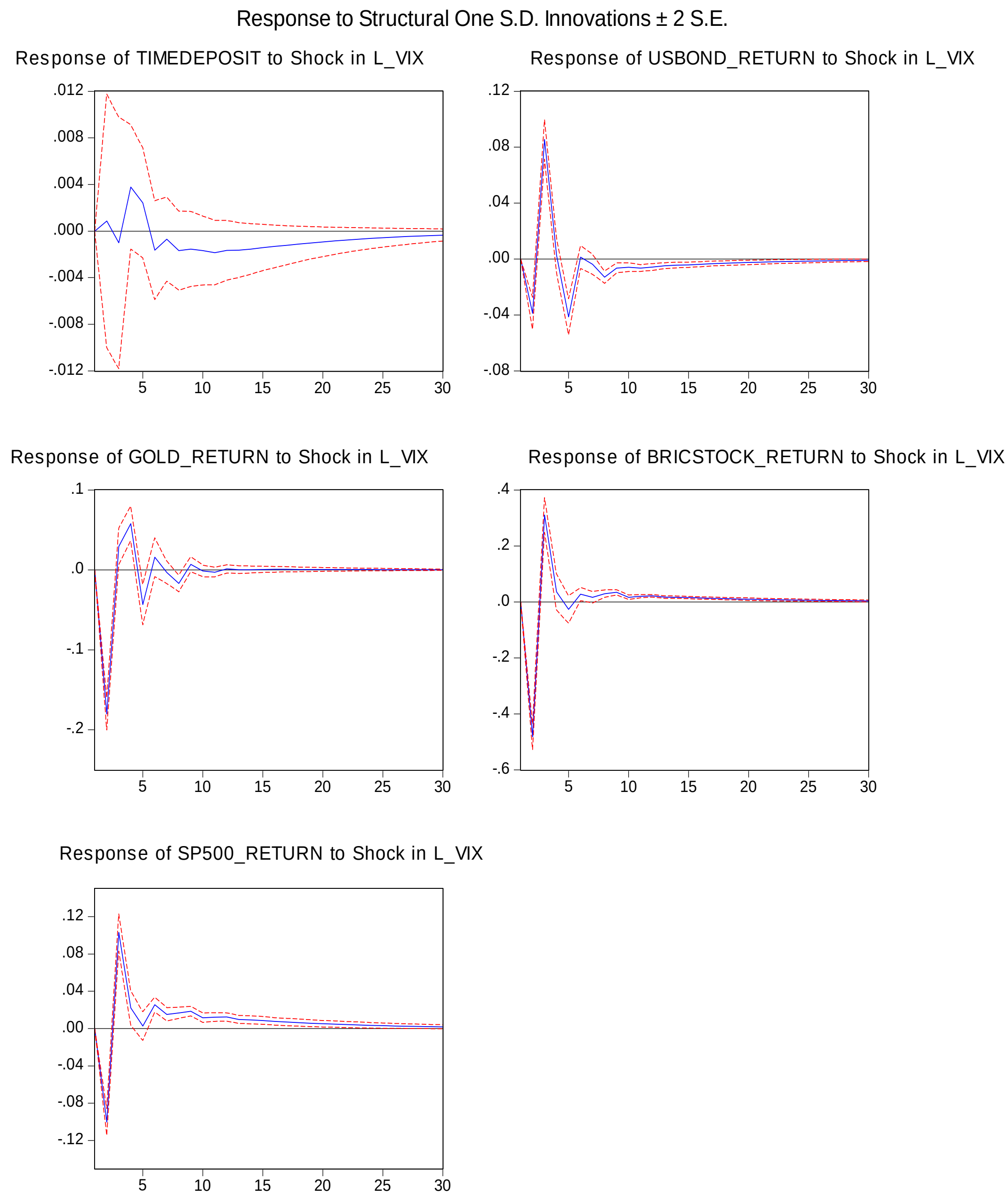


Figure 2.25 Structural-form IRFs for SVAR(6) to Impulse from(Def_Premium) [Timedeposit, USBond_Return,Gold_Return, BRICStock_Return, SP500_Return, Def_Premium]

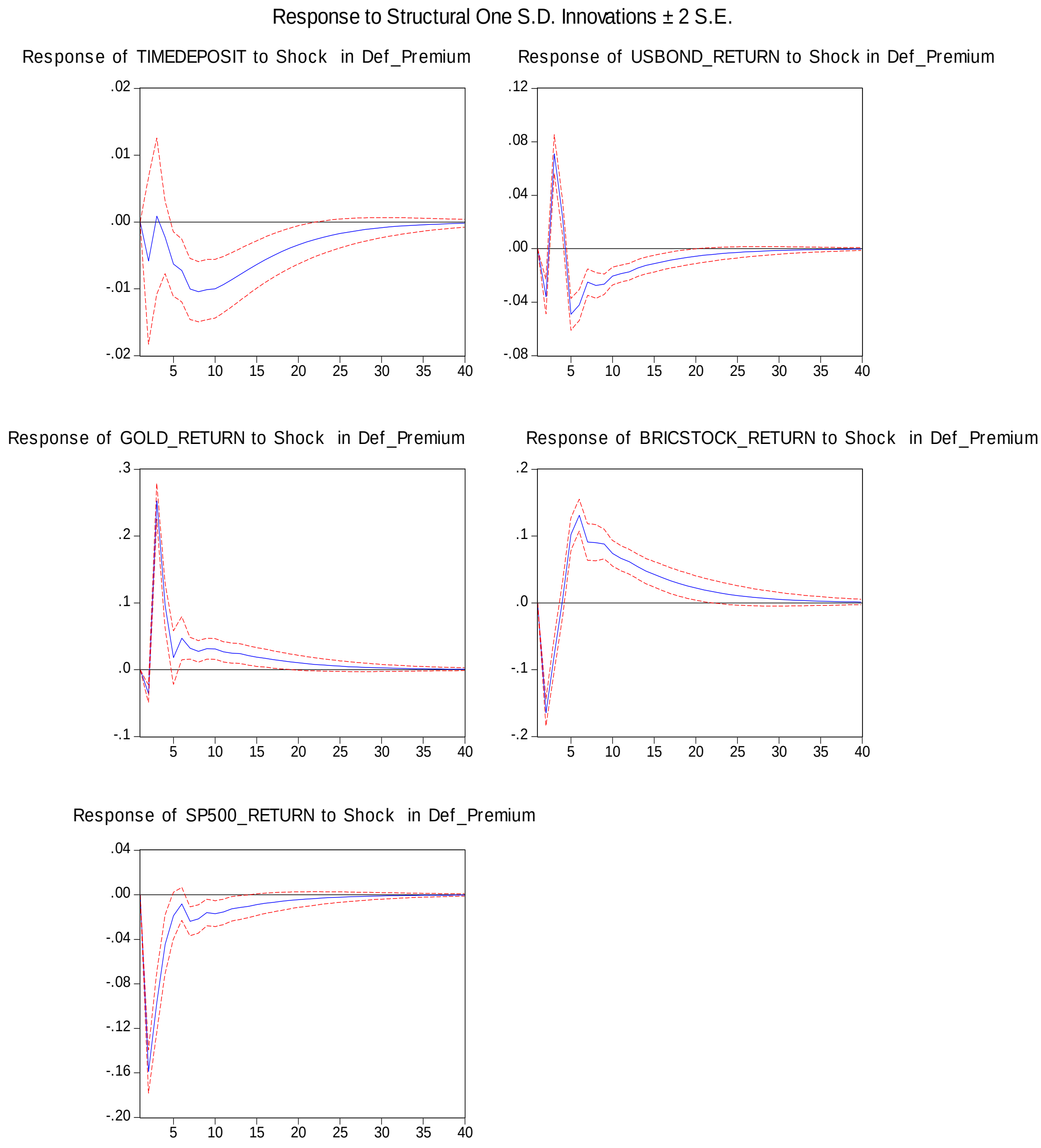
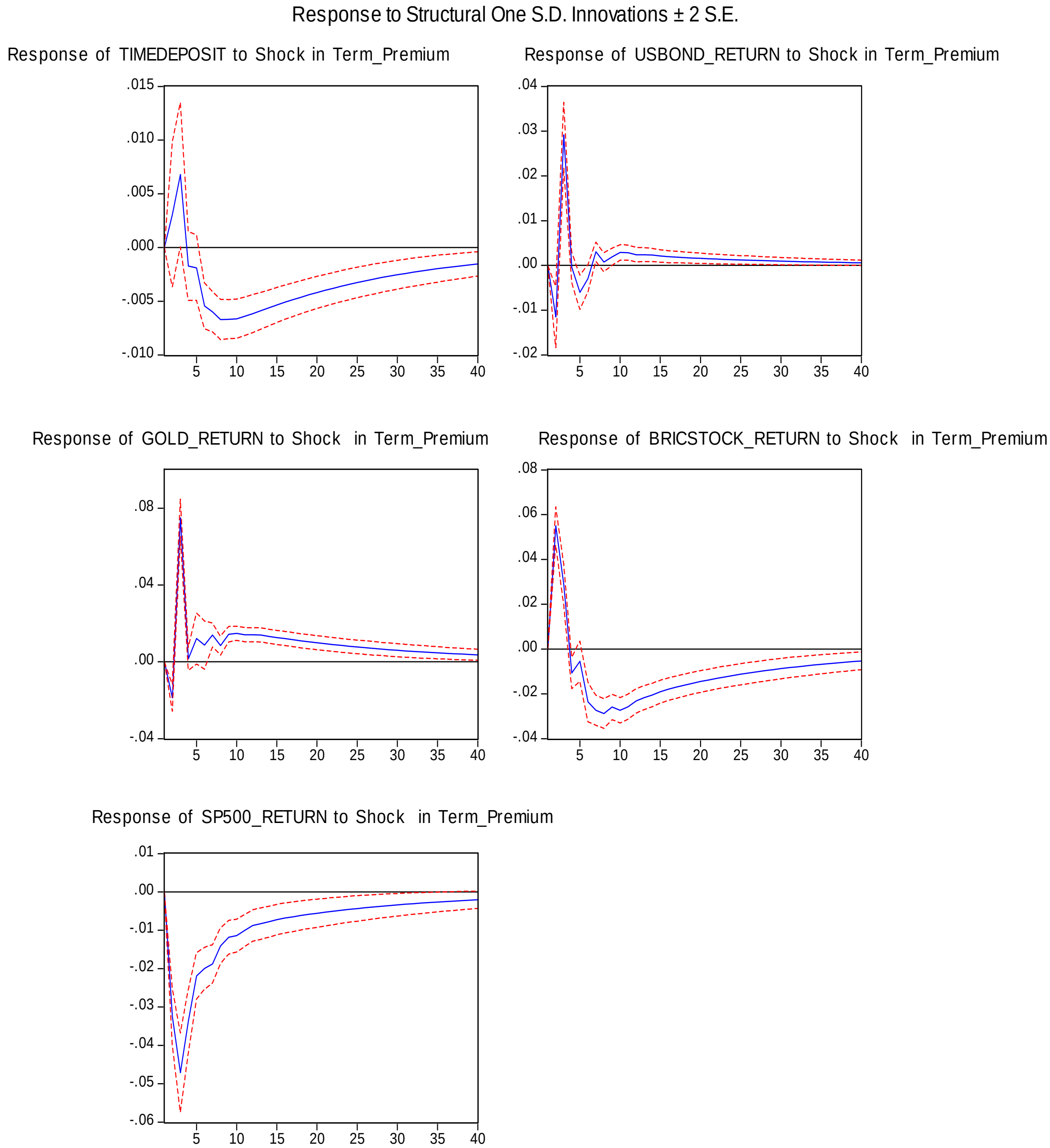


Figure 2.26 Structural-form IRFs for SVAR(6) to Impulse from(Term_Premium) [Timedeposit, USBond_Return,Gold_Return, BRICStock_Return, SP500_Return, Def_Premium]



References:

Barksy, R. (1989). 'Why don't the prices of stocks and bonds move together?'. *American Economic Review, 79, 1132-1145* .

Baur, D. G., & Lucey, B. M. (2010). 'Is Gold a Hedge or a Safe Heaven? An analysis of Stocks, Bonds and Gold'. *The Financial Review, 45, 217-229* .

Baur, D., & McDermott, T. (2010). 'Is Gold a Safe haven? International Evidence'. *Journal of Banking and Finance, 34, 1886-1898* .

Bekaert, G., Baele, L., & Inghelbrecht, K. (2007). "The Determinants of Stock and Bond comovements". *Review of Financial Studies*, 2374-2428.

Bekaert, G., Engstrom, E., & Granadier, S. (2010). "Stock and Bond Returns with Moody Investors". *Journal of Empirical Finance, Vol. 17*, 867-894.

Bekaert, G., Hoerova, M., & L., D. M. (2010). "Risk, Uncertainty and Monetary Policy". *NBER Working Paper No. 16397*.

Bernanke, B. (1986). "Alternative explanation of the money-income correlation". *In: Brunner, K., Metzler, A. H. (Eds), Real Exchange Rates, and Actual Policies. Carnegie-Rochester Series on Public Policy 25. North-Holland, Amsterdam*, 49-99.

Bernanke, B. S. (September 2, 2010). "Causes of the Recent Financial and Economic Crisis". *Financial Crisis Inquiry Commission, Washington, D.C.*

Bernanke, B. S., & Gertler, M. (2001). "Should Central Banks Respond to Movements in Asset Prices?". *The American Economic Review, Vol. 91, No. 2*, 253-257.

Bernanke, B., Gertler, M., & Gilchrist, S. (1999). "The Financial Accelerator in a Quantitative Business Cycle Framework". *Handbook of Macroeconomics, ed. by J.B. Taylor, and M. Woodford. Elsevier*.

Bjornland, H., & Jacobsen, D. (Forthcoming 2012). "House Prices and Stock Prices: Different Roles in the U.S Monetary Transmission Mechanism". *Scandinavian Journal of Economics*.

Campbell, J. Y., & Ammer, a. J. (1993). "What moves the stock and bond markets? A variance decomposition for Long-term Asset returns.". *Journal of Finance 48(1)*, 3-37.

Ceccehetti, S. G., Lipsky, J., & Wadhwani, S. (2000). "Asset Prices and Central Bank Policy". *Geneva Report on the World Economy 2, CEPR and ICMB*.

Chauvet, M., & Huang, M. (2010). "The Seeds of the 2007-2009 Crisis: the Housing Market and the Business Cycle". *Manuscript, University of California, Riverside*.

Chen, N. F., Roll, R., & Ross, S. (1986). "Economic forces and the stock market". *Journal of Business, 59,* 383-403.

Christiano, L. J., Eichenbaum, M., & and Evans, C. L. (1999). "Monetary policy shocks: What have we learned and to what end?". *Handbook of Macroeconomics, Volume 1A, ed. by J. B. Taylor, and M. Woodford, Elsevier Science*, 65-148.

Christiano, L. J., Eichenbaum, M., & and Evans, C. L. (2005). "Nominal ridities and the dynamic effects of a shock to monetary policy". *Journal of Political Economy*, 1-45.

Connolly, R., Stivers, C., & Sun, L. (2005). "Stock Market Uncertainty and Stock-Bond Return". *Journal of Financial and Quantitative Analysis, 40*, 161-194.

Cotter, J., & Stevenson, S. (2006). "Multivariate Modeling of Daily REIT Volatility". *Journal of Real Estate Finance and Economics*, 305-325.

Duca, J. V., Muellbauer, J., & Murphy, A. (2010). "Housing Markets and the Financial Crisis of 2007-2009: Lessons for the future". *Journal of Financial Stability* , 203-217.

Enders, W. (2003). *"Applied Econometric Time Series" 2nd Edition.* New Jersy: John Wiley & Sons.

Engle, R., Gghysels, E., & Sohn, B. (2008). "On the economic sources of stock market volatility". *Working Paper, New York University*.

Errunza, V. (1977). 'Gains from Portfolio Diversification into less developed countries' securities'. *Journal of Business and Economic Studies, 52, 83-99* .

Fama, E. F., & French, K. (1989). "Business conditions and expected returns on stocks and bonds". *Journal of Financial Economics, 25*, 23-49.

Fama, E., & French, K. (1993). "Common Risk Factors in the Returns on Stocks and Bonds". *Journal of Financial Economics, 33,* 3-56.

Flemeing, J., Kirby, C., & Ostdiek, B. (1998). 'Information and volatility linkages in the stock, bond and money markets'. *Journal of Financial Economics, 49, 111-137* .

Forbes, K., & Rigobon, R. (2002). 'No Contagion, Only Interdependence: Measuring stock market comovements'. *Journal of Finance, 57, 2223-61* .

Giuliodori, M. (2005). "The role of house prices in the the monetary transmission mechanism across european courntries". *Scottish Journal of Political Economy, 52(4)*, 519-543.

Glascock, J. L., Lu, C., & So, R. W. (2000). "Further Evidence on the integration of REIT, Bond and Stock Returns". *Journal of Real Estate Finance and Economics, 20*, 177-194.

Goodhart, C., & and Hofmann, B. (2001). "Asset prices, financial conditions, and the transmission of monetary policy". *Proceedings from Federal Reserve Bank of San Fransisco*.

Guidolin, M., & Timmerman, A. (2007). "Asset Allocation under Multivariate Regime Switching". *Journal of Economic Dynamic & Control*, 3503-3544.

Guidolin, M., & Timmermann, A. (2006). "An Econometric Model of Nonlinear Dynamics in the Joint Distribution of Stock and Bond Returns". *Journal of Applied Econometrics*, 1-22.

Gulko, L. (2002). "Decoupling". *Journal of Portfolio Management, 28*, 59-67.

Huang, J., & Zhong, Z. (2011). "Time Variation in Diversification Benefits of Commodity, REITs, and TIPs". *Journal of Real Estate Finance and Economics*.

Ibbotson, R., & Chen, P. (2011). "Will Bonds Outperfom Stocks over the Long Run? Not Likely". *Research Foundation Publications, Vol. 11, No. 4*.

Ilmanen, A. (2003). "Stock-Bond Correlations". *Journal of Fixed Income,* 55-66.

Khosla, R., & Gayithri, K. (2010). 'The New Economic and Climatic Context and Changing Migration Pattern in India'. *Submitted at 10th Round Regional Research Competiton of South Asia Network of Economic Research Institutes*.

Levy, H., & Sarnat, M. (1970). 'International Diversification of Investment Portfolios'. *American Economic Review, 60, 668-75* .

Li, L. (2002). "Macroeconomic Factors and the Correlation of Stock and Bond Returns". *Yale ICF Working Paper*.

Ling, D., & and Naranjo, A. (1999). "The integration of commercial real estate markets and stock markets". *Real Estate Economics, 27*, 483-515.

Liu, C., Hartzell, D., Greig, W., & Grissom, T. (1990). "The Integration of the Real Estate Market and the Stock Market: Some Preliminary Evidence. *Journal of Real Estate Finance and Economics, 3*, 261-282.

Rubio-Ramirez, J. F., Waggoner, D. F., & and Zha, T. (2010). "Structural vector autoregressions: Theory of identification and algorithms for inference". *Review of Economic Studies*, *77*, 665-696.

Scheitzer, M. E., & and Venkatu, G. (2009). "Adjustable-rate mortgages and the libor surprise". *Economic commentary, Federal Reserve of Cleveland*.

Shiller, R. (2008). *"The subprime solution".* New Jersy: Princeton University Press.

Shiller, R., & Beltratti, A. (1992). "Stock Prices and bond yields". *Journal of Monetary Economics, 30*, 25-36.

Sims, C. A. (1980). "Macroeconomics and Reality". *Econometrica*, 1-48.

Sims, C. A. (1986). "Are forecasting models usable for policy analysis?". *Federal Reserve Bank of Minneapolis Quarterly Review 10*, 2-16.

Svensson, L. (1997). "Inflation forecast targeting: Implementing and monitoring Inflation Targets". *European Economic Review, 41*, 1111-1146.

Yang, J., & Zhou, Y. (2012). Asymmetric correlation and volatility dynamics among stock, bond and securitized real estate markets. *Journal of Real Estate Finance and Economics, Vol 45, Number 2*, 491-521.

Zacharias, A., & Vakulabharanam, V. (2009). Caste and Wealth Inequality in India. *Economics Working Paper, The Levy Economics Institute*.